June 25, 1946. N. SHARPE 2,402,921

APPARATUS FOR FREEZING COMESTIBLES

Filed Aug. 18, 1942 3 Sheets-Sheet 1

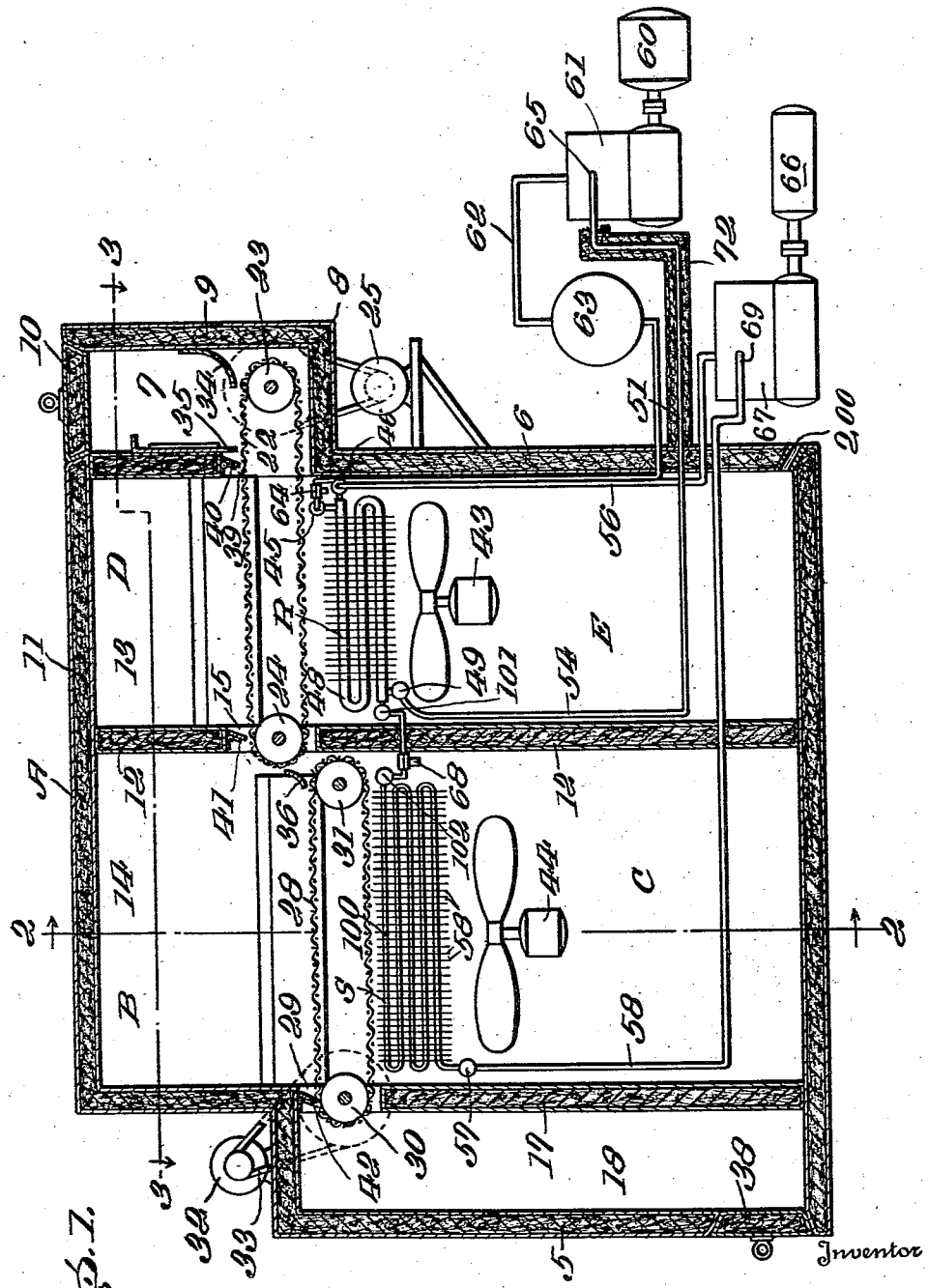

Fig. 1.

