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F. OPHULS

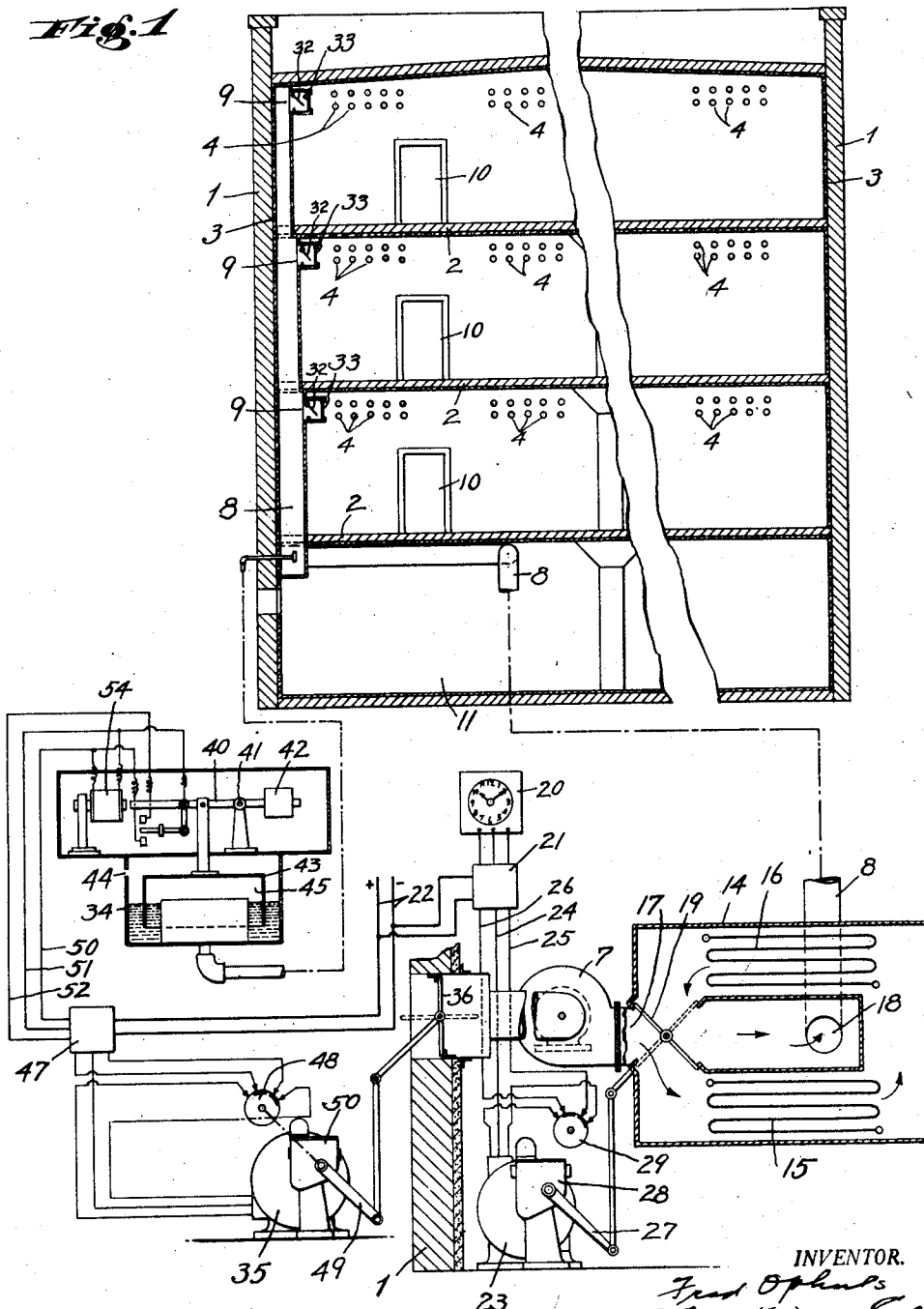
1,947,223

REFRIGERATING ROOMS AND BUILDINGS

Filed Jan. 6, 1930

2 Sheets-Sheet 1

Fig. 1



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REFRIGERATING ROOMS AND BUILDINGS

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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REFRIGERATING ROOMS AND BUILDINGS

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20 Claims. (Cl. 62—171)

The invention aims to preserve the integrity and thermal insulating qualities of the wall structure of rooms or spaces used for refrigeration or cold storage purposes. Such walls are subject to gradual disintegration as the result of the entrance of moisture into the material of which such walls are made, and at times the freezing of this moisture therein.

