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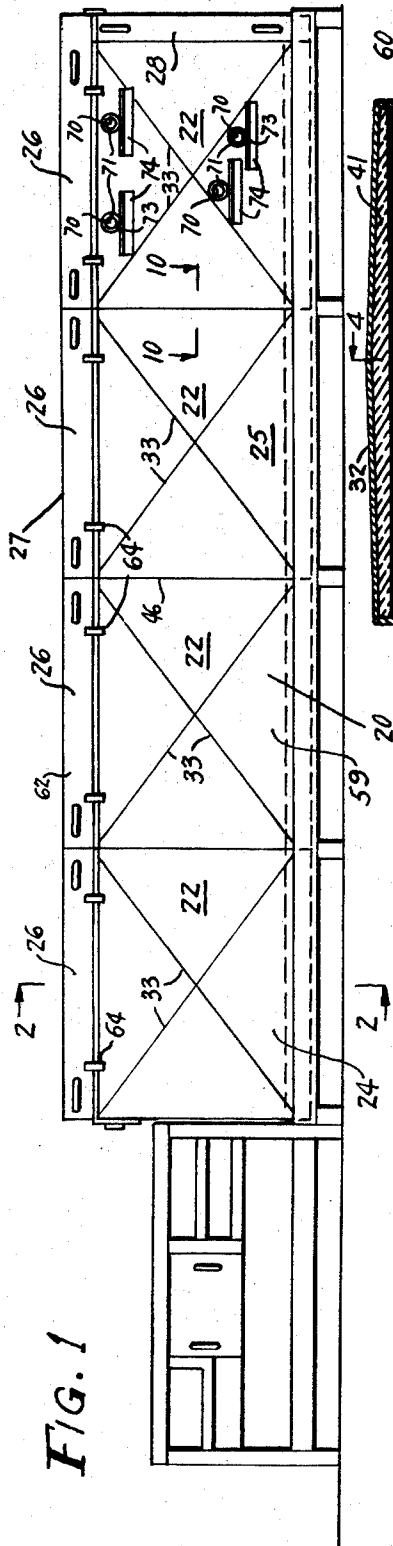
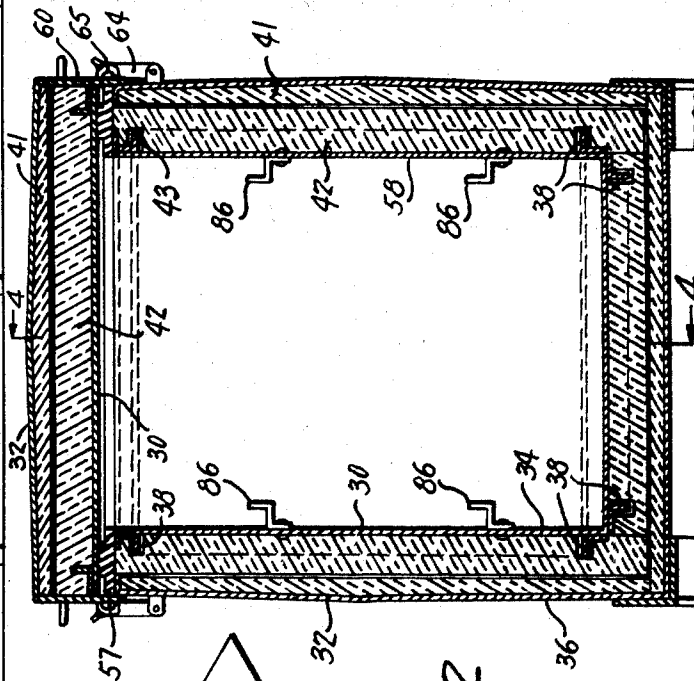
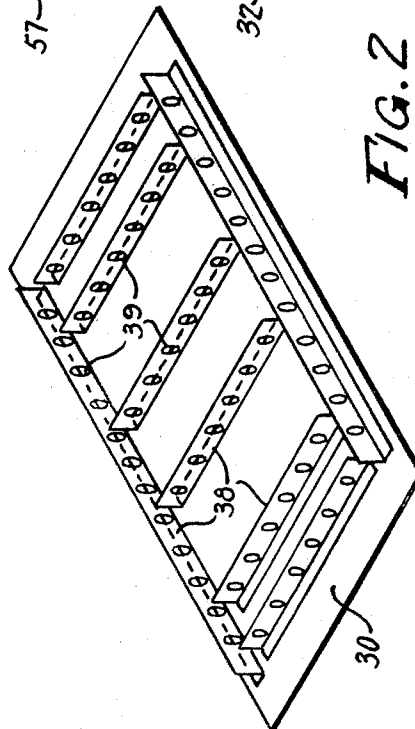
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3,472,570

