

[54] DOUBLE WALL CARGO TANK HAVING  
INSULATING SECONDARY BARRIER

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[51] Int. Cl. .... B65d 25/18

[58] Field of Search ..... 220/9 LG, 11, 9 A, 15;  
114/74 A

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[57] ABSTRACT

A double wall tank for transporting cryogenic materials by ship. The inner wall of the tank, the primary barrier, takes the form of an integral metallic corrugated structure. The outer wall of the tank, the secondary barrier, takes the form of a plurality of insulating panels structurally connected to the inner wall of the tank through the means of external webs and is in liquid and gas-tight relation to external face plates. There are disclosed several types of insulating panels, several procedures for attaching the panels to the external face plates, and several procedures for securing adjacent panels to one another.

30 Claims, 15 Drawing Figures

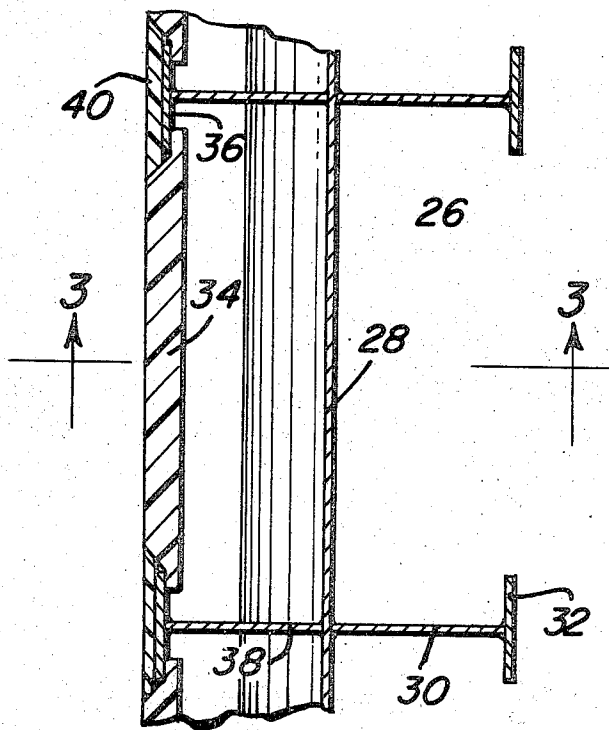


Fig. 1

PRIOR ART

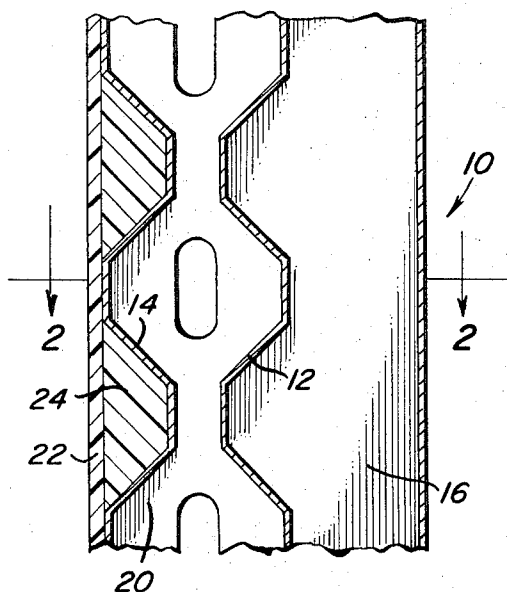


Fig. 2

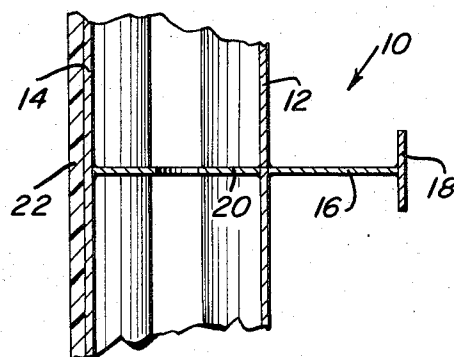


Fig. 4

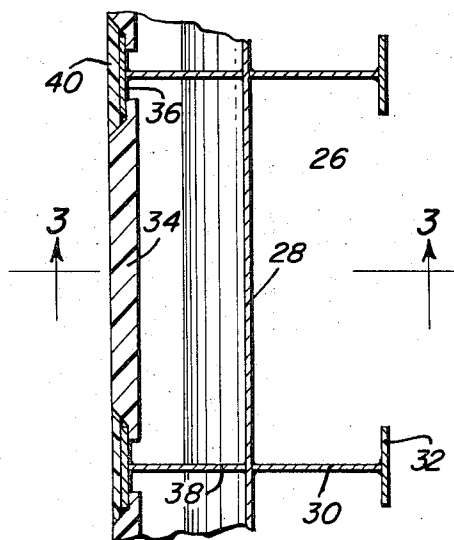
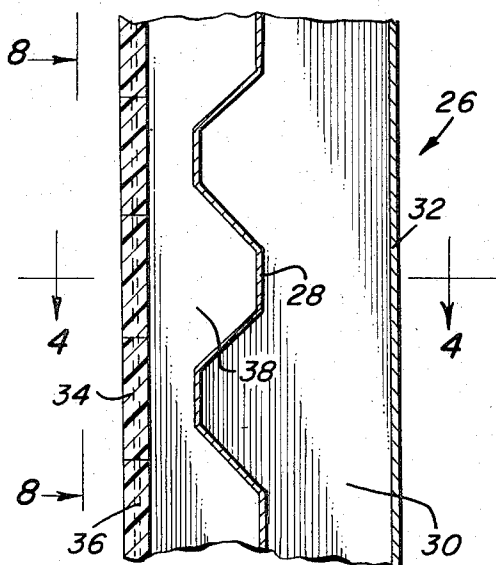