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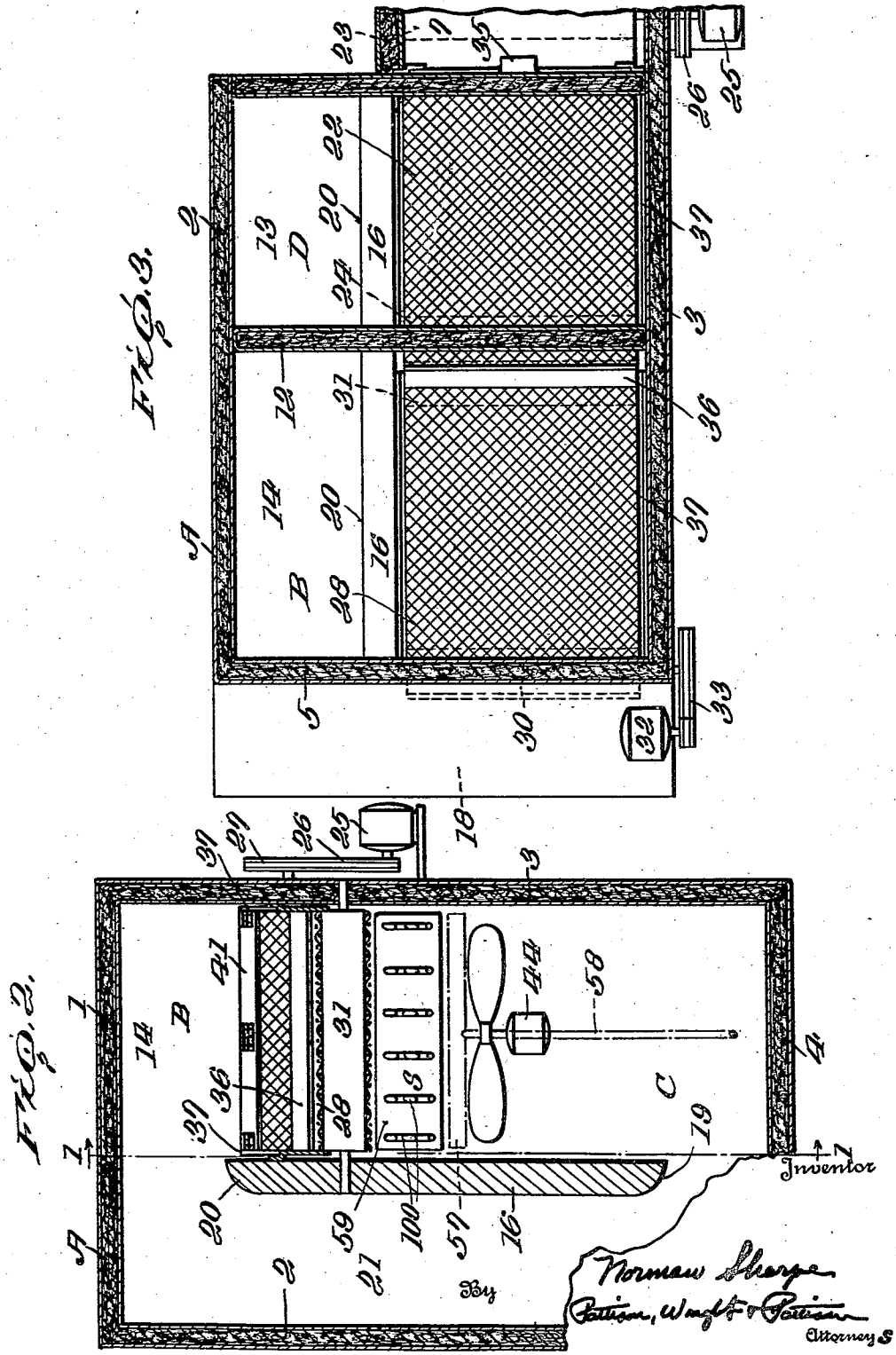

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APPARATUS FOR FREEZING COMESTIBLES