My investigations of this effect indicate that the entering moisture comes mostly from outside the structure and not from within the refrigerating space, even though the relative humidity within the latter may be, and frequently is, relatively higher than the humidity of the outside atmosphere. The wall structure is always more or less pervious to air, and the moisture seems to be carried into it by a slow inward seeping movement through the wall, produced by outside air pressures exceeding the internal air pressure. Such higher outside pressures may result from barometric changes, or from damper adjustments in the case of an indirectly cooled space; damper adjustments may produce a sub-atmospheric pressure within an indirectly cooled space. Inasmuch as the temperature within the space is normally lower than the temperature outside the structure (that is to say, excepting possibly during the coldest weather), the inwardly seeping air passes into progressively lower temperatures within the wall structure, and after the dew point of such air is reached, the water vapor therein is condensed and left behind in the minute interstices of the structure.

Whether this theory is correct, or whether the moisture intrudes by the effect of osmosis or results from still some other cause, I have found that it can be prevented by a systematic control of the air pressure within the refrigerated space, and that new walls can be kept dry and old ones dried out, by maintaining the pressure within the refrigerated spaces somewhat higher than the pressure externally, that is to say, on the opposite side of the walls. The pressure difference requisite for this purpose need not be so great as to cause any inconvenience in the normal use of the space or room, and my invention consists in this method of preserving such wall structures, as well as in apparatus for the purpose, as below pointed out. Inasmuch as the wall structures of refrigerated rooms are commonly made of cellular materials, which includes masonry, cork, mineral wool filling, etc., I infer that the novel effect I have produced results at least in part from maintaining a more or less constant seepage or percolation of the inside air through the material

of the wall itself at a rate at least sufficient to prevent entrance of outside water vapor into the air-pervious structure, or entrance to such a point therein as is cold enough to condense such vapor. Any water vapor in the inside air, if it passes through the wall, does not condense for the reason that it encounters progressively higher temperatures and lower pressures in such passage. Except, usually, while the doors are open to give access to the refrigerating space, I usually maintain this outward air movement at least while the outdoor temperature is higher than the temperature of the refrigerating space. The outward air flow can be produced by subjecting the outside of the insulation or wall to suction, i. e. by maintaining a sub-atmospheric pressure at the outside surface of the insulation or wall, or, and preferably, by maintaining a super-atmospheric pressure within the refrigerated space. A difference of pressure represented by from one-quarter to two inches of water is sufficient. Preferably I provide an automatic controller to hold the pressure difference at a substantially constant value; this assures continual maintenance of sufficient pressure difference, assures the necessary pressure difference without excess at any time due to the fact that the atmospheric pressure is variable, and reduces the power consumed by the apparatus to a minimum. These and other features of the invention appear in the various embodiments of the invention illustrated in the accompanying drawings and hereinafter described in some detail.

Herein I use the term "blower" as including any kind of air-flow-producing apparatus that may serve the purpose indicated. Ordinarily a centrifugal blower will be found suitable.

In the accompanying drawings, Fig. 1 diagrammatically illustrates a pressure system of my invention applied to a number of directly refrigerated rooms. Fig. 2 diagrammatically illustrates an application of my invention to a number of rooms indirectly refrigerated. Fig. 3 is a diagrammatic illustration of a suction system of my invention.