Fig. 3



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Fig. 5

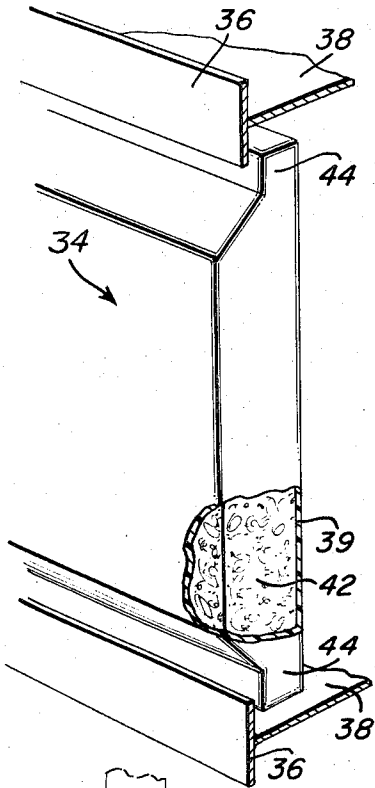


Fig. 6

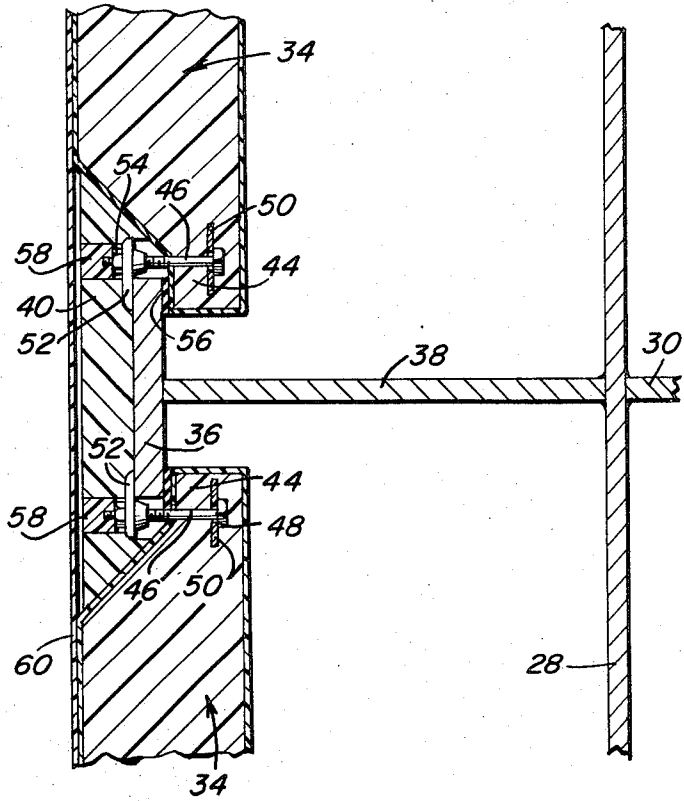
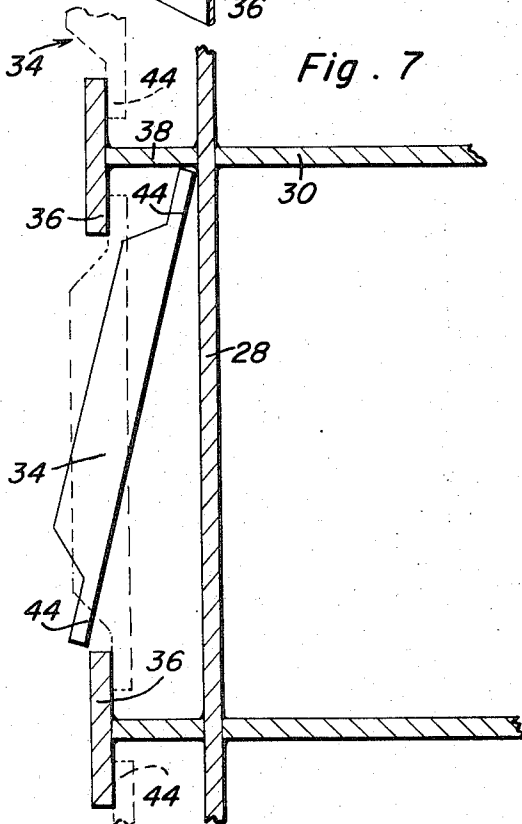


Fig. 7



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Fig. 8

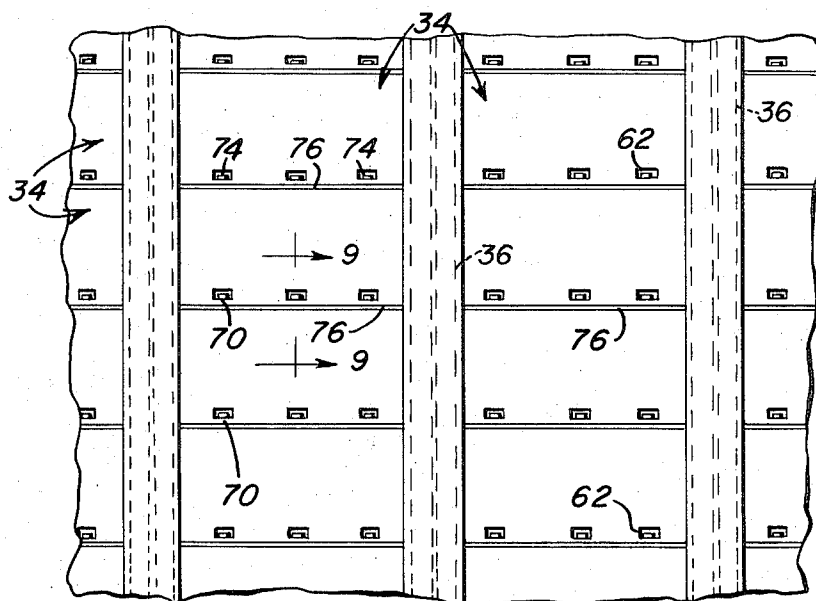


Fig. 11

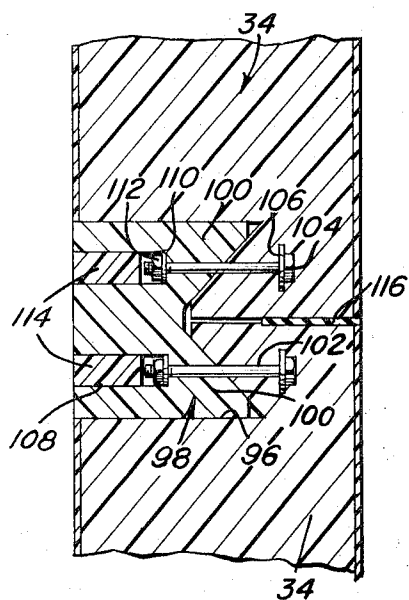


Fig. 10

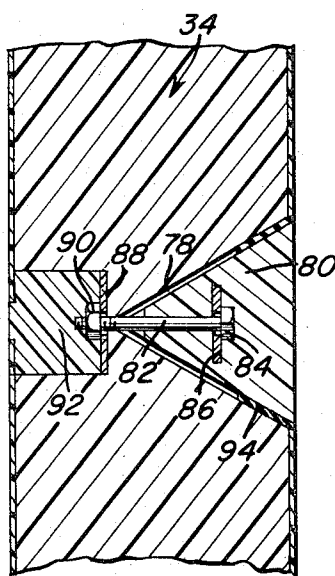
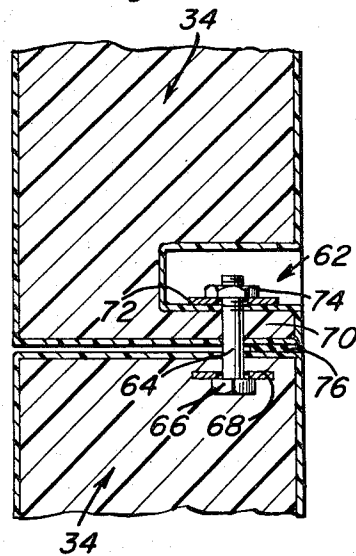


