

[54] **PORTABLE CRYOGENIC FLUID IMMERSION-TYPE FREEZER**

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 [58] **Field of Search** 62/63, 266, 374, 375, 378, 62/381; 198/33 AD, 25

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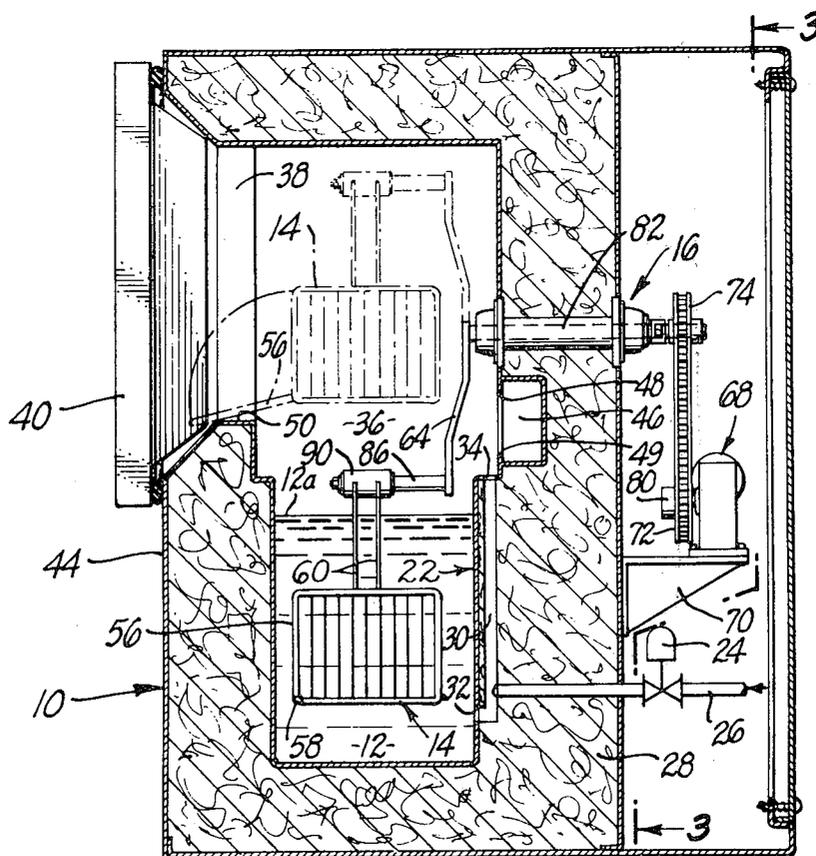
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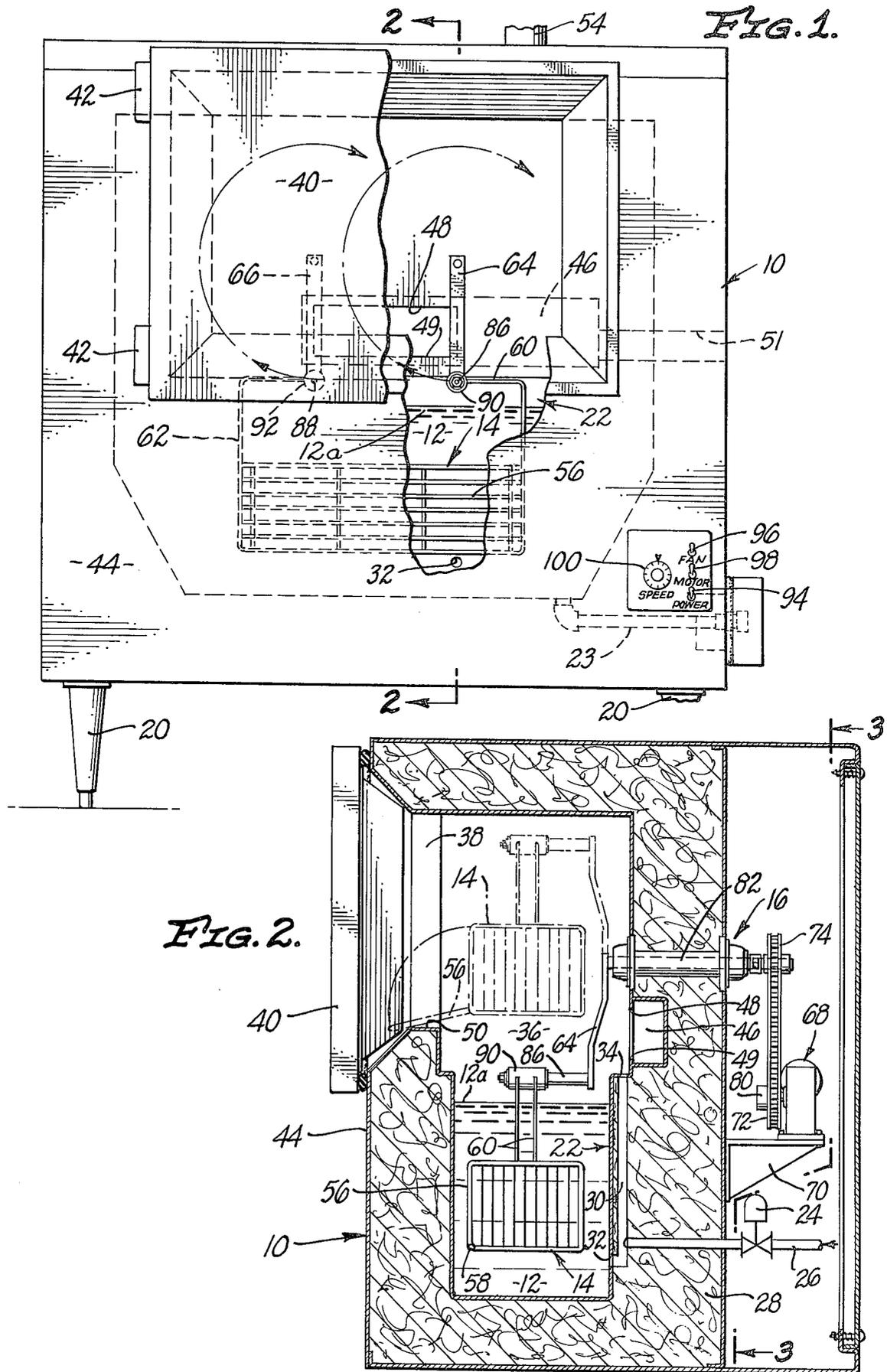