MODULAR INSULATED FREEZER TUNNEL AND CONSTRUCTION METHOD

Filed Feb. 14, 1967

3 Sheets-Sheet 1



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MODULAR INSULATED FREEZER TUNNEL AND CONSTRUCTION METHOD

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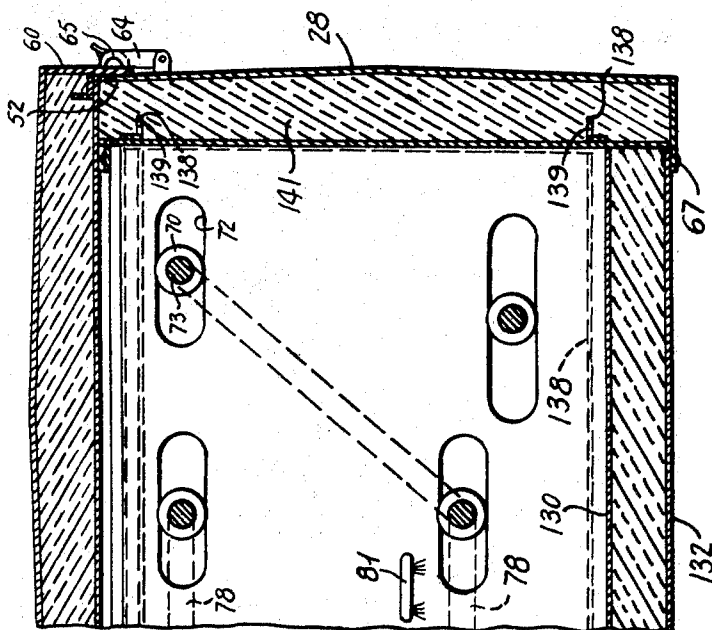