Fig. 9



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Fig. 12

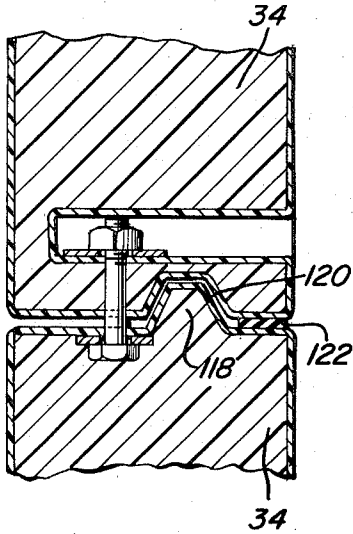


Fig. 13

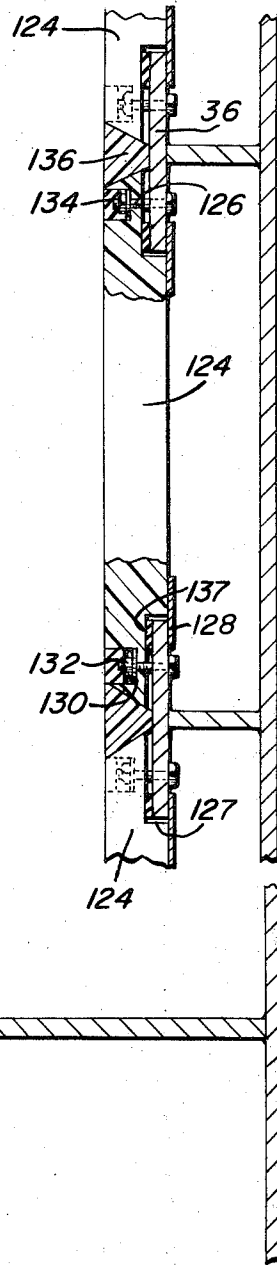
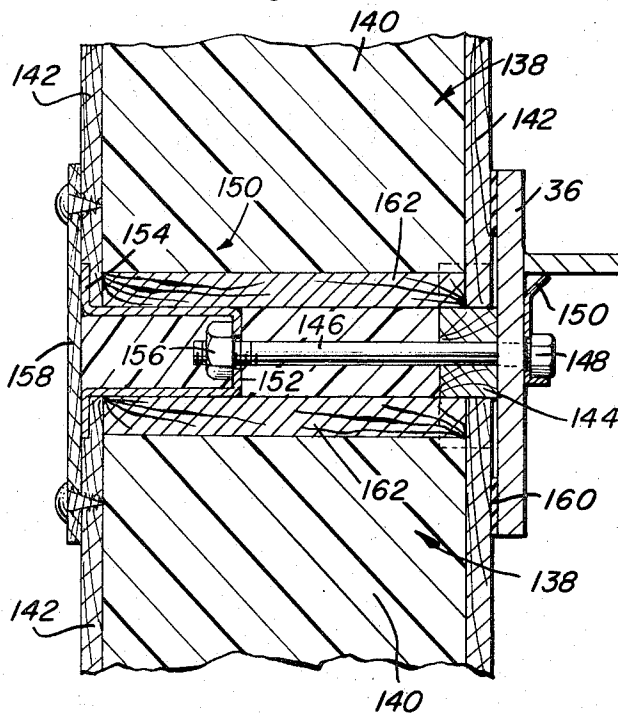


Fig. 14



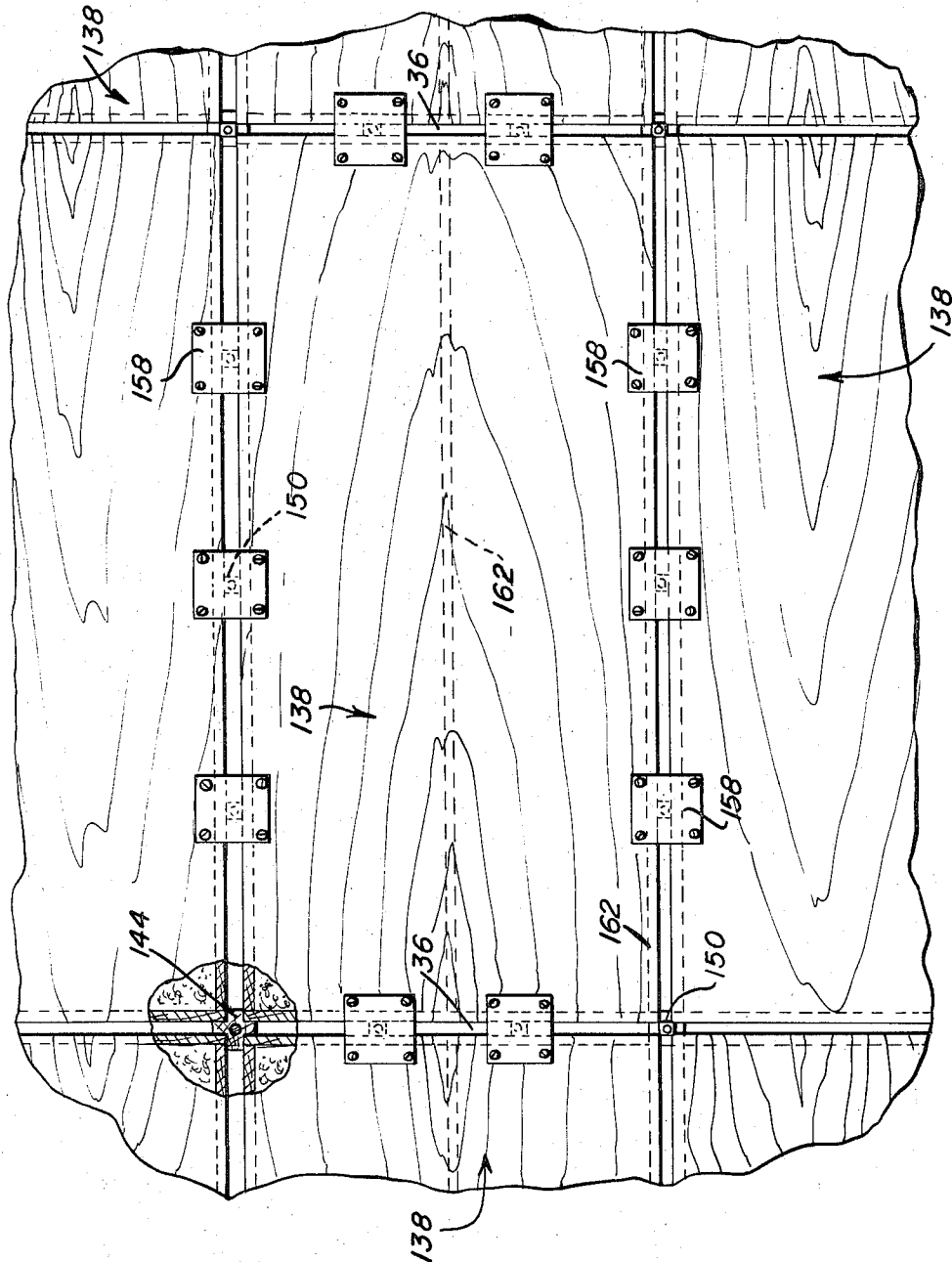
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Fig. 15



