Dec. 21, 1965 E. S. KORDYBAN ET AL 3,224,622

STABILIZED INSULATED CONTAINERS

Filed Feb. 1, 1963 2 Sheets-Sheet 1

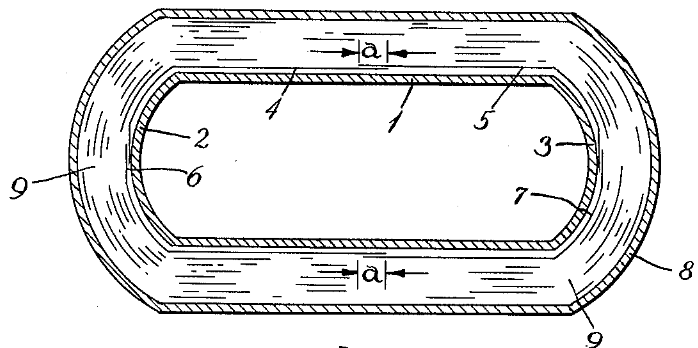

Fig. 1.

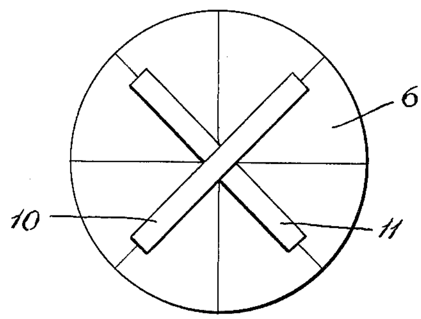

Fig. 2.

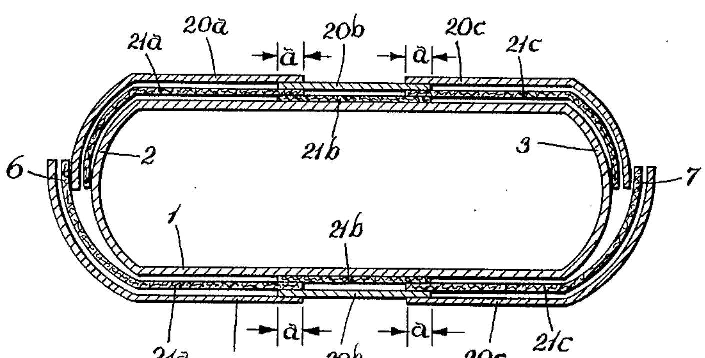

Fig. 3.

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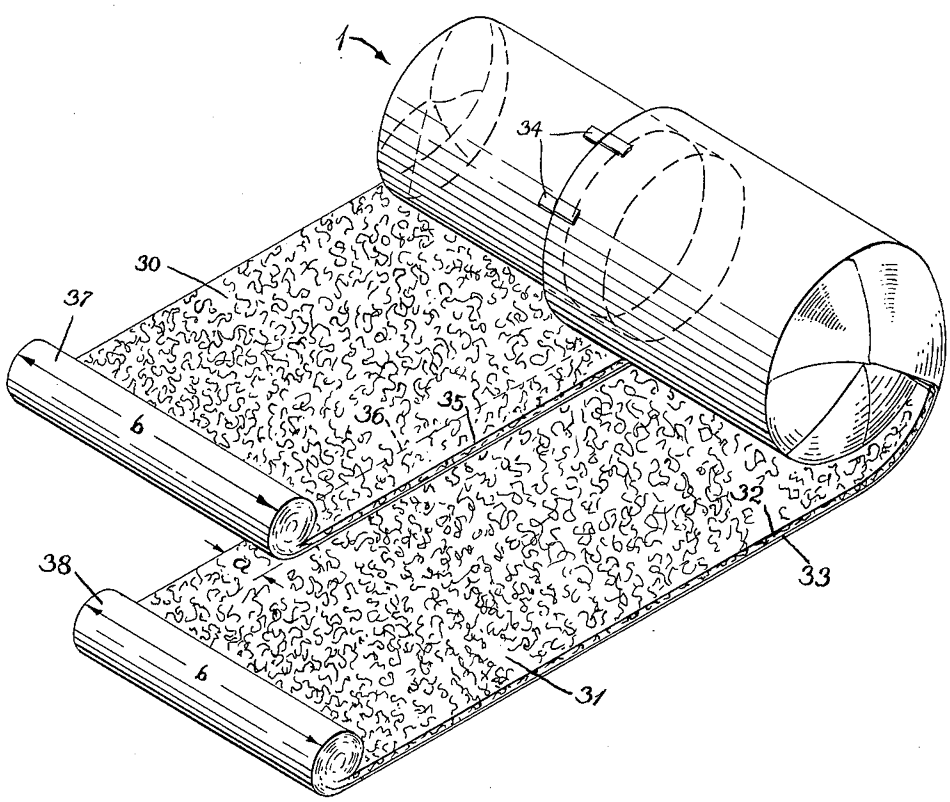