The building of Fig. 1, of, say, brick walls 1, divided into a number of rooms by floors 2 and lined with some suitable thermal insulating material 3, is directly refrigerated by the cooling coils 4 suspended from the ceilings of the various rooms, all in accordance with common practice as will be recognized; the refrigerating apparatus supplying these coils is not illustrated. To maintain a super-atmospheric pressure within the various rooms, I have added a motor-driven

blower 7, the outlet of which delivers into the header 8 which has ports or branches 9 delivering into each room. As before indicated, the super-atmospheric pressure developed thereby in the various rooms need not be great; I contemplate that a pressure difference of say from one-quarter to two inches of water will ordinarily give sufficient percolation or leakage of air through the wall structure 1 and 3. Ordinarily, I keep the blower 7 in operation at all times except possibly when the outdoor temperature is lower than that within the building. It will be understood that the apparatus illustrated in the lower portion of Fig. 1 may be installed in the building, say in the cellar at 11; I have shown this apparatus outside the structure in order to illustrate it on an adequately large scale. To avoid the effect of blowing relatively warm air into the refrigerated spaces, and also to dehydrate this pressure-maintaining air to prevent condensation of its moisture within the refrigerated spaces, I pass this air through a cooling bunker 14 having cooling coils 15 and 16 for example; these coils may be supplied from the same source as the coils 4 for example. Also, for the same purposes, the ports 9 may be so located that the air from them strikes or flows over the coils 4. The air from the blower 7 enters the cooling bunker at the port 17, and leaves the bunker at port 18. A shutter 19 serves to equalize the cooling action of the two coils 15 and 16; with this shutter in the position illustrated in full lines, the air from the blower flows first over coil 15 and then over coil 16; when the shutter is reversed to its broken-line position, the air flows first over coil 16 and then coil 15. The position of the shutter 19 is reversed from time to time so that the two coils 15 and 16 may share equally in cooling the pressure-maintaining air. It may be reversed automatically in various ways; for example, as the conditions of the two coils 15 and 16 may require, or periodically as illustrated. For this purpose the clock 20 is employed to control the reversing switch 21, which in turn controls the supply of current from the current source 22 to the reversible motor 23, which operates the shutter; the middle conductor 24 being permanently connected to one of the supply lines 22 and the motor for example, the clock 20 may periodically, at desired intervals, cause the switch 21 to connect the other of the supply leads to either the conductor 25 or the conductor 26 and thereby drive the motor 23 in such a direction as to turn the shutter 19 from its full line to its dotted line position, or vice versa. The motor armature may be connected to the reversing crank 27 through a speed reducing gearing 28; to stop the motor when the shutter has reached one or the other of its two positions, the shaft of the crank 27 may be provided with a limit switch 29; assuming that the conductor 25 serves (with conductor 24) to drive the motor in such a direction as to turn shutter 19 clockwise, and conductor 26 (with 24) drives the motor in the opposite direction, the limit switch 29 will be arranged to open conductor 26 when the shutter 19 reaches its full line position illustrated, and hold this conductor open until current in conductor 25 starts the shutter toward its broken line position; likewise the limit switch will hold conductor 25 open while the shutter is in its broken line position.

The capacity of the motor driven blower 7 and the capacity of header 8 are such that opening the door of, say, one of the refrigerated rooms

(and thereby reducing the pressure within that room to atmospheric) does not prevent the continuance of a supply of air to the other rooms, and correspondingly a continued maintenance of a super-atmospheric pressure in the other rooms; that is to say, the blower and header are preferably of such capacities that the pressure at the header side of the various individual branches or ports 9 serving the different rooms, is held more or less substantially fixed at its initial value when the door 10 of one or more of the rooms is opened and thereby the pressure in that room is reduced to atmospheric. To this end, the branches or ports 9 to the various rooms are restricted, relative to the size of the header, and preferably they are restricted by shutters, as by the sliding shutters 33 indicated in the drawings, whereby the distribution of air to the different rooms may be controlled. If desired, shutters 32, opened by the pressure-maintaining air flow and self-closing toward the header, may be added to prevent or assure against the passage of air from one room to another.