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## DOUBLE WALL CARGO TANK HAVING INSULATING SECONDARY BARRIER

### BACKGROUND OF THE INVENTION

The field of transporting cryogenic materials by ship has become increasingly active in the past few years. Many new tank designs have developed and each, in its own way, solves a problem prevalent in the art.

An example of the latest type of cargo tank may be found in U.S. Patent application, Ser. No. 70,869 filed on Sept. 9, 1970, entitled Double Wall Corrugated LNG Tank, and assigned to the present assignee. Such a tank has corrugated metallic primary and secondary barriers rigidly interconnected by means of interbarrier diaphragms. Insulation is affixed to the external wall of the secondary barrier and serves to insulate the cryogenic material housed within the tank from the hull of the ship.

While the double wall tank disclosed in the above-referenced U.S. patent application is a successful tank having many advantages, it also has several disadvantages. With such a tank, for example, having its primary and secondary barriers rigidly connected and in thermal association with one another, substantial stresses are developed in the tank walls when the tank experiences extreme thermal variations. These stresses may be minimized by reducing the distance between the primary and secondary barriers. However, such a distance reduction significantly increases the difficulty of construction, and hence results in increased construction costs.

Therefore, this type of prior art tank must strike a design compromise. A substantial spacing between tank walls, simplifying construction and inspection, results in a significant thermal gradient between the walls, causing the walls to expand and contract at different rates, and thereby elevating stress. Small spacings between tank walls, reducing stresses, makes construction more difficult, thereby elevating costs.

Further to the above, the prior art double wall metallic cargo tanks are relatively expensive. The material out of which the tanks are constructed must be of such a nature that it is unaffected by cryogenic temperatures and is able to withstand extreme temperature changes. Such material is quite expensive. Therefore, when two tank walls, as well as the structural supporting members, internal webs, face plates, interbarrier diaphragms, etc., are of this special material, the total cost of the tanks tends to be relatively high.

In the U.S. patent application referenced above, the inner and outer tank walls are both corrugated. The corrugations significantly increase the strength of the tank and allow for inspection of the tank walls from between the walls, without significant increase in the overall tank dimensions. But the two corrugated walls also significantly increase the complexity of the tank. The fabrication of the wall corrugations is difficult, the dimensioning of the interbarrier diaphragm is burdensome, and the application of an insulating layer is a complex procedure.

And also, each of the metallic double wall tanks known to the prior art requires an insulation layer to prevent the cryogenic temperature of the housed cargo from reaching the hull of the ship. This further increases the weight of the tank, increases the complexity of the tank, and increases the cost of the tank.

It is toward the elimination of the above-noted drawbacks associated with the double wall cargo tanks forming a part of the prior art that the present invention is directed.

### SUMMARY OF THE INVENTION

The present invention relates to a double wall tank for the transportation of cryogenic materials by ship. The inner wall of the tank, the primary barrier, is metallic, is corrugated, and is identical with that barrier described above with reference to the prior art. Within the primary barrier, the inventive tank is provided with internal webs, internal face plates, etc. These members are also identical with those used in the prior art tank described above. However, the outer wall of the tank, the secondary barrier, takes the form of a plurality of interconnected insulating panels each forming liquid and gas-tight seals with its neighboring panels and with two external face plates on which the panels are mounted. The external face plates are rigidly connected to the inner wall of the tank.

External webs extend from the primary barrier to the secondary barrier of the inventive tank. And the surface of the external web associating with the primary barrier, as in the prior art tank described above, is shaped to mate with the corrugations of the primary barrier. The surface of the external web associating with the secondary barrier is, however, linear. Hence, the construction of the external web used with the inventive tank is simplified when compared with the construction of the external web used with the prior art tank described above. Further, the amount of material required for the external web in the inventive tank may conveniently be reduced from that amount required for the external web in the prior art tank.

With the inventive cargo tank, the secondary barrier is of insulating material. Hence, with the inventive tank, it is unnecessary to have both a metallic structural secondary barrier and a layer of insulation. Hence the cost of the metallic structural secondary barrier is substantially eliminated. So, too, is the weight of the metallic secondary barrier. And yet the insulating barrier of the inventive tank is strong enough to withstand the pressures which would be developed by the cargo should the primary barrier rupture.

With the inventive tank, the development of extreme stress between the primary and secondary barriers is substantially eliminated. With the design of the inventive tank the primary and secondary barriers are constructed of different materials, may expand and contract at different rates, are structurally interconnected, and yet are able to move relative to one another without stress developing therebetween. With the inventive tank, the rigid structural interconnection between the primary and secondary barriers is eliminated. This low stress design of the inventive tank makes it possible to increase the distance between the primary and secondary barriers, to allow easy inspection and repair.

At the same time, because of the ease with which the inventive tank can be constructed, it is possible to significantly decrease the distance between the primary and secondary barriers. This can be done if hold cubic is limited. This simplicity of construction is evident from the fact that the secondary barrier is defined by relatively small panels of insulating material and adjacent external face plates. Once the external face plates are welded to the external webs, the panels are at-

tached to the external face plates, from the outboard side, with bolts or the like. There is never the need to weld or perform any other construction between the two barriers of the tank. Further, the insulating panels may be easily detached for repair, replacement, or access to the primary barrier.

From the above, it should be evident that the inventive double wall cryogenic cargo tank is relatively simple in design, inexpensive to construct, is strong and yet substantially eliminates interbarrier stress, is versatile, lightweight, and may easily be repaired.

Accordingly, it is the main object of the present invention to provide a double wall cargo tank having an insulating liquid and gas-imperious secondary barrier.

It is another object of the present invention to provide a double wall cryogenic tank whose insulation layer makes unnecessary the provision of a metallic secondary barrier.

It is a further object of the present invention to provide a double wall cargo tank having a corrugated primary barrier and a planar insulating secondary barrier.

Yet another object of the present invention is to provide a double wall cargo tank whose secondary barrier is defined by a plurality of insulating panels which are easily assembled and disassembled.

