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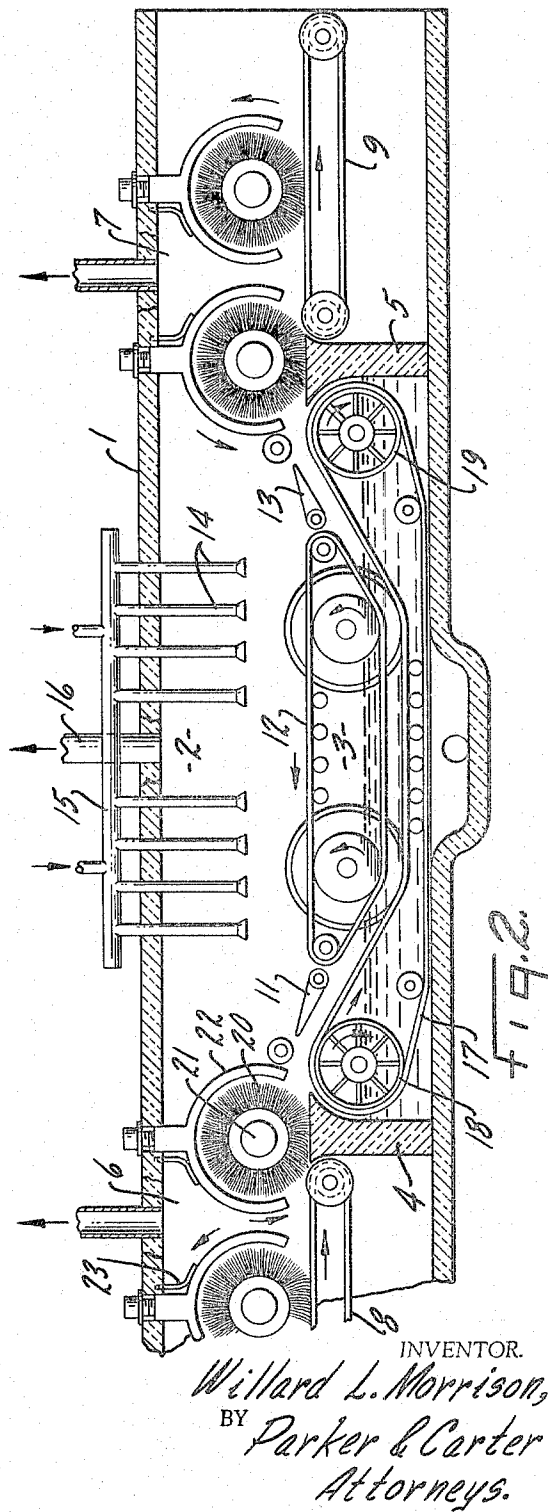
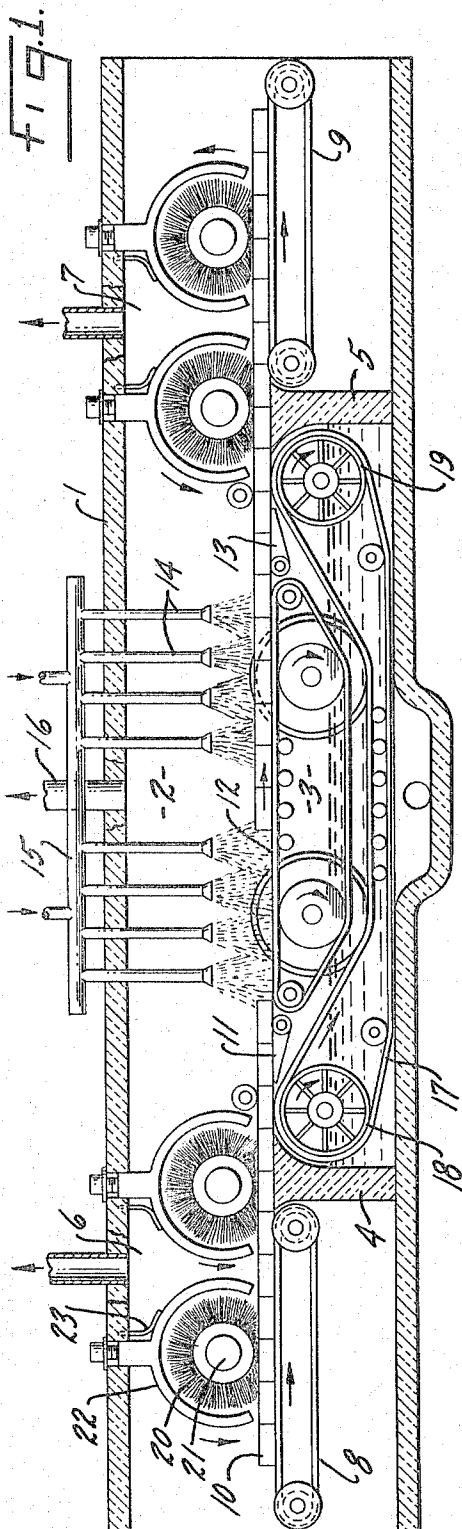
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METHOD AND APPARATUS FOR FREEZING PERISHABLE MATERIAL