Fig. 4.

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3,224,622
STABILIZED INSULATED CONTAINERS

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This invention relates to improved insulated containers for storing liquefied gases.

It has become common practice to insulate containers used to store liquefied gases by wrapping the containers with sheets of insulating materials. Such containers are often subjected to longitudinal inertial forces during handling and shipping. In the case of insulated containers having an inner cylindrical vessel wrapped with sheets of an insulating material, such forces may cause the movement of the insulating material in a longitudinal direction toward one end of the insulated container, thereby descreasing the amount of insulating material over the other end of the inner vessel. Various means have been suggested to avoid such movement of insulating materials when such insulated containers are subjected to longitudinal inertial forces. By way of illustration, it has been suggested that increasing the friction between the insulating material and the inner vessel (e.g. by local compression of the insulating material against the vessel, which can be achieved either by providing bands around the outer surface of the insulating material or by urging spring-loaded members against the outer surface of the insulation material) would overcome this problem. Although the latter-mentioned expedients have proven successful, they involve a substantial localized increase in the density of the compression sensitive insulating material which impairs the insulating properties of the insulating material to some extent at such localized areas. Moreover, such expedients involve the use of additional materials (e.g. metal bands and springs) which increase material and labor costs.

It is an object of this invention to stabilize the insulation on insulated containers against movement relative to the container due to longitudinal inertial forces without significantly impairing the insulating properties of the insulation.

Another object of this invention is to provide a stabilized insulated container which can be produced with a minimum of material and labor costs.

The above, as well as additional objects of the invention, will be more clearly understood from the following description of several of its exemplifications, reference being made to the accompanying drawings wherein:

FIGURE 1 is a longitudinal view of the cross-section of an insulated container of the invention showing in detail one layer of insulating material composed of two sheets.

FIGURE 2 is an end view of the container shown in FIGURE 1.

FIGURE 3 is a sectional view of an insulated container illustrating another embodiment of the invention wherein the inner vessel is wrapped with two layers of insulation, each composed of three sheets of insulating material.

FIGURE 4 is an isometric view illustrating the wrapping of two courses of insulating material on a cylindrical container in the production of the insulated container of this invention.

This invention is based on the discovery that the movement of insulating materials used to insulate containers having inner cylindrical vessels wrapped with insulating materials can be avoided by providing overlapping between each adjacent pair of sheets of the insulating material, and by attaching one or more layers of the insulating material to one or both ends of the vessel. Such overlapping and attaching of the insulating material prevents the movement of the material relative to the inner vessel when the container is subjected to longitudinal inertial forces. Such forces are transmitted through the insulating material by friction between the overlapping portions of the material to the end or ends of the vessel to which the material is attached.

Referring now more specifically to the drawings and particularly to FIGURE 1, the illustrative insulated container of this invention consists of an inner cylindrical vessel **1**, headers **2** and **3** fitted transversely at the ends thereof and, in detail, one insulating layer composed of two substantially rectangular sheets of insulating material **4** and **5**. Sheets **4** and **5** overlap and their overlapping surfaces form annular ring "*a*" around the circumference of vessel **1**. Portions **6** and **7** of sheets **4** and **5** are folded over the headers **2** and **3** thereby providing attachment of the layer to each of the header. Gas tight outer shell **8** and inner cylindrical vessel **1** are arranged so as to provide an intervening evacuable space **9**.