Still another object of the present invention is to provide a double wall cargo tank which is strong, but yet lightweight, and which has structurally interconnected primary and secondary barriers, but which substantially eliminates stress between the two barriers.

These and other objects of the present invention, as well as many of the attendant advantages thereof, will become more readily apparent when reference is made to the following description taken in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross-section showing an example of a prior art double wall cargo tank;

FIG. 2 is a cross-section taken along line 2—2 of FIG. 1;

FIG. 3 is a cross-section similar to FIG. 1, but illustrating the inventive double wall cargo tank;

FIG. 4 is a cross-section taken along line 4—4 of FIG. 3;

FIG. 5 is a perspective view illustrating the construction of a typical insulating panel and its relationship with a pair of external webs and face plates;

FIG. 6 is a horizontal cross-section through the walls of an inventive cargo tank illustrating one manner of securing the insulating panels to the face plates;

FIG. 7 is a top view of the walls of an inventive cargo tank illustrating the method of positioning an insulating panel;

FIG. 8 is a side view of the inventive cargo tank illustrating the outer wall of the secondary barrier;

FIG. 9 is a cross-section taken along line 9—9 of FIG. 8 showing one manner of attaching adjacent insulating panels;

FIG. 10 is a view similar to FIG. 9, but showing an alternate manner of uniting adjacent panels;

FIG. 11 is also a view similar to FIG. 9, but showing a further method of joining adjacent panels;

FIG. 12 is still another view similar to FIG. 9, showing another manner of joining adjacent panels;

FIG. 13 is a cross-section similar to FIG. 6, showing another manner of securing insulating panels to face plates;

FIG. 14 is an enlarged cross-section showing still another securing procedure; and

FIG. 15 is a side view of the inventive cargo tank illustrating the outer wall of the secondary barrier, when using the securing procedure illustrated in FIG. 14.

#### DETAILED DESCRIPTION OF THE DRAWINGS

With reference first to FIGS. 1 and 2, the prior art double wall cargo tank disclosed in the U.S. patent application noted above will be described. The cargo area is shown generally at 10 and is defined by a primary barrier 12 rigidly supported by a secondary barrier 14. The primary barrier 12 is strengthened by a number of internal webs 16, each having a stiffening face plate 18. An interbarrier diaphragm 20 rigidly connects the primary barrier 12 to the secondary barrier 14. A layer of insulation 22 thermally isolates the hull of the ship from the cryogenic material housed within the tank, and insulation blocks 24, inserted in the corrugations of the outer barrier 14, enhance the effect of the insulation layer 22.

It should be readily apparent that the tank illustrated in FIGS. 1 and 2 is relatively complex. Both the primary barrier 12 and the secondary barrier 14 are corrugated. This complicates the fabrication of the tank, increasing the cost of construction, the cost of materials, and increasing the overall weight of the tank. Because of the corrugations in both the primary and secondary barriers, the interbarrier diaphragm 20 must be cut, at both edges thereof, to mate with corrugated walls. This, too, significantly adds to the complexity and cost of the tank. Further adding to the complexity and cost is the necessity to provide both a metallic secondary barrier and at least one insulation layer. As will be readily apparent from the following description of the present invention, the above-enumerated drawbacks are substantially eliminated.

With reference then to FIGS. 3 and 4, the basic construction of the tank forming the present invention will be described. The cargo area is indicated generally at 26 and is bounded by a metallic corrugated primary barrier 28. The primary barrier 28 is strengthened by a number of internal webs 30 which, in turn, are stiffened by internal face plates 32. Thus far, the inventive cargo tank of FIGS. 3 and 4 is identical with the tank known to the prior art and illustrated in FIGS. 1 and 2.

The inventive tank differs from those tanks known to the prior art in that the secondary barrier of the inventive tank is defined by the internal surfaces of a plurality of insulating panels 34 and the internal surfaces of the external face plates 36, the face plates 36 being held rigid with respect to the primary barrier 28 through the means of a plurality of external webs 38. The external surfaces of the face plates 36 are covered by insulating pads 40 so as to ensure a break in the thermal path between the cryogenic cargo and the hull of the ship.

In FIG. 5, the configuration and construction of a typical insulating panel 34 may be seen, as well as the association of the insulating panel with a pair of external webs 38 and their face plates 36. In FIG. 5, the connection between the insulating panel 34 and the face plates 36 has been eliminated for purposes of clarity.

The insulating panel 34 comprises a relatively rigid shell 39 filled with insulating material 42. The shell 39, at its ends, defines ears 44 whose extremities are spaced apart a distance less than the distance between adjacent external webs 38 but greater than the distance between the adjacent edges of the external face plates 36. The thickness of the ears 44 is less than that of the insulating panel 34 at its center, in this manner adding to the ease with which the panel 34 may be secured in place. With the insulating panels 34 designed as shown in FIGS. 3 through 5, rupture of the primary barrier, with the consequent force of the cargo acting on the internal wall of the secondary barrier, urges the insulating panels 34 against the face plates 36 and enhances the liquid and gas-tight seal between the panels and the face plates.

In FIG. 7, the ease with which the insulating panels 34 may be positioned is demonstrated. One ear 44 of a panel 34 is first positioned between the face plate 36 and the primary barrier 38, adjacent the external web 38. This allows ready access for the other ear 44 to the region between the primary barrier 28 and its adjacent face plate 36. Then, the insulating panel 34 is secured to the face plates, as will be explained below. An insulating panel 34 is shown in solid lines during an intermediate stage of insertion. FIG. 7 also shows, in phantom, the position of several insulating panels 34 ready for affixation to their face plates 36.

With reference now to FIG. 6, one manner of attaching the insulating panels 34 to their respective face plates 36 will be described. In FIG. 6, two insulating panels 34 are shown in abutting relationship with their common external face plate 36, the respective ears 44 of the insulating panels 34 overlapping the surface of the face plate 36. Several bolts 46 having heads 48 are rigidly embedded in each insulating panel 34 in the region of the ears 44 thereof, and with their respective threaded ends protruding from the insulating panel.

As the bolts associate with nuts at their threaded ends extending from the insulating panel, it is important to maintain the bolts fixed with respect to such panels. The heads 48 of the bolts 46 are shaped so as to prevent rotation of the bolts in the insulating panels 34. And washers 50 are embedded in the insulating panel 34, abutting the heads 48 of the bolts 46, and preventing lateral movement of the bolts. A clamp 52 is positioned over the threaded end of each bolt 46 and overlaps the external surface of the face plate 36. A nut 54 is then tightly threaded onto each bolt 46 thereby securely clamping the respective insulating panels 34 to their face plates 36. Gaskets 56 are provided between the internal surfaces of the face plates 36 and the insulating panels 34 so as to ensure liquid and gas-tight seals between the insulating panels and the face plates.