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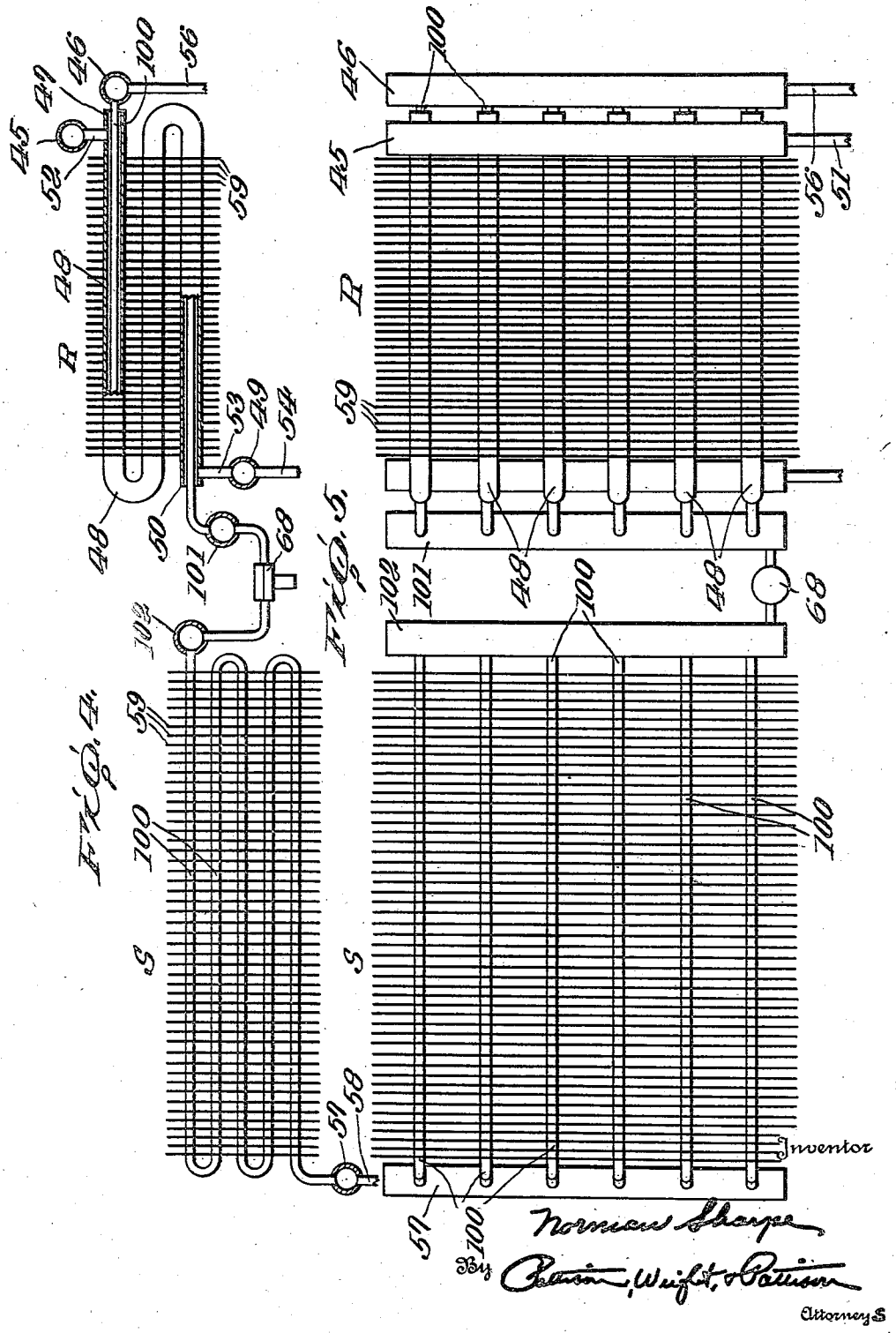

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APPARATUS FOR FREEZING COMESTIBLES

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12 Claims. (Cl. 62—102)

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This invention relates generally to apparatus for freezing comestibles, but is directed more particularly to apparatus wherein a two stage refrigerating system is used in combination with an improved type of combination condenser and evaporator or condenser and precooling coil.

The primary object of the invention is to provide a simple, comparatively cheap yet highly efficient apparatus for freezing foods.