Filed Jan. 12, 1965

2 Sheets-Sheet 1



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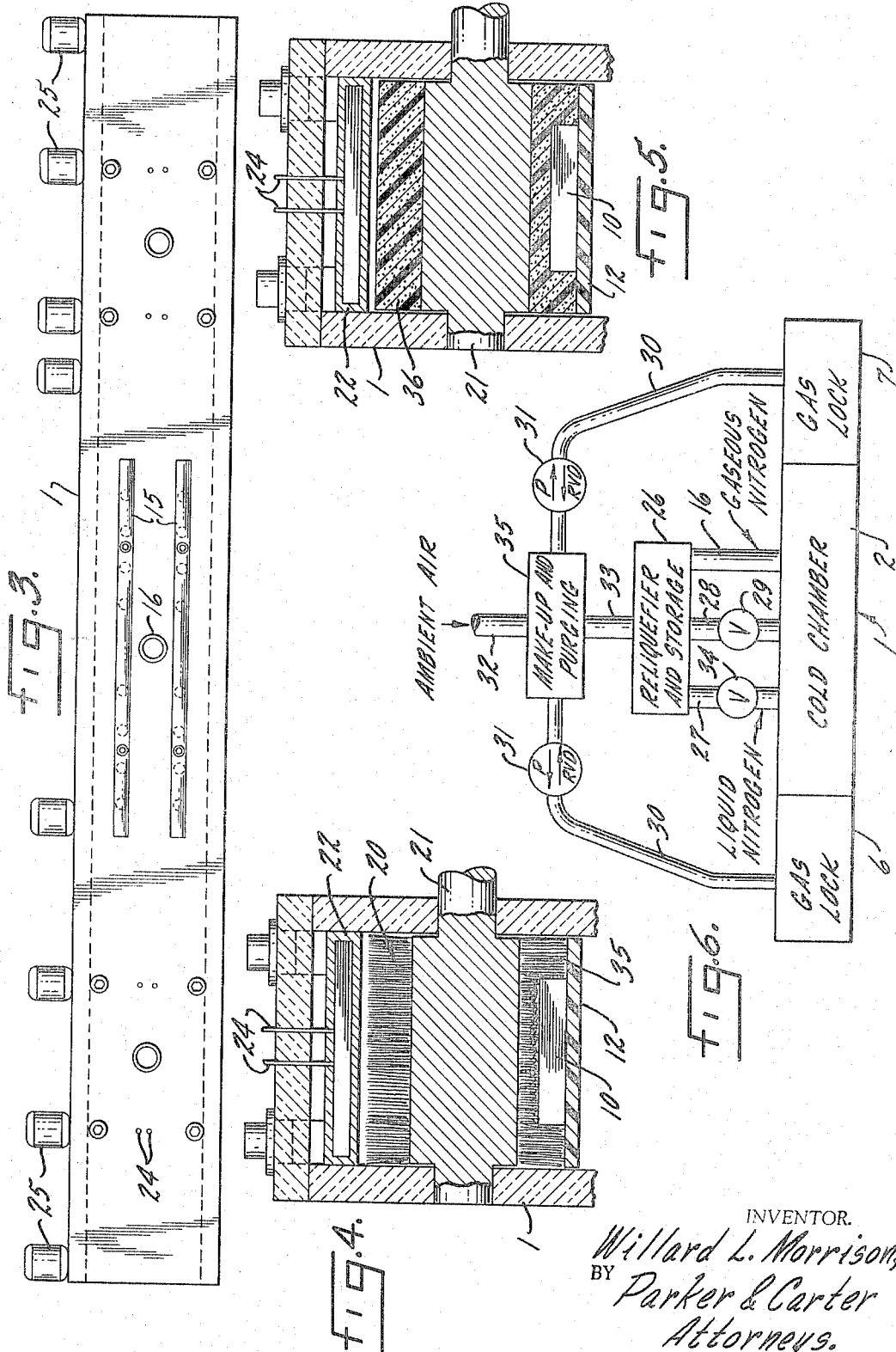
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3,302,423