To enhance the insulating properties of the secondary barrier, insulating pads 40 are positioned between adjacent insulating panels 34, just over the external surfaces of the respective face plates. The insulating pads 40 are provided with a number of bores passing there-through equal to the number of bolts 46. The bores are located in the vicinity of the nuts 54 and allow ready access to the nuts for purposes of affixing or removing insulating panels. Then insulating plugs 58 are fit in each bore in the panels 34, after the nuts are tightened, and serve to break the thermal path between the cryogenic cargo and the hull of the ship. An optionally provided vapor barrier 60 covers the external surfaces of

the insulating panels 34 and the insulating pads 40, and serves as an additional precaution against vapor reaching the space between the primary and secondary barriers.

Above, the discussion has been directed to the vertical attachment of the insulating panels 34 to their respective face plates 36. With reference now to FIGS. 8 and 9, the horizontal attachment, that between adjacent insulating panels 34, will be described.

In FIG. 8, a view of the inventive double wall cargo tank from outside the secondary barrier, several insulating panels 34 are shown attached to their respective face plates 36. Each insulating panel 34 is provided with three, for example, recesses located near its lower edge. Each panel is also provided with three bolts 64 located near its upper edge and adapted to align with the recesses 62 in the adjacent panel. Each bolt has a head 66 to prevent rotational movement, and each is associated with a washer 68 to prevent lateral movement.

Each bolt 64 in one insulating panel 34 is adapted to pass through a thin region 70, in the adjacent insulating panel, extending into the respective recess 62 therein. Then, a washer 72 is positioned over the bolt 64 and is fastened in place by means of a nut 74. The nut 74, acting between adjacent insulating panels 34, brings adjacent panels together and hence ensures a liquid and gas-tight seal therebetween. As an added safety feature ensuring the integrity of the seal, a gasket 76 is provided between adjacent insulating panels. With the joining of the insulating panels 34 to their respective face plates 36 as described with reference to FIG. 6, and with the attachment of adjacent insulating panels 34 as explained with reference to FIGS. 8 and 9, it should be clear that the outer wall of the inventive tank forms a structurally sound and liquid and gas-impervious barrier. At the same time, each of the advantages enumerated heretofore is present. The tank is strong, light, compact, inexpensive, and relatively easy to construct.

With reference now to FIG. 10, another manner of attaching adjacent insulating panels 34 along their horizontal edges will be described. Here, the adjacent edges of each panel facing the primary barrier are tapered at 78. The tapered edges 78 are adapted to mate with an insulating pad 80 having a bolt 82 solidly embedded therein. The head 84 of the bolt 82 prevents the bolt from rotating in the pad 80 and a washer 86 prevents the bolt from experiencing lateral movement. The threaded end of the bolt 82 extends from the tapered end of the pad 80 and lies between the respective insulating panels 34. Bolt 82 is provided with a washer 88 and a nut 90 introduced through a bore defined in the united panels 34. An insulating plug 92 is then fit over the bolt 82 so as to break the thermal path between the cryogenic cargo and the hull of the ship. To further ensure a liquid and gas-tight seal, a gasket arrangement 94 is positioned intermediate the panels 34 and the pad 80.

FIG. 11 illustrates a further method of uniting adjacent panels 34. In this Figure, angled, or wedge-shaped, recesses 96 are carved out of the corner of adjacent panels, with the recesses lying on the outboard side of the panels. An insulating pad 98, cut in the shape of two integral wedges, 100 associates with the adjacent insulating panels 34. When in place, the respective wedges 100 of the insulating pad 98 are received by the

angled recesses 96 in the respective insulating panels 34 and serve to draw the adjacent panels toward one another. Each panel 34 is provided with a number of bolts 102 having heads 104 and washers 106 associated therewith, the heads and washers serving the same purposes as described above. The threaded ends of bolts 102 extend from the insulating panels 34 and into the insulating pad 98. The pad 98 is provided with a series of bores 108 adapted to align with and to receive the threaded ends of the bolts 102. Washers 110 are fit over the bolts 102, the bolts ultimately receiving nuts 112 for securing adjacent insulating panels 34. Small insulating plugs 114 cover the bolts 102 and break the thermal path between the cryogenic cargo and the hull of the ship. A gasket 116 ensures a liquid and gas-impervious junction between adjacent insulating panels 34.

In FIG. 12, still a further arrangement for securing adjacent insulating panels 34 is illustrated. This arrangement is much like that described with reference to FIG. 9 and hence only the differences will here be described. In FIG. 9, and notwithstanding the presence of gasket 76, there is a potential planar heat flow path. This cannot be tolerated when dealing with shipboard cryogenics. The attachment arrangement illustrated in FIG. 12 serves to eliminate the planar heat flow path and to reduce the potential danger of heat transfer between adjacent insulating panels 34.

Each insulating panel 34 shown in FIG. 12, is provided at its upper edge with an upstanding tongue 118. Each panel is also provided at its lower edge with a groove 120. The tongue 118 is adapted to align with groove 120 when adjacent insulating panels are bolted together. Therefore, the potential planar heat path is broken up into five separate heat paths, thus reducing the possibility of heat flow between panels. Further, such an arrangement increases the contact surface between panels, thereby increasing the chance for a liquid and gas-tight seal. A gasket 122 is fit between adjacent insulating panels 34 to further ensure a proper liquid and gas-impervious seal.

In the embodiment of the invention illustrated in FIGS. 3 through 7, the insulating panels extend a substantial distance on both sides of the face plates. Therefore, a certain width of insulation is wasted in the area of the face plates. In FIGS. 13 through 15, two further embodiments of the present invention are illustrated, which embodiments substantially increase the effectiveness of a given width of insulation.

In FIG. 13, three representative insulating panels 124 are shown attached to a pair of face plates 36. Each side of each insulating panel is provided, in the regions of its face plates, with a depression 127 of a depth substantially equal to the width of a face plate 36. The depressions 127 are adapted to mate with respective face plates. With this embodiment, it should be evident that the width of each insulating panel is used to maximum efficiency over substantially the entire length of the panel, an efficiency loss appearing only near the face plates, and this being relatively small. Only a width of insulation equal to the thickness of the face plate is wasted.

With continuing reference to FIG. 13, it can be seen that a metallic plate 128 is welded to the innermost surface of each end of the face plates 36, lying flush with the face plates and the insulating panels 124 and hence serving to increase the structural bearing surface for

the panels. A series of bolts 126 extend through each face plate 36, and through a portion of each insulating panel 124. As was the case with the embodiment illustrated in FIG. 6, each panel 124 is provided with mating bores to allow for the insertion of washers 130 and nut 132. When the nuts 132 are tightened, the insulating panels 124 are held secure with respect to their respective face plates 136. Insulating plugs 134 fill the bores in the insulating panels 124 and cover the bolts 126, while insulating pads 136 are provided between adjacent insulating panels 124 serving to ensure the continuity of the insulation. Gaskets 137 serve to guarantee a liquid and gastight seal.

