

June 9, 1953

R. H. BISHOP

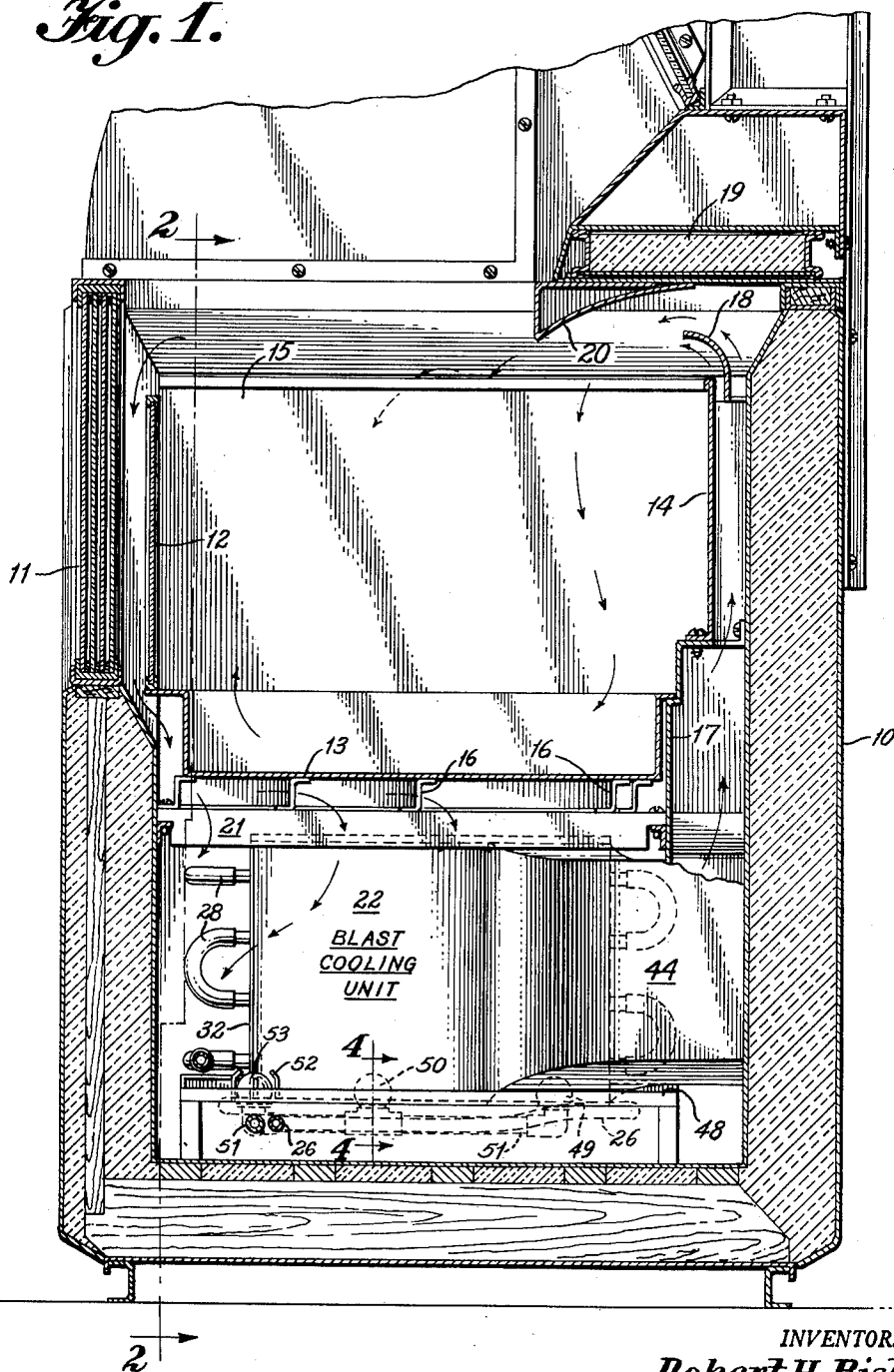
2,641,111

REFRIGERATION APPARATUS AND METHOD

Filed March 14, 1952

3 Sheets-Sheet 1

Fig. 1.



INVENTOR.