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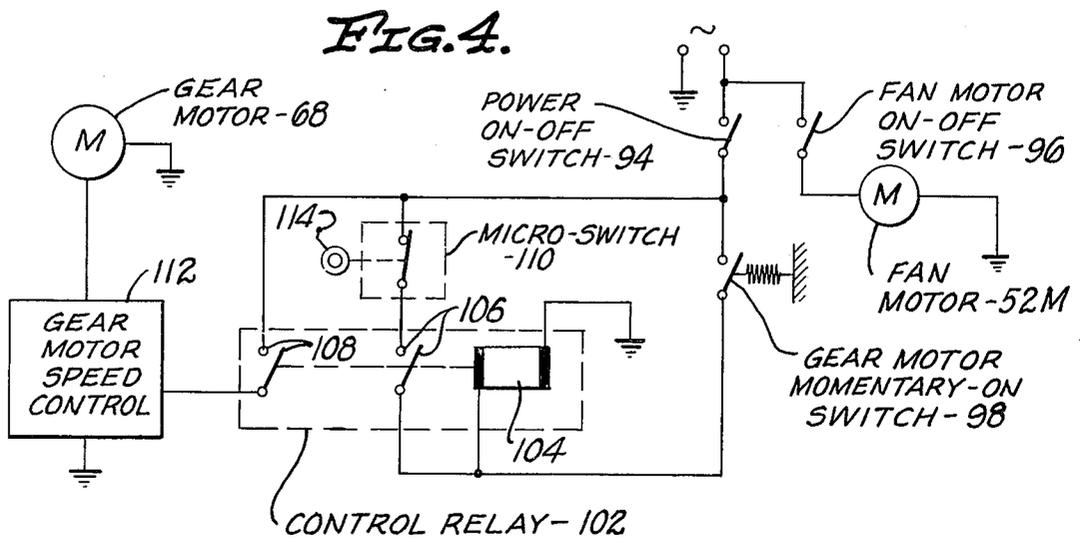
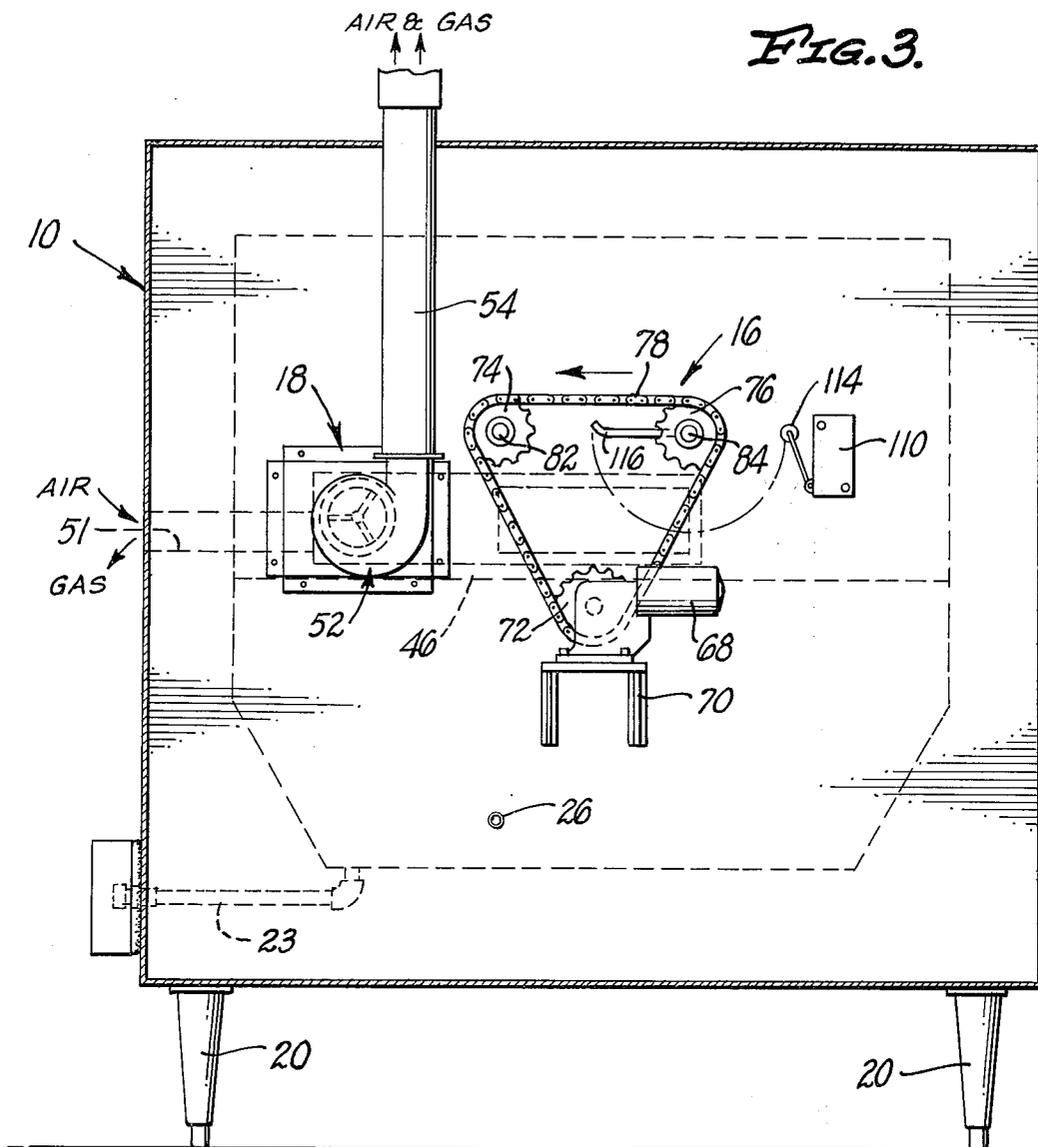
[57] **ABSTRACT**

