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MEMBRANE-TYPE INSULATED TANKS

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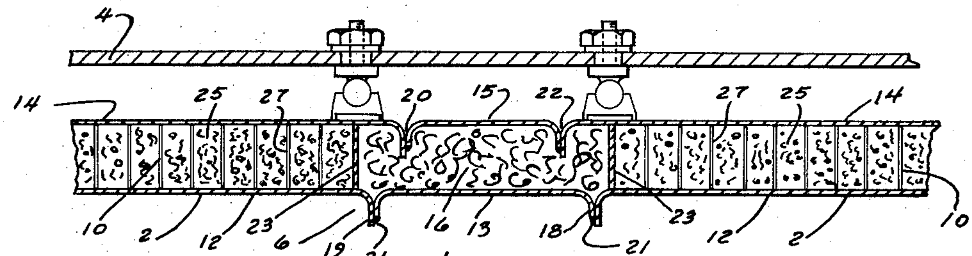

FIG. 1

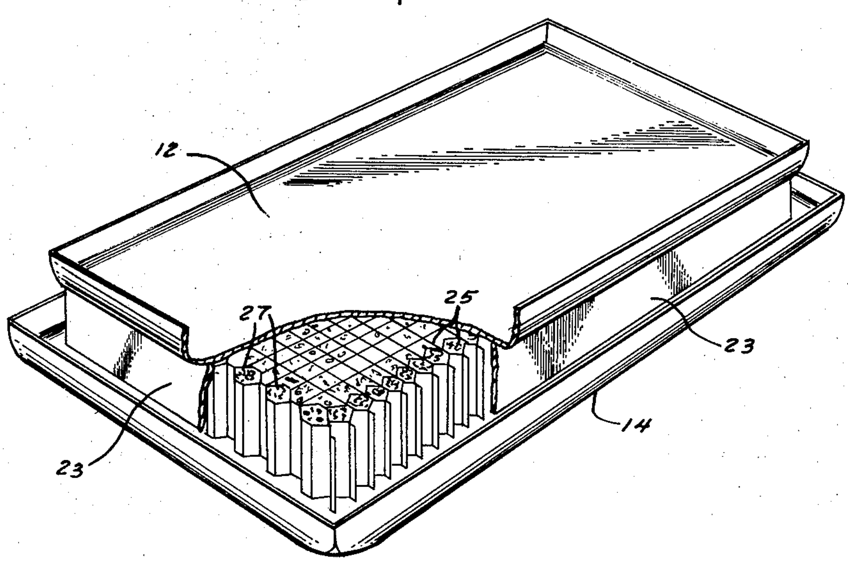

FIG. 2

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MEMBRANE-TYPE INSULATED TANKS

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This invention relates to an insulated space of large dimensions suitable for use in the transportation and storage of materials which must be maintained at extremely low temperatures. It relates more particularly to an improved design of such vessels adapted for the storage and transportation of liquefied gases and other materials of extremely low boiling points.

The membrane-type insulated tanks which result from the concepts of this invention are constructed of panels having an inner surface which is impervious to the passage of liquids and vapors, and a like outer surface which provides a secondary barrier to the passage of such materials and also provides a means for supporting the panels on a supporting wall.

The invention is further particularly concerned with a membrane-type insulation construction which provides, in addition to the inner and outer primary and secondary barriers, an extremely light and easily assembled panel for the making of the membrane-type tanks.

Prior structures employed for the storage and transportation of liquefied gases have included tanks maintained substantially independently within insulated chambers. Structures of this type required means to stabilize the tanks during movement of the vehicles transporting them, and further means to maintain full and complete control of the movements of the tank with respect to the remainder of the transporting structure. Additionally, it was necessary to provide means which permitted freedom of the tanks for movement relative to the structure by reason of the change in dimension of the tanks upon expansion and contraction due to temperature change but without loss of stability. Additional disadvantages of the prior structures included the use of relatively thick metal walls which made up the tanks carrying the cold materials.

In application Serial No. 80,785, filed January 5, 1961, by John D. Sudbury, a construction was disclosed which overcame many of the above difficulties. This construction provided a membrane-type tank with primary and secondary barriers which proved to be safe and relatively inexpensive. This structure, however, nevertheless necessitated the use of relatively thick panels which made up the membrane tank in order to provide adequate insulation.

