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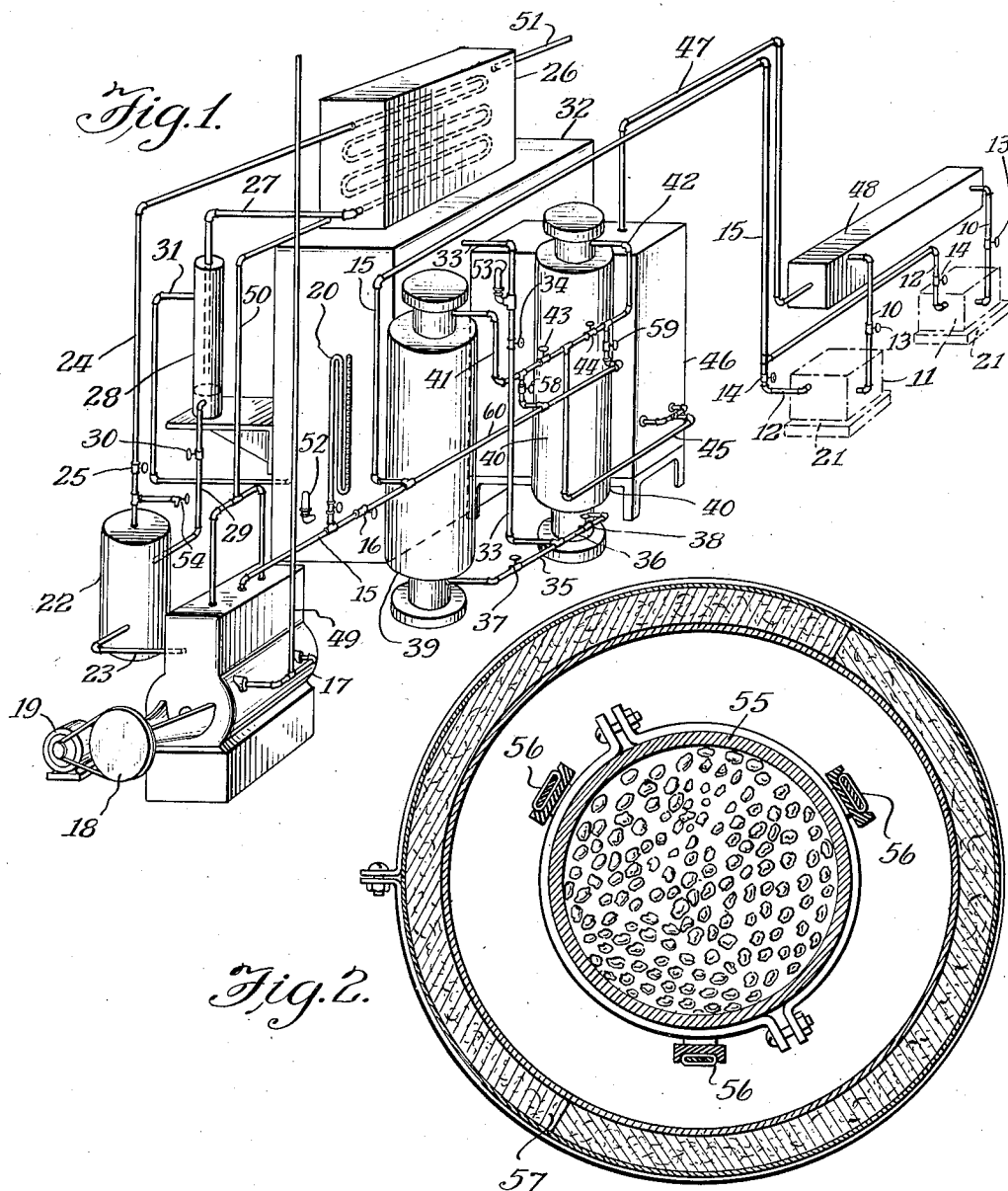
F. A. WATSON ET AL