A portable cryogenic fluid immersion-type freezer comprising an insulated enclosure including a lower compartment containing a bath of cryogenic liquid, an upper compartment open to the lower compartment for containing cold vapor from the cryogenic bath, a front door for access to the upper compartment and a cold gas exhaust duct in a back of the enclosure having an inner end open to the upper compartment below a lowermost edge of the door and an outer end open to a side of the enclosure. A support member for carrying articles to be frozen upon immersion in the bath is supported entirely within the enclosure and driven by means operable from outside the enclosure between the upper compartment adjacent the door where articles to be frozen may be placed on the support means and the lower compartment where the articles may be fully immersed and frozen in the bath. A fan is coupled to the cold gas exhaust duct for simultaneously drawing cold gas from inside the enclosure and relatively warm air from outside the enclosure through opposite ends of the gas exhaust duct for discharge through an external exhaust port.

7 Claims, 4 Drawing Figures







PORTABLE CRYOGENIC FLUID IMMERSION-TYPE FREEZER

The present invention relates to quick freezing apparatus and more particularly to a portable cryogenic fluid immersion-type freezer particularly useful in the quick freezing of foods and other articles.

In freezing foods and the like, it has been found through years of experience that normally the quicker the foods are frozen the better the resulting quality of the foods. Cryogenic fluids such as liquid nitrogen, carbon dioxide, and others offer an excellent vehicle for quick freezing due to their temperature range from -100° to -400° F. Further, freezing with such fluids basically is a simple process. For example, products such as meat, fruit or vegetables may be loaded on or hung from a conveyor and either immersed in or sprayed with a cryogenic fluid for a longer or shorter time to produce a greater or lesser degree of freezing.

While the basic process of freezing with cryogenic fluids is very simple, in the past, the mechanisms for effecting such freezing have been very large, rather complicated, and relatively inefficient. For example, in such mechanisms, relatively large precooling spray or coldroom stages are often employed prior to the bath of cryogenic fluid into which the food items are immersed. Further, in such mechanisms, the conveyor for the food items is usually circulated into and out of the spray and bath regions such that only a relatively small portion of the conveyor is exposed to or immersed in the cryogenic fluid at any one time. Thus, large quantities of cryogenic fluid are required just to cool the conveyor. This is highly wasteful of cryogenic fluid and significantly lowers the efficiency and increases the costs of the overall freezing operation.

Not only are prior mechanisms for effecting quick freezing with cryogenic fluids large and inefficient, they are also very expensive stationary units. There are many situations, however, where relatively light weight portable and inexpensive cryogenic freezers might be usefully employed. For example, relatively light weight, portable cryogenic freezers could eliminate the need for large cooling and freezing lockers and tanks on board most commercial fishing boats and in small meat, fruit and vegetable processing plants.

Accordingly, to overcome the foregoing problems and shortcomings associated with prior cryogenic fluid freezing apparatus, it is an object of the present invention to provide a portable, relatively inexpensive yet highly efficient cryogenic fluid immersion-type freezer particularly suited to the quick freezing of food items.

Another object of the present invention is to provide such a portable cryogenic freezer wherein the support means for the food items is maintained at all times within an insulated enclosure for transporting food items into and out of a bath of cryogenic fluid contained in a lower compartment of the enclosure.

A further object of the invention is to provide a portable cryogenic freezer of the foregoing character wherein the drive for the support means is outside the insulated enclosure and drives the support means along a circular path from a door in the enclosure where the support may receive items to be frozen, downward into the bath to freeze the items, and back up to the door where the support is stopped to permit withdrawal of the frozen items through the door.