It is therefore an object of this invention to provide a means for storing and transporting liquefied gases and other materials which must be maintained at extremely low temperatures, the storing and transporting means having inner surfaces impervious to the passage of liquids or vapors while at the same time expanding and contracting in accordance with temperature conditions to which they are subjected.

It is an additional object of this invention to eliminate the need for support and control means as employed in independent-type tanks, and to eliminate the need for securing means and complex means for permitting expansion and contraction of independent-type tanks.

It is a further object of this invention to provide a membrane-type insulated construction which provides an initial barrier effective to prevent the passage of cold materials to outer supporting means, and an equally effective secondary barrier adding to the safety of the construction.

It is an additional object of this invention to provide a means for accomplishing the foregoing objects without

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necessitating the use of relatively thick insulating walls, thereby increasing available space and ease of assembly.

These and other objects of this invention will appear hereinafter and in order to illustrate more particularly the invention, specific embodiments are shown in the accompanying drawings, in which—

FIGURE 1 is a sectional view of a fragmentary portion of an insulated space embodying the concepts of this invention; and

FIGURE 2 is a perspective view, partly in section, of the improved panel of this invention.

It has previously been found that double barrier honeycomb panels eliminate the need for a primary container made up of relatively thick plate and independently supported within an insulated shell. In the membrane-type tanks which obviated the use of the above, the use of plastic foam within the spaces of the honeycomb employed in the construction of the membrane-type panels was found to substantially increase the insulating value. However, the foam-filled honeycomb panels were still relatively thick, which tended to increase assembling difficulties and necessarily decreased the amount of available storage space.

It has been discovered that if a vacuum is effected within the honeycomb panels, particularly when employed in combination with plastic foam filling the evacuated spaces, a substantial decrease in the thickness of the panels will provide essentially the same insulating value as the thicker panels. Where honeycomb panels which are individually sealed off after being evacuated are assembled into a membrane-type insulated space, a reduction in thickness by a factor of 6 over the thicker panels is possible. For example, where 12-inch thick honeycomb panels were previously employed, panels with a thickness of about 2 inches which are evacuated, filled with foam, and sealed in accordance with this invention, will provide equally effective results.

The panels and consequent insulated space of this invention include assemblies of membrane-type constructions as disclosed in the aforementioned Sudbury application. The particular embodiment shown in FIGURE 1 includes honeycomb panels 2 connected to a supporting wall 4 which, in the case of a ship will be an inner hull or the main hull, in such a manner as to provide a membrane-type assembly 6. Cellular honeycomb cores 10 are provided with primary and secondary metal facings or sheets 12 and 14, the facings being secured by the members 13 and 15. It is to be noted that the spacing between the two primary sheets 12 of adjacent honeycomb cores is greater than the spacing between the secondary sheets 14, thus providing working space for joining member 15 to the sheets 14 prior to the joining of sheets 12 to the member 13.

Insulation material 16 fills the space between adjoining panels 2, which space is filled after the joints 20 and 22 are effected and before the joining of the metal facings at 18 and 19. It will be noted that the metal sheets 12 and 14 overlap the respective members 13 and 15 at 21, thus facilitating the welding of these members.

It will be understood that the inner portions of the formed panels, identified by the facing sheets 12, will be subject to expansions and contractions due to the wide temperature change to which the inner portions of the panels will be exposed. For example, when the insulation is employed as a means or in combination with means for the storage of liquefied natural gas at a temperature of about −258° F., the portion 12 of the panels will range in temperature from −258° F., when the tank is filled with liquefied natural gas, to about 100° F. when empty. Such wide temperature change will result in change in dimension of the inner portion of the panel due to expansions and contractions taking place to increase or decrease the space between the panels. In this connection, the corrugated portions formed at 21 by joining of the overlap portions of sheets 12 and 13 will enable the connecting portions 13 to function as an expansion joint, while still providing a barrier to the passage of liquid.

A further concept in alleviating the change in dimension of the panels due to expansions and contractions is to make use of facing sheets 12 and 13 of dimpled construction throughout or with a cross-ribbed pattern of checkerboard or diamond-like shape, the dimpled construction being preferred because of its more uniform elimination of stress and supply of material for neutralization of contraction.