FIGURE 2 shows the portion **6** of sheet **4** folded over header **2** of the illustrative cylindrical container of FIGURE 1. Two strips of adhesive tape **10** and **11** serve to maintain the folded portion **6** of sheet **4** over header **2**.

Any longitudinal inertial forces exerted on the container illustrated in FIGURE 1 and FIGURE 2 is transmitted through the overlapping area "*a*" by friction to the opposite end of the container, owing to the attachment of the insulating material at the header **2**. The amount of such sliding friction can be increased, for example, by increasing the amount of wrapping tension employed in wrapping the insulation around the vessel. Such tension causes a relatively minor increase in insulation density at the area of overlap and hence causes a correspondingly minor impairment of the insulating properties of the insulation.

FIGURE 3 illustrates an insulated cylindrical container of this invention having six sheets of insulating material **20*a***, **20*b***, **20*c***, **21*a***, **21*b*** and **21*c***. Sheets **20*a***, **20*b*** and **20*c*** compose an outer insulating layer and sheets **21*a***, **21*b*** and **21*c*** compose an inner insulating layer. The three outer sheets of insulating material **20*a***, **20*b*** and **20*c*** are sheets of reflective metal foil and the three inner sheets of insulating material **21*a***, **21*b*** and **21*c*** are sheets of a fibrous glass web material. The area of overlapping between each pair of adjacent sheets in FIGURE 3 is indicated by "*a*." As in the illustrative insulated container of FIGURE 1, the portions **6** and **7** of insulating material in FIGURE 3 are also folded over headers **2** and **3**.

FIGURE 4 shows a step in the application of two sheets of insulating material **30** and **31** to a cylindrical vessel **1** in producing an insulated container of this invention. Each of the sheets is composed of two plies of **32** and **33**. Ply **32** is composed of the same fibrous material as sheets **21*a***, **21*b*** and **21*c*** of FIGURE 3 and ply **33** is composed of the same metallic material as sheets **20*a***, **20*b*** and **20*c*** of FIGURE 3. Additional means **34** for ensuring the transmission of longitudinal inertial forces from one sheet to the other are shown in FIGURE 4. These additional means **34** may be strips of adhesive tape which extend from one sheet to the other across the area of overlap. These means **34** are preferably disposed substantially parallel to the longitudinal axis of the cylindrical vessel **1** and substantially perpendicular to the mating edges **35** and **36** of the sheets **30** and **31**. The area of overlap is shown by "*a*." The width of the sheets is shown by line "*b*."

The amount of overlapping between each adjacent pair of sheets of insulating material in the insulated containers of this invention is not narrowly critical. The desired amount of overlap is that amount which provides sufficient friction between the overlapping adjacent sheets to transmit longitudinal inertial forces from one sheet to another and ultimately to a header to which a layer of the insulating material is attached. In general, the amount of overlapping is greater with less resilient materials than it is with more resilient materials, and the amount of overlapping is greater when a low wrapping tension is employed, than when a higher wrapping tension is employed. Moreover, the amount of overlapping should be greater when nearer the headers than at the center of the inner cylindrical vessel since the longitudinal inertial forces are greater nearer the headers. In any given case, the desirable amount of overlapping will be dependent upon the expected magnitude of the longitudinal inertial forces to which the insulated container will be subjected in the particular use envisioned for the container. Still further, the desirable amount of overlapping will be greater for more dense insulating materials than for less dense insulating materials. Such overlapping, in order to be effective for the purpose of this invention, must be between adjacent pairs of sheets whose lateral edges are in a plane substantially perpendicular to the longitudinal axis of the cylindrical vessel. In practice it has been found that overlapping of from 0.5% to 15% of the width of a sheet of insulating material is adequate for the purposes of this inevntion. In specific reference to FIGURE 4, the amount of overlapping "*a*" should represent from 0.5% to 15% of the width "*b*" of sheet **30** or **31** of the insulating material.