BY *Robert H. Bishop*

Burns, Doane & Benedict
ATTORNEYS

June 9, 1953

R. H. BISHOP

2,641,111

REFRIGERATION APPARATUS AND METHOD

Filed March 14, 1952

3 Sheets-Sheet 2

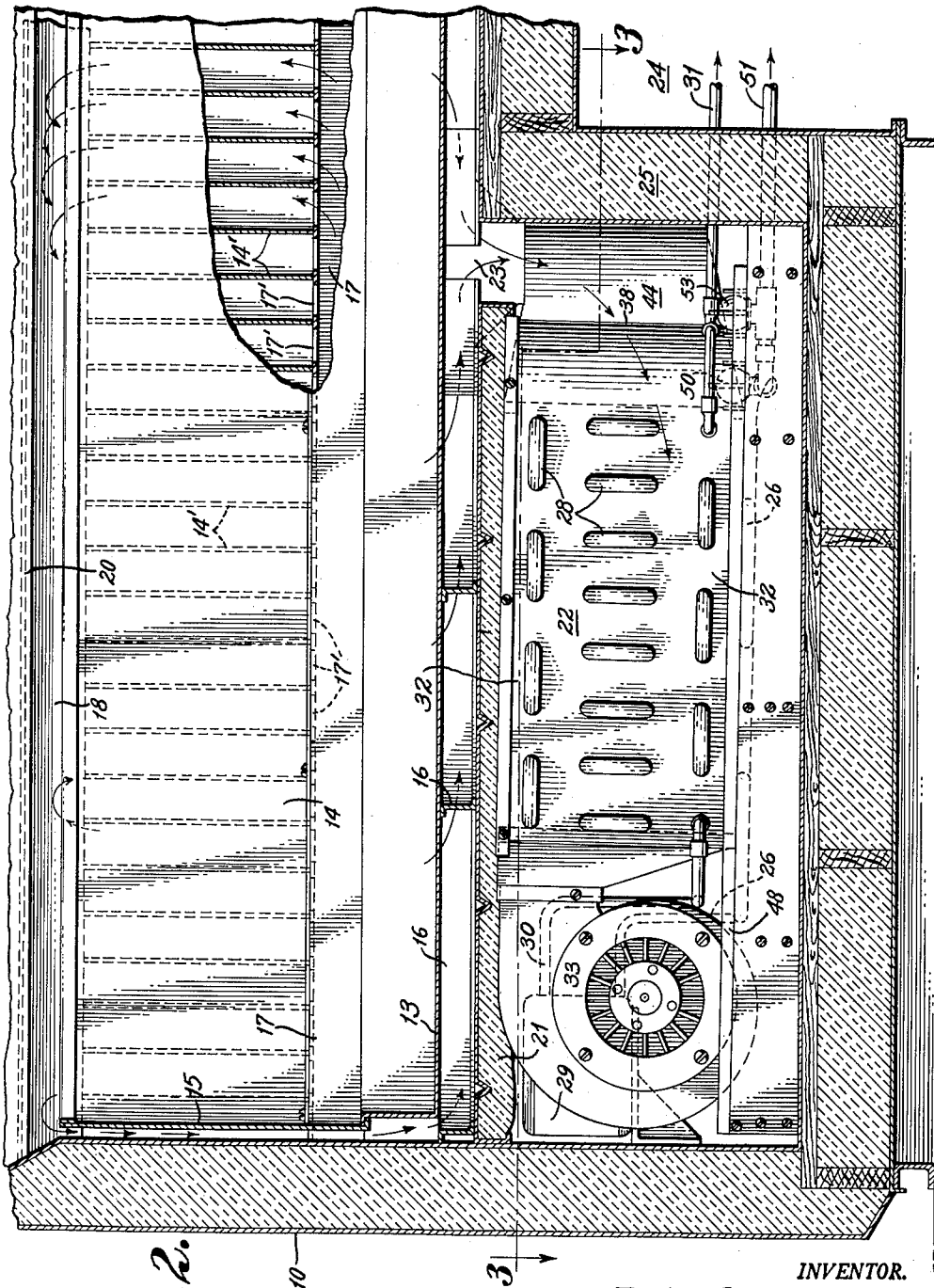


Fig. 2.

INVENTOR.