2,223,588

DRYING REFRIGERATING UNITS AND LIKE APPARATUS

Filed June 25, 1936

3 Sheets-Sheet 1



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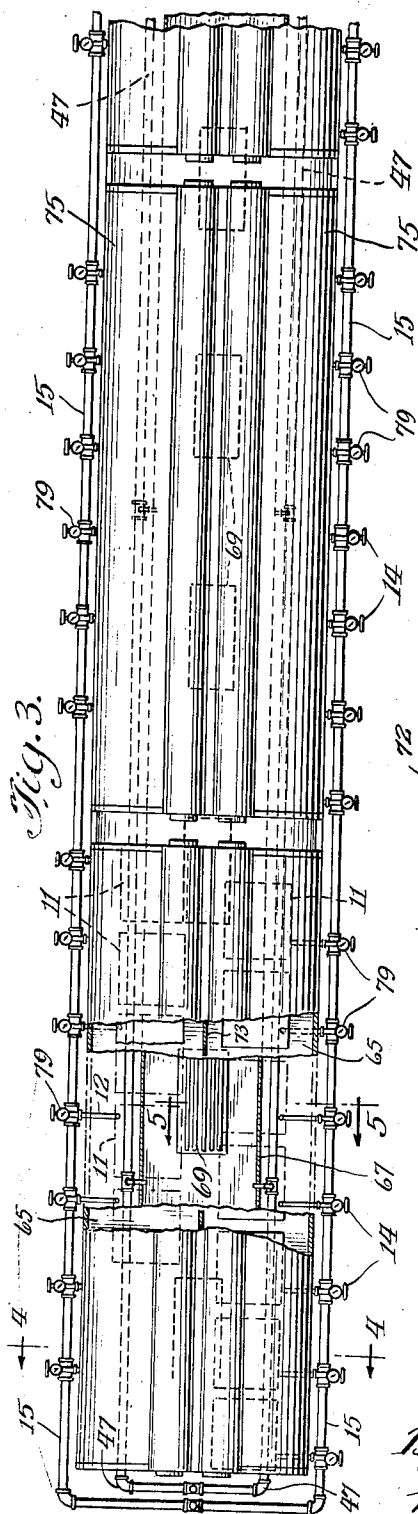
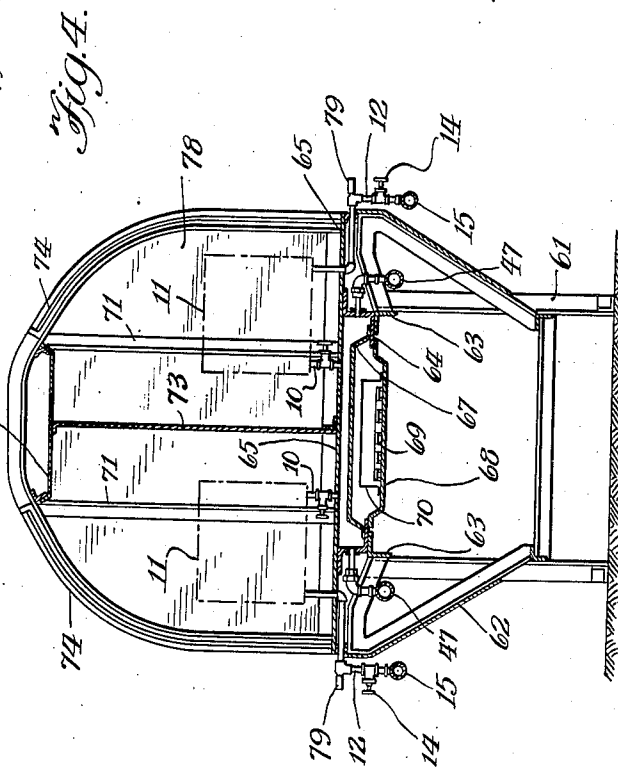