Although it is often not essential to provide additional means for transmitting longitudinal forces beween adjacent courses of insulating material in the insulated containers of this invention, such additional means can be employed if desired (e.g. where the inner vessel is relatively long, where the insulated container may be subjected to extremely severe longitudinal inertial forces in use or where insulating material having very low resiliency, such as a paper insulation, are employed). For reasons of economy, such additional means are desirably employed, rather than increasing the overlap beyond 15% of the width of a sheet of insulating material, in cases where especially severe longitudinal forces are encountered. Such additional means for transmitting longitudinal forces or for increasing resistance to relative movement of the overlapping adjacent courses include adhesive tapes (e.g. strips of aluminum containing an adhesive material on one surface), gluing, interlacing of the adjacent courses by deformation or perforation (particularly where the insulating material is a metal foil) and mechanical metallic attaching means (e.g. staples and the like). When such additional means for transmitting longitudinal forces are employed, in embodiments such as that of FIGURE 1, it is desirable that the overlapping area be maintained porous to permit the passage of gases during evacuation of the annular space (space **9** in FIGURE 1) between the inner cylindrical vessel and the outer shell is evacuated. Thus, in the embodiment of FIGURE 4 where adhesive tape is employed, it is preferable to apply several short strips of the adhesive tape **34** longitudinally about the inner vessel **1** rather than to apply a single continuous strip of the adhesive tape circumferentially around the inner vessel over the overlapping sheets of insulating material. Similarly, in an embodiment where the adjacent sheets are glued together to provide additional means for transmitting longitudinal forces, it is preferable to apply the glue at separated points rather than continuously around the overlapping area.

The manner in which the overlapping between adjacent sheets of insulating material is achieved in producing the insulated containers of the present invention is not critical. One suitable method for obtaining overlapping is illustrated in FIGURE 4 and involves the application of the insulating material to the inner cylindrical vessel simultaneously from two rolls **37** and **38** of insulating material. The rolls are disposed in spaced relation to one another so as to effect the desired amount of overlapping. FIGURE 4 illustrates a spiral wrapping of the insulating material around the inner cylindrical vessel and this manner of wrapping is particularly adaptable and convenient. As shown in FIGURE 4, each roll of insulating material **37** and **38** consists of two plies **32** and **33** of different insulating materials and the resulting insulation on the vessel consists of alternate layers of these two insulating materials. Such alternate layer insulation can also be provided on the inner cylindrical vessel by applying each type of insulation separately from a different roll.

After the insulated material has been wrapped around a cylindrical vessel in as many layers as are necessary to achieve the amount of insulation desired, it may be desired (although it is not essential) to provide means for increasing the friction between the insulating material and the inner cylindrical vessel. Such means include wrapping metal bands circumferentially around the outer layer of insulating material. Such bands (e.g. bands of the crinkled metallized plastic sheets or bands of the metal foil materials described below) are preferably applied over the overlapping areas of the adjacent sheets of the insulating material. Such friction-increasing means also include applying compression members normal to the outer layer of insulating material.

As used herein "attachment" of a layer of insulating material to a header denotes the arrangement or disposition of the layer in relation to a header so as to provide a longitudinal inertial force transmitting means between the layer and the header. Thus "attachment" encompasses folding the layer over the header; urging the layer against the header (e.g. by compression means or metal bands urged against the outer surface of the layer); fastening the layer (e.g. by thread or cord) to fastening means (e.g. hooks) provided on the header; or any other suitable means for transmitting longitudinal inertial forces from the layer to the header. At least one and preferably most or all of the layers are so attached to a header. The layers can be so attached to one or, preferably, both headers. When a layer is attached to only one header, the layer is thereby stabilized against movement in only one direction due to longitudinal forces. The layers can be attached to a header in groups or, preferably, singly since somewhat better thermal performance is attained in the latter case.

The headers in the insulated containers of this invention are located traversely across each end of the cylindrical vessel. Such headers are conventionally curved metal plates having a circular cross-section. The headers can be originally separate members that are suitably attached (e.g. welded) to the vessel or they can be an integral part of the vessel (e.g. when the header-vessel assembly is produced as single casting). Such headers are alternately designated "heads," "head plates" or "closure means."