Still another object of the present invention is to provide a portable freezer of the foregoing character in-

cluding a gas venting system which minimizes the escape of cold gas through the open door during the loading and unloading of food items and which prevents frost build-up at the door and any related problems of freezing door gaskets and seals.

A still further object of the present invention is to provide a portable cryogenic freezer of the foregoing character wherein the gas venting system includes an exhaust duct in a side of the enclosure with an open inner end below a lowermost edge of the door and a fan for drawing cold gas from inside the enclosure and warmer gas from outside the enclosure and discharging the combination through an external port.

The foregoing as well as other objects and advantages of the present invention may be more clearly understood by reference to the following detailed description when considered with the drawings which, by way of example only, illustrate one form of portable cryogenic fluid immersion-type freezer embodying the features of the present invention.

In the drawings:

FIG. 1 is a front view of the portable freezer with a portion of the door and front wall broken away to expose the interior of the freezer;

FIG. 2 is a sectional side view of the freezer taken along the line 2—2 in FIG. 1;

FIG. 3 is a sectional rear view of the portable freezer taken along the line 3—3 in FIG. 2 and showing the drive for the support means in the insulated enclosure of the freezer and the fan and exhaust ducts of the gas venting system; and

FIG. 4 is an electrical wiring diagram for the drive and fan motors of the freezer.

Generally speaking, to accomplish the foregoing objects, the freezer of the present invention basically includes an insulated enclosure 10 containing a bath 12 of cryogenic liquid. In operation, the bath freezes items on a support 14 as the support is moved into and out of the bath by a drive system 16. To maintain a high cold-transfer efficiency of freezer operation and to reduce to a minimum the escape of cold gas vapor through a door 40 in the enclosure 10 during loading and unloading of the freezer, cold gas vapors produced during freezer operation are withdrawn from the enclosure by a gas venting system 18.

More particularly, the enclosure 10 is a generally rectangular hollow box-like structure having four extendable legs 20 for supporting the enclosure on a table or floor as desired. Within the enclosure 10 is a generally rectangular lower compartment 22 having a bottom drain pipe 23 and adapted to contain the cryogenic bath 12 to a level generally indicated at 12a. In this regard, the freezer may include a conventional automatic fluid level control system (not shown) for regulating the opening and closing of a valve 24 in a fluid supply line 26 into a bottom of a lower compartment 22 to maintain the level of the cryogenic fluid at about 12a.

Note that in the illustrated form of the freezer, the supply line 26 is through a back 28 of the enclosure and opens into a duct 30 having a lower end 32 open to the lower compartment 22 adjacent its bottom and an upper end open to an upper compartment 36 in the enclosure 10. The purpose of the duct 30 is to separate cold gas vapor developed during supply of the cryogenic fluid to the bath 12 from the cryogenic fluid and to prevent gas bubbling in the bath and at the surface 12a. In these regards, the cryogenic fluid may be liquid nitrogen at about -300° F. and the gas may be cold ni-

trogen gas. Normally liquid nitrogen is maintained in supply tanks at a pressure of 15 to 30 psi above atmospheric pressure. When such liquid nitrogen is introduced through the valve 24, the pressure drop to atmospheric pressure causes vaporization of a portion of the liquid nitrogen. The cold nitrogen gas is vented by the duct 30 to the upper compartment for exhausting by the system 18 rather than entering the bath 12 and causing undesired "boiling" action in the bath.

As mentioned, in addition to the lower compartment 22, the enclosure 10 includes the upper compartment 36. The upper compartment is generally rectangular and is open to and above the lower compartment 22. Access to the upper compartment 36 is provided by a rectangular front opening 38 in the upper compartment which is normally closed and sealed by a door 40 hinged at its left side at 42 to a front 44 of the enclosure. The upper compartment is adapted to contain gas vapor emanating from the bath 12 and from the supply line 26 for evacuation from the enclosure by the gas venting system 18.