METHOD AND APPARATUS FOR FREEZING PERISHABLE MATERIAL

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3 Claims. (Cl. 62-266)

This invention relates to improvements in method of and apparatus for freezing perishable material and has for one object to provide a method and apparatus whereby perishable material may selectively, at the will of the operator, under atmospheric pressure, be immersed in a bath of liquid nitrogen or other cold boiling liquid inert to the material, or may be subjected to a rain of such liquid.

Another object is to provide a gas lock whereby the gas vaporized from the liquid by the heat of the relatively warm material being treated may be kept within the treatment chamber without substantial loss of gas and without substantial entrance of ambient air so that gas may be reliquefied for reuse in the system.

This invention is an improvement on Patent No. 3,090,134 issued May 21, 1963, in the name of Willard L. Morrison.

In freezing material according to the present invention, a series of packages of material to be frozen are continuously fed into, through and discharged from a treatment chamber, preferably by a conveyor system. The packages pass through gas locks as they enter and as they are discharged from the chamber.

Each gas lock includes a lock chamber preferably under a controlled pressure, closed at each end by a compressible roller which contacts the floor of the gas lock along which the package travels and yields to permit the packages to pass along the floor.

The rollers closing the outer ends of the gas locks are exposed to ambient air at atmospheric pressure. The rollers at the inner ends of the gas locks are exposed to the cold gas evaporated from the liquid nitrogen in the treatment chamber. As each package enters the entrance gas lock chamber, it may carry with it some ambient air and there may be some leakage of ambient air into the chamber through or around the roller. Some gas may also be drawn into the lock chamber from the cold chamber to mix with the ambient air.

As each package enters the exit gas lock chamber it carries with it some nitrogen gas from the treatment chamber and some ambient air may enter the chamber.

The rollers must be maintained continuously in a soft, flexible condition. The two rollers adjacent the treating chamber are exposed directly to the cold conditions therein. The outer roller on the discharge lock is also exposed to contact with the cold packages. As a result there is danger that the soft material may be frozen, become stiff and hard and lose its insulating and material swallowing effect. Hence the rollers are shrouded and the shrouds are heated so that the rollers themselves even though exposed to cold conditions remain in a soft, pliable, compressible condition.

The gaseous nitrogen boiled off from the liquid at substantially atmospheric pressure may be withdrawn from the freezing chamber to be reliquefied and returned for further use. The gas lock chambers may contain some diluents for example air and water vapor as well as nitrogen. If the nitrogen from the vapor lock chambers is to be reliquefied, it must first be purged of those diluents. As the frozen material is discharged from the system it may carry with it some nitrogen which must be replaced.

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The system therefore must include a reliquefying means, purging means and nitrogen make-up means. The gas from the freezing chamber will be reliquefied for reuse. The gas from the lock chambers may be wasted or may be taken into the purging and reliquefying system to be mixed with make-up nitrogen before reliquefaction. A suitable purging make-up and reliquefying system is disclosed in Patent No. 2,926,501 to Willard L. Morrison.

The pressure in each vacuum chamber is controllable. Under some circumstances it could well be slightly below atmospheric. Under other circumstances it could be slightly above atmospheric or it might actually be maintained at substantially atmospheric as is the cold chamber. The essential thing is that the entrance of ambient air into the cold chamber and the escape of gaseous nitrogen from the cold chamber be inhibited and the pressure in the lock chambers and the supply of nitrogen to or the withdrawal of gas from the chamber is under the control of the operator dependent upon the conditions of operation.

The apparatus disclosed is directed in detail to a situation where the packages may travel along a horizontal path in a straight line when exposed to the rain of liquid nitrogen or may be downwardly deflected in the same vertical plane for immersion in the bath. Other switching arrangements would be equally satisfactory. The material might be guided upwardly into a rain area or laterally into a rain area. The position of the bath might be changed. There might be two parallel paths into the cool chamber through the gas locks. Many details of routing might be used. The essential point is that a single cold freezing unit may be used to cause nitrogen to be rained on the food or to cause the food to be immersed in a nitrogen bath and the control of conditions and the purging, reliquefaction and provision of make-up gas can all be assembled in a single unit.