This invention is broadly applicable to insulated containers wherein the insulation is any of the various types of insulating materials employed in commercial practice. Such suitable insulating materials include those which are applied as a single component material as well as those that are applied along with another insulating material, e.g. those which are applied in alternate layers with a second insulating material. Typical of suitable single component insulation materials are the crinkled metallized plastic sheets disclosed in U.S. Patent 3,018,016. Suitable insulation materials disclosed by the latter patent are crinkled polyethylene terephthalate or polytetrafluorethylene sheets covered with a thin film of aluminum, gold, silver or copper. Suitable insulation also includes sheets of fibrous material and particularly sheets of fibrous material which are applied alternately between sheets of metal foil material to provide alternate layer composite insulation. Such alternate layer composite insulation is disclosed in U.S. Patent 3,009,600 which relates to insulation comprising alternate layers (a) of fibrous material in the form of paper and (b) metal foil material. Such alternate layer composite insulation is disclosed in U.S. Patent 3,009,601 which relates to insulation comprising alternate layers of (a) fibrous material in the form of web and (b) metal foil material. Such metal foil sheets function as radiation-impervious radiant heat barriers and can have a thickness from 0.002 mm. to 0.2 mm. and can be composed of any suitable metal such as aluminum. Such fibrous materials preferably have diameters of less than 10 microns and are preferably composed of glass fibers. It is within the contemplation of the present invention to provide a fine low-conductive powder in the voids between the fibers of such fibrous materials. It is also within the contemplation of this invention to employ fibrous material-metal foil insulations wherein the different materials are not in alternating disposition.

In general suitable fibrous-metal foil alternate layer composite insulation can be more specifically described as external load-free insulation comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible sheet radiation barrier layers, said radiation barrier layers being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiation barrier layers in a limited space for reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross, each radiation barrier layer being disposed in contiguous relation on opposite sides with a layer of the fibrous sheet material, the fibers of said fibrous sheet material being oriented substantially parallel to the radiation barrier layers and substantially perpendicular to the direction of heat inleak across the space occupied by the layers, said fibrous sheet material being composed of fibers having diameters less than about 10 microns, said radiation barrier sheet having a thickness less than about 0.2 millimeters, and said multi-layered composite insulation being disposed in the space occupied by the layers to provide more than 4 radiation barrier layers per inch of said composite insulation.

The above-mentioned insulation of U.S. Patent 3,009,600 can be more specifically described as a composite multi-layered, external load-free insulation in the space occupied by the layers comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible radiant heat reflecting shields, said radiant heat reflecting shields being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiant heat reflecting shields in a limited space for reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross, each radiant heat reflecting shield being disposed in contiguous relation on opposite sides with a layer of the fibrous sheet material, the fibers of said fibrous sheet material being oriented substantially parallel to the heat reflecting shields and substantially perpendicular to the direction of heat inleak across the space, said fibrous sheet material being a permanently precompacted paper composed of unbonded fibers having diameters less than 5 microns and a length of less than about 0.5 inch, said radiant heat reflecting shields having a thickness less than about 0.2 millimeters, and said multi-layered composite insulation being generally spirally wound in the space to provide more than 40 radiant heat reflecting shields per inch of said composite insulation.

The insulation of U.S. Patent 3,009,601 can be more specifically described as a composite multi-layered, external load-free insulation in the space occupied by the layers comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible radiant heat reflecting shields said radiant heat reflecting shields being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiant heat reflecting shields in a limited space for reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross each radiant heat reflecting shield being disposed in contiguous relation on opposite sides with a layer of the brous sheet material, the fibers of said fibrous sheet material being oriented substantially perpendicular to the direction of heat inleak across the insulating space, said fibrous sheet material being an elastically compressible web composed of bers having diameters between about 0.2 and 5 microns, said radiant heat reflecting shields having a thickness less than about 0.2 millimeters and being, if desired, perforated to provide flow paths through the shields and said multi-layered composite insulation being generally spirally wound in the insulation space to provide more than 5 radiant heat reflecting shields per inch of said composite insulation.