The barometric regulator 34, reversible motor 35 controlled thereby, and shutter or valve 36 in the inlet to the blower 7, serve to maintain a constant pressure difference between the interior of the refrigerated spaces and the atmosphere. In the particular barometric regulator illustrated, a lever 40, hinged at 41 and with an adjustable weight 42 at one end, suspends a bell 43, the top of which is open to the atmosphere as at port 44 while its bottom is sealed by water as illustrated and its interior 45 subjected to the pressure in the refrigerated space under its control. Where the pressure in a number of refrigerated rooms is controlled by a single header, as 8 for example, the interior 45 of the bell 43 may be connected to this header as here illustrated. Changes in the difference between the pressures internally and externally, cause the bell to move up or down of course, and this moves the lever 40 and thereby serves to operate the reversing switch 47 which, in turn, causes the motor 35 to drive in one direction or the other to open and close the shutter 36 as needed to restore the pressure difference to the value for which the barometric regulator 34 is adjusted; reversing switch 48 on the shaft of the crank 49 (to which the armature shaft of motor 35 is connected through a speed-reducing gearing 50) serves to stop the motor and shutter should the shutter reach either of its two limit-positions illustrated. Assuming that the middle conductor 51 is permanently connected to one of the supply conductors 22, movement of the bell 43 downwardly serves to connect this conductor to the conductor 52 whereby reversing switch 47 is so actuated as to cause the motor 35 to move the shutter 36 toward its open position illustrated in broken lines; likewise movement of the bell 43 upwardly serves to connect the middle conductor 51 directly to the conductor 53 so that reversing switch 47 is actuated to cause the motor 35 to drive in the opposite direction. The solenoid 54, facing one end of the lever 40, serves to impose a certain amount of drag on this lever, to prevent rapid vibration of it; assuming this solenoid to be a sufficiently high resistant one, it may be connected directly to conductors 51 and 53 as illustrated. It will be apparent therefore that the regulator 34 serves to adjust the shutter 36 in such a manner as to maintain a substantially constant difference between the atmospheric pressure and the

pressure within the refrigerated rooms—excepting of course any room the door of which may be open, the pressure in that particular room being atmospheric so long as its door is open.

In an indirectly cooled plant the cooling coils 55 are ordinarily located in a bunker as in Fig. 2, while a motor driven blower 56 circulates refrigerating air between the bunker and the cooling room or rooms, the air passing from the bunker to the blower and thence through the header 56a, ports 58, the various rooms, ports 59, and header 60, back to the bunker. Ordinarily the ports or branches 58 and 59 are provided with adjustable shutters, such as the sliding shutters 61 and 62, by the conjoint use of which the amount of air passed through the various rooms, and the refrigeration in the various rooms, is regulated. In accordance with my invention, the effective passage-ways through the ports or branches 59 are so restricted (i. e., by the shutters 62 or otherwise) as to maintain a super-atmospheric pressure in each of the rooms; the ports or branches 58 are then so chosen or regulated (by shutters 61 or otherwise) as, primarily, to secure the desired distribution of air to the various rooms. The super-atmospheric pressure within the rooms is preferably maintained automatically as before. For this purpose the barometric regulator 63, for example such a one as is illustrated in Fig. 1, exposed at one side to the pressure of the atmosphere and at the other side to the pressure within the header 60, preferably at the end of the header remote from the cooling bunker, controls a reversing switch 64, the latter in turn controlling the reversible motor 65 which serves to adjust a shutter or valve 66; this shutter permits the entry of more or less air to the intake of the blower 56 from the atmosphere, and hence the more or less constant addition of air to the closed circulating system, and hence controls the pressure within the system. A limit switch 67 may be employed on the shaft of the crank 68 as before. The pressure maintained in the header 60 may be super-atmospheric or sub-atmospheric, as will be apparent. Preferably however, I so adjust the effective passageways through the ports 58 as to secure an equal distribution, or any other desired distribution, of the refrigerating air to the various rooms, and permanently so fix them (as by permanently fixing the shutters 61 in those positions which give the desired distribution); I then set the barometric regulator 63 to maintain atmospheric or slightly super-atmospheric pressure in the header 60, and regulate the refrigeration as required by manipulation of the shutters 62.

As before mentioned, the desired pressure difference can be obtained by a sub-atmospheric pressure outside the insulating wall or structure. Fig. 3 illustrates such an arrangement. Here the main and thermally-insulating wall 70 is enclosed in a false wall 71, and the space between these two walls is connected to the inlet of a blower 72, so that a sub-atmospheric pressure is maintained in the intermediate space. A barometric regulator 73, controlling a shutter 74 in the inlet pipe to the blower 72, serves to maintain about constant the difference between the pressure within the refrigerated space and the pressure in the space between the two walls 70 and 71; one side of this barometric regulator may be connected to the space between 70 and 71 as illustrated, while the other side of

the regulator is connected to the interior of the refrigerated space as indicated at 75.