Robert H. Bishop

BY

Burns, Doane & Benedict

ATTORNEYS

June 9, 1953

R. H. BISHOP

2,641,111

REFRIGERATION APPARATUS AND METHOD

Filed March 14, 1952

3 Sheets-Sheet 3

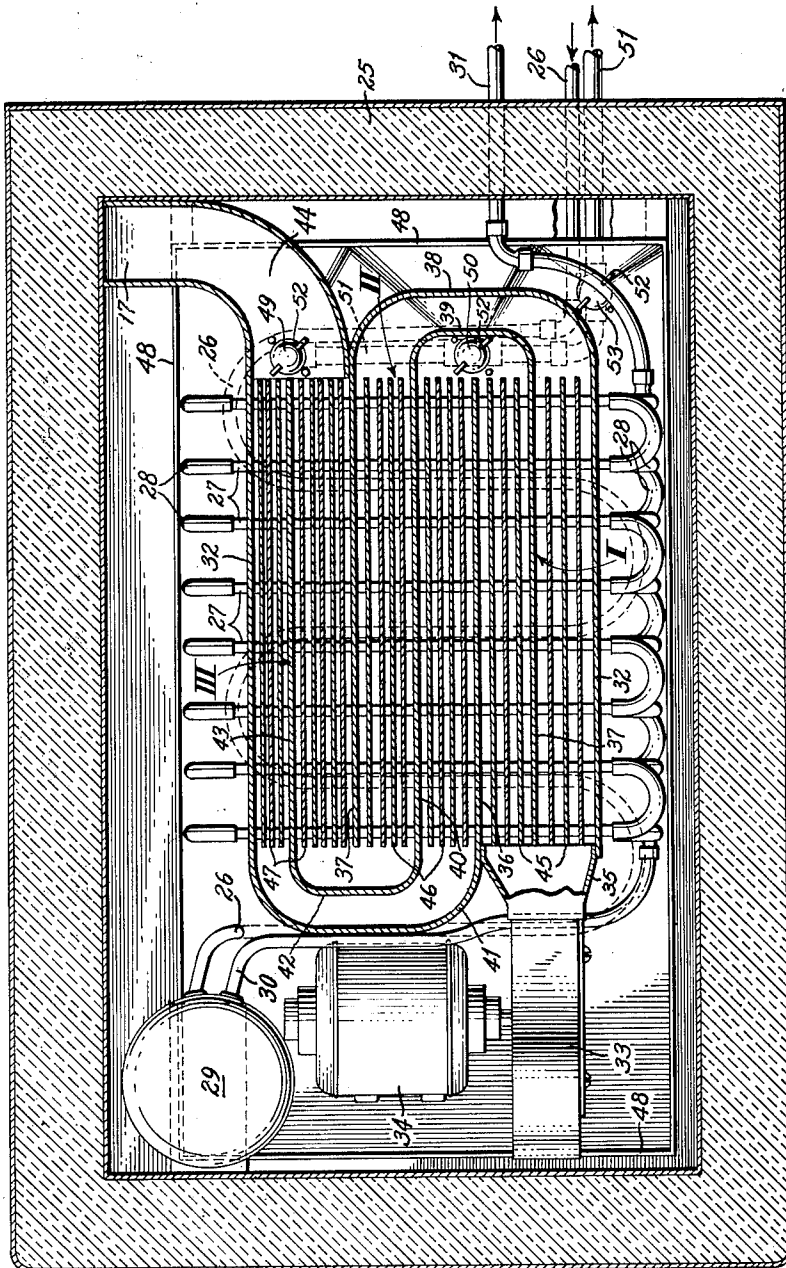


Fig. 3.

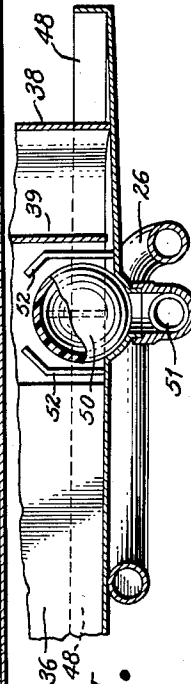


Fig. 4.

INVENTOR.

Robert H. Bishop

BY

Burns, Doane & Benedict

ATTORNEYS

UNITED STATES PATENT OFFICE

2,641,111

REFRIGERATION APPARATUS AND METHOD

Robert H. Bishop, Champaign, Ill.

Application March 14, 1952, Serial No. 276,603

3 Claims. (Cl. 62—102)

1

This invention relates to a commercial refrigeration system. More particularly it relates to an apparatus for defrosting, i. e., dehumidifying, and cooling a gaseous coolant such as air, and an apparatus for distributing the cooled gas over materials to be refrigerated, and then recirculating it for further cooling, dehumidification and distribution. It especially relates to an improved frozen food display cabinet for commercial use.