Another and further object is to provide an apparatus carrying out the improved method which apparatus calls for the minimum space requirements, little if any insulation of the refrigerant-carrying conduits, and an apparatus requiring fewer parts than those required normally in the practice of freezing foods, all to the end that the apparatus is convenient of use and installation and comparatively cheap and simple of manufacture, yet highly efficient in operation.

Other specific objects, novel features of construction and improved results of the apparatus will appear from the following description and accompanying drawings in which an apparatus capable of performing the present improved method is described and illustrated.

In the drawings:

Fig. 1 is a longitudinal vertical sectional view through the refrigerating cabinet taken on the line 1—1 of Fig. 2 looking in the direction indicated by arrows, parts of the refrigerating system being shown in full line and exterior of the cabinet.

Fig. 2 is a transverse vertical sectional view through the refrigerating cabinet, the section being taken on line 2—2 of Fig. 1 looking in the direction indicated by arrows.

Fig. 3 is a horizontal sectional view of the refrigerating cabinet, the view being taken on the line 3—3 of Fig. 1 looking in the direction indicated by arrows.

Fig. 4 is a side view, partly in vertical section of the combined condenser and precooling coil and the evaporator coil.

Fig. 5 is a plan view of the coils illustrated in Fig. 4 of the drawings.

Using similar reference numerals and characters to designate like parts, an apparatus found suitable for practicing the present improved method will now be described.

A designates a closed cabinet or housing composed of a top 1, a front wall 2, a rear wall 3, a bottom wall 4 and end walls 5 and 6 and a hopper 7. All of the aforementioned walls including the bottom wall 8 and end wall 9 as well as the front and rear walls and cover 10 of the hopper are insulated walls. They are illustrated as being in the form of a double wall construction with the space between the walls filled with a suitable insulating material 11.

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Intermediate its length the cabinet is divided by a vertically disposed insulated wall 12 at the opposite sides of which are positioned what I have termed a precooling chamber 13 and a quick freezing chamber 14. Intermediate its length the wall 12 is provided with a horizontally disposed and extending opening 15 which provides communication between the chambers 13 and 14 for a purpose which will hereinafter appear.

The cabinet is provided with a second division wall 16 disposed at right angles to the wall 12 and extending from the end 6 of the cabinet to the insulated interior wall 17 of the frozen food receiving bin 18. This wall has its lower ends 19 and 20 stopping considerably short of the bottom 4 and top 1 of the cabinet. This wall divides each of the chambers 13 and 14 intermediate the extent of these chambers from the front towards the rear of the cabinet but permits free communication in each of these chambers between the upper and lower ends thereof as the wall 16 in reality forms a passageway 21 providing communication between the upper end B and the lower end C of the chamber 14 and between the upper end D and the lower end E of the chamber 13 in which a similar passageway is formed.

An endless pervious conveyor 22, such as wire mesh, has one end within the lower end of the hopper 7 while its opposite end extends through the opening 15 in the division wall 12 so that it will discharge into the quick freezing chamber 14. This conveyor is trained over a driven pulley 23 and an idler pulley 24. A motor 25 through a belt 26 trained over a pulley 27 constitutes the motive power for the driven pulley 23. This motor is a variable speed motor and through its drive connection and the pulley 23 it constitutes a very flexible means for driving the conveyor at variable speeds in accord with particular conditions under which the system or process is operated and in accord with the particular food being frozen.

A second pervious endless conveyor 28 extends across the quick freezing chamber 14 but is disposed in a horizontal plane beneath the top of the first mentioned conveyor 22 so that it receives the discharge from the conveyor 22. The conveyor 28 extends through an opening 29 in the interior wall 17 of the bin 18 to discharge into said bin. This conveyor is trained over a driven pulley 30 and an idler pulley 31 and is driven by a second motor 32. This motor is a

variable speed motor and is connected with the driven pulley by a belt 33.

Should it be found desirable both conveyors could be driven by a single motor but it is considered perferable to provide separate drive means for the conveyors as under certain conditions the process can be operated more advantageously by moving the food to be frozen through the precooling and quick freezing chambers at different speeds. In any event, the conveyors are at all times driven slowly irrespective of whether or not one may be driven slightly faster than the other.