It will be understood that my invention is not limited to the detailed forms above described and illustrated in the accompanying drawings, except as appears hereinafter in the claims.

I claim:

1. The method of preserving the wall structure of refrigerated spaces against the effects of moisture, which consists in maintaining an average air pressure in such space higher than the average external air passage, and sufficiently high to prevent intrusion of water vapor into the wall structure, from outside the space, to a point within the wall structure where the vapor can condense.

2. The method of preserving, against the effect of moisture therein, an air-pervious enclosing wall of a refrigerated space, which consists in maintaining a flow of air outward from said space through the material of said wall at a rate sufficient to prevent the inward movement of water vapor through said walls to a point therein where the vapor can condense.

3. The method of preserving, against the effect of moisture therein, an air-pervious enclosing wall of a refrigerated space, which consists in maintaining a flow of air outward from said space through the material of said wall at a rate greater than sufficient to prevent the inward movement of water vapor through said walls to a point therein where the vapor can condense.

4. The method of preserving, against the effect of moisture therein, an air-pervious enclosing wall of a refrigerated space, which consists in maintaining a super-atmospheric pressure within the refrigerated space adequate to cause a flow of air outwardly through said walls at such a rate as to prevent the inward movement of water vapor through said walls to a point therein where the vapor can condense.

5. The combination of porous heat insulation enclosing a space wherein the temperature is lower than the outdoor temperature, a blower connected on one side of said insulation establishing a difference in pressure between the inside of said space and the outside of said insulation, the pressure within the space being superior, means to vary the pressure within said space, and a pressure-sensitive regulator connected to said means and adjusted to maintain a substantially constant difference between the pressures at the two sides of said insulation.

6. The combination of porous heat insulation enclosing a space wherein the temperature is lower than the temperature at the outer side of said insulation, a blower forcing air into said space and establishing a super-atmospheric pressure therein, means to vary the pressure within said space, and a pressure-sensitive regulator for said means subject to the air pressure of the space enclosed by said insulation and the air pressure outside said insulation and adjusted to maintain a substantially constant difference between the air pressure of said space and the air pressure outside said insulation.

7. The combination of porous heat insulation enclosing a space wherein the temperature is lower than the temperature at the outer side of said insulation, a blower forcing air into said space and establishing a super-atmospheric pressure therein, means to control the amount of air supplied to said space by the blower, and a pressure-sensitive regulator subject to the air pressure of the space enclosed by said insulation and

the air pressure outside said insulation and connected to said means to control the latter and adjusted to maintain a substantially constant super-atmospheric pressure in said space.

8. The combination of porous heat insulation enclosing a plurality of separate spaces wherein the temperature is lower than the outdoor temperature, a header, having a port to serve each of said spaces, a blower maintaining super-atmospheric pressure in said spaces, said header being connected to said blower for the production of an air flow between said spaces and the blower, means to vary the pressure in said header, and a pressure-sensitive regulator for said means connected to said header and adjusted to maintain a predetermined pressure therein.

9. The combination of porous heat insulation enclosing a plurality of separate spaces wherein the temperature is lower than the outdoor temperature, a header having restricted ports serving the said spaces, a blower forcing air into said spaces, means controlling the pressure in said header, and a pressure-sensitive regulator controlling said means and connected to said header and adjusted to maintain a predetermined pressure therein.

10. The combination with porous heat insulation enclosing a space, and means therein to reduce the temperature therein, of a blower to force air into said space to maintain a superatmospheric pressure therein adequate to cause a flow of air outwardly through said insulation at a rate substantially sufficient to prevent the inward movement of water vapor through said insulation to a point therein where the vapor can condense.

11. The combination with porous heat insulation enclosing a space, and means in said space to reduce the temperature therein, of a blower, and means providing a passageway for leading air from said blower to said space to maintain a superatmospheric pressure therein adequate to cause a flow of air outwardly through said insulation at a rate substantially sufficient to prevent the inward movement of water vapor through said insulation to a point therein where the vapor can condense, the outlet from said passageway being so located that the air passing therefrom passes over the first mentioned means.

