May 7, 1968 C. D. FORMAN ETAL 3,381,843

INSULATION SYSTEM

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FIG. 1

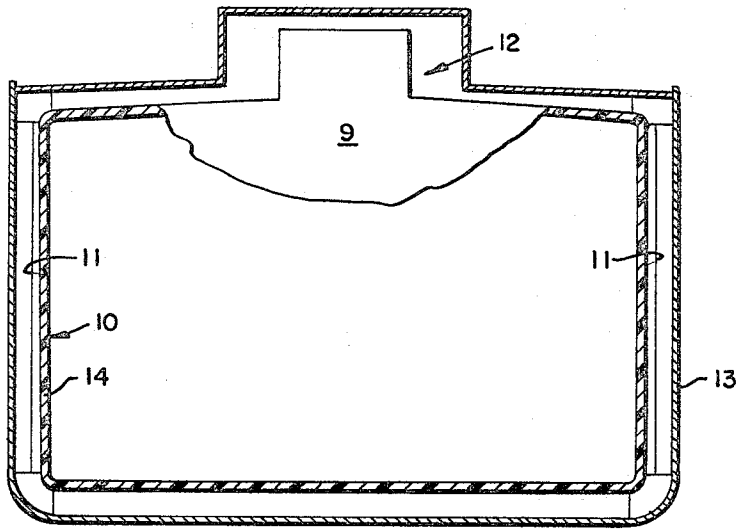
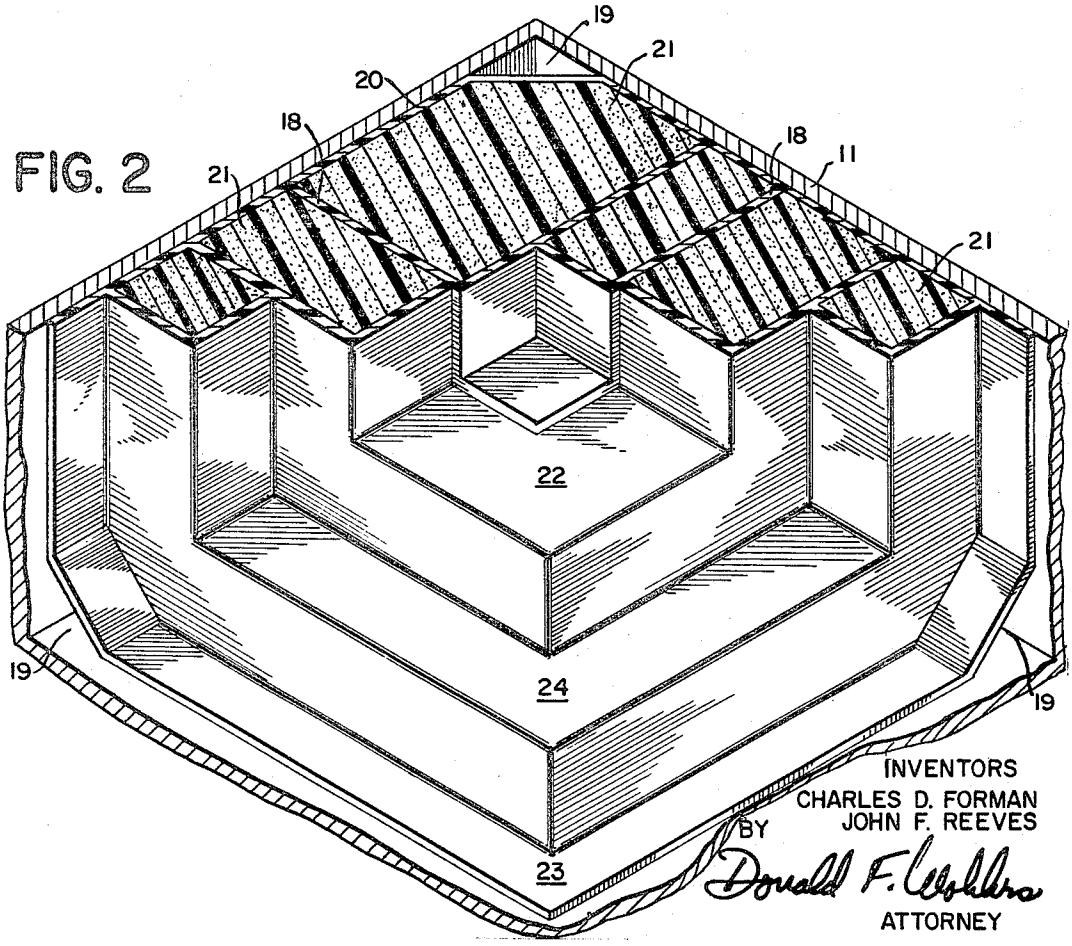