Other objects will appear from time to time throughout the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings, wherein

FIGURE 1 is a longitudinal diagrammatic section through the freezing apparatus illustrating the application of liquid rain or coolant;

FIGURE 2 is a similar section through the apparatus illustrating the use of a bath of coolant in the same treatment chamber;

FIGURE 3 is a plan view of the device;

FIGURE 4 is a vertical section on an enlarged scale through one form of gas lock roller and associated parts;

FIGURE 5 is a section similar to FIGURE 4 through a different form of roller;

FIGURE 6 is a flow sheet.

Like parts are indicated by like numerals throughout the specification and drawings.

The treatment chamber

The insulated housing 1 takes the form of an elongated tunnel which contains intermediate its ends a freezing chamber 2, having in the bottom thereof a bath 3, the bath being bounded at each end by vertical walls 4 and 5. In the tunnel are an entry gas lock chamber 6 and an exit gas lock chamber 7. The inner ends of the chambers are immediately above the walls 4 and 5. An intake conveyor belt 8 terminating at the wall 4 and a discharge belt conveyor 9, terminating at the wall 5 make sealing contact with the tunnel walls, define the floors of the gas lock chambers 6 and 7 and extend outwardly to the intake and discharge ends of the tunnel.

A stream 10 of packages or of material in other forms to be frozen are placed upon the conveyor 8 by any suitable means, manual or otherwise and are fed inwardly

through the gas lock 6 across an angularly adjustable switch blade 11, onto a conveyor belt 12 in the freezing chamber, across an angularly adjustable switch blade 13 into the gas lock 7 to the discharge belt 9 for discharge from the tunnel. Material traveling as above indicated is subjected to a rain of liquid coolant, for example liquid nitrogen at atmospheric pressure, discharged through nozzles 14, fed by the manifold 15 receiving liquid nitrogen from any suitable source as will be hereinafter discussed. The heat of the relatively warm material vaporizes the liquid nitrogen and the vapor is discharged from the freezing chamber through the duct 16. If any of the liquid is not vaporized it will fall as a liquid into the bath 3.

If the material to be frozen can better be treated by immersion in a bath rather than by a rain of the liquid, the switch blades 11 and 13 are rotated into the position shown in FIGURE 2. The drive for the belt conveyor 12 is reversed. The belt conveyor 17 traveling in the direction of the arrows shown in FIGURES 1 and 2 conveys the material under the switch blade 10 onto the bath. The conveyors 12 and 17 traveling in the same direction at the same rate of speed hold the packages immersed, carry them through the bath and the packages then pass out under the switch blade 13 for discharge into the gas lock 7 to be fed out of the tunnel by the exit or discharge conveyor 9.

The belt conveyor 17 immersed in the bath travels over pulleys 18 and 19 immediately adjacent the vertical walls 4 and 5. The belt where it passes over the pulleys 18 and 19 supports the material being fed as it leaves or enters the relatively short distance across the walls 4 and 5 and assists in the propulsion of the stream of packages across the switch blades 11 and 13 to and from the conveyor 12. The conveyor 17 always travels in the same direction as the belts 8 and 9.

The gas lock

The gas locks 6 and 7 are identical and a description of one will suffice for both. Each lock includes at each end spaced, soft, flexible, compressible rollers 20 on shafts 21, bounding respectively the entry and discharge vacuum chambers 6 and 7.

All the rollers are driven in counter-clockwise direction, they may be made of a multiplicity of closely spaced radially extending fingers. If they are made of bristles, they can bend tangentially. If the fingers are compressible, extendable, intercellular plastic, they can bend tangentially and be compressed radially. The roller may also be made of a solid mass of compressible intercellular plastic or of grouped layers of the plastic. All of these arrangements have in common that while the periphery of each roller is in contact with the floor along which the food travels, the rollers yield as the packages go through to swallow the packages up in order to inhibit, if not completely prevent gas movement as the packages pass into and out of the gas locks.