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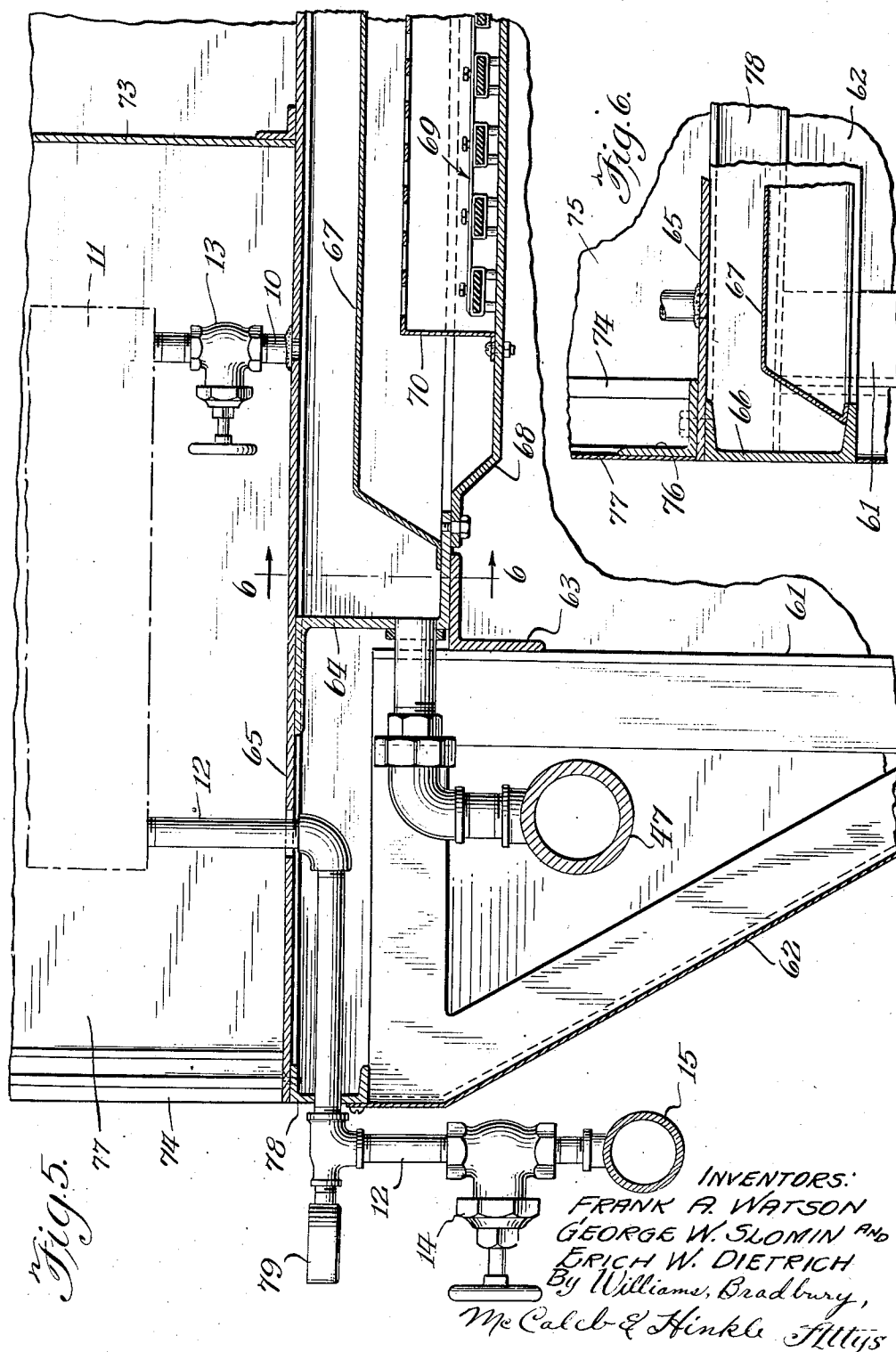
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3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

