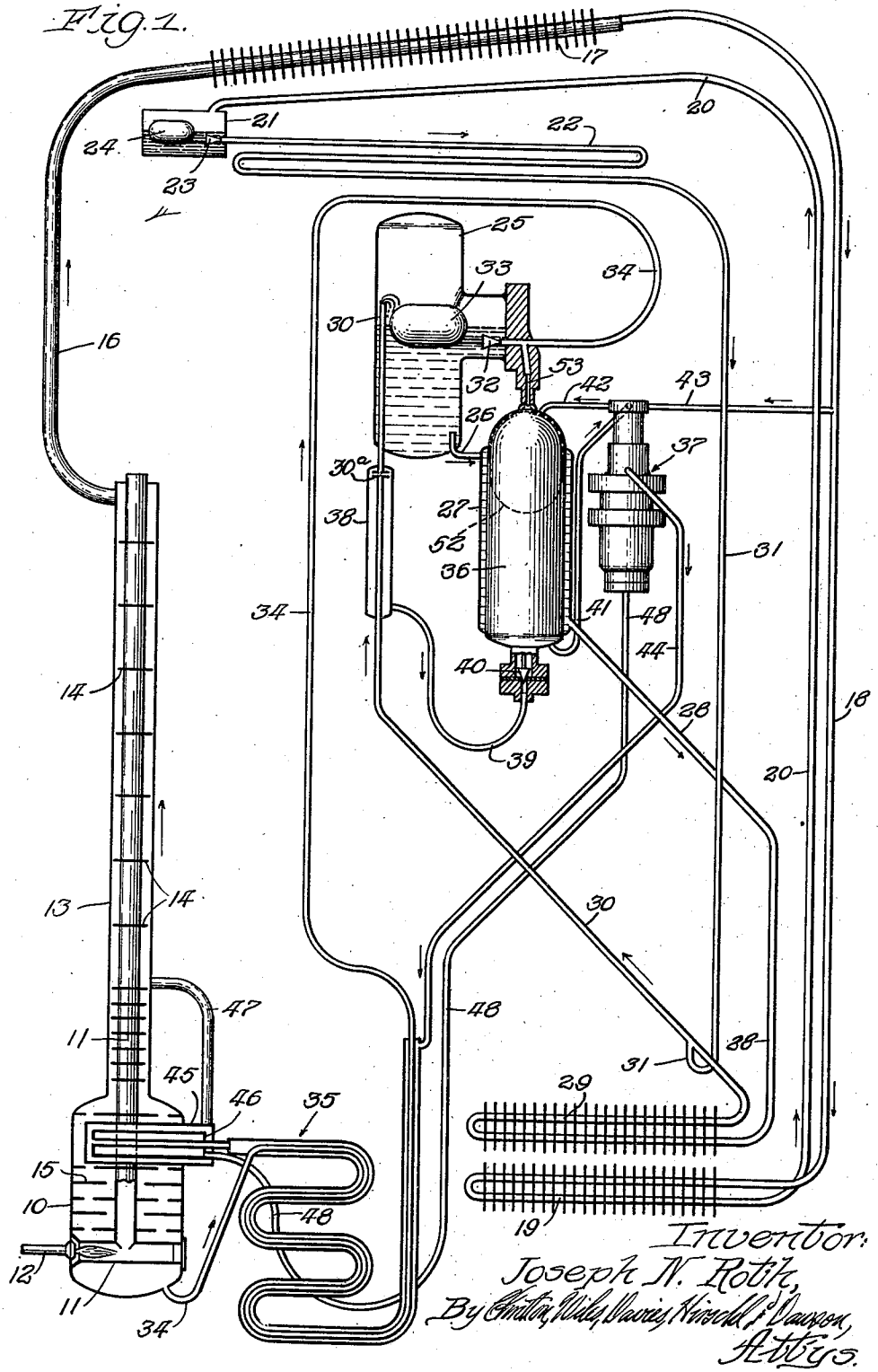
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CONTINUOUS ABSORPTION REFRIGERATOR

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Fig. 1.