The adequate display of frozen foods is an important matter. Heretofore these have been arranged in refrigerated bins or boxes, open from above. Some have used circulating cold air for refrigeration. The blast cooling systems of such units have required defrosting at intervals of three to six hours with the result that foods in storage may become partially thawed and thus change in quality. Many of these require lines connected to external drains to remove the water resulting from melting the frost.

The present invention provides a means whereby defrosting need be done but once in 24 hours, and eliminates the need for drain connections by a novel evaporation system. It provides an apparatus whereby coolant air is defrosted and cooled to extremely low refrigerating temperatures with high efficiency and without substantial change in cooling efficiency, and without cutting the volume of air handled over long periods of time. It provides an apparatus in which the visual display of goods is increased with no decrease in cooling efficiency, while keeping the food in frozen condition without partial thawing. It eliminates dividers in food compartments, as well as need for defrosting the food compartment itself. It provides uniform distribution of coolant air at all times without "overflow" from the open box.

Figure 1 is an end view in section of the refrigerator box, taken through one end of the blast cooling coil compartment.

Figure 2 is a sectional elevation taken along the lines 2—2.

Figure 3 is a plan view in section of the blast cooling coil and compartment, taken along the lines 3—3.

Figure 4 is a sectional detail of one element of the moisture drainage system, taken along the lines 4—4.

The apparatus comprises an open-top insulated box 10, which may be of any suitable design and need not be described in detail. The front portion of the box comprises a Thermopane 11, running the full length of the box and

2

extending to a height approximately equal to the ends and back insulated portion thereof. The Thermopane element comprises several sheets of glass, spaced from each other and having an evacuated space between. This affords both insulation and visual inspection of the contents of the box from the front. Mounted within the box and spaced inwardly from the walls thereof, is the food compartment, which comprises a glass front 12 which may be a single sheet of plate glass, a bottom tray 13, rear wall 14, end wall 15, and of course a corresponding end wall at the opposite end, not shown. The food compartment is supported by clips or brackets 16, upon which the bottom of tray 13 rests. A duct 17 extends the full length of the box. The front wall of the duct 17 is offset, as are the end walls 15, and the tray 13 rests thereon, making it possible for tray 13 and front wall 12 to be removed periodically for cleaning. The rear wall 14, being spaced inwardly from the insulated rear wall of the box, forms a vertical continuation of duct 17, into which it opens through a manifold having spaced orifices 17'. Vertical sheet metal partitions 14', between the orifices, divide this duct into vertical columns. This construction is described in my copending application 256,203, filed November 14, 1951, of which this application is a continuation-in-part. Near the top of the vertical duct is a curved splitter 18, which extends upwardly and outwardly over the wall 14 for purposes of directing a portion of the air outwardly as indicated by the arrow. Above the duct and splitter is a heavily insulated shelf 19, having attached thereto a curved deflector 20 extending outwardly and downwardly. Air which is not deflected by splitter 18 strikes the element 19 and the deflector 20, and is directed outwardly and downwardly as indicated by the arrows. The two streams of air, one directed by the splitter 18 and the other by deflector 20, co-mingle at a point just above the top of the food compartment, creating a turbulence which results in a movement of air downwardly and forwardly across the food compartment and any packages of food that may be therein. Because of the construction shown, the flow of cold air is uniform, so that it blankets the food within the compartment and overflows into the space between the elements 11 and 12, and between the walls of the food compartment and the end walls of the box, without substantial "spillage" of the air out of the box and into the room. It is noted

that the walls of the box extend substantially above the top of the storage compartment.

Below the bottom tray 13 of the storage compartment, is an insulated horizontal partition 21, upon which the spacers 16 rest. The space thus formed forms a part of the air return system. In the compartment formed by the lower portion of the insulated box and the partition 21, is located the blast cooling unit generally designated as 22. Approximately centrally of the partition 21 is an opening 23 therethrough, by which air is returned to the blast cooling compartment as indicated by the arrows in Figure 2. The blast cooling compartment is separated from the compartment 24, which houses the conventional condensing unit, by an insulated partition 25. The entire blast cooling coil compartment is insulated, and, except for the ducts leading to the food compartment and the return air duct, is substantially gas-tight.