The above-mentioned insulation of U.S. Patent 3,018,016 can be more specifically described as metal-coated-non-metallic, flexible plastic material, said plastic material being essentially free of any substance having an equilibrium vapor pressure at 20° C. of greater than 10 micron mercury absolute there being between 12 and 120 layers of flexible material per centimeter of thickness of insulation space occupied by the layers, the metal coating on the flexible material having a thickness less than .25 micron and being sufficiently thick to have an emissivity less than .06, the flexible material having a low heat conductivity to give a low lateral heat conductivity to the metal-coated flexible material of less than 10×10^{-6} watts per square per ° K. at 300° K., the layers of flexible material being peramnently deformed, as by crumpling, so that they are free of extensive areas of planar contact while having numerous point contacts therebetween, said layers being essentially free of spacer elements therebetween, the major portions of said layers being held in spaced relation by said point contacts between layers, the apparent thermal conductivity of the insulation being less than about 1 microwatt/cm. ° K.

For simplicity the insulated containers shown in the figures contain relatively few layers of insulation. In order to achieve the degree of insulation usually required in commercial applications, it is usually desirable to apply several layers of insulating material over the inner cylindrical vessel until the desired overall thickness of insulation is provided over the vessel. In the case of the above-described alternate layer type composite insulations, it is usually desirable to have at least four metal foil sheets per inch of thickness of the insulation. When several layers of insulating material are so applied over the inner cylindrical container, it is desirable that the successive overlapping pairs of adjacent sheets over a given section of the container be so disposed that the overlapping area of each of the outer pairs of adjacent sheets is superimposed over the overlapping area of the inner most pair of adjacent sheets as is shown in FIGURE 3. This superimposition (or registry) of the successive pairs of adjacent sheets allows for an overall increase in the friction between the inner layer (e.g. the layer composed of sheets **20***a*, **20***b* and **20***c* in FIGURE 3) and the outer layers (e.g. the layer composed of sheets **21***a*, **21***b* and **21***c* in FIGURE 3).

The embodiments such as those of FIGURES 1 and 3, the gas-tight outer shell **8** and the inner cylindrical vessel **1** are preferably rigid self-supporting walls which can be composed of any of these materials customarily employed in known insulated containers. Preferably, the shell is composed of carbon steel and the inner cylindrical vessel is composed of an alloy such as Monel, aluminum, or stainless steel. The annular space between the shell and the inner cylindrical vessel can be evacuated, if desired, in the manner and to the extent usually employed in conventional insulated containers when used in similar applications. The subatmospheric pressure in the annular space is preferably no greater than 25 microns of mercury pressure.

In some applications, the outer shell can be composed of a semi-rigid or non-rigid material (e.g. a plastic material such as a Mylar sheet). In other applications, no outer shell is required (e.g. where the inner vessel is a rocket designed for travel in outer space).

Insulated containers of the present invention, particularly the double-walled containers such as that depicted in FIGURE 1, are admirably suited for storing and shipping liquefied gases, as for example, liquefied oxygen and hydrogen. The insulated containers of this invention can be employed in any position (e.g. in the vertical or in the horizontal position).

While this invention is most suitable and preferably used for spirally wrapped insulations, it can also be used to advantage where the insulation is applied in other ways (e.g. applied in concentric layers).

The insulated containers of this invention can contain the various attachments and fittings customarily found in conventional insulated container. By way of illustration, the containers can be provided with pressure release means, filling means, discharge means and the like. For simplicity, such attachments and fittings are not shown in the figures.

