INSULATION APPARATUS

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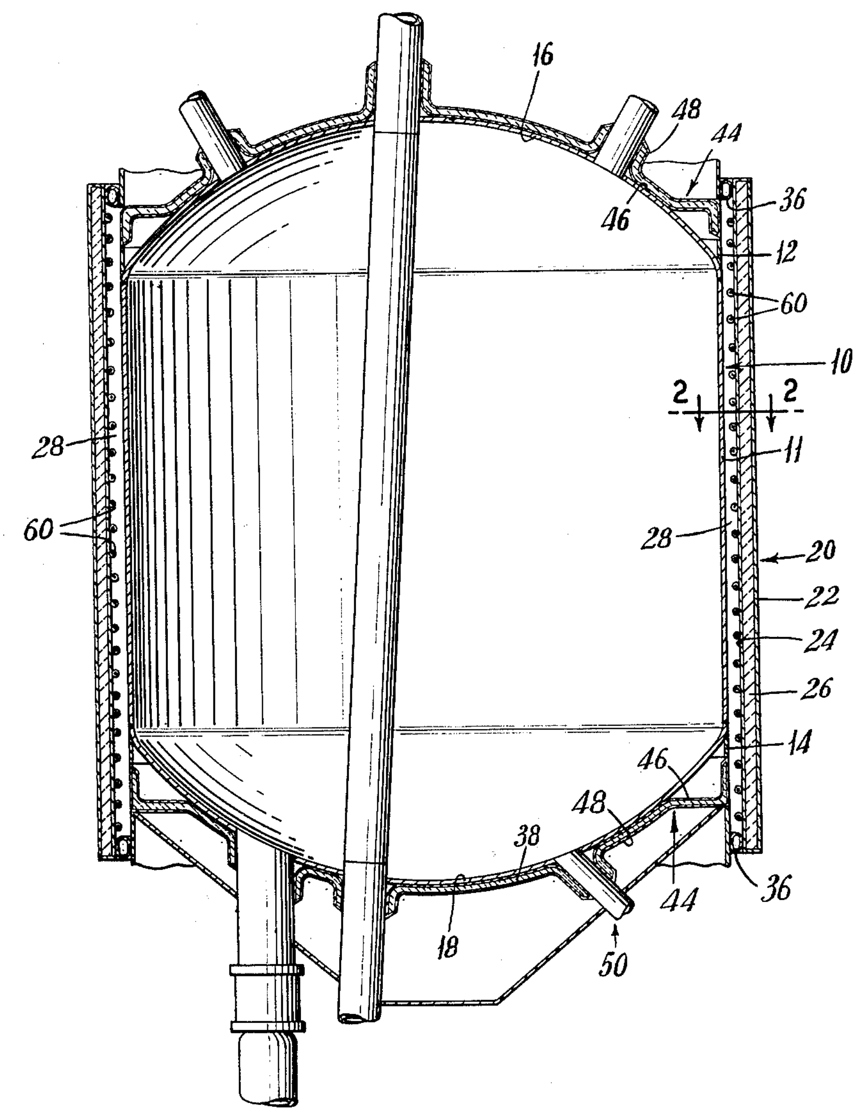

Fig. 1.

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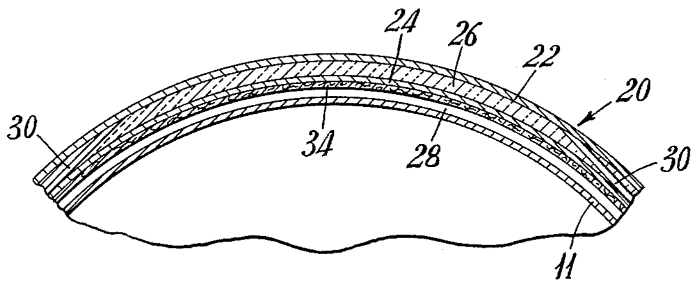

Fig. 2.

Fig. 5.