The particular comestible to be frozen is of course placed in the feed hopper 7 and fed therefrom by gravity. To assist in directing the material to be frozen onto the feed end of the conveyor 22 a guide or deflector 34 is provided. A vertically sliding and adjustable gate 35 will cause the material to spread thinly upon the conveyor. A similar guide or deflector plate 36 is provided at the feed end of the conveyor 28 for assuring that the material discharged from the conveyor 22 is directed properly to the conveyor 28.

Both of the conveyors have upwardly extending side walls or rails 37 to prevent the material being frozen from discharging or being displaced from the side edges of the conveyors.

It is quite essential to the economical and efficient operation of the system that the cabinet be kept closed as tightly as possible. Accordingly the hopper 7 is provided with the aforementioned lid 10 and the bin 18 is provided with an insulated door 38. Additionally it is highly desirable to prevent to the greatest degree possible the circulation of air from the precooling chamber 13 into the quick freezing chamber 14 and to prevent the ingress of air from the hopper 7, when the cover thereof is removed, into the chamber 13 and to prevent the passage of air in the chamber 14 into the bin 18. Accordingly a horizontally pivoted and vertically swinging door 39 is provided in the opening 40 through which the conveyor 22 extends into the bin 7; a similar door 41 is provided in the opening 15 through which the conveyor 22 extends into the quick freezing chamber 14; and a third and similar door 42 is provided in the opening 29 through which the conveyor 28 extends into the upper end of the bin 18.

Hereinafter the refrigeration which takes place in the precooling chamber will be referred to as stage 1 and that taking place in the quick freezing chamber 14 as stage 2. The power required per unit of refrigeration of stage 2 is greater than that of stage 1. Accordingly the swinging door 41 plays an important part by eliminating to the greatest degree possible the passage of heat from the precooling chamber 13 into the quick freezing chamber 14. It is this desire to prevent the passage of heat from the chamber 13 into the chamber 14 which dictates that the division wall 12 between these chambers should be insulated.

For the above reason, in part, two separate distinct conveyors have been used rather than a single conveyor extending from the hopper completely across both chambers 13 and 14 to the bin 18. A single conveyor would carry with it heat from the chamber 13 into the chamber 14. Also the two conveyors provide flexibility of speed of movement of the materials being treated, as has been pointed out, and additionally assist materially in preventing transmission of moisture from the chamber 13 into the chamber 14. Most of the excess moisture of the material being frozen will be removed in the precooling chamber 14 and condensed out of the air on the combination condenser and precooling coil R, as will hereinafter more fully appear, but there might be a small amount of moisture left between the material being frozen and the conveyor belt 22. Were a single conveyor used this moisture would be not only conveyed into the quick freezing chamber 14 but would cause the material when passing through the quick freezing chamber to freeze to the conveyor.

Thus far none of the refrigerating equipment and arrangement of the system has been described other than the broad general reference to the combined condenser and precooling coil R. The refrigerating arrangement and equipment will now be described in detail.

A combination condenser and precooling coil R extends substantially entirely across the precooling chamber below the conveyor 22 and beneath it is positioned an electric or other suitably motorized fan 43 disposed for circulating air through the coil and through the perforate conveyor 22 and around and over the comestibles carried thereby.

The evaporator coil S extends substantially entirely across the quick freezing chamber 14 and beneath it is positioned an electric or other suitably motorized fan 44 disposed to circulate air upwardly through the perforate conveyor 28 and around and over the comestibles carried thereon.

The combination condenser and precooling coil, specifically illustrated in detail in Figs. 4 and 5 of the drawings, comprises a pair of headers 45 and 46 disposed at or adjacent the ends 47 of a plurality of coiled pipes 48 and a third header 49 disposed adjacent the opposite end 50 of the pipes. The pipes 48 are not concentrically coiled but are provided intermediate their ends with a plurality of U bends, as clearly appears in Fig. 4 of the drawings.

An inlet pipe 51 is connected to the header 45 which in turn is connected to the pipes 48 by short connecting conduits 52. The pipes 48 discharge through short conduits 53 into the header 49 from which leads the discharge conduit 54.