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Fig. 2.

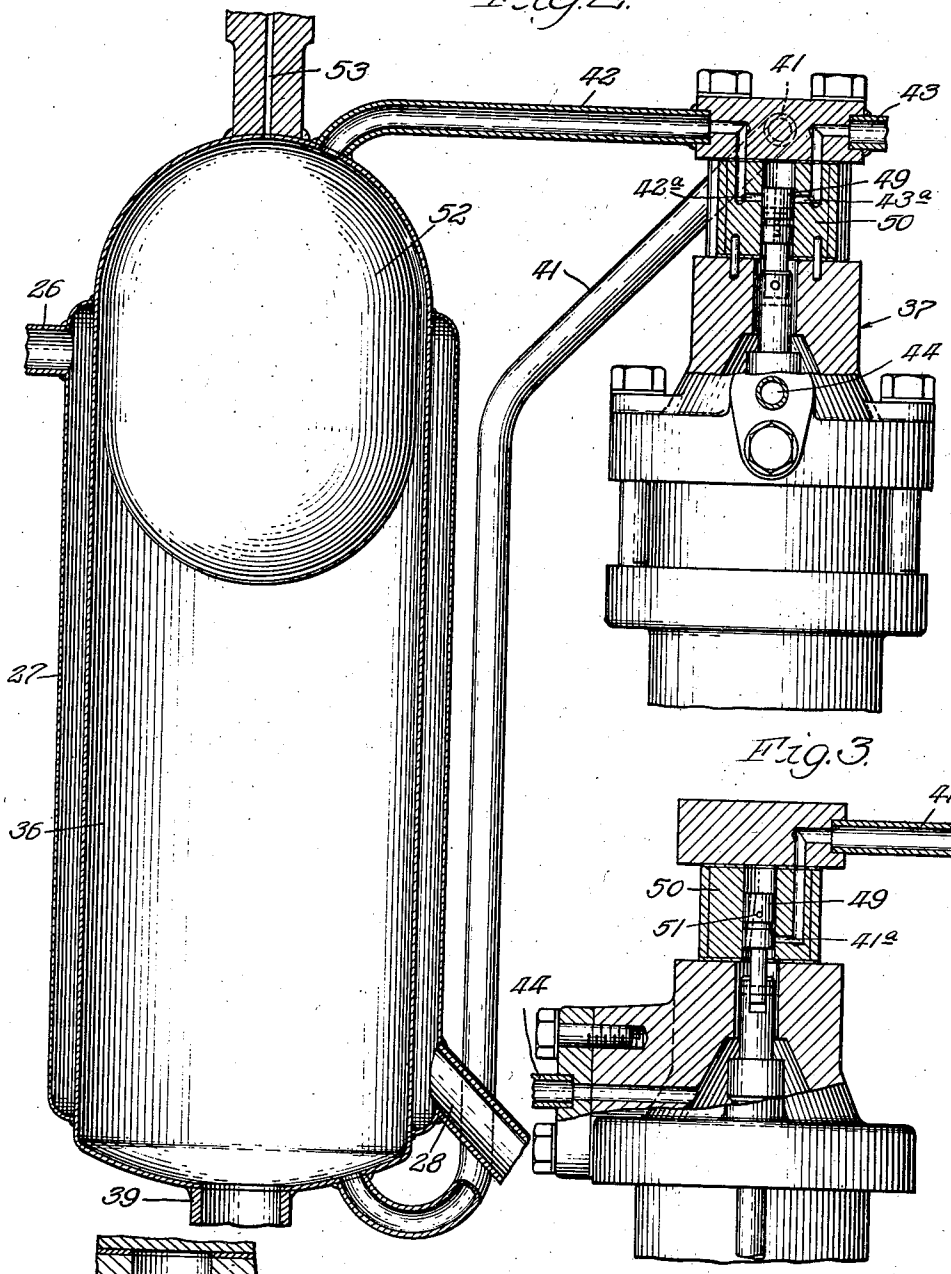
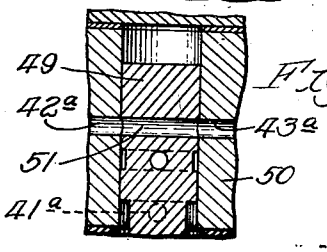



Fig. 3.