FIG. 4

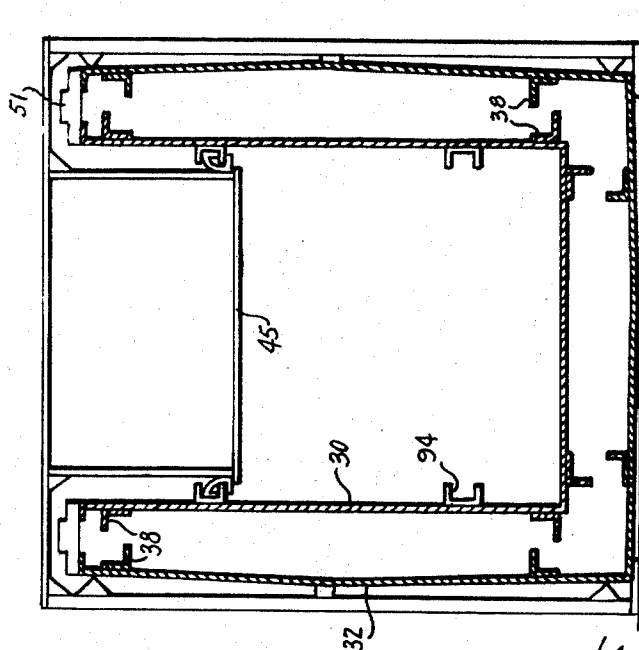


FIG. 5

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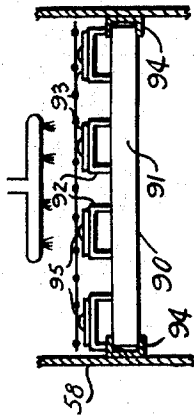
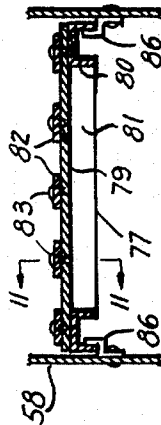
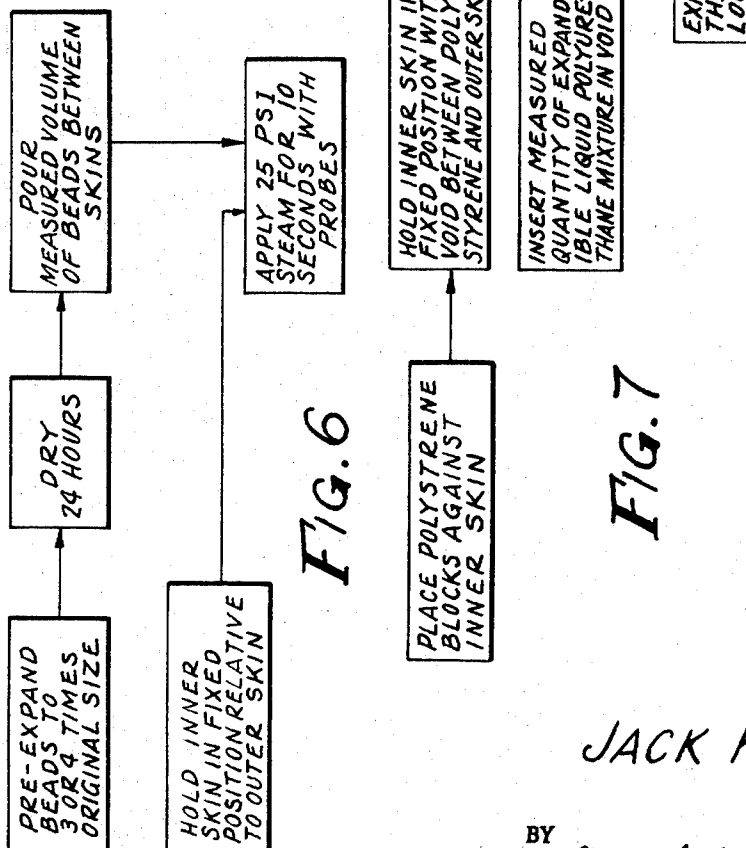
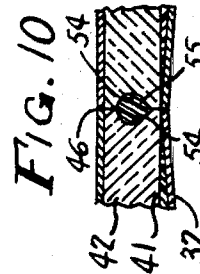
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MODULAR INSULATED FREEZER TUNNEL AND CONSTRUCTION METHOD

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3,472,570

MODULAR INSULATED FREEZER TUNNEL AND CONSTRUCTION METHOD

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20 Claims

ABSTRACT OF THE DISCLOSURE

A cryogenic cooling structure and a method of constructing the same in which a first relatively rigid structure which changes dimensions in response to temperature changes, for example, the inner metal skin of a liquid nitrogen tunnel freezer is connected to a second structure, for example, the outer metal skin of the tunnel, by a flexible mounting, for example, expandable foam plastic insulation. Similar flexible connections may be used to join other tunnel parts; for example, a brass wear plate is mounted on a stainless steel rack by a lost motion connection and the rack is loosely mounted in brackets fixed on the inner walls of the tunnel. The tunnel is made in four feet long modules to permit construction of a tunnel of any desired length.

This invention relates to the art of constructing items used under extreme temperature conditions, for example, freezers utilizing nitrogen or other cryogenic liquids such as those disclosed in my co-pending application for Continuous Freezer, Ser. No. 559,923, filed June 23, 1966.

Cryogenic liquids are those which boil at a temperature of -250°F . or less at atmospheric pressure. The possibility of freezing food with such liquids has long been recognized, but numerous practical difficulties have been experienced in constructing freezers suitable for utilizing these cryogenic liquids.

Jamming of moving parts and destruction of both fixed and moving parts have occurred because of stresses created when structurally connected members contract at different rates. These stresses are particularly destructive because at cryogenic temperatures most known materials are so brittle that they shatter easily. Parts contract at different rates when different materials, for example, stainless steel and brass, are used together. Another cause of differential contraction is the wide variation of temperatures found in different parts of the structure. For example, the temperature on the inside of a freezer utilizing nitrogen may be -320°F . The temperature on the outside may be close to ambient. As a result, in a tunnel 30 feet long, the inner skin may contract several inches while the dimensions of the outer skin are unaffected. This might cause buckling.

Insulation mounted between the inner and outer skins of such freezers has been known to be ground to bits. Parts secured to other parts by rivets have been known to shear a whole line of rivets with a sound like a machine gun. Practical commercial structures require conveyor belts. Mounting of such conveyor belts for low temperature operation is difficult. A shaft passing through a wall can be seriously damaged when the inner skin of the wall substantially contracts without the corresponding contracting of the outer skin. It is difficult to find a satisfactory supporting structure for a conveyor belt in a cooling tunnel which may be at a temperature of -320°F . at its discharge end and close to ambient at its inlet end.