A pipe 100 is disposed within each pipe 48 and being of smaller diameter is arranged in spaced relationship to the interior walls of said pipe. An inlet conduit 56 is connected to the header 46 and the pipes 100 are connected to and constitute the discharge for said header. The pipes 55 extend outwardly through the ends 50 of the coil R or pipes 48 and are connected to a header 101 from which the pipes extend and are connected to the header 102 of the coil S. An expansion valve 68 is positioned in the line connecting the headers 101 and 102. The pipes 100 extend outwardly from the header 102 in the form of a plurality of U bends to provide the aforementioned evaporator coil S. The evaporator coil S composed of the pipes 100 discharges into a header 57 from which extends a discharge pipe or conduit 58.

In conformity with the usual and common practice each of the coils is provided with a plurality of heat absorbing fins 59.

Referring to Fig. 1 of the drawings, 60 is a motor for driving a compressor 61 the discharge of which travels through the conduit 62 to a condenser 63 from which it passes by way of the pipe 51 to the header 45. Intermediate its length and in front of the header the pipe 51 is provided with an expansion valve 64. The outlet pipe 54 from the header 49 of the coil R leads to the inlet 65 of the compressor 61 thus making a complete

closed fluid transmission system. It is understood of course that the system is filled with any suitable and well known refrigerant.

As for stage 2 of the system, 66 is a motor for driving a compressor 67 to the inlet side of which is connected the aforementioned pipe 56 which is connected to the aforementioned header 46. This stage of the refrigeration like the first stage constitutes a closed liquid conduit system within which is confined any one of the well known refrigerants. From the header 46 the refrigerant passes through the pipe 100 in the pipe 48 of the coil R. Before being itself formed into a coil the pipe 100 is provided with an expansion valve 68. Beyond the expansion valve 68 the pipe 100 is provided with the aforementioned U shaped bends to constitute the evaporator coil S which discharges into the aforementioned header 57 from which the refrigerant passes through the aforementioned conduit 58. This conduit is connected as at 69 to the intake side of the compressor 67.

By placing the compressor 69 within the chamber E it is unnecessary to insulate any part of stage two of the system.

Although the fans are illustrated as creating an upward current of air through the coils they could be arranged to pull the air downwardly through the coils without departing from the inventive concept.

From the foregoing it will be seen that the combined condenser and precooling coil is in reality made up of the evaporator of stage 1 of the refrigerating system and the condenser of stage 2 of the refrigerating system. Thus the condensation of the refrigerant of stage 2 of the system is effected by the evaporation of the refrigerant of stage 1 of the system.

Operation

To a better understanding of the invention let it be assumed that the comestible to be frozen is peas. The peas would first be washed and blanched and then delivered to the feed hopper 7 the lid of which would promptly thereafter be replaced so as to render the cabinet as near airtight as possible. The peas under the force of gravity would be guided on to the conveyor 22 by the guide 34 and would be spread out on the conveyor by the adjustable gate or valve 35. With the conveyors in operation the peas would pass through the precooling chamber 13 and as they are moved slowly therethrough by the conveyor the fan 43 would force air through the combined condenser and precooling coil R and upwardly through the pervious conveyor and around and over the peas. This air would escape over the upper end of the cabinet division wall 16 and pass downwardly behind said wall and forwardly beneath its lower end into the lower end E of the precooling chamber where it would be recirculated in the exact manner immediately before described. Thus cold air is continuously circulated through the conveyor and around and over the peas. No new air, with the exception of such possible unintended leakage as is present in the cabinet, would be added to the original air stream with the consequence that the operation is very efficient as no un-cooled air is being added to the circulating and refrigerating air stream.

The air which is circulated continuously through the conveyor and in more or less a circular path in the precooling chamber is of a temperature, as will be hereinafter explained, to nearly the freezing point, that is, approximately 32° F.

After completing their travel through the precooling chamber the peas are deposited upon the conveyor in the quick freezing chamber 14 and here an air stream having a temperature below the freezing point, that is below 32° F., is circulated through the pervious conveyor 28 and on and about the peas in the exact manner described in respect to the air circulation in the precooling chamber. That is to say, the fan 44 forces the air through the evaporator coil S upwardly through the conveyor and over the upper end of the cabinet division wall 16 and then downwardly behind said wall in the passageway 21 and under the lower end of the division wall into the lower end C of the chamber. Here the air is picked up by the fan 44 and caused to re-circulate in the manner immediately before described.