2,223,588

DRYING REFRIGERATING UNITS AND LIKE APPARATUS

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9 Claims. (Cl. 34—24)

Before a refrigerant, such as sulphur dioxide, is introduced into refrigerating apparatus, the apparatus must be thoroughly dried, because moisture that is not removed combines with the sulphur dioxide to form a corrosive acid. Heretofore the drying of refrigerating apparatus has been carried out by evacuation of the apparatus while it is being heated in an oven. About four hours are required to complete the drying by simple evacuation and external heating of the apparatus.

The invention relates to a system for the drying of refrigerating units and the like, by which the units can be completely dehydrated in less than two hours. The principal object of the invention is to make possible more rapid and efficient drying of refrigerating units and like apparatus. More specific objects and advantages are apparent from the description, in which reference is had to the accompanying drawings illustrating preferred apparatus for carrying out the invention.

Fig. 1 is a perspective view of an apparatus embodying the invention;

Fig. 2 is a horizontal sectional view of one of the drying towers employed in the apparatus of Fig. 1;

Fig. 3 is a plan view partly in section of the portion of the preferred drying apparatus that contains the units themselves;

Fig. 4 is a vertical sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 is a fragmentary vertical sectional view taken on the line 5—5 of Fig. 3; and

Fig. 6 is a fragmentary vertical sectional view taken on the line 6—6 of Fig. 5.

These specific drawings and the specific description that follows are to disclose and illustrate the invention and are not to impose limitations upon the claims.

In accordance with the invention a gas for drying the units, or other apparatus, is passed through a heater and then through the interior of the units and is kept at a reduced pressure while it is passing through the units, the pressure being preferably as much as fifteen inches below that of the atmosphere. Simultaneous external heating of the units is desirable.

In the preferred embodiments of the invention the gas that leaves the units is passed through a device for removing vapor therefrom and is then returned to the heater. A closed-cycle system of such a type functions more satisfactorily if a gas reservoir of substantial volume is included therein.

The preferred device for keeping the pressure of the air slightly reduced while it passes through the units, is a vacuum pump connected between the unit or units and the vapor removing device. If more than one unit is to be dried at one time, the units are connected in parallel in the system. The hot, dry air passing through the units quickly heats them to the desired temperature, and has a scrubbing action on the moisture in the interior of the units that greatly expedites its evaporation.

In the preferred apparatus illustrated in Fig. 1, the pipe 10 (see also Fig. 5) leading to each of the units 11 (shown in phantom) and the pipe 12 leading away from each of the units 11 are provided with valves 13 and 14, respectively. From the pipes 12 a line 15 leads through a valve 16 to a vacuum pump 17. In the drawings the vacuum pump is shown as one of the rotary type having a driving pulley 18 that is driven by means of a V-belt from a pulley on an electric motor 19. A manometer 20 for determination of the vacuum produced by the pump is connected to the pipe line 15 by means of a valve. To heat the units externally, electric heaters 21 may be employed. The units should be enclosed in a heat-retaining chamber or oven, not shown in Fig. 1, in order to minimize heat loss.

Leading from the outlet of the pump 17 to an oil separator 22 is an exhaust line 23. A further pipe line 24 leads the air from the top of the oil separator and is provided with a valve 25. As the air from the oil separator is led through a coil immersed in water in an oil condenser 26, the oil condenses and drains out through the pipe 27 that leads the air out at the bottom of the oil condenser 26. After being separated from the air in the oil trap 28, the oil is led back to the oil separator by means of a pipe 29, which is provided with a valve 30. The air leaving the oil trap 28 passes through a line 31 to an air reservoir 32.

Leading from the top of the reservoir 32 is a pipe 33 which has a valve 34 and is connected to lines 35 and 36 provided with valves 37 and 38 and connected with the lower ends of drying towers 39 and 40, respectively. Pipes 41 and 42 are connected with the tops of drying towers 39 and 40 and are provided with valves 43 and 44, respectively, through which they are connected with a common outlet pipe 45. The outlet pipe 45 leads to the lower end of a dust separator 46 having an outlet at its top from which a pipe 47 leads the air finally to the heater 48. The dust separator may be simply a closed box having

a bottom manhole for the removal of dust and a fine screen inside the box protecting its outlet, neither of which is shown in Fig. 1.

Water for cooling the vacuum pump may enter through a pipe 49 and flow from the pump through a pipe 50 to the bottom of the oil condenser 26. A drain pipe 51 through which the water finally leaves the system, is connected to the top of the oil condenser. In order to prevent the gas reservoir 32 from collapsing, an inlet valve 52 is provided that opens whenever the pressure in the reservoir falls slightly below that of the atmosphere. In addition a safety valve 53 is connected to the pipe 33 leading from the reservoir to prevent the pressure in the reservoir from getting too high.