Among objects of this invention are the provision of:

- (1) A method and means for insulating cooling tunnels used at cryogenic temperatures.
- (2) A cooling tunnel construction suitable for use at cryogenic temperatures.

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(3) A means for mounting a conveyor supporting rack on the interior of a cooling tunnel utilizing cryogenic fluid.

(4) A means for mounting a brass wear plate on stainless steel so as to accommodate the differential expansion rates of brass and stainless steel.

(5) A construction suitable for joining parts subject to temperature changes of greater than 150°F ., particularly in the cryogenic range.

Other objects and advantages of the invention will be apparent from the following description considered in conjunction with the accompanying drawings in which:

FIG. 1 is a side view of a cooling tunnel constructed in accordance with the present invention;

FIG. 2, a vertical sectional view on the line 2-2 of FIG. 1;

FIG. 3, a perspective illustrating the stiffener members mounted on the interior of the skin of a cooling tunnel in accordance with the present invention;

FIG. 4, a fragmentary section on the line 4-4 of FIG. 2;

FIG. 5, a sectional view similar to FIG. 2, illustrating the method by which the cooling tunnel is held during the construction process;

FIG. 6, a flow diagram illustrating the method of construction of one embodiment of the invention;

FIG. 7, a flow diagram illustrating the method of construction on another embodiment of the invention;

FIG. 8, a fragmentary vertical section through the tunnel illustrating the construction utilized for the conveyor supporting racks;

FIG. 9, a fragmentary vertical section similar to FIG. 8, illustrating a different embodiment of the conveyor supporting rack construction;

FIG. 10, a vertical section on the line 10-10 of FIG. 1, and

FIG. 11, a vertical section on the line 11-11 of FIG. 9.

Briefly stated, the invention comprises a construction in which one member is mounted to another for parallel movement relative to each other while held together. In one aspect of the invention, a cooling tunnel construction includes an inner metal and an outer metal skin. The skins are tied together by the insulation between them. The inner skin can contract at a different rate than the outer skin and thus portions of the inner skin can move parallel to the outer skin.

The invention involves a method for forming an insulation which can serve this purpose. An inner skin structure is formed and is mounted within an outer skin structure. The space between the skins is filled with a measured amount of expandable plastic beads. These beads have voids within them filled with a gas. When subjected to steam or other source of high temperature, the plastic softens and the gas expands. The beads are pre-expanded to three or four times their original size before being placed within the skin. After they are placed within the skin, steam probes are inserted and steam is applied to further expand the beads until they are united together to form a continuous expanded plastic foam insulation between the skins.

In another aspect of the invention, solid blocks of pre-expanded plastic such as polystyrene are placed against the inner skin of the tunnel. A measured amount of a liquid mixture which expands into a foam plastic is injected between the outer skin of the tunnel and the polystyrene blocks. When expanded it binds the blocks to the outer skin. The entire tunnel is constructed by joining channel-shaped modular units together to form a relatively long tunnel.

In another aspect of the invention, a Teflon bearing

for a conveyor drive shaft is secured to the outer skin of the tunnel with its inner end extending through a slot in the inner skin of the tunnel.

In another aspect of the invention, a conveyor belt supporting rack is mounted in a bracket on the interior of the tunnel for longitudinally sliding movement relative to the tunnel side walls to accommodate differential contraction rates of the rack and the tunnel.

In another aspect of the invention, a brass wear plate is secured to the top of a stainless steel plate forming part of a conveyor supporting rack by a rivet or screw which passes through an elongated slot in the brass wear plate. This accommodates differential expansion rates of the brass wear plate and the underlying stainless steel plate.

Referring to the drawings, a cooling tunnel 20 comprises a number of modular units 22. Each modular unit includes a lower channel-shaped module 24 and an upper cover module 26; the lower channel-shaped modules 24 are all joined to form a lower tunnel 25. The upper cover modules 26 are also joined to form a unitary cover 27. An end member 28 is joined to the last modular unit 22.