12. The combination with porous heat insulation enclosing a space and means to reduce the temperature therein, of a blower to force air into said space to maintain a superatmospheric pressure therein adequate to cause a flow of air outwardly through said insulation at a rate substantially sufficient to prevent the inward movement of water vapor through said insulation to a point therein where the vapor can condense, and means to cool the air forced into said space by said blower.

13. The combination with porous heat insulation enclosing a space and means to reduce the temperature therein, of a blower to force air into said space to maintain a superatmospheric pressure therein adequate to cause a flow of air outwardly through said insulation at a rate substantially sufficient to prevent the inward movement of water vapor through said insulation to a point therein where the vapor can condense, and dehydrating means, the air of said blower being passed through said dehydrating means.

14. The combination with porous heat insulation enclosing a space and means therein to reduce the temperature therein, of a blower to force air into said space to maintain a super-atmospheric pressure therein adequate to cause a flow

of air outwardly through said insulation at a rate substantially sufficient to prevent the inward movement of water vapor through said insulation to a point therein where the vapor can condense, an air cooler, means for carrying the air of said blower over said cooler, and means for reversing the direction of the flow of said air over said cooler from time to time.

15. The combination with porous heat insulation enclosing a space and means therein to reduce the temperature therein, of a blower to force air into said space to maintain a superatmospheric pressure therein adequate to cause a flow of air outwardly through said insulation at a rate substantially sufficient to prevent the inward movement of water vapor through said insulation to a point therein where the vapor can condense, an air cooler, means for carrying the air of said blower over said cooler, and means automatically reversing the direction of the flow of said air over said cooler from time to time.

16. The combination with porous heat insulation enclosing a space and means therein to reduce the temperature therein, of a blower to force air into said space to maintain a superatmospheric pressure therein adequate to cause a flow of air outwardly through said insulation at a rate substantially sufficient to prevent the inward movement of water vapor through said insulation to a point therein where the vapor can condense, an air cooler, means for carrying the air of said blower over said cooler, and means periodically reversing the direction of the flow of said air over said cooler.

17. The method of preserving, against the effects of moisture, a porous wall structure of a refrigerated space normally closed against passage of air between the space and the atmosphere except for leakage through the enclosing wall structure, which consists in supplying air to said space from outside the space, and regulating the quantity of air so supplied in accordance with the air pressure within said space to maintain an average air pressure in the space slightly higher than the average external air pressure for the purpose and with the result of preventing intrusion of external moisture into such wall structure.

18. The method of preserving, against the effect of moisture therein, an air-pervious enclosing wall of a refrigerated space normally closed against passage of air between the space and the atmosphere except for leakage through the enclosing wall structure, which consists in providing for a flow of air into said space from outside said air-pervious wall, and regulating said flow in accordance with the air pressure within the space to maintain a flow of air outward from said space through the material of said air-pervious wall at a rate sufficient to prevent the inward movement of water vapor through said air-pervious wall to a point therein where the vapor can condense.

19. The method of preserving against the effect of moisture therein, an air-pervious enclosing wall of a refrigerated space normally closed against passage of air between the space and the atmosphere except for leakage through the enclosing wall structure, which consists in providing for a flow of air into said space from outside said air-pervious wall, and regulating said flow in accordance with the air pressure within the space to maintain a flow of air outward from said space through the material of said air-pervious wall at a rate greater than sufficient to prevent the inward movement of water vapor through said wall

to a point therein where the vapor can condense.

20. The method of preserving, against the effect of moisture therein, an air-pervious enclosing wall of a refrigerated space normally closed against passage of air between the space and the atmosphere except for leakage through the enclosing wall structure, which consists in providing for a flow of air into said space from outside said air-pervious wall, and regulating said flow in ac-

cordance, with the air pressure within the space to maintain a superatmospheric pressure within the refrigerated space adequate to cause a flow of air outwardly through said wall at such a rate as to prevent the inward movement of water vapor through said walls to a point therein where the vapor can condense.

FRED OPHULS.

10	85
15	90
20	95
25	100
30	105
35	110
40	115
45	120
50	125
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60	135
65	140
70	145
75	150