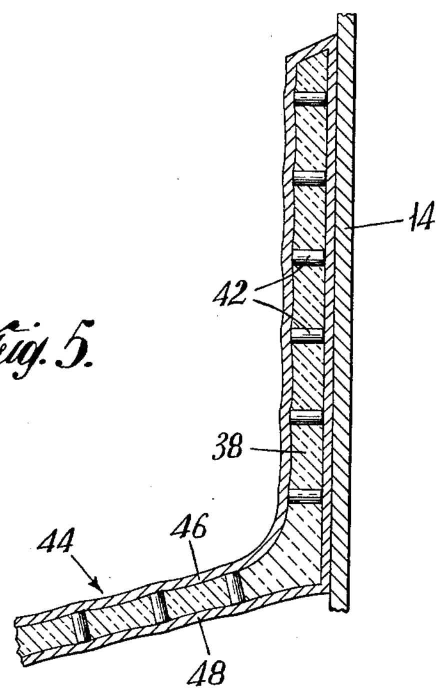

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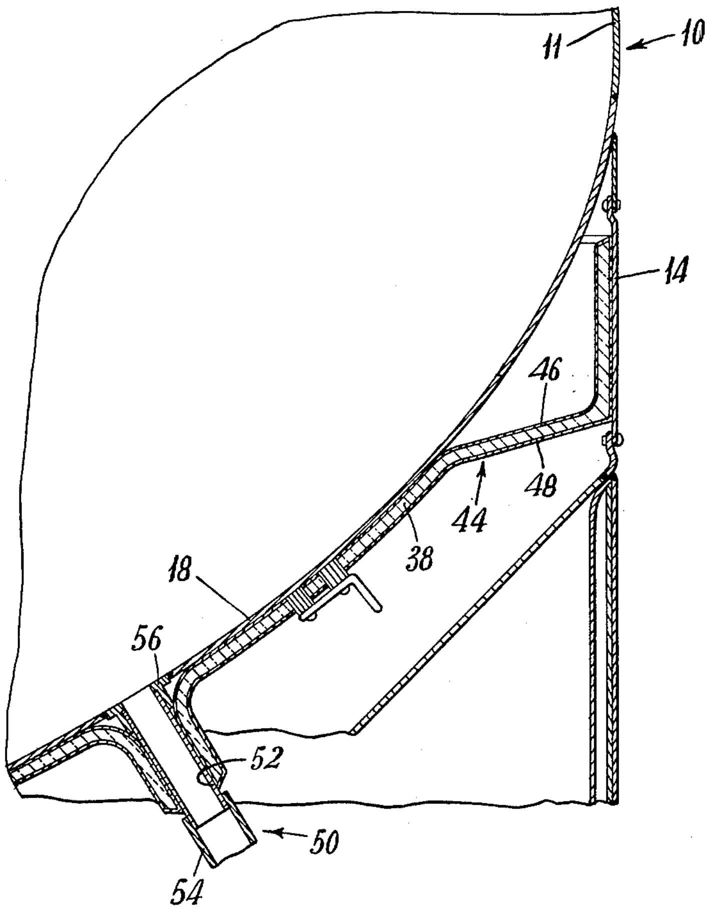
Fig. 4.



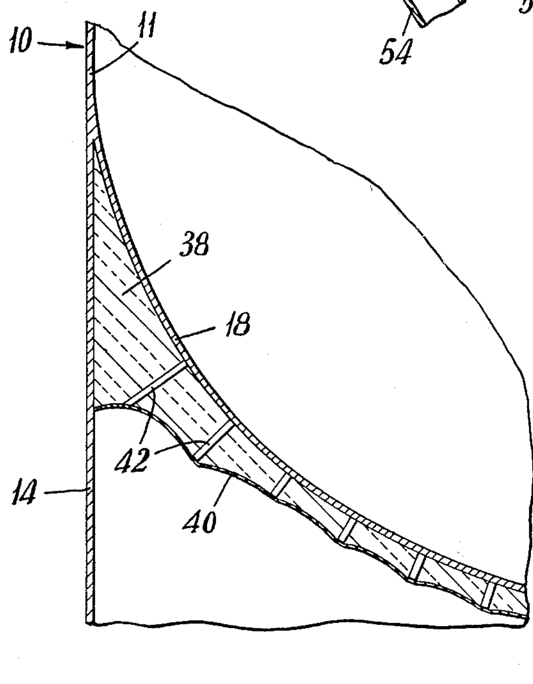


Fig. 3.