What is claimed is:

1. In an insulated container adapted for shipment and so subject to displacement of the insulation by forces encountered during shipment comprising an inner cylindrical vessel, said inner cylindrical vessel having (a) a header fitted transversely to each end thereof and (b) the outer surface entirely covered with at least one insulating layer each of which layers is composed of at least two adjacent, substantially rectangular sheets of insulating material disposed about the longitudinal axis of the cylindrical vessel so that each lateral edge of each sheet is in a plane substantially perpendicular to the longitudinal axis of the cylindrical vessel, the improvement which comprises the provision of overlapping and longitudinal load transmitting contact between each adjacent pair of sheets of the insulating material and the attachment of at least one layer of the insulating material to at least one of said headers, the amount of overlapping and the degree of contact between each adjacent pair of sheets being sufficient to permit the transmission of longitudinal inertial forces to which the insulated container is subjected during shipment through the overlapping adjacent sheets of a layer of insulating material to a header to which the layer is attached.

2. The insulated container of claim **1** wherein the amount of overlapping between the adjacent sheets of insulating material is from 0.5 to 15 percent of the width of a sheet.

3. The insulated container of claim **1** wherein at least some of the adjacent sheets are attached at the overlapping areas by adhesive tape disposed longitudinally across the overlapping area and parallel to each other and the longitudinal axis of the vessel.

4. The insulated container of claim **1** wherein the inner cylindrical vessel is covered with a multiplicity of said insulating layers which provide a composite multi-layered, external load-free insulation comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible sheet radiation barrier layers, said radiation barrier layers being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiation barrier layers in a limited space for reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross, each radiation barrier layer being disposed in contiguous relation on opposite sides with a layer of the fibrous sheet material, the fibers of said fibrous sheet material being oriented substantially parallel to the radiation barrier layers and substantially perpendicular to the direction of heat inleak across the space occupied by the layers, said fibrous sheet material being composed of fibers having diameters less than 10 microns, said radiation barrier sheet having a thickness less than 0.2 millimeters, and said multi-layered composite insulation being disposed in the space occupied by the layers to provide more than 4 radiation barrier layers per inch of said composite insulation.

5. The insulated container of claim **1** wherein the inner cylindrical vessel is covered with a multiplicity of said insulating layers which provide a composite multi-layered, external load-free insulation in the space occupied by the layers comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible radiant heat reflecting shields, said radiant heat reflecting shields being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiant heat reflecting shields in a limited space for reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross, each radiant heat reflecting shield being disposed in contiguous relation on opposite sides with a layer of the fibrous sheet material, the fibers of said fibrous sheet material being oriented substantially parallel to the heat reflecting shields and substantially perpendicular to the direction of heat inleak across the space, said fibrous sheet material being a permanently precompacted paper composed of unbonded fibers having diameters less than 5 microns and a length of less than 0.5 inch, said radiant heat reflecting shields having a thickness less than 0.2 millimeters, and said multi-layerer composite insulation being generally spirally wound in the space to provide more than 40 radiant heat reflecting shields per inch of said composite insulation.

6. The insulated container of claim **1** wherein the inner cylindrical vessel is covered with a multiplicity of said insulating layers which provide a composite multi-layered, external load-free insulation in the space occupied by the layers comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible radiant heat reflecting shields, said radiant heat reflecting shields being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiant heat reflecting shields in a limited space for reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross, each radiant heat reflecting shield being disposed in contiguous relation on opposite sides with a layer of the fibrous sheet material, the fibers of said fibrous sheet material being oriented substantially perpendicular to the direction of heat inleak across the insulating space, said fibrous sheet material being an elastically compressible web composed of fibers having diameters between 0.2 and 5 microns, said radiant heat reflecting shields having a thickness less than 0.2 millimeters and said multi-layered composite insulation being generally spirally wound in the insulation space to provide more than 5 radiant heat reflecting shields per inch of said composite insulation.

7. The insulated container of claim **1** wherein the inner cylindrical vessel is covered with at least thirty of said layers and wherein the insulating material is metal-coated-non-metallic, flexible plastic material, said plastic material being essentially free of any substance having an equilibrium vapor pressure at 20° C. of greater than 10 microns mercury absolute, there being between 12 and 120 layers of flexible material per centimeter of thickness of insulation space occupied by the layers, the metal coating on the flexible material having a thickness less than .25 micron and being sufficiently thick to have an emissivity less than .06, the flexible material having a low heat conductivity to give a low lateral heat conductivity to the metal-coated flexible material of less than 10×10^{-6} watts per square per ° K. at 300° K., the layer of flexible material being permanently deformed, as by crumpling, so that they are free of extensive areas of planar contact while having numerous point contacts therebetween, said layers being essentially free of spacer elements therebetween, the major portions of said layers being held in spaced relation by said point contacts between layers, the apparent thermal conductivity of the insulation being less than about 1 microwatt/cm. ° K.