Connected to the line 24 leading from the oil separator to the oil condenser, ahead of the valve 25, is a branch pipe that terminates in a valve 54 for venting the line 24 to the atmosphere.

Fig. 2 shows the drying towers to consist of an inner casing 55 filled with granulated hygroscopic material and surrounded by electrical heating elements 56, outside of which is insulation 57. Any hygroscopic material may be employed that can be reactivated, and can be obtained in granules large enough to permit free flow of the air through the drying towers. The preferred materials are activated alumina, anhydrous barium or magnesium perchlorate and anhydrous calcium sulphate. When activated alumina is employed, a charge of 100 pounds thereof in the drying tower can absorb 25 pounds of water and thus take care of about 5,000 refrigerating units, before reactivation is required.

To permit reactivation of the drying towers, the outlet lines 41 and 42 from the towers may be connected through valves 58 and 59, respectively, to a line 60 that joins the inlet line 15 of the vacuum pump.

The operation of the apparatus shown in Fig. 1 is as follows:

At the beginning of the operation of drying refrigerating units, valves 14, 16, 25 and 34 are open. Either valves 43 and 37 or valves 44 and 38 are open and valves 58 and 59 are closed, so that the air leaving the reservoir 32 passes through one or the other of the drying towers 39 and 40. The air is heated by the heater 48, and is under a vacuum of about fifteen inches and at a temperature of about 150° F. as it passes through the units. If necessary, the vacuum may be regulated by adjustment of the valve 34 in the line 33 that leads out of the air reservoir 32. The passing of the air through the units continues for thirty minutes and valve 54 is then opened and valves 13 and 25 closed. While the heated air is passing through the units, the exterior of the units should also be kept at a temperature of 150° F. The pressure in the refrigerating units soon falls below one millimeter of mercury and this high vacuum is maintained for thirty minutes to complete the drying and to effect the necessary evacuation of the units. During the evacuation of the units, the valve 30 in the oil pipe 29 may be opened long enough to drain the oil from the oil trap. The inlets and outlets of the refrigerating units are then sealed, the valves 14 are closed and the units, after being disconnected, are ready to be filled with the refrigerant.

After 5,000 units have been treated, the two out of the four valves, 43, 44, 37 and 38 that have been closed are opened and the two valves that have been open are closed, in order to put a reactivated drying tower in service and to permit

reactivation of the tower that has been in use. The reactivation of the tower is then carried out; but the reactivation must be interrupted during each of the thirty-minute periods for which the other drying tower is in use. The total time required for the reactivation is about three hours.

In order to accomplish the reactivation, the electric heater in the tower to be treated is turned on, heating the tower to 400° or 500° F., and the valve 58 or 59 that connects the tower with the inlet line 15 of the vacuum pump is opened. During the reactivation the valve 25 in the line 24 leading to the oil condenser is, of course, closed and the valve 54 is open.

The gas to be supplied to the units is preferably heated in a duct that passes below the units, and the units are preferably enclosed in a housing that retains the heat. In the preferred structure the table made of conducting material upon which the units are supported constitutes the top of the air duct itself. A skirt preferably surrounds this supporting table, to retain the heated air surrounding the duct.

In the most convenient arrangement, an elongated duct in which the gas is heated extends adjacent to a row of units enclosed in an elongated housing. Two rows of units may be arranged in the elongated housing to receive gas from a single heated duct.

The preferred form of apparatus for containing the units, illustrated in the drawings, comprises two or more sections placed end to end and connected in the piping system in parallel. Each of the sections is made up of a frame 61 (see Fig. 4), surrounded by a skirt 62 that extends more than halfway to the floor. The frame is made in the general shape of a horizontal hollow rectangle and is provided with inwardly projecting angle brackets 63 (see Fig. 5), upon which are mounted Z-beams 64 forming the side walls of the gas duct. Welded upon the Z-beams is a plate 65 that forms the upper side of the gas duct as well as the table upon which the refrigerating units are placed. The plate 65 is welded at its ends upon channels 66 (see Fig. 6) that constitute the end walls of the gas duct. In order to close the bottom of the gas duct a pan 67 is welded to the lower flanges of the Z-beams 64 and the channels 66. Brackets 68 are hung at intervals from the lower flanges of the Z-beams 64 to support electrical heating units 69, each of which is covered by a perforated housing 70. Vertical frame members 71 (see Fig. 4) are mounted upon the plate 65 to support a cover plate 72 that forms the top of the enclosure for the refrigerating units. A partition 73 extending between the plate 65 and the cover plate 72 divides the enclosure longitudinally into two halves, each of which accommodates one row of refrigerating units. Curved corner posts 74 extend downward from the tops of the four end frame members 71 to the corners of the plate 65 and are provided with guides for the edges of rolling doors 75, shown only in Fig. 3.