Fig. 4.




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Patented Jan. 25, 1944 2,339,814

# UNITED STATES PATENT OFFICE

2,339,814

## CONTINUOUS ABSORPTION REFRIGERATOR

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Application March 27, 1940, Serial No. 326,292

5 Claims. (Cl. 62—5)

This invention relates to a continuous absorption refrigerator, and more particularly to improved means for effecting movement of liquor from the absorber to the still in a refrigeration system adapted to maintain the still at a high pressure and the absorber at a low pressure.

One feature of this invention is that it provides improved transfer means for returning rich liquor from the absorber to the still; another feature of this invention is that it provides more quiet and more positive operation in a system of the type wherein the transfer chamber is at times at high still pressure and at times at a pressure as low or lower than the low pressure in the absorber; a further feature of this invention is that it provides positive movement of fluid when desired with a simplified valve arrangement; yet another feature of this invention is that it provides means for dissipating heat which may be generated in the transfer chamber; and still another feature of this invention is that it provides a considerably simplified structure accomplishing all of the functions and advantages of refrigeration systems disclosed and claimed in my earlier applications. Other features and advantages of this invention will be apparent from the following specification and the drawings, in which:

Figure 1 is a schematic or diagrammatic showing of a continuous absorption refrigerator embodying my inventions; Figure 2 is a detail view, principally in vertical section, of the transfer chamber and valve mechanism; Figure 3 is a view, principally in vertical section, of the valve mechanism shown in Figure 2, and at right angles to a showing in such view; and Figure 4 is a small fragmentary sectional view, similar to a portion of the valve mechanism shown in Figure 2, but showing the valve plunger up in the open position.

In the particular embodiment of my invention described herewith, the system in general comprises a still adapted to have a mixture of refrigerant and absorbent, as ammonia and water, boiled therein by the application of heat; a condenser connected by a vapor conduit to the still to liquefy the refrigerant vapor delivered thereby; an evaporator or cooling unit in which the liquefied refrigerant is permitted to vaporize, the evaporator having restricted connection with the condenser; an absorber in which the gas from the evaporator is reabsorbed in liquid; and means for effecting flow of weak liquor from the bottom of the still to the absorber and flow of rich liquor from the bottom of the absorber to the still. This latter means includes a transfer chamber intermediate the absorber and the still and various valves so arranged as to periodically effect flow of liquid from the absorber to the transfer chamber, and from the transfer chamber to the still.

Referring more particularly to a specific system schematically or diagrammatically illustrated in Figure 1, the still 10 is adapted to contain a mixture of water and ammonia. A flue 11 is provided within the still and heat delivered thereto by the combustion of gas or some other fuel delivered by the burner 12. An analyzer tower 13, in the form of a long cylindrical tubing enclosing the flue 11, rises from the upper part of the still, which is a vertical cylindrical vessel. Both the analyzer tower and the still are provided with baffle plates, as 14 and 15, these plates serving to stratify the liquid in the still and to improve the efficiency of the apparatus.

Rich ammonia vapors boiled off the liquor in the still pass upwardly through the analyzer tower 13 and then through the pipe connection 16 to the rectifier 17, a finned inclined tube at the top of the system. From there the ammonia vapors, any entrained water vapor having been removed by the rectifier, pass down through the connection 18 to a condenser 19 at the lower end of the apparatus. This condenser comprises one or more lops of piping, finned to increase the heat radiation. The ammonia vapor is here condensed into liquid ammonia, and then elevated by the vapor pressure behind it through the connection 20 to the receiver 21.

The amount of ammonia boiled off and liquefied is a function of the concentration of the liquor in the still and of the amount of heat supplied to it, so that if the concentration of liquor is kept relatively constant the rate of delivery of liquid ammonia to the receiver 21 will be practically a direct function of the amount of heat supplied to the still. The amount of fuel delivered to the burner 12, and thus the amount of heat supplied and the rate of delivery of liquid ammonia to the receiver, can be regulated in any desired manner, as by a valve (not here shown) actuated in conventional manner by a thermostat in the cooling chamber of the refrigerator.