The gas venting system 18 is located in the back 28 of the enclosure 10 and includes a generally horizontal gas exhaust duct 46. The duct 46 includes a rectangular inner end 48 open to the upper compartment 36 with a lower edge 49 below a lowermost edge 50 of the rectangular opening 38 for the door 40, and an outer end 51 open to a side of the enclosure and to atmosphere. In addition, the gas venting system 18 includes a motor driven fan 52, such as a conventional squirrel cage fan, secured to the back 28 of the enclosure 10 with its intake open and coupled to the gas exhaust duct 46 and its outlet connected to a vertical duct 54 to atmosphere.

When the freezer is not in operation, the motor driven fan 52 is deenergized. Any cold gas vapor formed within the enclosure 10 from the bath 12 rises slowly above the cryogenic fluid level 12a. Such gas vapor is heavier than air and therefore its rise is rather slow. As the gas vapor continues to rise, it reaches the lower edge 49 of the open inner end 48 of the gas exhaust duct 46. The gas vapor then flows into the gas exhaust duct 46 and by gravity out of the enclosure through the open outer end 51 of the duct. (See downwardly directed arrow labeled "GAS" in FIG. 3.) Such gravity flow of cold gas vapor from the enclosure 10 is from a point below the lowermost edge 50 of the front opening 38. This means that when an operator opens the door 40 to load the support 14 with items to be frozen, cold gas vapor does not flow through the open door onto the operator or the supporting table or floor. The exhausting of the upper compartment 36 from below the level of the door 40 also substantially eliminates the escape of cold gas vapor through the open door after a period of freezer operation as when the operator desires to remove frozen items from the support 14.

More particularly, when the freezer is in operation to freeze food or other items, and/or when cryogenic fluid is being introduced into the enclosure through the supply line 26, relatively large quantities of cold gas vapor may be produced as the cryogenic fluid comes in contact with warmer objects. In fact, during freezer operation, unless the gas vapor is evacuated, it will rapidly fill the upper compartment 36 and create a vapor pressure retarding the cold exchange and freezing operations within the freezer. Further, such cold gas vapor filling the upper compartment would flow through the

door 40 when operated to either load or remove items from the support 14. Accordingly, during the operation of the freezer of the present invention, the motor driven fan 52 is energized to rapidly draw cold gas vapor from the upper compartment 36 through the open end 48 of the gas exhaust duct 46, and to blow the gas through the vertical duct 54 to atmosphere. This maintains the level of cold gas vapor below the door 40 and eliminates any undesired vapor pressure buildup in the upper compartment. By itself, however, such exhausting of cold gas vapor would freeze and hence prevent operation of the motor driven fan 52. In the gas venting system 18 of the present invention, while the fan 52 is drawing cold gas vapor from the upper compartment 36 it is simultaneously drawing warm air through the open end 51 of the exhaust duct 46. The warm air combines with and heats the cold gas vapor to a temperature which can be comfortably handled by the fan, the combination of warm air and cold gas being exhausted through the vertical duct 54 as indicated in FIG. 3.

In the illustrated and preferred form of the present invention, the support 14 is a wire basket maintained at all times within the enclosure 10 either in the upper compartment 36 where it is subject to cold gas vapor or in the lower compartment where it is immersed in the cryogenic bath 12. Preferably, the basket as well as all other metal parts in the support 14 and those portions of the drive 16 within the enclosure are formed of stainless steel or other metals having a low heat conductivity. Because of this, little cryogenic fluid is required to cool the support 14 and other metal parts in the enclosure 10 thereby reducing to a minimum the quantities of cryogenic fluid required for freezing operations and improving the efficiency of the freezer particularly when compared with conventional quick freezing mechanisms employing cryogenic fluids.

As illustrated in FIG. 2, the wire basket includes a front 56 hinged at its lower edge 58 for raising and lowering to rest on the lowermost edge 50 of the opening 38. In this regard, the front 56 of the basket acts as a ramp for loading and unloading of items into or from the basket. Further, the basket includes two pair of similar hanger arms 60 and 62 extending vertically from the right and left sides of the basket and bending inwardly toward each other for connection to two identical vertically extending support arms 64 and 66 forming a part of the drive 16.