Each lower channel-shaped module 24, each upper cover module 26, and each end member 28 include an inner skin plate 30 and an outer skin plate 32. The inner skin plate 30 is made of 20-gauge stainless steel plate. The outer skin plate 32 is made of 18-gauge stainless steel plate. The outer skin plate 32 on each side, bottom, top, and end is bent outwardly approximately $1\frac{1}{2}$ inches along intersecting diagonal bend lines 33 to rigidify it. Three inner skin plates 30 are welded together to form a channel-shaped inside jacket 34. Three outer skin plates 32 are welded together to form a channel-shaped outside jacket 36. Angle stiffener members 38 having lightening holes 39 spaced along their length are secured to inner skin plates 30 and outer skin plates 32.

Insulation including pre-molded polystyrene blocks 42 and foamed-in-place polyurethane 41 is placed between inside jacket 34 and outside jacket 36. During assembly, channel-shaped inside jacket 34 is fitted within channel-shaped outside jacket 36 and is held therein by a jig 45. Each inner skin plate 30 is spaced from its opposite outer skin plate 32 by a distance of approximately 4 inches at the plate edges 46. Polystyrene blocks 42, which are approximately 4 inches thick, are placed between the jackets and against the inner skin plates 30. The polystyrene blocks 42 have slots 43 cut on one side to receive the stiffener members 38 secured to the inner skin plates 30. A void of approximately $1\frac{1}{2}$ inches at its widest point therefore exists between blocks 42 and outer skin plates 32.

To form foamed-in-place polyurethane 41 the void is injected with approximately one lb./cu.ft. of a liquid plastic mixture which expands in place to form a foam plastic. Products manufactured by Flexible Products of Marietta, Ga. and sold under the trade name of Flexipol, list numbers FP 18A and B, and NP 11A and B, have been found satisfactory. These are mixed in accordance with the manufacturer's directions and injected. Upon completion of expansion a composition having very good insulating qualities and a rubber-like flexibility is formed. The flexibility helps accommodate dimension changes caused by temperature changes. Alternatively pre-expanded plastic beads having entrapped gases therein may be expanded by steam to form foamed-in-place polyurethane 41.

A number of lower channel-shaped modules are formed in this fashion. Semi-cylindrical grooves 54 are cut in the ends of the polystyrene blocks 42 which face each end of the lower channel-shaped modules 24. A cylindrical polystyrene gasket 55 of slightly larger diameter than grooves 54 is forced within the grooves 54. The ends of adjacent modules 24 are forced together and

abutting outer skin plates 32 are welded to adjacent abutting outer skin plates 32 to form a continuous inner lining 58. Abutting edges of inner skin plates 30 are welded together to form a continuous outer lining 59.

A continuous lid seal 57 of hard wood is placed along the top of lower channel-shaped modules 24 and is secured to the outer skin plates 32.

Each upper cover module 26 is formed by securing flange plates 60 to the sides of an outer skin plate 32, by placing a polystyrene block 42 and an inner skin plate 30 within the flanges, and expanding polyurethane to bond the polystyrene block 42 to the outer skin plate. The abutting ends of the skin plates of individual upper cover modules 26 are secured together to make a continuous cover 62. Suitcase-type locks 64 are fixed to the outer sides of lower channel-shaped modules 24 and engage catches 65 secured to flange plates 60 to pull the continuous cover 62 down into tight engagement with the lid seal 57. This slightly compresses the insulation within the cover modules 26 and forms a tight seal. End members 28 are formed in a similar fashion and are secured to the last channel-shaped module 24 by sheet metal screws 67.

Teflon bearings 70 are fixed with holes 71 in outer skin plate 32 of the last channel-shaped module 24. The inner ends of these bearings pass through elongated slots 72 in the compressed inner skin plate 30. The bearings 70 are secured to angle member 74 which are welded to the outer skin plate 32.

As is described in my aforementioned co-pending application, 559,923, conveyor belts 78 are entrained over shafts 73 and are supported by racks 77. As described in the said application, the rack includes a stainless steel plate 79 to prevent nitrogen vapor from passing from below to above the conveyor belts 78 in certain embodiments of the invention. Stainless steel plate 79 is secured to longitudinal stainless steel channel members 80 and transverse stainless steel channel members 81. Conveyor belts 78 are formed of woven stainless steel wire. A brass wear plate 82 is mounted between the stainless steel plate 79 and the conveyor belts 78. Brass wear plate 82 is secured to stainless steel plate 79 by rivet 83 which are secured to plate 79 and pass through elongated slots 84 in the brass wear plate 82. Brackets 86 are secured to the inner skin plates 30 which form the opposite side walls of lower channel-shaped module 24. Brackets 86 are outwardly bent at 87 to receive flanges 88 of longitudinal channel members 80. The conveyor belt 78 carries articles to be frozen beneath liquid nitrogen which is injected from a nitrogen spray header 89.