Liquid ammonia passes from the receiver 21 to the dry evaporator 22, preferably comprising several coils of piping, through the restriction interposed by a valve 23 controlled by the float 24. The float and valve are so arranged that, as more liquid ammonia is delivered to the re-

ceiver, the valve opens further to permit increased flow to the evaporator to maintain the level of liquid in the receiver substantially constant.

Absorbing apparatus is provided in the form of an upper chamber or vessel 25 having extending downwardly therefrom a cooling and absorption loop. The downward flow path is through a short pipe 26 to an annular jacket 27 around a transfer chamber, to be hereafter more fully described, then down through a pipe 28 to an absorber cooling coil 29, also finned for better heat radiation and preferably located, with the condenser, at the bottom of the cabinet in which the apparatus is housed. The flow path in this cooling and absorption loop is then brought back to the absorber vessel 25 through the upwardly extending pipe 30, preferably terminating an inch or so above the normal level of liquid in the absorber chamber 25.

Expanded ammonia vapor from the evaporator 22 passes through a pipe 31 into the rising leg 30 of the absorber loop, near the lower end thereof. The incoming vapor creates bubbles in the leg 30 which provide a liquid lift or pump action insuring circulation of absorption liquid through the loop. Inasmuch as the liquid in this rising leg is weak liquor withdrawn from the bottom of the absorber vessel, and cool as a result of passing through the finned radiator 29, all absorption normally takes place in the pipe 30, enriched liquid flowing out of the top of this pipe into the absorber chamber 25.

The level of liquid in the absorber vessel is maintained by a valve 32 controlled by a float 33, the valve 32 controlling flow of liquid from the end of the pipe 34. This pipe leads from the lower end of the still (where the liquor therein is weakest) through a heat exchanger indicated in general as 35, and then on up to open into the absorber vessel, the flow through this pipe 34 being controlled by the valve 32, as previously mentioned.

The means for returning rich liquor from the absorber to the still comprises as its principal parts a transfer chamber 36, a valve assembly 37, and associated connections to render the combination operative. The rising leg 30 of the absorber loop is provided, just under the absorber vessel 25, with a cylindrical jacket 38. A short cross tube 30a in communication with the pipe 30, the cross tube having open ends, affords communication with this jacket, and there is thus a flow path for rich liquid from the absorber through the jacket 38 and pipe 39, past check valve 40, into the bottom of the transfer chamber 36. This flow path is controlled only by the check valve 40, and thus whenever the transfer chamber pressure is equal to or lower than that in the absorber vessel there is a flow of enriched liquid into the transfer chamber.

The valve device 37 has opening into its housing, and controlled by the valve element therein, a pipe 41 leading from the bottom of the transfer chamber 36; a pipe 42 leading from the top of the transfer chamber; and a pipe 43 connected to the pipe 18 which is always filled with high pressure vapor. In addition, a pipe 44 has one end opening into the valve housing, this pipe passing through the heat exchanger 35, through a jacket 45 around a thermostat bulb 46 in the still, and then up through a pipe 47 to open into the analyzer tower 13 a short distance above the still proper.

The thermostat bulb 46 is designed to contain a mixture of refrigerant and absorbent of substantially the same concentration as that which is intended to be the minimum concentration in the still. Pressure generated in the thermostat bulb by the heat of the still is transmitted through the liquid actuating leg 48 to the bottom of the valve housing, where it is applied to one side of a Sylphon; still pressure, delivered to the valve housing through the pipe 47, jacket 45 and pipe 44, is applied to the other side of the Sylphon. When the concentration in the still has boiled down as much as is desired, therefore, the pressure on the bulb side of the Sylphon exceeds that on the other side, and the valve-actuating mechanism moves. The actuating mechanism preferably includes snap-acting means, so that the valve element or plunger 49 moved by the actuating mechanism always stands in either upper or lower position; and never assumes any intermediate position.

