FIG. 1
This invention relates to double-walled containers for the storage of liquefied gases and more particularly to supports for the inner vessel of such a container within the outer vessel and substantially spaced therefrom.

The most generally accepted manner hithertofore employed for supporting the inner vessel of a double-walled container has been to suspend it from the outer vessel by long thin rods of a material having a relatively low thermal conductivity such as stainless steel. This manner of support however has one main deficiency and that is that during shipment of the containers and at other times when they are subjected to rough handling, the suspended vessel tends to bounce and thereby subject the inner vessel to a relatively large lateral movement of the inner vessel. Furthermore, the material from which the rods must be made in order to possess satisfactory tensile strength to support the load in compression does not have the low thermal conductivity properties of other materials now available which might be used to support an equal load in compression. It has been proposed to support the inner container by supporting members which are disposed to support the load in compression. However, none of the latter type of supports has made provision for preventing lateral relative movement between the inner vessel and outer vessels nor has substantially decreased the heat gain which takes place through the supports. Wood has been suggested as the material for a compression support but is not particularly satisfactory because the space between the inner and outer vessels is usually evacuated for insulating purposes and this dehydrates the wood rendering it more brittle and substantially weakens it and lessens its span.

The primary object of this invention is therefore to provide supports for the inner vessel of a double-walled container for the storage of liquefied gases which provide resistance to substantial lateral relative movement of the inner vessel to the outer vessel, which are more efficient heat barriers than supports heretofore proposed have been, and which allow for only limited movement of the inner vessel with respect to the outer vessel because of expansion or contraction of the inner vessel.

Accordingly, a support constructed in accordance with this invention comprises a bracket secured to the inner vessel and a bracket secured to said outer vessel. A hollow member of a plastic laminate material is provided to interconnect the brackets by being secured therebetween. The hollow member is relatively loosely connected to at least one of the brackets whereby relative movement between the two vessels is directly attributable to the expansion and contraction of the inner vessel is permitted but substantially all other relative movement between the two in any form of support contemplated by the invention, the outer bracket is secured to the outer face of the outer casing and the hollow member of plastic laminate material is provided to support the composite container. In this form, the bracket is secured to the outer casing by airright connections and is adapted to be engaged by legs for supporting the composite container.

For a more detailed description of the abovementioned form of support, which comes within the scope of the invention, reference may be made to the accompanying drawings, in which:

Fig. 1 is an elevational view partly in section in one form of double-walled container in which the supports of my invention may be employed and illustrates the use of the preferred form of support;

Fig. 2 is an enlarged sectional view of the preferred form of support illustrated in Fig. 1; and

Fig. 3 is a sectional view of the preferred form of support illustrated in Fig. 2.

The double-walled container illustrated in Fig. 1 comprises a spherical inner vessel 10 adapted to contain a liquefied gas, which is to be stored, and an outer vessel 11 of substantially spherical shape to contain inner vessel. A plurality of supporting legs 12 are located beneath the side of the outer vessel 11 and provide support for the composite container, when in an upright position. A bracket 13 is fastened to the upper end of the inner vessel and is provided for lifting the entire double-walled container for shipment. The space between the inner and outer vessels contains a number of liquefied gas conduits or pipes through which the liquefied gas may be fed into the inner vessel for storage and removed therefrom for use. As these various pipes or conduits play no part in the present invention, they are not further described, except to say that provision is made at both of the openings in the outer vessel through which the inner pipe and outlet pipe extend, to maintain them normally closed by gas-tight seals, so that the two vessels are used for insulating purposes and may be filled with insulating material, such as powdered Santocel. Furthermore, this space is usually evacuated.

The inner vessel 10 is supported within the outer vessel 11 solely by a plurality of supports indicated generally at 14 in Fig. 1. These supports constitute my invention, those shown in Fig. 1 being the preferred form of support illustrated in greater detail in the enlarged sectional view of Fig. 2 and in Fig. 3.

Referring now to Figs. 2 and 3 of the drawings, the preferred form of support comprises an angular bracket 15 secured, as by welding, to the outer face of the inner vessel 10. A pair of side plates 16 are secured to opposite sides of bracket 15 and extend substantially below the bracket. Each is provided with an integral flange 17. A second support bracket 18 is secured, again as by welding, to substantially the outer face of the outer vessel 11. The connection between bracket 18 and outer vessel 11 must be gas-tight to maintain the space between vessels 10 and 11 gas-tight for insulating purposes, in view of the fact that the support is to extend through the outer vessel, to make it more brittle and substantially weaken it and lessen its span.

Referring now to Figs. 2 and 3 of the drawings, the preferred form of support comprises an angular bracket 15 secured, as by welding, to the outer face of the inner vessel 10. A pair of side plates 16 are secured to opposite sides of bracket 15 and extend substantially below the bracket. Each is provided with an integral flange 17. A second support bracket 18 is secured, again as by welding, to substantially the outer face of the outer vessel 11. The connection between bracket 18 and outer vessel 11 must be gas-tight to maintain the space between vessels 10 and 11 gas-tight for insulating purposes, in view of the fact that the support is to extend through the outer vessel, to make it more brittle and substantially weaken it and lessen its span.