FIGURE 8 illustrates a different rack 90 utilized as disclosed in my said co-pending application in situations where it is desired that the nitrogen vapor pass through the woven wire conveyor. Rack 90 is formed of transverse channel members 91 and longitudinal channel members 92, and has brass wear plates 93 secured to the tops of longitudinal channel members 92 by rivets 95 mounted in slots (not shown) which are similar to slots 84. Racks 90 are mounted for longitudinal sliding movement in channel-shaped brackets 94 secured to opposite walls of the lower channel-shaped modules 24.

When the freezer is in operation and the cooling effect of a spray of liquid nitrogen is utilized, extreme temperature variations occur within the freezer. The continuous inner lining 58 of the freezer contracts as a unit and moves longitudinally relative to the continuous outer skin lining 59 to a limited extent. The conveyor supporting racks 77 or 90 are free to move longitudinally relative to the cooling tunnel within their supporting brackets 86 or 94. The inner end of the conveyor shaft-supporting bearings 70 can move relative to continuous inner skin lining 58 of the tunnel.

FIG. 4 illustrates a different embodiment of the invention. The insulation between the inner and the

outer skins comprises foamed-in-place expanded polystyrene 141 which completely fills the space between inner skin plate 130 and outer skin plate 132. The construction is substantially identical to that used in the FIGS. 1-3 embodiment except that polystyrene blocks 42 of the FIGS. 1-3 embodiment are omitted. In addition, angle stiffener members 138 are made of comparatively light and flexible 22-gauge stainless steel plate. The expanded polystyrene surrounds the angle stiffener members 138 and passes through lightening holes 139.

The polystyrene beads are pre-expanded to three or four times their original size and are dried for 24 hours. A measured volume of beads are then inserted between the skins while the inner skin is held in fixed position relative to the outer skin as illustrated in FIG. 5. 25 p.s.i. steam is applied for 10 seconds through probes which are inserted into the space between the skins.

When the freezer is in operation, the continuous inner jacket 158 contracts to a greater extent than the continuous outer skin jacket 159. However, the flexibility of the light angle stiffener members 139 and of the polystyrene accommodates any distortions.

It will be readily apparent that a structure and construction method have been provided which can accommodate distortions occurring between adjacent members used under conditions of extreme temperature variation.

The invention may be utilized in the construction of a freezing tunnel having inner and outer skins, in the mounting of conveyor belt supporting racks within a tunnel, and in the mounting of bearings in the walls of a tunnel.

It will be obvious to one skilled in the art that various changes may be made in the invention without departing from the spirit and scope thereof, and, therefore, the invention is not limited by that which is illustrated in the drawings and described in the specification.

What is claimed is:

1. A structure for use under conditions of extreme temperature variation comprising
 - a first member including a solid building material which changes dimensions in response to temperature variations,
 - a second member including a solid building material which changes dimensions in response to temperature variations,
 - means mounting the first member relative to the second member for limited movement relative to each other when the members change their relative dimensions while holding the two members together, and
 - means for changing the temperature of one of the members in excess of 150° F.
2. The structure of claim 1, in which
 - the first member is a stainless steel plate,
 - the second member is a brass wear plate mounted parallel to the first member, and
 - the means mounting the two members relative to each other includes a rod-like member secured to one member and passing through a slot in the other member.
3. The structure of claim 1, in which
 - the first member is a cooling tunnel means having parallel side walls and forming a chamber,
 - the second member comprises rack means for supporting the weight of a conveyor belt, and
 - the means mounting the members relative to each other are bracket means mounted on the opposite inner side walls of the cooling tunnel for supporting the rack means for longitudinal sliding movement within the tunnel.
4. The structure of claim 1, in which
 - the first member comprises inner skin means for a cooling tunnel,
 - the second member comprises outer skin means surrounding the inner skin means, and

the means mounting the members for relative movement are means holding the corresponding portions of the inner and the outer skin means in parallel spaced relationship.