As may be best seen in Figures 2 and 3, which show the valve plunger 49 in lower position, all valve-controlled connections in the valve arrangement are closed in this position. That is, the ports in the valve cylinder 50 which are connected to the pipes 41, 42 and 43 are all sealed or blocked by the valve element when it is in lower position. Under these conditions the transfer chamber is filled with liquid drawn from the absorber.

When the concentration in the still has boiled down to the desired minimum, the pressure in the actuating bulb exceeds the still pressure sufficiently to snap the valve plunger to upper position, as shown in Figure 4. In this position ports 42a and 43a, connected respectively to pipes 42 and 43, are connected by an opening 51 drilled through the valve plunger; and port 41a is uncovered by the bottom of the plunger, so that there is a connection from the bottom of the transfer chamber through the pipe 41, the valve housing, the pipe 44, the heat exchanger 35, the jacket 45, and the pipe 47 into the still. Inasmuch as high pressure vapor is being delivered to the top of the transfer chamber at this time, and the transfer chamber is located at a level higher than the still, liquid in it siphons up through the pipe 41 and passes to the still. In doing so it passes through the jacket surrounding the thermostat bulb, and rather rapidly cools the bulb. In a very brief interval, therefore, generally less than a minute, the valve snaps back to closed position. This is preferably designed to occur when only about two-thirds of the liquid in the transfer chamber has been moved to the still. The float 52 separates the vapor from the liquid in the transfer chamber during this operation to prevent undesired absoption.

A connection is provided between the weak liquor supply pipe 34 and the top of the transfer chamber through a passage 53 which has at least a portion considerably restricted, so that only an exceedingly fine stream of weak liquor passes through the top of the transfer chamber. As soon as the valve has moved to lower or closed position, however, no more vapor flows into the top of the transfer chamber through the pipe 42; and the absorption of this vapor by the fine stream of weak liquor entering the top of the transfer chamber reduces the pressure in that chamber. The pressure drops rather rapidly, going even below the pressure in the absorber vessel 25. Normally, the absorber would operate at about fifteen pounds pressure, and the

transfer chamber pressure would drop, in a matter of seconds after connection to the still has been blocked, to several pounds less than this, as for example ten pounds. The difference in height and pressure between the two chambers then opens the check valve 40 and causes a flow of liquid into the bottom of the transfer chamber through the pipe 39. This continues until the transfer chamber is completely filled with liquid, whereupon the fine stream of weak liquor entering it immediately begins to raise the pressure, and continues to do so until the pressure in the transfer chamber is substantially the same as that in the still. The transfer chamber then stays in this condition, filled with liquid and at high pressure until the still again calls for further rich liquor, generally in the neighborhood of seven or eight minutes later.

While the continuously operating absorption refrigeration system described herein contains a number of inventions and improvements over other known systems, this present application is particularly concerned with the transfer chamber and valve arrangement. Other improvements in the system are the subject of my other copending joint and sole applications filed both earlier and later than this application. One of the earlier is application, Serial No. 296,995, filed September 28, 1939; another is application, Serial No. 298,110, filed October 5, 1939; and still another is application Serial No. 314,704, filed January 19, 1940.

Continuously operated absorption refrigeration apparatus to maintain the still at high pressure and the absorber at low pressure and to return liquor to the still periodically by a transfer chamber and associated apparatus presents a number of problems, particularly when designed in a size appropriate for use as a domestic or household refrigerator. In the first place, the pressure in the high side of the system is frequently two hundred pounds per square inch or higher, while that on the low side of the system is generally about atmospheric pressure. Early work done on refrigeration systems of this general type by Ralph E. Schurtz, illustrated in Patents Nos. 1,414,527, 1,627,808, 1,796,410, 1,891,028, 1,890,531 and 1,905,308, switched the transfer chamber alternately from the high pressure to the low pressure side of the system. This was highly undesirable in a domestic refrigerator, because when the transfer chamber was switched from the high to the low side of the system the vapor vented into the low side with a highly objectionable loud hissing or rushing noise, and there was a considerable reduction in absorber efficiency. Moreover, at all times the valve means had to withstand the complete pressure drop across the system, and it is rather difficult to prevent leakage across a simple slide valve maintaining a pressure difference in the neighborhood of two hundred pounds per square inch, particularly after some wear.