The blast cooling unit is of unique design which permits of operation without defrosting, for many hours beyond those conventionally employed. It is best described in connection with Figures 2 and 3.

Referring to Figure 3, a pipe 26 leads from the condensing unit through the insulated wall 25, and forms a series of flat loops below a tube bundle made up of numerous tubes 27 connected by return bends 28. Line 26 leads to an accumulator of liquid refrigerant 29. Line 30 leads from the accumulator to the tube bank, and thence by line 31 to the condensing unit. The function and location of the loops in line 26 will be explained hereinafter.

The tube bundle is housed in a housing 32. A fan 33, driven by motor 34, draws air from within the blast cooling coil compartment, and forces it through a duct 35 into the housing 32. The housing is divided longitudinally into compartments I, II and III, by partitions 36 and 37. Compartment I may have a second partition 37 extending intermediate thereof, although this is not essential. A duct 38 carries the air from compartment I into compartment II formed by the partitions 36 and 37. A splitter 39 is employed to assist in distributing the air evenly over the tubes in compartment II. This splitter may be an extension of the partition 37. Another partition 40, forming an extension of splitter 39, may extend through compartment II. A duct 41, in which is a splitter 42, serves to conduct and distribute the air from compartment II into compartment III. The splitter 32 may also extend in the form of a partition 43, to divide this compartment. Leading from the final compartment is a duct 44, which leads to the horizontal duct 17 and thence distributes the air into the food compartment as previously described.

The tube bundle is held together by vertical fins 45, 46 and 47, which are thin metal sheets of aluminum, copper or the like. The fins 45 in compartment I are spaced more widely apart than those in compartment II, which in turn are spaced farther apart than those in compartment III. For example, the fins 45 may be about three to the inch; fins 46 in compartment II may be about four to the inch; and fins 47 in compartment III may be about five to the inch. Lying beneath the blast cooling unit, below all parts of the unit that may become covered with frost, is a tray 48. A part of the tray forms the bottom of housing 32. The loops of line 26 lie under tray 48, and in close proximity thereto. In the floor of the tray are openings in which are mounted

floats 49, 50 and 53, which float on the water formed during defrosting, thus opening the holes and permitting the water to drain therethrough. The floats are maintained in place by brackets 52. The floor of the tray slopes toward these openings to facilitate draining. During the cooling cycle the floats seal the openings. The holes or ports are joined by line 51, which preferably leads to a moisture evaporator of the type shown in my above-mentioned copending application, although it may lead to a drain.

The operation

During the cooling period, the liquid refrigerant from the condensing unit is pumped through line 26, and thence through the accumulator 29, and the tube bundle (evaporator), and returns to the condensing unit through line 31. Air from the air return system is drawn into the blast coil compartment by fan 33. The blast coil is of such dimensions that the return bends 28 lie close to the insulated walls of the compartment. Thus, the returning air is forced to pass over the exposed return bends, which of course are cooled by the refrigerant. These return bends are without fins, and present a primary defrosting surface. The temperature of the air is not lowered to any great extent by passage over the return bends, but the moisture which the air has accumulated as it passed over the food containers in the storage box is deposited to a large extent on these primary surfaces. The air is then blown into compartment I, where it passes over the numerous sections of pipe and between the fins. At this point, additional frost is removed from the air and deposited on the fins and pipes, while substantial cooling occurs. This stream of air from compartment I is directed by duct 38 and splitter 39 into compartment II, wherein the fins are more closely spaced. A small amount of frost and substantial additional cooling of the air occurs in this compartment. In a like manner, duct 41 and splitter 42 direct and distribute the air over the fins and pipes in compartment III. Because of the increased cooling surface, and because substantially all of the frost has been removed in the early stages, the final cooling of the air occurs here. It is then directed through duct 44 and duct 17 to the food compartment, as previously described.