In addition to the support arms 64 and 66, the drive 16 includes a gear motor 68 supported on a bracket 70 secured to the back wall 28 of the enclosure; a drive gear 72; two driven gears 74 and 76; and a drive chain 78. The drive gear is connected to a drive shaft 80 of the gear motor 68 while the driven gears are secured to ends of first and second horizontal, coplanar drive shafts 82 and 84. The drive shafts 82 and 84 are journaled in and extend through the back of the upper compartment 36 for drive connection to ends of the support arms 64 and 66, respectively. The drive chain 78 is trained around the drive and driven gears in a continuous manner such that operation of the gear motor 68 produces a turning of the drive and driven gears in synchronism to produce a turning of the support arms 64 and 66. In these regards, the support arms are secured to the drive shafts in such a manner as always to be parallel to each other and at all times to support the basket in a horizontal condition while moving the basket along a circular path between the upper and lower compart-

ments. To accomplish this, the ends of the support arms 64 and 66 opposite the drive shafts 82 and 84 carry forwardly and horizontally extending rods 86 and 88 and sleeves 90 and 92 for turning on the rods 86 and 88, respectively. Upper ends of the hanger arms 60 and 62 from the basket connect to the sleeves 90 and 92, respectively, to complete pivotal connections for the hanger arms to the support arms.

It is a feature of the drive 16 for a preferred form of the present invention that the rate of movement of the basket between the upper and lower compartments and hence the dwell time of the basket within the cryogenic bath 12 is variable and that basket automatically halts adjacent the opening 38 for the door 40 after each cycle of movement between the upper and lower compartments. To provide these features, the freezer includes the electrical circuit shown in FIG. 4 controlled by three switches 94, 96 and 98, and a control dial 100 on the front of the enclosure 10 as shown in FIG. 1. The switches 94 and 96 comprise the power on-off switch for the electrical circuit and the on-off switch for the fan motor 52*m* and are connected in parallel to a conventional source of alternating current. Thus, when it is desired to start the fan motor, the operator simply closes the fan motor switch 96. When it is desired to provide power to the freezer, the operator simply closes the power switch 94.

The switch 98 is in series with the power switch and comprises a gear motor momentary on switch. A closing of the momentary on switch 98 supplies power to a control relay 102 including a coil 104 and two pair of normally open contacts 106 and 108. Current passing through the coil 104 produces a closing of the pairs of contacts to complete electrical circuits from the power source to the coil through a normally closed microswitch 110 and to the gear motor 68 through a conventional gear motor speed control device 112 including the control dial 100.

By virtue of the closed circuit to the coil 104 through the microswitch 110 and closed contacts 106, the control relay remains actuated despite the opening of a momentary on switch 98. Thus, the drive 16 including the gear motor 68 will remain energized until such time as the microswitch 110 is open. In this regard, the microswitch and a control contact 114 therefore are mounted on the back wall 28 of the enclosure 10 adjacent the drive shaft 84 and driven gear 76 (see FIG. 3). A control arm 116 is secured to the drive shaft 84 such that a turning of the drive shaft will bring the control arm into contact with the microswitch contact 114 once each complete revolution of the drive shaft. The rotational position of the control arm 116 on the drive shaft is set such that the control arm will engage the microswitch contact 114 when the basket is about at its uppermost position in the upper compartment 36. When this occurs, the microswitch is momentarily opened to deenergize the control relay 102 and open the pairs of contacts 106 and 108. This immediately deenergizes the gear motor 68 such that a reclosing of the microswitch will not reenergize the drive 16—it remaining for an additional manual closing of the momentary on switch 98 to effect such a reenergizing of the drive. Thus, the basket is halted after each complete cycle of movement from the upper compartment 36 adjacent the door 40 where items to be frozen may be placed in the basket and again when the basket is in its uppermost position having returned from the cryo-

genic bath 12 with the items now frozen and ready for removal from the freezer.