It is to be understood of course that throughout this period the liquid refrigerant is being continuously circulated throughout the system by the two compressors 61 and 67. The evaporator S operates as does any other evaporator in a mechanical refrigerating system of the present type, but by reason of the combined condenser and precooling coil a refrigerating system having definite and distinct advantages is obtained, as will now appear.

The compressed gas of stage 2 will enter the combined condenser and precooling coil R through the header 46 and be circulated through the pipe 100 which is within the pipe 48 of the coil R and surrounded by the liquid refrigerant which is circulated through the pipe 48. The refrigerant within the pipe 48 is in the stage 1 refrigerating system and after passing through the expansion valve 64 will enter the pipe 48 through the header 45. Heat from the air in the precooling chamber 13 will be carried to the refrigerant within the pipe 48 through the coil fins 59 and the metal wall comprising the tube or pipe 48. The heat of condensation from the stage 2, or quick freezing portion of the system, will be transmitted through the metallic walls of the pipe or tube 100 to the refrigerant liquid within the pipe or tube 48. This heat absorbed from the air in the precooling chamber 13 and the heat of condensation of stage 2 will be absorbed by the evaporating refrigerant within the pipe 48 which evaporates between the interior walls of said pipe and the exterior walls of the pipe or tube 100.

That portion of the pipe 54 which is exterior of the cabinet is insulated as at 72. Should it be found desirable the compressor 61 could be placed in the cabinet and then this insulation would be unnecessary.

The coils R and S are illustrated as extending in a vertical plane but it is to be understood that should it be found desirable they could extend in a horizontal plane, that is to say, the loops of the coils could be superimposed so that each coil loop would be disposed in a horizontal plane and extend in a horizontal direction parallel to the particular conveyor with which it is associated.

The apparatus illustrated is merely illustrative of one capable of practicing the method, and the invention accordingly is not to be limited by the specific constructional illustrations of the drawings other than to the extent that said constructions are embodied into and made a part of the invention defined by the hereinafter following claims.

I claim:

1. An apparatus for freezing comestibles or the like comprising, a pair of substantially closed

chambers, means for circulating an individual air stream in each of said chambers, a mechanical refrigerating system for cooling each of said chambers and the circulating air streams therein, a conveyor extending across one chamber and the path followed by air circulating therein and discharging into the other and second chamber, a conveyor in said second chamber for receiving the discharge from said first named conveyor, the conveyor of said second chamber extending across the chamber and the path followed by air circulating therein and discharging at a point exterior of said second chamber, the refrigerating system of the first chamber being operable to chill the air stream therein to a temperature which will cool the comestibles to a temperature above but closely adjacent to their freezing point, the refrigerating system of the second chamber being operable to chill the air stream therein to a temperature below the freezing point of the comestibles, means to feed the comestibles to the conveyor of the first chamber, each of said refrigerating systems including a refrigerating evaporator coil and a condenser coil, and the evaporator coil of that system serving the less cold chamber being combined in heat exchange relationship with the condenser coil of that system serving the colder chamber.

2. A two stage refrigerating apparatus for freezing comestibles or the like comprising, a closed cabinet having therein a pair of chambers in side by side relationship, means for feeding comestibles associated and communicating with one of said chambers and a frozen comestible discharge passageway from the second of said chambers, each of said chambers provided with means for circulating a stream of air, means in each of said chambers for directing said stream of air in a continuous unbroken divided path about said chamber, a mechanical refrigerating system for each of said chambers each of which includes an evaporator refrigerating coil and a condenser coil, the evaporator coil of each system being disposed transverse the path followed by the stream of air circulated in its respective chamber, an individual conveyor extending across each of said chambers and the path followed by the air circulating therein at a point behind said evaporator coils, the conveyor in one of said chambers receiving comestibles from said comestible feed means and discharging into said second chamber and onto the conveyor of said second chamber, and the conveyor of said second chamber discharging said comestibles through said discharge passageway.