That part of the roller in contact with the package assists in moving each package forwardly. The shafts 21 are rotatably mounted in the side walls of the tunnel. Shrouds 22 may be raised and lowered as indicated to compensate when necessary for food packages of different thickness. Flexible sealing flaps 23 close the space between the top of the shroud and the top of the tunnel. Each shroud is warmed by electric resistance elements contained therein, supplied with current through electric conductors 24.

The conveyors and the rollers are driven by variable speed motors 25 indicated diagrammatically, at least one of them being reversible. The wiring control for such motors is conventional and its details form no part of the present invention and are therefore not illustrated.

Referring to the flow sheet, gas evaporated from the liquid either in the bath or in the rain passes out through

duct 16 to the reliquefier and storage system 26. The gas is liquefied and stored in the system for return to the cold chamber through a liquid nitrogen duct 27 which supplies the spray heads 14. Liquid nitrogen is also discharged to the bath through the duct 28 through the flow control valve 29. Ducts 30 controlled by variable speed reversible pumps 31 lead from the gas locks 6 and 7 to the make-up and purging system where gas from the locks 6 and 7 is purged to free it from diluents and mixed with make-up nitrogen drawn from ambient air through the duct 32. The resultant purged substantially pure nitrogen gas is supplied to the reliquefier and storage system through the duct 33. The valve 29 maintains the level of liquid in the bath substantially constant. The valve 34 in the duct 27 may be manually manipulated to control the flow of raining liquid to maintain the pressure in the system at substantially atmospheric.

Under ordinary circumstances, the pumps 31 will be operated to maintain a slight vacuum on the gas locks 6 and 7. The result may be some movement of gaseous nitrogen from the cold chamber to each gas lock and also entrance of ambient air into each gas lock. The gas drawn from the locks will be purged in the make-up system and no ambient air can enter the cold chamber. Under other circumstances, it might sometimes be desirable to supply nitrogen gas into the gas locks at a slight pressure. Some of that gas could escape to the cold chamber and some of it might be wasted to atmosphere. The pumps 31 give the operator the possibility of independently manipulating the pressure in each gas lock to correspond with the desired control of the situation in and at both sides of the cold chamber.

In FIGURE 4 is illustrated diagrammatically the fingers or bristle-like elements 35 making up the roller. In FIGURE 5 is illustrated a more or less solid, flexible, compressible roller mass at 36.

The fingers 35 may be made of organic or synthetic bristles, bendable but not compressible or they may be made of inter-cellular, compressible, expandable, plastic having a memory which can be compressed radially and bent or distorted or displaced tangentially.

Under some circumstances the fingers 11 and 13 will remain constantly in the position shown in FIGURE 2. Under those circumstances the conveyor 17 and the conveyor 12 will travel as indicated by the arrows in FIGURE 2 so as to urge food packages from entrance to discharge by contact above and below and hold the packages beneath the level of the bath but because the conveyor 12 is foraminous, the level of the bath can under some circumstances be lowered so that it is below the upper run of the conveyor belt 17. Under these circumstances the rain will pass through the cold foraminous belt 12 and rain upon the food as it passes above the level of the bath. Under these circumstances by manipulation of the bath level the material may be caused selectively to pass along to effectively different paths because one path would be beneath the level of the liquid in the bath and the other path would be above it, the level of the bath being controlled by manipulation of the valve 34.

I claim:

1. A freeze down apparatus which includes an insulated cold treatment chamber having a refrigerant therein, means for passing material to be frozen to and through the chamber along two paths in the chamber means for selecting one path or the other while maintaining refrigerating conditions in the chamber to thereby enable material to be passed along either one of the desired paths without termination and reestablishment of refrigerating conditions during change over from one path to the other, and means for subjecting the material as it passes along one path to a rain of liquid nitrogen and for immersing the material as it passes along the other path in a bath of liquid nitrogen.

2. A gas lock for a freezing chamber which includes a rectangular passage having a flat floor, a pair of rollers

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spaced along the passage and contacting the floor to define a gas lock chamber, means for feeding materials to be frozen along the floor, the rollers being so soft and compressible that as the material is feed along the floor it is swallowed up by and enclosed within the periphery of each roller and means for heating the rollers. 5

3. Claim 1 characterized by the fact that the guiding means includes two load carrying belts, one including a generally horizontal load carrying section above the level of the bath, the other including a load carrying section below the level of the bath, and switch means interposed between the two belts for selectively guiding the material to and from the belt section above the bath on the one hand and to and from the belt section beneath the bath on the other hand. 10 15

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