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INSULATION APPARATUS

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13 Claims. (Cl. 62—45)

This invention relates to insulation apparatus for containers and especially for containers storing volatile, low temperature liquids. It relates, more particularly, to an insulated tank for containing liquefied propellant in a self-propelled missile or a self-contained, reaction propelled space vehicle, which tank provides a portion of the missile outer surface.

The following discussion is directed to both self-contained missiles and reaction propelled space vehicles wherein the primary driving or propelling force is provided by the removed expansion of gases produced in the reaction between a suitable fuel and oxidant. To simplify the discussion, we will refer to a self-propelled missile utilizing liquid oxygen as the oxidant.

As a propellant in the self-propelled missiles or vehicles here concerned, liquid oxygen is found to be excellent in many respects, two of the more favorable characteristics exhibited being ease of handling and overall safeness. Liquid oxygen, in contrast to other oxidizers, such as fuming nitric acid, is relatively inexpensive and, in addition, it provides a comparatively high specific thrust and a high density.

In spite of these favorable aspects, liquid oxygen still has some disadvantages as an oxidant for self-propelled missiles. One of its most serious drawbacks, for example, is the extremely high rate of evaporation exhibited by the liquid when stored in uninsulated containers. In addition, liquid oxygen's boiling point of −183° C. is so extreme as to tend to chill or freeze any equipment or apparatus with which it becomes associated or in contact. This could become a problem during long standby conditions wherein missile equipment could be rendered inoperative.

Because of the above-mentioned problem of evaporation, it is a rather standard procedure to charge the self-propelled missile with liquid oxygen immediately prior to firing. This, of course, entails a significant time period during which the missile tanks are being charged. In that many of our missiles are intended as deterrent or defensive weapons requiring usage on short notice, an extended loading period is highly undesirable and greatly detracts from any missile's effectiveness. Also, the equipment required for storing the propellant and rapidly transferring it to the missile is complex and costly, especially for underground sites wherein said equipment must be also installed underground.

It is, therefore, an object of the present invention to provide a missile cryogenic propellant tank capable of being maintained in a substantially fully charged condition over long standby periods to permit substantially instantaneous firing of the missile.

A further object is to provide a cryogenic propellant tank having a structure characterized by a high degree of insulating qualities positioned in contiguous relation to the wall of the tank to minimize heat leak and consequent evaporation of the cryogenic propellant.

An additional object is to provide the combination of a propellant tank for a missile with insulated ends and an outer insulating jacket cooperating with said tank, which tank and jacket are readily separable for launching purposes.

Still further object is to provide an insulated missile

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propellant tank which eliminates the necessity for complex and costly servicing equipment necessary for rapid charging of the tank shortly prior to launching of the missile.

Still another object is to provide a load bearing vacuum type insulation panel which is useful for insulating containers, especially cryogenic storage vessels.

Other objects, features and advantages of the present invention will be apparent from the following description of certain embodiments thereof taken in conjunction with the accompanying drawings in which:

FIG. 1 is a view of a longitudinal cross section through a tank embodying the principles of the invention;

FIG. 2 is a view in enlarged scale taken on line 2—2 of FIG. 1;

FIG. 3 is a fragmentary view in cross-section and on an enlarged scale of an alternate embodiment of the disclosed container wall structure;

FIG. 4 is a view in enlarged scale of a fragmentary section of a preferred embodiment of the container wall structure shown in FIG. 1; and

FIG. 5 is still another view in cross-section and on an enlarged scale of an alternate embodiment of the container wall structure.

In brief, the invention contemplates a novel vacuum insulated container for storing volatile, low temperature liquids which comprises a generally cylindrical center tank portion surrounded by a removable insulating jacket. A pair of head portions joined to the center tank portion define the container and can accommodate a number of fittings and conduits requisite to operation of a missile and conduction of liquid into and from the tank.

In FIG. 1 there is shown an insulated liquefied gas container **10** embodying the features of the present invention. The container is generally elongated in shape having a cylindrical central wall portion **11** with upper and lower ringlike skirts **12** and **14** respectively extending from either end thereof. A pair of heads **16** and **18** provide end closures to the central tank portion and define the liquid storage chamber. The respective head portions are joined to the central wall portion by conventional means such as welding in order to provide gas tight pressure joints. The skirt members function generally as connecting means intermediate the liquid propellant container and the portions of the missile body disposed above and below the tank.