FIG. 2



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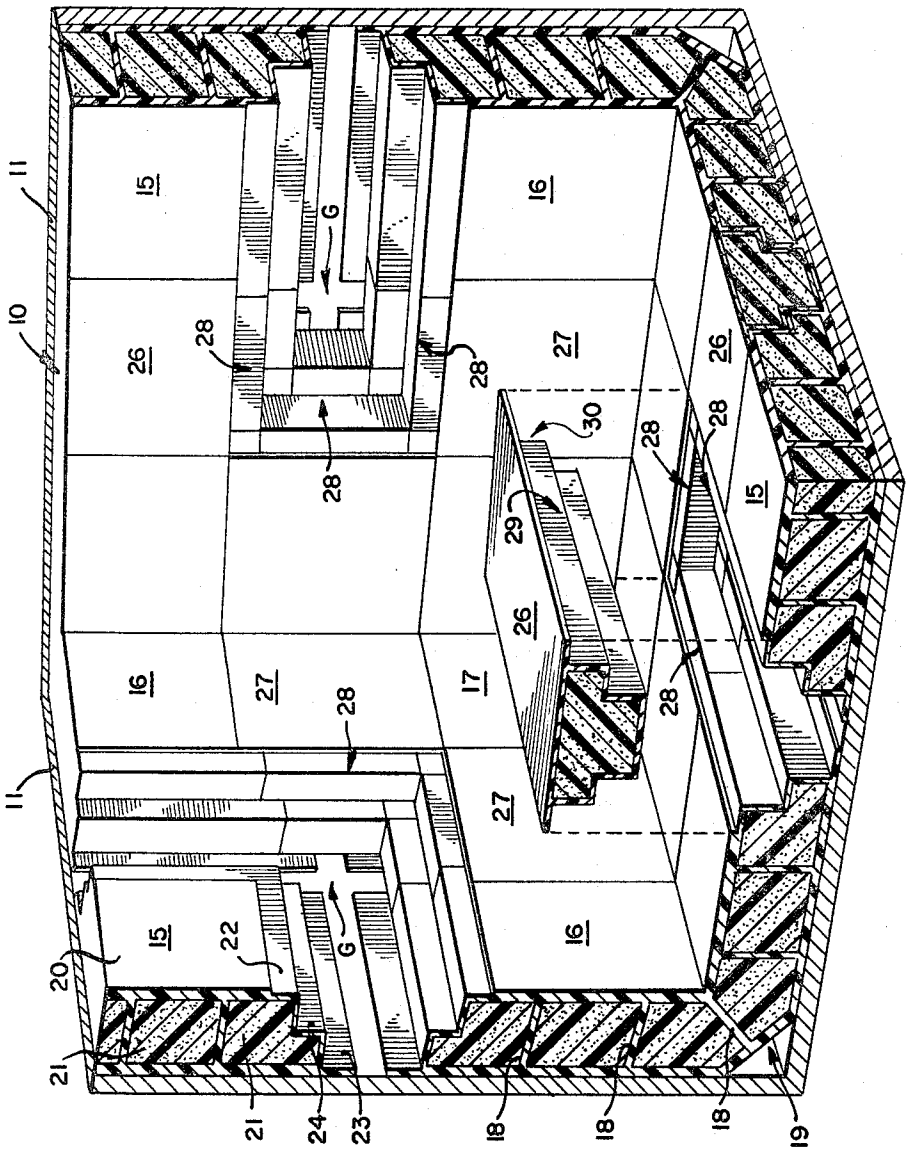