3. An apparatus constructed as defined in claim 1 wherein, a comestible feed means is provided with an opening through which the conveyor of the less refrigerated chamber extends and receives comestibles from said feed means, said chambers being provided with an opening interconnecting the same, said last named conveyor extending through said opening and discharging comestibles onto the conveyor of the colder chamber, said colder chamber being provided with an opening through which its conveyor extends and discharges at a point exterior of said colder chamber, normally closed doors associated with each of the aforementioned openings for reducing to the greatest degree possible the passage of air through said openings, and said doors being movable to an open position by the moving comestibles.

4. A construction such as defined in claim 1 wherein, an individual variable speed drive is provided for each of the individual conveyors.

5. A construction such as defined in claim 1 wherein, each of said refrigerating systems includes a compressor, and the condenser coil of that system serving the colder chamber having a substantial portion of its length disposed within and in spaced relation to the inner walls of the pipe constituting the evaporator of that refrigerating system serving the less cold chamber.

6. A construction such as defined in claim 1, wherein the closed chambers are insulated from the surrounding atmosphere and from one another.

7. A two stage refrigerating apparatus for freezing comestibles or the like comprising, a closed cabinet having therein a pair of chambers in side by side relationship, each of said chambers provided with a partition stopping short of opposite walls of said chamber to divide said chamber into two compartments having communication with one another at their ends, a conveyor extending across one of the compartments of each of said chambers, one of said chambers constituting a precooling and the other a quick freezing chamber, means in each of said chambers for circulating a continuous unbroken air stream from one compartment of said chamber to the other compartment thereof, a pair of mechanical refrigerating systems each of which serves one of said compartments, each of said refrigerating systems including an evaporator refrigerating coil and a condenser, the refrigerating coil of each system being placed in the path followed by the air stream of its respective chamber, means to feed comestibles to the conveyor of the precooling chamber, the arrangement being such that the conveyor of the precooling chamber may discharge comestibles into the quick freezing chamber and onto its conveyor and the conveyor of the quick freezing chamber may discharge comestibles exterior of said quick freezing chamber, the refrigerating system of the precooling chamber being operable to refrigerate the air stream thereof to a temperature which will cool the comestibles to a temperature slightly above the freezing point of the comestibles but below room temperature, and the refrigerating system of the quick freezing chamber being operable to refrigerate the air stream thereof to a temperature below the freezing point of the comestibles.

8. A construction such as defined in claim 7 wherein, an individual variable speed drive is provided for each of the conveyors.

9. A construction such as defined in claim 7 wherein, the condenser coil of the refrigerating system of the quick freezing chamber is arranged in heat exchange relationship with the evaporator of the refrigerating system of the precooling chamber.

10. A construction as defined in claim 7 wherein, each of said refrigerating systems includes a compressor, and the condenser coil of that system serving the colder chamber having a substantial portion of its length disposed within and in spaced relation to the inner walls of the pipe constituting the evaporator of that refrigerating system serving the less cold chamber.

11. An apparatus for freezing comestibles or the like comprising, a precooling chamber and a quick freezing chamber, a mechanical refrigerating system for cooling each of said chambers, each of said refrigerating systems including a refrigerating evaporator coil and a condenser coil, a compressor for each of said systems, and the condenser coil of that system serving the quick freezing chamber having a substantial portion of

its length disposed within and in spaced relation to the inner walls of the pipe constituting the evaporator of the refrigerating system serving the precooling chamber.

12. An apparatus for freezing comestibles or the like comprising, a substantially closed pre-cooling chamber and a substantially closed quick freezing chamber, a mechanical refrigerating system for cooling each of said chambers, each of said systems including an evaporator disposed within the particular chamber the system is serving, means for circulating in each of said chambers an air stream over the evaporator thereof, means for conveying comestibles through the pre-cooling and quick freezing chambers and across the path followed by the air streams therein and

delivering them to a point of discharge exterior of the quick freezing chamber, each of said refrigerating systems including a condenser, the evaporator of the system serving the pre-cooling chamber being combined in heat exchange relationship with the condenser of the refrigerating system serving the quick freezing chamber, and said refrigerating systems being respectively operable to chill the air in the pre-cooling chamber to a temperature which will cool the comestibles therein to a temperature above but closely adjacent their freezing point and the air stream in the quick freezing chamber to a temperature below the freezing point of the comestibles therein.

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