Because of the self-contained compact box-like structure of the freezer of the present invention and because of its high efficiency and speed of operation, it may be produced in extremely small sizes such as 4 by 4 by 3 feet to freeze about 1,000 pounds of food items each hour at a cost per unit of less than 20 percent of conventional cryogenic immersion-type freezers. This renders the present invention extremely useful as a light weight portable freezer on board commercial fishing boats and in small meat, fruit and vegetable processing plants to replace or eliminate the need for large cooling and freezing lockers or expensive cryogenic freezers for processing such food items.

While a particular form of freezer has been described in some detail herein, it is appreciated that changes and modifications may be made in the illustrated form without departing from the spirit of the invention. Accordingly, it is intended that the present invention be limited in scope only by the terms of the following claims.

I claim:

1. A portable cryogenic fluid immersion-type freezer comprising:

an insulated enclosure including a lower compartment for containing a bath of cryogenic fluid, an upper compartment open to said lower compartment for containing vapor from said bath, and a door for access to said upper compartment;

a gas exhaust duct in said enclosure having an inner end open to said upper compartment with a lowermost edge below a lowermost edge of said door, and having an outer end open to a side of said enclosure such that gas vapor in said upper compartment flows into said exhaust duct and by gravity out of said enclosure rather than out through said door when open;

support means in said enclosure;

drive means operable from outside said enclosure for reciprocating said support means between said upper compartment adjacent said door where articles to be frozen may be placed thereon and frozen articles may be removed therefrom through said door when open, and said lower compartment where articles on said support means are fully immersed in said bath; and

an external exhaust port and fan means having an open intake coupled to said gas exhaust duct for simultaneously drawing cold gas from inside said enclosure through said inner end of said gas exhaust duct and relatively warm gas from outside said enclosure through said outer end of said gas exhaust duct and having an outlet connected to said exhaust port for discharging said cold gas and said warm gas through said external exhaust port such that said warm gas heats said cold gas at said intake of said fan means.

2. A portable cryogenic fluid immersion-type freezer comprising:

an insulated enclosure including a lower compartment for containing a bath of cryogenic fluid, an upper compartment open to said lower compartment for containing vapor from said bath, and a door for access to said upper compartment;

support means in said enclosure; and

drive means operable from outside said enclosure for reciprocating said support means between said upper compartment adjacent said door where arti-

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cles to be frozen may be placed thereon and frozen articles may be removed therefrom through said door when open, and said lower compartment where articles on said support means are fully immersed in said bath;

said support means including a horizontally extending support member for carrying articles to be frozen in said bath; and

said drive means including

first and second vertically extending arms pivotally connected at their lower ends at opposite sides of said support member to maintain said support member horizontal and

means connected to upper ends of said first and second arms for simultaneously driving said arms in similar circular paths to move said horizontally maintained support member between said upper and lower compartments.

3. The freezer of claim 2 wherein said freezer further includes control means for halting said drive means upon each revolution of said support member at said upper compartment adjacent said door for unloading and loading of articles from said support member.

4. The freezer of claim 2 wherein said drive means includes

first and second drive shafts extending horizontally in a common plane through a back of said enclosure to connect to upper ends of said first and second arms respectively to support and maintain said arms parallel, and

motor drive means for turning said first and second drive shafts in unison to move said horizontally maintained support member in a circular path to carry articles to be frozen into and out of said bath.

5. The freezer of claim 4 wherein:

said enclosure further includes a gas exhaust duct having an inner end open to a back of said upper compartment below a lowermost edge of said door and an outer end open to a side of said enclosure, said door being in a front of said enclosure; and said freezer further comprises fan means coupled to said gas exhaust duct for simultaneously drawing cold gas from inside said enclosure and relatively warm gas from outside said enclosure through opposite ends of said gas exhaust duct to discharge same through an external exhaust port.

6. The freezer of claim 5 further comprising electrical circuit means for powering said motor drive means including a normally closed switch means for opening to deenergize said motor drive means upon each revolution of said first and second drive shafts to halt said horizontally maintained support member in said upper compartment adjacent said front door for unloading and loading of articles from said support member.

7. The freezer of claim 6 wherein said support member comprises a wire basket having a front hinged at its lower edge to swing onto a bottom sill of said door to function as a slide for transporting articles to and from said basket.

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