FIG. 3

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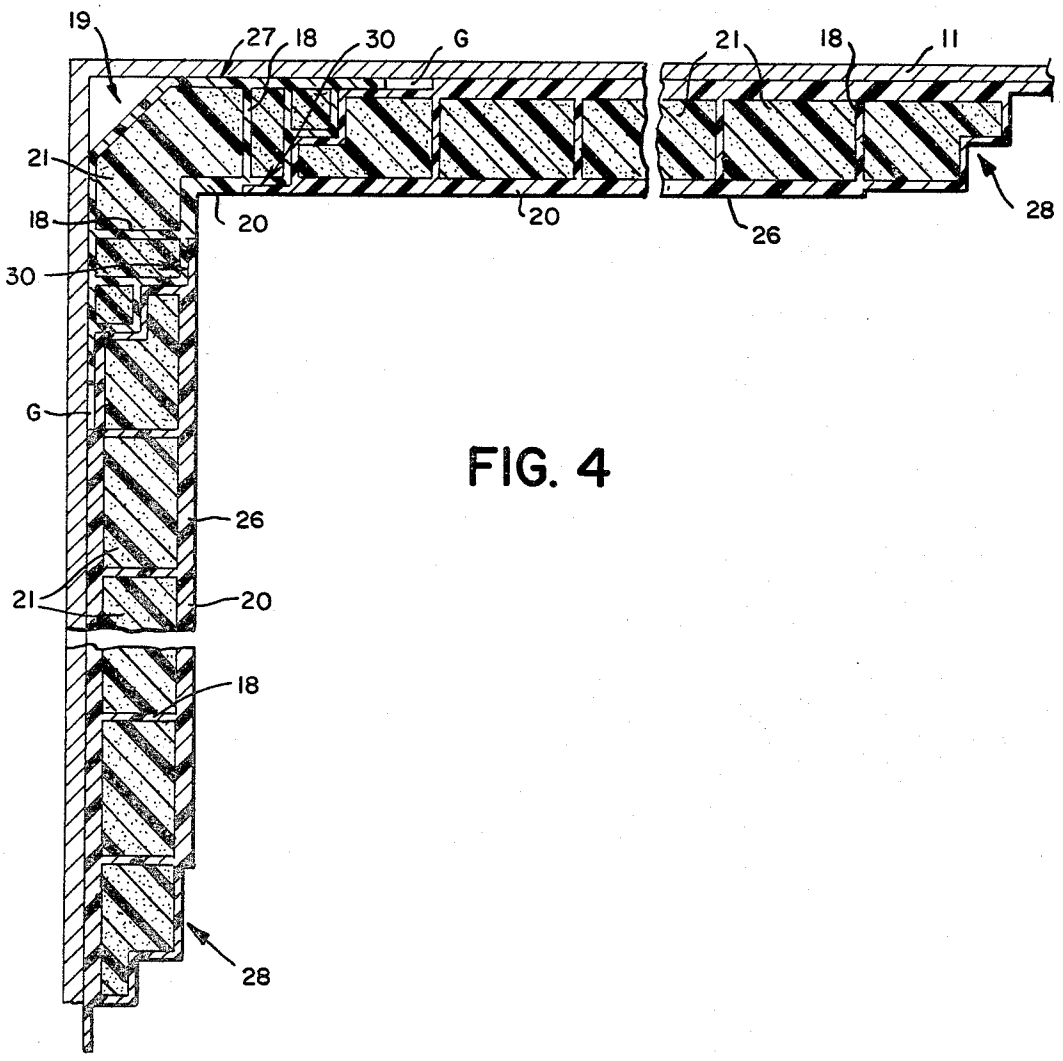


FIG. 4

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3,381,843

INSULATION SYSTEM

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Filed May 6, 1966, Ser. No. 548,309
4 Claims. (Cl. 220—9)

The present invention relates to insulated cargo tanks of the type adapted to store liquefied natural gas and the like at cryogenic temperatures and, more particularly, to a new and improved system of interlocking wall panels and plug panels of thermal insulation which form an impervious and stable cargo barrier.