Referring now to Figs. 2 and 3 of the drawings, the preferred form of support comprises an angular bracket 15 secured, as by welding, to the outer face of the inner vessel 10. A pair of side plates 16 are secured to opposite sides of bracket 15 and extend substantially below the bracket. Each is provided with an integral flange 17. A second support bracket 18 is secured, again as by welding, to substantially the outer face of the outer vessel 11. The connection between bracket 18 and outer vessel 11 must be gas-tight to maintain the space between vessels 10 and 11 gas-tight for insulating purposes, in view of the fact that the support is to extend through the outer vessel, to make it more brittle and substantially weaken it and lessen its span.

Referring now to Figs. 2 and 3 of the drawings, the preferred form of support comprises an angular bracket 15 secured, as by welding, to the outer face of the inner vessel 10. A pair of side plates 16 are secured to opposite sides of bracket 15 and extend substantially below the bracket. Each is provided with an integral flange 17. A second support bracket 18 is secured, again as by welding, to substantially the outer face of the outer vessel 11. The connection between bracket 18 and outer vessel 11 must be gas-tight to maintain the space between vessels 10 and 11 gas-tight for insulating purposes, in view of the fact that the support is to extend through the outer vessel, to make it more brittle and substantially weaken it and lessen its span.

Referring now to Figs. 2 and 3 of the drawings, the preferred form of support comprises an angular bracket 15 secured, as by welding, to the outer face of the inner vessel 10. A pair of side plates 16 are secured to opposite sides of bracket 15 and extend substantially below the bracket. Each is provided with an integral flange 17. A second support bracket 18 is secured, again as by welding, to substantially the outer face of the outer vessel 11. The connection between bracket 18 and outer vessel 11 must be gas-tight to maintain the space between vessels 10 and 11 gas-tight for insulating purposes, in view of the fact that the support is to extend through the outer vessel, to make it more brittle and substantially weaken it and lessen its span.

Referring now to Figs. 2 and 3 of the drawings, the preferred form of support comprises an angular bracket 15 secured, as by welding, to the outer face of the inner vessel 10. A pair of side plates 16 are secured to opposite sides of bracket 15 and extend substantially below the bracket. Each is provided with an integral flange 17. A second support bracket 18 is secured, again as by welding, to substantially the outer face of the outer vessel 11. The connection between bracket 18 and outer vessel 11 must be gas-tight to maintain the space between vessels 10 and 11 gas-tight for insulating purposes, in view of the fact that the support is to extend through the outer vessel, to make it more brittle and substantially weaken it and lessen its span.

Referring now to Figs. 2 and 3 of the drawings, the preferred form of support comprises an angular bracket 15 secured, as by welding, to the outer face of the inner vessel 10. A pair of side plates 16 are secured to opposite sides of bracket 15 and extend substantially below the bracket. Each is provided with an integral flange 17. A second support bracket 18 is secured, again as by welding, to substantially the outer face of the outer vessel 11. The connection between bracket 18 and outer vessel 11 must be gas-tight to maintain the space between vessels 10 and 11 gas-tight for insulating purposes, in view of the fact that the support is to extend through the outer vessel, to make it more brittle and substantially weaken it and lessen its span.
must have a very low thermo-conductivity value, whereby it is capable of transferring very little heat and thus is an efficient heat barrier. In the form of support illustrated, the hollow cylindrical member made of a plastic laminate material forms a heat barrier, because, any heat transferred from the outer vessel to the inner vessel must pass through.

A number of materials are contemplated, from which the hollow cylindrical members may be made. Two specific examples are (1) a glass cloth laminated melamine resin bonded plastic and (2) an asbestos cloth laminated melamine resin plastic. The melamine glass laminate weighs about one-half as much as aluminum and has an average density of about .05 lb. per cubic inch. Furthermore, in compression, it has a strength exceeding that of structural steel when the load is applied normal to the laminate and, as an insulating material, is one of the best known. It resists both cold and heat and is not subject to embrittlement at temperatures below zero down to —300° F. and, additionally, its compressive strength tends to increase as the temperature is lowered. Another, and perhaps equally important characteristic of this material, and of others which might be employed, is that it is very easily fabricated. Other filter materials beside glass cloth and asbestos, which might be used in the plastic are, for instance, paper, canvas duck, and like fibrous materials, which have good strength characteristics. While powder fillers might be used, they lack the strength of the fibrous type. Other plastics that might be used include the phenolics and ureas.