Referring to FIGURE 2, the cores 10 and metal facings 12 and 14 are shown assembled, making up an insulated panel 2 in accordance with this invention. Sealing means 23 surround the lateral surfaces of the panels 2 to provide the panels, in conjunction with the sheets 12 and 14, with a vacuum-tight closure. The means 23 may be continuous, vapor-impervious sheets or simply strips which close off the spaces formed by the edges of the honeycomb along the lateral surfaces of the panels. The sealing of the passages 25 in the core 10 may be effected in any well-known manner as long as a vacuum-tight seal of the panels 2 results.

The closure or sealing means 23 may be of the same material as the facing sheets 12 and 14, and may be selected from such materials as aluminum, aluminum alloys, copper, magnesium, stainless steel or other metals capable of maintaining ductility and strength at very low temperatures, or from materials including plywood, glass fiber reinforced plastics, and similar non-metallic materials.

The honeycomb and insulating compositions are of the same type as employed in the aforementioned Sudbury application, and it is contemplated that the spaces between the adjacent panels and between the outer sheet and the supporting wall will be filled with insulating material, in addition to the evacuated passages of the honeycomb cores.

When the cells of the honeycomb are to be filled with a plastic foam or other insulation material, such as expanded perlite, diatomaceous earth or the like, it is desirable to fill the cells before evacuation. Evacuation of the honeycomb cells can be accomplished by sealing the interior with sheets 12, 14 and 23 to enclose all but a selected portion of panel 2 through which evacuation can be effected, after which the remainder is sealed off to hold the vacuum. In this connection, the walls 27 of the honeycomb 10 may be inherently vapor-pervious to permit evacuation, or small apertures may be formed therein to facilitate the evacuation. In any case, the character of the walls 27 and/or the size of the apertures formed therein should not be of such a nature as to detract from the structural strength of the panels.

The performance of a group of 2-inch panels making up a membrance tank will be approximately equivalent, insofar as the prevention of the passage of cold fluids and with regard to insulating characteristics is concerned, to prior panels six times as thick.

It will be understood that the assembly panels can be used to define an insulated space in which reliance is had upon an interior member as the primary container for the liquid, the panels thereafter functioning as a secondary container or second line of defense against the penetration of cold liquid to the walls of the ship or other housing. In such instance, the primary container can be a membrane in the form of a thin metallic sheet or film applied as a continuous lining about the insulated space and which may rest upon the inner face of the panels for support when under liquid load. In the alternative, such primary container can comprise a self-sufficient tank formed of metal plate of sufficient wall thickness to maintain the liquid load without reliance upon the insulation panels for support.

It will be understood that various modifications in the insulated tank of this invention will be obvious to those skilled in the art, particularly in light of the following claims.

I claim:

1. In an insulated space of large dimension for the storage of a material which needs to be maintained at a temperature differing considerably from ambient temperature, a supporting wall defining the space to be insulated, a plurality of prefabricated insulation panels formed of honeycomb cores, said cores having evacuated passages formed therein, a continuous outer sheet of a fluid- and vapor-impervious material facing one surface of said core and adhesively bonded thereto, a continuous inner sheet of a fluid- and vapor-impervious material facing the other surface of said core and adhesively bonded thereto, sealing means completely enclosing the lateral surfaces of said core between said outer and inner facing sheets, means for attaching insulation panels in end-to-end and in side-by-side relation on the supporting walls with the inner sheet facing away from the wall, and means interconnecting the inner and outer sheets in sealing relationship one with the other in adjacent panels, said interconnecting means including expansion means to enable relative movements between the panel sections in expansion and contraction without disturbing the sealing relationship.

2. The insulated space according to claim 1 wherein the evacuated passages are filled with plastic foam and the panels are in the order of about 2 inches thick.

3. The insulated space according to claim 2 wherein the spaces between adjacent panels and the space between said outer sheet and said supporting wall are filled with insulating material.

4. An insulated space as claimed in claim 1, in which the inner sheet of fluid- and vapor-impervious material comprises a metal sheet of a temperature insensitive material formed with a dimpled construction throughout.

5. An insulated space as claimed in claim 1, which includes a primary container for liquid storage disposed adjacent said panel sections separate and apart from the assembly of insulated panels and positioned interiorly thereof within the insulated space.

6. An insulated space as claimed in claim 5, in which the primary container comprises a membrane of temperature insensitive material present as a continuous lining about the insulated space adjacent the inner face of the panels.

7. An insulated space as claimed in claim 5, in which the primary container comprises a self-sufficient tank formed of metal walls of a temperature insensitive material having sufficient thickness and strength to maintain the liquid load filling the tank.

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