The insulating wall panels of the invention are generally flat for flat wall portions, are generally L-shaped for corner portions defined by the intersections of two walls, and are generally boxlike for corner portions defined by the intersections of three walls. All of the wall panels have ascendingly stepped lateral edges. The plug panels are interposed in mating relation between the ascendingly stepped edges of the aforementioned wall panels and are correspondingly either of generally flat or L-shaped configurations and have descendingly stepped side edges. As an important aspect of the invention, the L-shaped and boxlike corner panels are heavily reinforced with internal webbing or stiffeners to provide sufficient strength at the corners of the completed insulation system to safely withstand the accumulated thermal and mechanical stresses which tend to arise at such corners when exposed to cryogenic temperatures.

As a further important aspect of the invention, the plug panels have end edges which are ascendingly and descendingly stepped and are interlocked to establish extremely rigid joints, the configuration of which substantially reduces the possibility of escaped cryogenic cargo seeping therethrough.

For a more complete understanding of the invention and its attendant advantages, reference should be made to the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic cross-sectional view of a cargo hold of a double hulled tanker including the insulation system of the present invention;

FIG. 2 is a perspective view of a reinforced, molded three-dimensional corner wall panel embodying the principles of the invention;

FIG. 3 is a fragmentary, perspective view of a corner of an insulted tank showing the interrelationship of the wall panels and plug panels; and

FIG. 4 is a cross-sectional view of a plug panel showing the alternate end edge configurations thereof.

Referring to FIG. 1, the overall shape of the insulating barrier **10** of the invention is determined by and generally duplicates that of the inner steel walls **11** of a cargo space **12** of a double hulled vessel **13** of conventional construction.

Specifically, the inner walls **11** are completely clad with thermal insulation panels **14** to form a so-called "secondary cargo barrier" which functions to insulate an inner tank **9** or integral "primary cargo barrier" (not shown), to provide an impermeable barrier for any leakage of liquefied natural gas and thus protects the vessel structure from the potentially deleterious effects of the supercooled cargo.

In accordance with the invention, the barrier **10** is established by a series of discrete insulation panels **14**, the majority of which are rectangular in shape and characterized as being generally flat. These generally flat panels are designated by reference number **15**.

The corners of the cargo space **12** are clad by new and

improved L-shaped panels **16** and boxlike panels **17**. In accordance with the inventive principles, the panels **16**, **17** include transverse internal membranes **18** which provide sufficient strength and rigidity to the corner panels **16**, **17** to enable them to withstand the accumulated thermal stress concentrations which tend to localize at the corners of the insulation barrier **10** while it is in service. As shown, the edges of corner panels **16**, **17** are beveled so that they may cooperate with the walls **11** of the supporting structure of triangular cross section to define a channel **19** which may be monitored for gas leakage, the detection of which would, of course, indicate a failure of the cargo barrier. The wall panels **15**, **16**, **17** are fabricated of molded shells **20** of polyester resins reinforced with fiberglass, which shells encapsulate a polyurethane foam filling **21**, in accordance with the general teachings of copending application Ser. No. 394,287 of Pratt et al., for "Insulation System," filed Sept. 3, 1964.

In accordance with the invention, the side edges of all of the wall panels **15**, **16**, **17** are ascendingly stepped with the innermost or "cold" (in terms of the relation of the installed barrier to the cargo) surfaces of the panels defining the top step **22**, and the outermost or "warm" surfaces of the panels defining the bottom step **23**, there being one intermediate step **24**, as shown.