In FIGS. 14 and 15, another embodiment of the present invention will be described. This embodiment maximizes the effect of a given width of insulation, more so even than the embodiment illustrated in FIG. 13. In FIG. 14 two adjacent insulating panels are shown generally at 138. As will be apparent from the following, the FIG. 14 cross-section is taken in an area where the corners of four insulating panels meet. See FIG. 15. The insulating panels 138 are defined by a body of insulating material 140 sandwiched between a pair of plywood face plates 142. With this embodiment of the invention, the insulating panels 138 are preferably rectangular.

As shown in FIG. 14, a spacer block 144, as of wood, is positioned at each junction of four insulating panels 138. A bolt 146 whose nut 148 is prevented from rotating by means of a stop 151 is inserted through the face plate 36 and through the wooden spacer block 144. A metallic cup 150, whose bottom 152 has a bore allowing the threaded end of the bolt 146 to pass there-through, is fit between mating insulating panels 138. The sides of the metallic cup 150, in cross-section, are square. The top of the cup 150 is flared outwardly and takes the form of a flange 154 which is square in elevation. The sides of the cup 150 are sized so as to contact mating insulating panels 138 and to maintain the spacing therebetween; while the flange 154 is sized so as to overlap and unite adjacent insulating panels. A nut 156 is secured on the threaded end of the bolt 146, from the inside of the cup 150, and maintains adjacent insulating panels 138 in their proper positions. Wood cover plates 158 are then screwed onto the plywood face plates 142, immediately above the cups 150, of the insulating panels 138. Gaskets 160 are provided between the insulating panels 138 and the face plates 36, thus ensuring the integrity of the liquid and gas-tight seal.

With particular reference to FIG. 15, certain aspects of this embodiment of the present invention will become apparent. First, it will be noted that the cups 150 are used both in the corners and along the edges of the panels 138. The wood spacer blocks 144, however, are used only in corners. Next, because face plates 138 extend only in the vertical direction, for example, spacings exist between insulating panels 138 along their adjacent horizontal surfaces. Accordingly, a wood backing is provided between the horizontal edges of adjacent insulating panels. This is necessary in view of the need for insulation between the hull of the ship and the cryogenic cargo. With the embodiment of the invention illustrated in FIGS. 14 and 15, insulation is foamed between adjacent panels 138 in both the vertical and the horizontal directions after the panels are secured in place. In this manner, a uniform layer of insulation is provided. One further point should be mentioned. Each

insulating panel 138 is approximately four feet by eight feet. The vertical webs, with their face plates, are, in this embodiment, spaced slightly more than eight feet apart. Therefore, the insulating panels 138 must be sound. In addition to the plywood face plates 142, eight foot boards 162 are positioned along the length of the panels 138 at their edges and at their mid-sections. These boards increase the strength of the panels and assist in directing forces along the faces of the insulating panels.

Above, several embodiments of the present invention have been described, it should be appreciated, however, that these embodiments are described for purposes of illustration only and are intended in no way to limit the scope of the present invention. For example, several attaching schemes have been disclosed, but these are by no means exhaustive of the possibilities that may be employed within the spirit and the scope of the invention. And, while two types of insulating panels have been described, they too may be substituted by numerous equivalents without departing from the teachings of this invention. Further, while the last embodiment of the present invention has been disclosed by specifically describing metallic cups as the means for rigidifying the insulating panels, such a limitation is by no means necessary. The metallic cups may, for example, be replaced by providing the insulating panels with small extensions along the edges thereof and by clamping these extensions directly to the external face plates. It is the intent, therefore, that the present invention not be limited by the above, but be limited only as defined in the appended claims.

What is claimed is:

1. A double wall tank for the transportation of cryogenic materials by ship, the tank comprising: a liquid and gas-impervious primary barrier defining a cargo space; a plurality of webs rigidly connected to the outer surface of said primary barrier and extending away from said cargo space; a plurality of thermally insulating panels spaced from said primary barrier and attached together to form a liquid and gas-impervious secondary barrier which will withstand the pressures developed by the cargo in the event of rupture in said primary barrier, said insulating panels being attached directly to said webs so that said insulating panels are supported by said webs.

2. The cargo tank recited in claim 1, wherein each thermally insulating panel is attached to a pair of adjacent webs in a liquid and gas-impervious manner.

3. The cargo tank recited in claim 2, wherein each thermally insulating panel is attached to a pair of adjacent webs in one direction; and wherein adjacent thermally insulating panels are attached to each other in a second direction transverse to said first direction.

4. The cargo tank recited in claim 1, and further comprising: an external face plate rigidly secured to the extremity of each web remote from the primary barrier, each face plate lying in a plane substantially parallel to the plane of the adjacent primary barrier; wherein each thermally insulating panel is of a length less than the distance between adjacent webs but greater than the distance between adjacent edges of neighboring external face plates; wherein each thermally insulating panel is provided with a pair of ears adapted to abut the surfaces of neighboring face plates adjacent the primary barrier; means for securing said thermally insulating panels to said face plates; and means for interrupting

the thermal path between the primary barrier and the surfaces of the thermally insulating panels remote from said primary barrier in the region of the face plates and intermediate adjacent thermally insulating panels.

5. The cargo tank recited in claim 4, wherein adjacent thermally insulating panels are attached to each other by: an elongated fastening member integral with one thermally insulating panel, having one end extending toward the adjacent thermally insulating panel and crossing the boundary between thermally insulating panels; and means associated with said adjacent thermally insulating panel integral with said fastening member.

6. The cargo tank recited in claim 5, wherein said fastening member takes the form of a bolt whose head is fixedly attached to said one thermally insulating panel, and whose threaded end extends into a recess defined in said adjacent thermally insulating panel, and a nut threaded onto said bolt so as to securely attach said one thermally insulating panel to said adjacent thermally insulating panel, the recess in said adjacent thermally insulating panel lying on the surface of said panel remote from said primary barrier and being of a dimension sufficient to allow operation on said nut.

7. The cargo tank recited in claim 5, and further comprising: a tongue defined in the edge of said one thermally insulating panel adjacent said adjacent thermally insulating panel; and a groove defined in the edge of said adjacent thermally insulating panel adapted to mate with said tongue in said one thermally insulating panel.

8. The cargo tank recited in claim 4, wherein adjacent thermally insulating panels are attached to each other by: tapered edges defined in adjacent surfaces of adjacent thermally insulating panels, said tapered edges facing the primary barrier; an insulating pad adapted to wedge between the tapered edges of said adjacent thermally insulating panels; an elongated fastening member integral with said insulating pad, and having a portion thereof extending from said insulating pad into the junction between adjacent thermally insulating panels; and means for urging the respective surfaces of said adjacent thermally insulating panels remote from said primary barrier toward said insulating pad.