The container **10** may preferably be fabricated from a relatively light metal such as aluminum since lightness in weight constitutes one of the essential desirable characteristics of any missile component. The actual thickness of the central wall portion **11**, or the heads **16** and **18**, depends to some degree on wether the container is located in the first stage of a missile which carries a large propellant load or in one of the succeeding upper stages which carry smaller loads. When aluminum is the metal used, the center portion wall **11** may be about 0.050–0.067 inch thicknesses. The upper head **16** may be about 0.032 to 0.050 inch thick while the lower head **18** is approximately 0.050 to 0.090 inch thick. If low heat conductive stainless steel is used, rather than aluminum, the central wall and heads constructed of this stronger material may of course be of a much thinner gage, in the order of about 0.011–0.022 inch thick for a typical 10 feet diameter missile tank.

There are several paths for heat to leak into the container **10** and thereby cause vaporization of the stored propellant. If the missile is to have a relatively long holding time in readiness condition, the total heat in-leak must be minimized to relatively immaterial amounts. This may be accomplished in the following manner. The container cylindrical portion **11** and the appended skirt portions **12** and **14** represent about 64–72% of the total outer surface area of an average missile oxidant tank and constitute a major source of heat leak. This cylindrical portion, as seen in FIG. 1 is surrounded by an insulating jacket **20** consisting essentially of an outer cylindrical wall **22** and concentric inner wall **24** fixedly positioned and gas tightly joined at the outer edges to define an annular evacuable space or enclosure **26** therebetween. The inner wall **24** of the jacket is positioned in contiguous relation to wall **11** for best insulating efficiency.

A plurality of low-thermally-conductive spacer members fabricated in tubular or column shape, for example from phenol-formaldehyde resin reinforced with fabric or paper, are so disposed as to maintain the desired spacing between outer wall **22** and inner wall **24** of insulating jacket **20**. Referring to FIG. 2, the jacket walls **22** and **24** are so provided with spacer members **30** that each wall can separately withstand the pressure difference created between the evacuated space **26**, and the ambient pressure, without excessive distortion of the wall structure. The spacer members **30** can be relatively few in number and preferably concentrated near the outer edges of the walls. As shown they are positioned in the evacuated space **26** substantially tangentially with respect to both jacket walls. This arrangement permits said spacer members to be of considerable length, thereby reducing thermal conductivity of the members. These members are preferably hollow and cylindrical and have a relatively large overall diameter with thin walls to aid in reducing the thermal conductivity along the spacer members by reducing the material cross-section thereof while maintaining maximum stability as a column.

In its simplest form, the jacket **20** employs a straight vacuum within the space **26**. Alternatively this space could be filled with a powdered medium as described in U.S. 2,396,459. The preferred embodiment of the present jacket utilizes an opacified-vacuum insulation system, such as described completely in copending applications U.S. Serial 580,897, now Patent No. 2,967,152, and Serial 597,947, now Patent No. 3,007,596.

Briefly, an opacified insulation refers to a two-component insulating system comprising a low heat conductive, radiation permeable material, and a radiant heat impervious material which is capable of reducing the passage of infra-red radiation rays without significantly increasing the thermal conductivity of the insulating system. To further elaborate on the terms presently referred to, vacuum as herein used is intended to apply to subatmospheric pressure conditions not substantially greater than 1000 microns of mercury, and preferably below 100 microns of mercury absolute.

The jacket **20** may comprise a unitary sleeve adaptable for sliding longitudinally along the missile body and into place surrounding the cryogenic propellant container **10**. A preferred embodiment, however, is to construct the jacket so as to be segmentally removable. This could be accomplished, for example, in a jacket consisting of two or more longitudinally divided segments which may be positioned adjacent the container **10** during standby periods and which are thereafter retracted away from the missile immediately before launching.

In practice, the retracted jacket **20** will still remain in the near vicinity of the missile during its launching and will consequently reflect a considerable amount of sound energy from the missile propulsion system back to the missile during launching causing vibrational damage to the missile. To lessen the impact of the reflected sound, the jacket **20** may be provided with an acoustic lining **34** as shown in FIG. 2, which is positioned adjacent the exposed outer surface of inner wall **24** to absorb sound energy and protect the missile. The lining, to be most effective, may be fabricated from a glass fiber mat, or a similar acoustic absorbing material.