The wall panels **15–17** are appropriately affixed to the walls by suitable means, for example, by using screws and adhesive as described in detail in the above-identified application, in a manner in which their ascendingly stepped edges are parallelly arrayed to define an open grid G. In accordance with the invention, the insulating cargo impermeable barrier **10** is completed by filling the spaces between wall panels, i.e., the open grid G, with straight plug panels **26** and L-shaped plug panels **27** formed similarly to the wall panels **15–17** of molded fiberglass reinforced polyester shells which encapsulate polyurethane foam. The plug panels **26**, **27** may be secured to the wall panels **15–17** by adhesives and screws in a manner illustrated in the aforementioned application Ser. No. 394,287. Thus, as shown in FIG. 3, the gaps between adjacent wall panels **15–17** are filled with appropriately shaped generally flat plug panels **26** and the gaps of the grid G located at the corners of the tank are filled by L-shaped plug panels **27**. It should be understood that the illustrated corner intersection of three walls of the barrier **10** embodies all of the shapes of wall panels and plug panels employed in cladding the walls **11** of the cargo hold **12**.

In accordance with the invention, the end edges **28** as well as the side edges **29** of the plug panels are stepped. More specifically, three of the four end edges of the plug panels meeting at every grid intersection are ascendingly stepped and arranged to terminate in alignment with the edges of the wall panels forming the intersection, as shown at the righthand side of the drawing in FIG. 3. The remaining plug panel which meets at the intersection and completes the joint has a descendingly stepped, extended edge **30** which engages in mating fashion all four of the wall panels at the intersection and the other three plug panels. As will be understood, the side edges **29** of all plug panels are descendingly stepped while the end edges may be either ascendingly or descendingly stepped (plug panels with both types of ends being shown in FIG. 4). However, at each grid intersection, only one of the end edges of the four plug panels meeting at the grid intersection is descendingly stepped. Furthermore, the plug panel having the descendingly stepped end edge will be of sufficient length to extend across and to completely fill in the space of the intersection.

Accordingly, it should be understood, at every grid intersection, the extended plug panel end edge (which is

descendingly stepped) overlaps and mates with the ascendingly stepped edges of the four wall panels, and the three plug panel end edges defining the intersection. Furthermore, all the four side edges of all of the plug panels overlap the ascendingly stepped edges of the wall panels. Therefore, in accordance with the invention, this overlapping, interlocking arrangement of plug and wall panels establishes a substantially rigid barrier, the joints of which provide a tortuous and substantially impenetrable path for escaped cryogenic cargo. Accordingly, the new and improved barrier construction tends to minimize strike through of liquefied natural gas that may have leaked through a primary barrier.

It should be understood that the specific structure herein illustrated and described is intended to be representative only, as certain changes may be made therein without departing from the clear teachings of the disclosure. Accordingly, reference should be made to the following appended claims in determining the full scope of the invention.

What is claimed is:

1. A continuous insulating barrier construction comprising

(a) a closed supporting structure having inner surfaces of predetermined geometric configuration;

(b) a plurality of insulation wall panels secured to said inner surfaces of said supporting structure;

(c) said wall panels having ascendingly stepped side edges defining a gridlike network of gaps therebetween;

(d) a plurality of insulation plug panels filling the gaps between opposed longitudinal sides of said wall panels;

(e) each intersection within the gridlike network being filled by an integral extension of one of said plug pieces;

(f) said extension engaging the ends of three other plug pieces terminating at said grid intersection;

(g) the innermost layer of said extension being superimposed upon the intermediate layers of said three other plug pieces and the intermediate layers of at least portions of the four wall panels defining said grid intersection.

2. A barrier construction in accordance with claim 1, in which

(a) the intersections of adjacent walls of said barrier being formed by molded L-shaped wall panels and plug panels;

(b) the corner intersections of three walls of said barrier being formed by molded boxlike wall panels having portions coplanar with each of the intersecting walls.

3. A barrier construction in accordance with claim 2, in which

(a) said boxlike and said L-shaped wall panels include sufficient reinforcement to withstand stresses developed therein.

4. A barrier construction in accordance with claim 1, in which

(a) all of the side edges of said plug panels are descendingly stepped;

(b) one of the four end edges of the plug panels meeting at each intersection is descendingly stepped;

(c) the end edges of the other three plug panels meeting at said intersection are ascendingly stepped.

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