Comparative tests have shown the following q values for tension loaded rods made of stainless steel, and compression loaded melamine asbestos laminate and melamine glass laminate supports, the q value representing the heat gained per hour through the rod. For stainless steel

\[ q = 1.71 \times 10^{-3} \times \frac{F}{L} \text{ B. t. u./hr.} \]

where F equals the load carried by the rod and L is the length of rod between points of contact with the inner and outer vessels. For a melamine asbestos laminate support

\[ q = 1.07 \times 10^{-3} \times \frac{F}{L} \text{ B. t. u./hr.} \]

and for a melamine glass laminate support

\[ q = 1.54 \times 10^{-3} \times \frac{F}{L} \text{ B. t. u./hr.} \]

From the above, it will be apparent that the supports of this invention are between 11 and 16 times more efficient as heat barriers than conventional stainless steel supports, since F and L depend on the size or weight of the tank in either case. In general, however, the length of the plastic supports of this invention would be about one-third the lengths of the corresponding stainless steel rod supports that have been previously employed. Thus, the relative efficiency of the supports of the invention as heat barriers with respect to the stainless steel support previously used would be approximately 4 or 5 to 1.

I claim:

1. In a double-walled container for the storage of liquefied gas including an inner vessel for holding the liquefied gas and an outer vessel completely surrounding the inner vessel and spaced therefrom, said outer vessel being air tight, a plurality of apparatus for supporting said inner vessel within said outer vessel and spaced therefrom so that each of which apparatus comprises a bracket secured to the inner vessel, a bracket secured to said outer vessel substantially outside the outer vessel, a support member fixedly secured to said last-mentioned outer bracket, an inner support member secured by a loose pin connection to the bracket secured to the inner vessel, and a hollow member of a plastic laminate material extending through an opening in the wall of the outer vessel and interconnecting said support members, the opposite ends of said hollow member overl contact the adjacent ends of said support member and being secured therebetween.

2. In a double-walled container for the storage of liquefied gas including an inner vessel for holding the liquefied gas and an outer vessel completely surrounding the inner vessel and spaced therefrom, said outer vessel being air tight, a plurality of apparatus for sup- porting said inner vessel within said outer vessel and spaced therefrom each of which apparatus comprises a bracket secured to the inner vessel, a bracket secured to the outer vessel substantially outside the outer vessel, an outer support member fixedly secured to said last mentioned outer bracket, an inner support member secured by a loose pin connection to the bracket secured to the inner vessel, a pair of side plates secured to opposite sides of said bracket secured to the inner vessel and receiving between them the inner end of the inner support member, a connecting pin extending through holes in said plates and said inner end of the inner support member, a number of said holes being substantially larger in diameter than the pin, and a hollow member of a plastic laminate material extending through an opening in the wall of the outer vessel and interconnecting said support members, the opposite ends of said hollow member overlaid by the adjacent ends of said support members and being secured thereto.

3. A double-walled container as set forth in claim 2, in which the bracket secured to said outer vessel substantially outside the inner vessel is secured to said outer vessel by an air tight connection, and in which said outer support member is fixedly secured to the inner face of said outer bracket.

4. A double-walled container as set forth in claim 2 including supporting legs for the container, each leg engaging one of said outer brackets.

5. In a double-walled container for the storage of liquefied gas including an inner vessel for holding the liquefied gas and an outer vessel completely surrounding the inner vessel and spaced therefrom, said outer vessel being air tight, apparatus for supporting said inner vessel, said hollow member of a plastic laminate material located between each bracket secured to the inner vessel and each bracket secured to said outer vessel, and means for connecting each said hollow member to its pair of brackets, said means means preventing sufficient lateral relative movement between said inner bracket and said hollow supporting member to permit dislodgement of said inner bracket from said hollow supporting member but permitting limited relative movement between said inner bracket and said hollow supporting member to accommodate different degrees of expansion and contraction of said vessels, and each said connecting means being free of a direct metal-to-metal joining of said brackets which it connects whereby heat transfer from one bracket to the other bracket is minimized.

References Cited in the file of this patent

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Inventor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,661,659</td>
<td>Gray</td>
<td>Mar. 6, 1928</td>
</tr>
<tr>
<td>1,810,615</td>
<td>Knight</td>
<td>June 16, 1931</td>
</tr>
<tr>
<td>2,460,355</td>
<td>Kornemann</td>
<td>Feb. 1, 1949</td>
</tr>
<tr>
<td>2,467,428</td>
<td>Haas</td>
<td>April 19, 1949</td>
</tr>
<tr>
<td>2,495,798</td>
<td>Wissmiller</td>
<td>Jan. 31, 1950</td>
</tr>
<tr>
<td>2,504,390</td>
<td>Caldwell</td>
<td>Apr. 18, 1950</td>
</tr>
<tr>
<td>2,528,780</td>
<td>Preston</td>
<td>Nov. 7, 1950</td>
</tr>
<tr>
<td>2,563,118</td>
<td>Jackson</td>
<td>Aug. 7, 1951</td>
</tr>
<tr>
<td>2,613,838</td>
<td>King</td>
<td>Oct. 14, 1952</td>
</tr>
</tbody>
</table>

UNITED STATES PATENTS