To more efficiently avoid heat leak and entrance of atmospheric moisture into the annular space **28**, defined by the jacket **20** and the container **11**, this space as well as the joints between insulating jacket segments are sealed with appropriate gasketing material or with formed gaskets **36**, such as illustrated in FIG. 1. These gaskets may be substantially solid but are preferably tubular in cross-section so as to be inflatable, and they are fabricated from material which has low thermal conductivity and which remains relatively flexible at depressed temperatures in the order of −195° C. The gaskets may be made of film, or in a shape extruded or molded of a suitable plastic material as trifluorochloroethylene polymer, tetrafluorochloroethylene polymer or polyethylene terephthalate resin. When an inflatable type gasket is provided, it may be expanded by introduction of a dry gas such as nitrogen and thence deformed under the pressure of the adjacent container and jacket to form a substantially air tight closure to the annular space **28**. In the instance of a segmented type of jacket, the gaskets would, of course, be made to interjoin or connect when urged into position against the container wall.

To minimize the amount of heat conducted into the propellant tank through the inner wall **24** of the jacket, this wall is preferably constructed of a low heat conductive material, such as stainless steel or titanium, in the order of about 0.005 inch thick, or alternatively, reinforced plastic material could be used. As previously mentioned, a preferred embodiment of the apparatus may employ two or more co-acting insulating jacket sections. The side edges of such sections which complete the enclosure of space **26**, are preferably constructed of a thin low heat conductive material as described above. When these hollow curved sections are evacuated, they will have a tendency to distort and thus change their dimensional relation with respect to each other and to the container contour. Such undesired distortion may be prevented however by providing rib supports, stiffening rings, or circumferential corrugations, not shown, about the jacket outer wall **22** to lend structural support.

Prevention of heat leak through the cylindrical portion of the liquid propellant container **10** would not be effective for long term standby service with the current design of missiles unless means were provided for preventing any substantial heat leak through the respective heads **16** and **18**, and the skirt portions **12** and **14**.

One means for insulating the respective container heads is illustrated in FIG. 3, where it may be seen that the circumferential skirt portion **14** provides the outer wall of an evacuable space **38**. A thin metal wall **40**, of material such as stainless steel is outwardly spaced from the tank head **18**, and circumferentially joined to the skirt **14**, to define the closure **38** for containing a vacuum type insulating medium; this wall **40** is relatively thin, being about 0.001–0.010 inch thick and preferably about 0.005 inch thick. In order to prevent inward collapse of wall **40** due to pressure differential between the container interior and exterior, the evacuable space **38** is provided with a plurality of low heat conductive columns **42** disposed intermediate wall **40** and the head **18**. In addition to providing desired spacing between the insulation panel walls, these columns also transmit forces from one wall to the other and thus allow the composite panel to be load-bearing.

These columns **42** can be constructed of ceramic, such as porcelain, but are preferably hollow tubes fabricated with fabric or paper reinforced organic thermo-setting resin. Useful organic resins are found to be reinforced phenol-formaldehyde and melamine-formaldehyde, for example. The columns are about ½ to 4 inches long having an outside diameter varying from 1/16 inch to ⅞ inch with a sufficient wall thickness to be rigid. They are spaced about 1 to 8 inches apart depending on the desired distance to be maintained between the adjacent walls and the thickness of wall **40**.

In accordance with the invention, the thin wall **40** is allowed to sag as shown in FIG. 3 a predetermined controlled amount. The walls must not be allowed to come into thermal contact or the insulation efficiency would be drastically reduced. Such controlled sagging of the panel wall enables overall stress in the wall caused by loads applied to the wall, to be carried in tension rather than in bending stress as is found under prior art conditions where straight or non-sagging curved walls were used. This novel combination now enables very thin walls in the order of 0.005 inch thickness to be used in a load-bearing type of vacuum insulation panel which reduces overall weight as compared to weight of prior art vacuum insulated panels using wall thickness in the range of ⅛ inch. As an example of the amount of sagging that can be expected with the present invention, it was found that a 0.005 inch thick wall of 17–7 pH annealed stainless steel sagged about ⅜ inch under 1 atmosphere pressure with 4½ inch spacing between column supports. This novel type of load-bearing insulation is useful not only for cryogenic storage vessels but is also useful wherever a high quality light weight insulation is required.