An angle 76 (see Fig. 6) extends across each end of the plate 65 between the corner posts 74. Closing the end of the housing and extending between the angle 76 and corner posts 74 at each end is an end sheet 77. Channels 78 are used to support the lateral edges of the plate 65 upon the frame 61. The pressure gauges 79 that are shown on pipes 12 leading from the units in Figs. 3, 4, 5 and 6 facilitate the testing of the apparatus and the observation of its operation.

The embodiments of the invention that have

been disclosed may be modified and various other systems embodying the substance of the invention may be devised to meet various requirements.

We claim:

- 5 1. A method of drying refrigerating units and the like that comprises passing gas through the interior of the units, heating the gas before it enters the units, and reducing the pressure of the gas passing therethrough substantially below the pressure of the atmosphere.
- 10 2. In a system for drying refrigerating units and the like, in combination, means for heating a gas, means for supplying the heated gas to the interior of the units, means for removing, from the gas leaving the units, liquid that has evaporated in the units, means for conducting the dried gas to the heating means, and means for propelling the gas through the system and for reducing the pressure of the gas passing through the units, substantially below atmospheric pressure.
- 20 3. A method of drying refrigerating units and the like that comprises passing a gas through the interior of the units, removing vapor from the gas leaving the units, heating the dried gas, returning it to the interior of the units, and maintaining the gas at a reduced pressure while it passes through the units.
- 25 4. In an apparatus for drying refrigerating units and the like, in combination, an enclosed heater for gas having an outlet for connection with an inlet of a unit, and having an inlet, means including a vacuum pump having an inlet for connection with an outlet of the unit, and having an outlet, and a vapor-remover connected between the outlet of the vacuum pump and the inlet of the heater, said means including a vacuum pump adapted to circulate the gas in a closed cycle and to reduce the pressure in said units below atmospheric pressure.
- 30 5. In an apparatus for drying refrigerating units and the like, in combination, an enclosed heater for gas having an outlet for connection with an inlet of a unit, and having an inlet, a vacuum pump having an inlet for connection with the outlet of the unit, and having an outlet, and an oil condenser and trap, a vapor-absorption tower and

a gas reservoir connected in series between the outlet of the vacuum pump and the inlet of the heater.

6. In an apparatus for drying refrigerating units and the like having inlet and outlet openings, in combination, a relatively narrow duct for supplying heated gas to be passed through the units, a conduit for connecting said duct to one of said openings, another conduit adapted for connection to the other of said openings for removal of gas from said units, the upper surface of said duct being of heat conducting material and serving to support said units in heat transfer relation thereto, a housing enclosing said units to minimize heat loss therearound and heating units adapted to heat the gas in said duct, whereby the heated gas in said duct heats both the inside and outside of said units.

7. In an apparatus for drying refrigerating units and the like, in combination, means for supplying a gas to the interior of the units, means for heating the gas before it enters the units, means for propelling the gas through the interior of the units and for reducing the pressure of the gas passing therethrough substantially below atmospheric pressure, and means for simultaneously heating the exterior of the units.

8. A method of drying refrigerating units and the like that comprises passing gas through the interior of the units, heating the gas before it enters the units, reducing the pressure of the gas passing therethrough substantially below the pressure of the atmosphere, and simultaneously heating the exterior of the units.

9. A method for conditioning refrigerating units prior to filling that comprises passing a current of hot dry gas substantially below atmospheric pressure through the units for an extended period to heat the units and remove moisture therefrom, and then cutting off the gas current and further decreasing the gas pressure within the units to complete the removal of moisture therefrom.

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