These and other objections in earlier systems of this type have been overcome by my present invention, and a very much simplified valve arrangement achieved. Instead of switching top and bottom connections to various other pipes, the valve here only opens or closes two connections or flow paths. There is a vapor flow path through the pipes 43 and 42, and a liquid flow path through the pipes 41 and 44; and these are either opened together, or both blocked. There is no switching of connections from one side of the system to the other. Moreover, the pressure in the transfer chamber is reduced from that of the high side of the system until it is equal to or lower than that in the low side before there is any flow path between the absorber and the transfer chamber. A simple check valve 40, which can be made fool-proof and positive, is the only valve between the transfer chamber and the low side of the system; and except for a rather brief interval, it normally withstands the pressure drop between the high and low side of the apparatus, both sides of the plunger valve normally having high pressure thereon. Since reduction in the pressure in the transfer chamber is effected by absorption therein, and generates heat, the jacket 27 and finned coil 29 provide means for quickly and readily dissipating this heat.

While I have described and claimed certain embodiments of my invention it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. Absorption refrigeration apparatus of the character described adapted to provide continuous refrigerating effect, including: a still; a condenser; the still and condenser being adapted to operate at high pressure; an evaporator; an absorber, the evaporator and absorber being adapted to operate at low pressure; a transfer chamber for effecting return of liquor from the absorber to the still; means for absorbing vapor in the transfer chamber; and a cooling loop through which liquid from the absorber circulates, a part of the loop being in heat exchange relation with the transfer chamber.

2. Apparatus of the character claimed in claim 1, wherein the loop has a heat dissipating portion and absorber liquid flowing in the loop passes through the portion in heat exchange relation before passing through the heat dissipating portion.

3. Absorption refrigeration apparatus of the character described adapted to provide continuous refrigerating effect, including: a still; a condenser, the still and condenser being adapted to operate at high pressure; an evaporator; an absorber, the evaporator and absorber being adapted to operate at low pressure; a transfer chamber for effecting return of liquor from the absorber to the still; vapor and liquid connections between the chamber and the still; transfer valve means including valves controlling each of said connections, said valves being interconnected and movable together to permit simultaneous flow in both connections for a period and simultaneously block flow in both connections for a period; a connection between the transfer chamber and the absorber including a check-valve preventing flow of fluid from the former to the latter; a conduit connecting the still directly to the transfer chamber to deliver weak liquor thereto; and control means for the transfer valve means; whereby the transfer chamber is refilled rapidly and its pressure rises rapidly to that of the still to maintain balanced pressures on the transfer valve means for the major portion of each transfer cycle.

4. Absorption refrigeration apparatus of the character described adapted to provide continuous refrigerating effect, including: a still; a condenser, the still and condenser being adapted to operate at high pressure; an evaporator; an

absorber, the evaporator and absorber being adapted to operate at low pressure; a transfer chamber for effecting return of liquor from the absorber to the still; vapor and liquid connections between the chamber and the still; transfer valve means including valves controlling each of said connections, said valves being interconnected and movable together to permit simultaneous flow in both connections for a period and simultaneously block flow in both connections for a period; a connection between the transfer chamber and the absorber including a check-valve preventing flow of fluid from the former to the latter; a conduit connecting the still directly to the transfer chamber to deliver weak liquor thereto; and control means including a thermally responsive element in heat exchange relation with the contents of the still and connected to the transfer valve means for shifting the latter in response to change in a condition in the still; whereby the transfer chamber is refilled rapidly and its pressure rises rapidly to that of the still to maintain balanced pressures on the transfer valve means for the major portion of each transfer cycle.

5. Apparatus of the character claimed in claim 4, wherein the conduit connecting the still to the transfer chamber is restricted at its point of entrance to the transfer chamber and unrestricted theretofore.

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