This controlled sagging may be accomplished either by preforming of the thin wall **40** or by application of a pressure differential through evacuation of the insulating space **38**, or even by a combination of these methods. The thin wall **40** may be spot reinforced by attaching thin (less than 0.010 inch thick) metal discs onto the ends of the spacer members **42** which in turn may be attached to either the inner or outer adjacent walls.

A preferred embodiment of this form of head insulation employs the combination of the plurality of spacer members **42** and an opacified insulation as herein described in the evacuated space **38**.

Referring to FIG. 4, a portion of another embodiment of the container including an insulating medium, is illustrated in section to show the skirt **14**, and lower head **18**, which parts are cooperatively insulated by the bulkhead **44**. This bulkhead consists of an inner panel **46** and an outer panel **48** spaced apart from each other and generally comformable in shape to the container head wall; a seal at the edges thereof provides an evacuable closure. The panel walls of bulkhead **44** are preferably formed of a thin stainless steel about 0.001-0.010 inch thick and preferably about 0.005 inch thick. When such thin panel walls are used, they are preferably mutually supported by spacer members in a controlled sagging condition similar to that described above to form a load-bearing light weight vacuum panel. FIG. 5 shows in more detail a portion of bulkhead **44**.

The evacuated space between adjacent walls **46** and **48** may also be provided with an opacified insulation of the type previously described. The use of an insulating bulkhead **44**, separable from the container head **18** provides the advantages that each portion may be fabricated individually and later united into a missile body. It is also advantageous to extend a portion of the bulkhead **44** along and adjacent to the skirt **14** as shown in FIG. 4 thereby providing more efficient insulation for the container. This is especially useful when plastic skirt materials are used as will be herein described. Alternatively the outer wall **48** of bulkhead **44** may constitute a section of the missile outer surface by forming the skirt portion. In such an instance, the portion of wall **48** that forms the skirt section will have a thickness on the order of about 0.015–0.040 inch.

It may be desirable in fabricating missile tanks in accordance with the invention, to provide the outer surface of the thin insulating walls with a protective layer of a light material such as natural or synthetic rubber, polyethylene terephthalate or polyethylene. For example, the thin surfaces referred to include the external surface of wall **40** shown in FIG. 3, or the outer surfaces of walls **46** and **48** shown in FIG. 4. A coating of the type described, protects these metal walls from being accidentally pierced or otherwise damaged during fabrication operations. A suitable thickness of the protective material

would be a thickness equivalent to the particular wall being protected with a maximum of about 0.005 inch.

A further means for reducing heat leak to container **10**, resides in the skirt members being constructed of a low thermal conductive material such as stainless steel or titanium having a thickness of about 0.015–0.040 inch. The skirt members should also be relatively short to reduce overall missile weight. Not only may the above noted metals be used for skirt construction but a favorable substitute is found to be high strength, low heat conductive organic plastic materials such as phenol formaldehyde polymer, reinforced with paper or fabric. Such plastic materials are readily usable for load-bearing members, but on the other hand, they are not suitable where a leak-tight joint is required. For instance, if a vacuum type insulation is used, as illustrated in FIG. 3, a metal skin must extend from wall **40** contiguous to the plastic skirt **14**, to form a metallic leak tight seal for the evacuated space **38**.

An additional method of reducing heat leak into the present container is through the insertion of low heat conductive barriers into the various conduits and fittings protruding from and extending through the container walls. This is illustrated in FIG. 4 in connection with outlet **50** showing an insert **52** interposed between the container proper and an aluminum conduit **54** for conducting liquid propellant from the container. The presence of the sleeve member **52** constructed of stainless steel or another material having a low thermal conductivity prevents excessive heat leak which would be ordinarily expected from use of the aluminum conduit. Such fittings may be further enclosed with an insulation layer for a portion of their length as shown in FIG. 4. Although the joining of dissimilar metals such as stainless steel to aluminum, exemplary of which is the joint at **56**, offers fabricating problems, various processes have been developed for accomplishing this. One such process is disclosed in a copending application Serial No. 769,224 of R. P. Skinner and R. M. Poorman, filed October 23, 1958, now Patent No. 3,105,293.