9. The cargo tank recited in claim 4, wherein adjacent thermally insulating panels are attached to each other by: respective angled recesses defined in adjacent surfaces of adjacent thermally insulating panels, said angled recesses facing away from said primary barrier; an insulating pad in the form of two integral wedges, the shape of said pad and its wedges adapted to mate with said angled recesses in said adjacent thermally insulating panels; fastening members integral with each of said adjacent thermally insulating panels extending into said insulating pad; and means for urging said insulating pad toward said primary barrier.

10. The cargo tank set forth in claim 1, and further comprising: an external face plate rigidly secured to the extremity of each web remote from said primary barrier, the plane of each external face plate being substantially parallel to the plane of the primary barrier adjacent thereto; and wherein said thermally insulating panels are mounted on the surfaces of said external face plates remote from said primary barrier.

11. The cargo tank recited in claim 10, and further comprising: means between adjacent thermally insulating panels, in the regions of said external face plates,

for breaking the thermal path between the primary barrier and the surfaces of the thermally insulating panels remote from said primary barrier.

12. The cargo tank recited in claim 11, and further comprising: means for attaching each of said thermally insulating panels to a pair of adjacent face plates for securing.

13. The cargo tank recited in claim 12, wherein adjacent thermally insulating panels are attached to each other by: an elongated fastening member integral with one thermally insulating panel, having one end extending toward the adjacent thermally panel and crossing the boundary between thermally insulating panels; and means associated with said adjacent thermally insulating panel integral with said fastening member.

14. The cargo tank recited in claim 13, wherein said fastening member takes the form of a bolt whose head is fixedly attached to said one thermally insulating panel, and whose threaded end extends into a recess defined in said adjacent thermally insulating panel, and a nut threaded onto said bolt so as to securely attach said one thermally insulating panel to said adjacent thermally insulating panel, the recess in said adjacent thermally insulating panel lying on the surface of said adjacent thermally insulating panel remote from said primary barrier and being of a dimension sufficient to allow operations on said nut.

15. The cargo tank recited in claim 13, and further comprising: a tongue defined in the edge of said one thermally insulating panel adjacent said adjacent thermally insulating panel; and a groove defined in the edge of said adjacent thermally insulating panel adapted to mate with said tongue in said one thermally insulating panel.

16. The cargo tank recited in claim 12, wherein adjacent thermally insulating panels are attached to each other by: tapered edges defined in adjacent surfaces of adjacent thermally insulating panels, said tapered edges facing the primary barrier; an insulating pad adapted to wedge between the tapered edges of said adjacent thermally insulating panels; an elongated fastening member integral with said insulating pad, and having a portion thereof extending from said insulating pad into the junction between adjacent thermally insulating panels; and means for urging the respective surfaces of said adjacent thermally insulating panels remote from said primary barrier toward said insulating pad.

17. The cargo tank recited in claim 12, wherein adjacent thermally insulating panels are attached to each other by: respective angled recesses defined in adjacent surfaces of adjacent thermally insulating panels, said angled recesses facing away from said primary barrier; an insulating pad in the form of two integral wedges, the shape of said pad and its wedges adapted to mate with said angled recesses in said adjacent thermally insulating panels; when said panels are in contact with one another; fastening members integral with each of said adjacent thermally insulating panels extending into said angled insulating pad; and means for urging said insulating pad toward said primary barrier.

18. The cargo tank recited in claim 1, and further comprising: an external face plate rigidly mounted on the extremity of each web remote from the primary barrier, the plane of each external face plate lying substantially parallel to the plane of the adjacent primary barrier; wherein each thermally insulating panel is supported by and extends between a pair of adjacent exter-

nal face plates, said thermally insulating panels being supported on the surfaces of the external face plates remote from said primary barrier and being spaced apart; means for maintaining the spacing between adjacent thermally insulating panels at the junctions between the corners of four panels; and fastening means positioned between and serving to maintain the spacing between thermally insulating panels.

19. The cargo tank recited in claim 18, wherein each of said fastening means comprises: a cup-shaped member having side walls for maintaining the spacing between adjacent insulating panels, the side walls being square in cross section, and having an outwardly extending flange at the upper region thereof for contacting the surfaces of adjacent thermally insulating panels remote from said primary barrier and being square in plan; and means for generating a compressive force between the surfaces of adjacent thermally insulating panels remote from said primary barrier and surfaces of adjacent thermally insulating panels adjacent said primary barrier.

20. The cargo tank recited in claim 19, wherein said means for generating compressive forces takes the form of a bolt acting between the bottom of said cup-shaped member and an external face plate.

21. The cargo tank recited in claim 19, wherein said means for generating said compressive forces takes the form of a bolt acting between the bottom of said cup-shaped member and a structural member overlapping the junction between adjacent thermally insulating panels on their surfaces adjacent said primary barrier.

22. The cargo tank recited in claim 18, and further comprising: insulating material filling all spaces between adjacent insulating panels.

23. The cargo tank recited in claim 19, and further comprising: an insulating cover plate covering each cup-shaped member on its surface remote from said primary barrier.

24. The cargo tank recited in claim 1, and further comprising: an external face plate rigidly connected to the extremity of each of said webs remote from said primary barrier, the plane of each of said face plates being substantially parallel to the plane of the adjacent primary barrier; means for attaching each of said thermally insulating panels to a pair of adjacent face plates in a liquid and gas-impervious manner; and wherein the secondary barrier is defined by the surface of the thermally insulating panels adjacent said primary barrier and the surfaces of said face plates adjacent said primary barrier.

25. The cargo tank recited in claim 24, wherein each thermally insulating panel is attached to a pair of adjacent face plates in one direction; and wherein adjacent thermally insulating panels are attached to each other in a second direction transverse to said first direction.

26. The cargo tank recited in claim 1, wherein said primary barrier is corrugated; and wherein said secondary barrier is planar.

27. The cargo tank recited in claim 1, wherein said primary barrier is rigid; and wherein said secondary barrier is relatively flexible.

28. The cargo tank recited in claim 27, wherein said primary barrier is metallic.

29. The cargo tank recited in claim 18, wherein each of said fastening means comprises: a bearing member

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for contacting the surfaces of adjacent thermally insulating panels remote from said primary barrier; and means for generating a compressive force between the surfaces of adjacent thermally insulating panels remote from said primary barrier and surfaces of adjacent thermally insulating panels adjacent said primary barrier.

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30. The cargo tank recited in claim 29, wherein said bearing member is planar at least in the region of contact with the surfaces of adjacent thermally insulating panels.

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