5. A cooling tunnel for use in the freezing of food comprising

inner skin means defining a substantially closed structure of a solid building material which changes dimensions when subjected to changes of temperature, outer skin means comprising a substantially closed structure surrounding the inner skin means of a solid building material which changes dimensions when subjected to changes of temperature, insulating means located between the inner and the outer skin, and means mounting the inner skin means within and spaced from the outer skin means for limited parallel movement relative to each other without damage to the insulation.

6. The structure of claim 5, in which the insulation means includes a first block of pre-molded expanded plastic located adjacent one skin and a second area of foamed-in-place expanded plastic between the first block and the outer skin means.

7. The structure of claim 6, in which the first block of plastic is mounted for sliding movement relative to the inner skin and the second plastic binds the outer skin to one side of the plastic block.

8. The structure of claim 6, in which the first plastic block is polystyrene and the foamed-in-place expanded plastic is polyurethane.

9. The structure of claim 5, in which the inner skin means is made of a number of substantially plane sections, the outer skin is made of a number of plates each mounted substantially parallel to the sections of the inner skin, and the outer skin is spaced outwardly from the inner skin.

10. The structure of claim 5, in which the insulation means include a foamed-in-place expanded plastic substantially filling all of the space between the inner and outer skin means.

11. The structure of claim 5, in which one skin means has secured thereto stiffener members having a flange into space between that skin means and the other skin means.

12. The structure of claim 11, in which the stiffener members are flexible and extend into a unitary foamed-in-place plastic insulation located between the skins which substantially fills the space therebetween.

13. The structure of claim 5, in which the cooling tunnel is an elongated structure formed of modular units,

the inner skin means of each modular unit is formed of substantially flat inner skin plates secured together to form a structure having opposite side walls and top and bottom walls and open at each end,

the outer skin means of each modular unit comprising a number of outer skin plates each substantially parallel to and spaced outwardly from corresponding inner skin plates and secured together to form corresponding structure having opposite side, top, and bottom walls surrounding and spaced from the inner skin plates and open at each end,

adjacent modular units being secured to each other by securing the abutting end edges of the inner skin plates of one unit to the inner skin plates of an adjacent unit to form a continuous inner tunnel lining and the abutting end edges of the outer skin plates of one unit secured to the outer skin plates of the next unit to form a continuous outer tunnel lining with the continuous inner lining being free to move longitudinally relative to the continuous outer lining.

14. The structure of claim 5, in which the inner skin means and the outer skin means are each channel-shaped jackets fitted within each other, each jacket comprising a pair of opposed side wall plates joined by bottom plates.

15. The structure of claim 14, including an insulated

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cover member bridging the area between the side plates of the outer skin and means detachably securing the cover member to the outer skin.

16. The structure of claim 14, including an insulated end member closing the area defined by the side and bottom plates of the outer channel-shaped jacket, and means securing the end member to the outer skin means.

17. The structure of claim 14, comprising
a tunnel formed of modular units, each modular unit comprising an inner and outer channel-shaped jacket structure fitted within each other and having an insulation means therebetween, adjacent end edges of inner skin plates of one section being joined to adjacent end edges of inner skin plates of the next section to form a continuous inner tunnel lining, and end edges of outer skin plates being attached to end edges of adjacent inner skin plates,

a top member formed of modular units, each modular unit comprising an inner skin plate and an outer skin plate with insulation means between the plates, end edges of adjacent outer plates secured together and end edges of adjacent inner plates secured together to form a continuous cover of the same length as the tunnel,

means detachably securing the cover member to the lower tunnel member, and
an insulated member closing one end of the tunnel and secured to the lower tunnel member.

18. A structure for holding apparatus for freezing food comprising:

(a) a housing formed by two unit structures each formed of two side walls joined by top and bottom

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walls and attached together at contiguous ends thereof to form a continuous elongated tunnel structure, the walls of each unit being impervious to gas and formed of insulating material, the contiguous ends of said walls of said two units each having semi-cylindrical recesses extending longitudinally thereof and the edges of said adjacent edges of said unit walls forming cylindrical chambers, and

(b) a cylindrical member in each of said cylindrical chambers substantially filling said chambers.

19. The structure of claim 18 in which the cylindrical member is made of insulating material.

20. The structure of claim 1 in which the first member is a plate having an elongated slot therein, and

the second member is a bearing for a shaft mounted within the said slot for limited movement therein.

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