Another important feature of the present invention is that during periods of standby-readiness condition the annular space **28** intermediate the insulating jacket **20** and the oxidant tank **10** may be pressurized with a dry gas, such as nitrogen, in order to purge this space and to prevent in-leak of moisture-laden air which could otherwise form ice along the chilled wall **11** of the tank **10**. Such ice formations are of course undesirable as they add to the weight of the missile and also cause possible fouling to the missile operating mechanisms.

Regarding the insulating efficiency of the present invention, it has been estimated that if a container and jacket combination of the type shown were maintained in a standby-readiness condition for several years, the amount of heat leak would result in a loss of oxygen amounting to about 0.2–1.0% per day. Although this represents a vast improvement over present missile liquid oxygen storage tanks, the container of the invention would still require periodic but minor additions of liquid oxygen to maintain a full charge. Toward eliminating even this need for minor periodic refilling, a preferred modification of the invention is proposed wherein a low temperature refrigerant, such as liquid nitrogen, is used to chill the container outer walls.

This may be accomplished by circulating the refrigerant through the annular space **28** or preferably and more conveniently as shown in FIG. 1 by use of the refrigerant coils **60** contiguous to the insulating jacket **20** and connectable to an external refrigerant source. The nitrogen refrigerant preferably in the liquid phase would not only circulate through the coils **60** but the nitrogen vapors resulting therefrom could also be used to pressurize the annular space **28** and to controllably inflate the various sealing gaskets. Such purge gas would leave the relatively air-tight annular space through any convenient exit means. Liquid nitrogen being colder than liquid oxygen, i.e. (N_2 boiling point of $-195°$ C.) can be supplied in sufficient amount to subcool the stored oxygen and substantially eliminate vaporization losses. In this fashion a missile can be maintained in standby-readiness condition for as long as five years and maintaining an exact quantity of liquid oxygen of known density in the missile without the need for replenishing the propellant. The method also eliminates possible accumulation of hydrocarbon impurities in the liquid oxygen caused by periodic replacement of evaporated liquid. Such subcooling will further provide about 5¼% higher oxygen density, as well as greatly reduce the time required for priming the pumps used to transfer the liquid oxygen to a subsequent combustion chamber of the missile. The pumps under such conditions can thus be maintained at room temperature during standby-readiness status and then rapidly cooled to the required low temperature operating conditions when needed by introduction of the subcooled oxygen to the pump.

Additional methods can also be used to obtain even greater degrees of propellant subcooling. One additional method is to utilize reduced pressure in the refrigerant coils **60**, this method in effect reduces the boiling point of the nitrogen and thus provides a lower temperature refrigerant. A means for reducing pressure is by use of a vacuum pump or even a suction blower connected to the outlet of coil **60**. It is understood that liquid oxygen could be used in the refrigerant coils in a manner similarly to that described in respect to liquid nitrogen. Since oxygen has a lower freezing point than nitrogen, if reduced pressure is used as above noted, oxygen can provide a potentially lower temperature refrigerant. Such lower temperatures enable the stored propellant to be even further subcooled and thereby provide a higher storage density. It might also be noted that use of liquid oxygen refrigerant has the added advantage of requiring only one source of cryogenic fluid when liquid oxygen is stored in the propellant tank.

When the liquid oxidant is refrigerated in the above described manner, it is desirable that the container **10** be pressurized to at least atmospheric pressure by introduction of helium gas. This compensates for the pressure decrease which generally accompanies subcooling. Maintaining above-atmospheric pressure within the container also provides high structural stability to the missile for withstanding wind and handling forces.

There have been several prior art proposals for insulating space vehicle and missile propellant tanks with insulation that forms a permanent part of or is attached to the tank outer shell. Among the advantages derived through use of the present invention, one of the most pertinent is the highly efficient insulation for standby condition on the ground combined with a minimum in-flight tank weight. It has been determined in this respect that for a typical large single stage missile, while an apparent added weight of approximately 150 pounds is realized, and in a two-stage missile, a differential of 250 pounds additional weight results, it is believed that this extra burden is offset partially by the elimination of the necessity for rapid fill methods which require special valves and apparatus all of which add to a missile's weight. Also a considerable weight saving is realized by the present invention which precludes the formation of ice on the missile outer surface prior to launching. Some further weight may be saved through use of the insulated tank heads by elimination of heating equipment otherwise needed to maintain at operating temperature missile parts located near the low temperature propellant tank zone.