It is thus seen that the air in effect undergoes a four-pass travel over the tube bank, first over a primary surface for defrosting, and then through three successive sections wherein the amount of cooling surface is successively increased. The first pass has the advantage of removing a large portion of frost, which puts less of a burden on the blast cooling coil proper. The second provides for further defrosting, with substantial cooling, but because the fins are widely spaced, it is possible to accumulate a substantial amount of frost without reducing the air volume capacity of the unit. A like effect takes place in the second compartment and in the third. Because the second and third compartments accumulate progressively less frost, the fins can be spaced more closely together and the efficiency of cooling can be greatly enhanced. The net effect is that the blast cooling unit can be operated for long periods of time between defrosting. It can be readily seen how this increases the overall efficiency of cooling. The normal operation of a commercial unit of this kind is to defrost once every twenty-four hours. Conventional commercial display boxes of this character must

be defrosted about once every three to eight hours. Since these display boxes are used primarily in grocery stores and the like, the result is that defrosting must be carried out during business hours. With the present unit, defrosting can be carried out at nighttime, during the hours when the stores are closed, due to the fact that the efficiency of cooling and rate of air circulation remains high all during the operating period.

Defrosting of the blast cooling unit may be carried out at regular intervals by employing a timer. The method of defrosting is well known, and comprises circulating hot gas through the evaporator coils in the blast cooling unit. These include an electric clock to start the defrost cycle at a set time and stop the fan motor. A solenoid valve, not shown, may be provided, which opens at the start of the defrost cycle to bypass hot gas around the condenser and expansion valve, direct to the blast coil evaporator. The accumulator tank in the succession line between the blast coil evaporator and the compressor, stores all liquid refrigerant in the system during the defrost cycle and prevents flooding the compressor. A thermostat control, not shown, automatically stops the defrost cycle when the discharge refrigerant from the evaporator rises to about 42° F., and puts the system control back into normal operation. Thus, the defrost period is only as long as necessary. A delayed action switch for the fan motor is provided (not shown), which automatically delays starting the fan until the blast coil evaporator has been cooled, and this prevents blowing warm air from the insulated blast coil compartment into the food storage compartment.

The warm refrigerant gases pass through the loops in line 25, first warming the drip pan, and because of their close proximity, also warm the drain line. The warm gases passing through the coils cause the frost thereon to melt, and this runs into the drip pan and out line 51 to be evaporated or drained away. During the defrost operation, the fan is not in operation. Before defrosting, which can be carried out after business hours, an insulated cover or blanket is placed over the food compartment to prevent the warm air of the room from reaching and thawing the food. With the insulated cover in place, the temperature in the food compartment will change no more than a few degrees in the period required for defrosting, and never rises above the freezing point.

One of the big disadvantages of the conventional types of display cabinets, lies in the fact that the defrosting must be carried out during business hours when the contents of the box cannot be protected from the warm air of the atmosphere. Consequently, partial thawing of the contents occurs, with accompanying deterioration of the food.

I claim as my invention:

1. In a commercial refrigeration unit comprising a food storage box, a blast cooling-unit compartment, a blast cooling unit, and means for circulating air from the cooling unit to the storage box and returning it to the cooling compartment, the improvement comprising a blast cooling unit having a coil housing divided into a plurality of cooling sections serially connected, cooling tubes within said sections, a prime frost collecting surface located adjacent the walls of the cooling compartment externally of the coil housing whereby air returning from the box must first pass over said prime surface and be dehumidified before entering the coil housing, fins on said cooling tubes, said fins being most widely spaced in the first of said sections, and being more closely spaced in each succeeding section, means for drawing air over the prime surface and passing it through said sections, and means communicating from the last section with the box whereby cooled dehumidified air from blast cooling unit is passed into said box.

2. In a commercial refrigeration unit comprising a food storage box, a condenser unit compartment, a blast cooling compartment containing a blast cooling unit, and means for circulating air from the cooling compartment to the storage box and returning it to the cooling compartment, the improvement comprising a blast cooling unit having a housing, longitudinal partitions in the housing forming a plurality of sections, ducts joining said sections in series, an inlet to the first section, an outlet from the last section in the series, a blower connected with said inlet, a duct connected to the outlet and leading to the food storage compartment, a plurality of pipes extending laterally through said housing and said partitions, headers joining said pipes externally of the housing to form a continuous coil having an inlet and an outlet, said headers extending from the housing to a point closely adjacent the walls of the blast cooling compartment, longitudinal fins on said pipes within the housing, said fins being more widely spaced in the first compartment and less widely spaced in each succeeding compartment in the series.

3. The unit of claim 2 wherein the inlet to the evaporator coil is formed into a series of flat loops lying adjacent the bottom of said housing.

ROBERT H. BISHOP.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,524,520	Junkers	Jan. 27, 1925
2,047,249	Ballard	July 14, 1936
2,200,502	Johnson	May 14, 1940
2,320,265	Clerc	May 25, 1943