While the preceding discussion has been directed at the use of liquid oxygen as the stored propellant in a missile it should be understood that the present invention is also useful with other self-contained reaction propelled space vehicles using other cyrogenic propellants, such as liquid hydrogen.

It is also understood that changes and modifications may be made in the disclosed apparatus without departing from the spirit and scope of the invention.

What is claimed is:

1. In a self-propelled missile, a container for storing a low temperature vaporizable fluid comprising an elongated cylindrical portion which forms an integral section of the missile outer surface, a closure fastened to each end of said cylindrical portion, said end closure comprising an inner wall peripherally joined to the cylindrical portion, a composite insulating barrier contiguous with the outer surface of said wall and substantially conforming in shape thereto, said barrier comprising a pair of inner and outer spaced panel members being joined at the edges thereof to define an evacuated closure, insulating means disposed in said closure for spacing said inner and outer members and providing mutual support thereto.

2. A self-propelled missile substantially as described in claim 1 wherein the evacuated insulating barrier closure is provided with an additional insulating medium.

3. A self-propelled missile substantially as described in claim 1 wherein the insulating barrier closure is substantially evacuated and provided with an opacified insulation.

4. In a self-propelled missile, a container for storing a low temperature vaporizable fluid which comprises an elongated cylindrical portion composed of a single wall coextensive with the missile outer surface, a circumferential skirt ring extending longitudinally from each end of said cylindrical portion, closure means fastened to each end of said cylindrical portion comprising a substantially rigid inner wall, an outer yieldable panel spaced therefrom and circumferentially joined to an inner wall surface of said skirt to define an evacuated closure intermediate said rigid inner wall, said skirt and said panel and low conductive means in said closure for providing mutual support to said wall and panel.

5. A container for storing a low temperature vaporizable fluid which comprises an elongated cylindrical portion compound of a single wall coextensive with the container outer surface, a circumferential skirt ring extending longitudinally from each end of said cylindrical portion, a closure fastened to the respective ends of said cylindrical portion comprising a substantially rigid inner wall forming a fluid tight connection with the cylindrical portion, a yieldable panel outwardly spaced from said wall and peripherally joined to an inner wall surface of said skirt defining an evacuable space intermediate said rigid inner wall, said skirt and said panel, a low conductive means disposed in said evacuable space for mutually supporting said wall and panel and means traversing said closures for conducting fluid into and out of said container.

6. A container for vaporizable fluid substantially as described in claim 5 wherein the low conductive means is an opacified insulation.

7. A container for vaporizable fluid substantially as described in claim 5 wherein the evacuable space intermediate the wall and panel is provided with a plurality of low conductive substantially rigid support members in mutual contact with said wall and panel.

8. A container for vaporizable fluid substantially as described in claim 5 wherein the wall and panel are held in spaced relationship by low heat conductive members disposed therebetween and the so formed space is evacuated and provided with an insulating material.

9. A container for vaporizable fluid substantially as described in claim 5 wherein the wall and panel are spaced by low heat conductive substantially rigid column members of an organic material, and the intermediate space formed thereby is provided with a substantially gas free atmosphere and also an opacified insulation material.

10. In a cryogenic storage vessel, a light weight load bearing insulation panel comprising, a first metallic wall, a second metallic wall spaced from said first wall defining an evacuable insulating space therebetween, at least one of said walls being relatively thin to permit movement

thereof when subjected to a loading force, the evacuable space intermediate said walls being provided with a plurality of low heat conductive column members spaced uniformly apart and disposed to transmit forces between said walls, said relatively thin wall being pre-stressed to inwardly sag toward the other of said walls by a pre-determined controlled amount prior to said load being applied, whereby when subsequent loading forces are applied to said panel, said forces will be resisted by tensional stresses within said walls rather than by bending stresses therein.

11. A load-bearing insulation panel substantially as described in claim 10 wherein the first and second walls are about 0.005 inch thick.

12. A load-bearing insulation panel substantially as described in claim 10 wherein the low heat conductive columns are fabricated from a material selected from the group consisting of porcelain, fabric-reinforced organic thermosetting resin, and paper-reinforced organic thermosetting resin.

13. A load-bearing insulation panel substantially as described in claim 12 wherein the low heat conductive columns are about ½ to 4 inches long and have an outside diameter of 1/16 to ⅞ inch and are spaced about 1 to 8 inches apart.

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