8. In an insulated container adapted for shipment and so subject to displacement of the insulation by forces encountered during shipment comprising a gas tight outer shell and an inner cylindrical vessel arranged so as to provide an intervening evacuable space, said inner cylindrical vessel having (a) a header fitted transversely to each end thereof and (b) the outer surface entirely covered with at least one insulating layer, each of which layers is composed of at least two adjacent, substantially rectangular sheets of insulating material disposed in the evacuable space about the longitudinal axis of the cylindrical vessel so that each lateral edge of each sheet is in a plane substantially perpendicular to the longitudinal axis of the cylindrical vessel, the improvement which comprises the provision of overlapping and longitudinal load transmitting contact between each adjacent pair of sheets of the insulating material and the attachment of at least one layer of the insulating material to at least one of said headers, the amount of overlapping and the degree of contact between each adjacent pair of sheets being sufficient to permit the transmission of longitudinal inertial forces to which the insulated container is subjected during shipment through the overlapping adjacent sheets of a layer of insulating material to a header to which the layer is attached.

9. The insulated container of claim 8 wherein the amount of overlapping between the adjacent sheets of insulating material is from 0.5 to 15 percent of the width of a sheet.

10. The insulated container of claim 8 wherein at least some of the adjacent sheets are attached at the overlapping areas by adhesive tape disposed longitudinally across the overlapping area and parallel to each other and the longitudinal axis of the vessel.

11. The insulated container of claim 8 wherein the inner cylindrical vessel is covered with a multiplicity of said insulating layers which provide a composite multi-layered, external load-free insulation comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible sheet radiation barrier layers, said radiation barrier layers being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiation barier layers in a limited space for reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross, each radiation barrier layer being disposed in contiguous relation on opposite sides with a layer of the fibrous sheet material, the fibers of said fibrous sheet material being oriented substantially parallel to the radiation barrier layers and substantially perpendicular to the direction of heat inleak across the space occupied by the layers, said fibrous sheet material being composed of fibers having diameters less than 10 microns, said radiation barrier sheet having a thickness less than 0.2 mm., and said multi-layered composite insulation being disposed in the space occupied by the layers to provide more than 4 radiation barrier layers per inch of said composite insulation.

12. The insulated container of claim 8 wherein the inner cylindrical vessel is covered with a multiplicity of said insulating layers which provide a composite multi-layered, external load-free insulation in the space occupied by the layers comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible radiant heat reflecting shields, said radiant heat reflecting shields being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiant heat reflecting shields in a limited space for reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross, each radiant heat reflecting shield being disposed in contiguous relation on opposite sides with a layer of the fibrous sheet material, the fibers of said fibrous sheet material being oriented substantially parallel to the heat reflecting shields and substantially perpendicular to the direction of heat inleak across the space, said fibrous sheet material being a permanently precompacted paper composed of unbonded fibers having diameters less than 5 microns and a length of less than 0.5 inch, said radiant heat reflecting shields having a thickness less than 0.2 mm., and said multi-layered composite insulation being generally spirally wound in the space to provide more than 40 radiant heat reflecting shields per inch of said composite insulation.

13. The insulated container of claim 8 wherein the inner cylindrical vessel is covered with a multiplicity of said insulating layers which provide a composite multi-layered, external load-free insulation in the space occupied by the layers comprising low conductive fibrous sheet material layers composed of fibers for reducing heat transfer by gaseous conduction and thin, flexible radiant heat reflecting shields, said radiant heat reflecting shields being supportably carried in superimposed relation by said fibrous sheet layers to provide a large number of radiant heat reflecting shields in a limited space reducing the transmission of radiant heat across said space without perceptively increasing the heat transmission by solid conduction thereacross, each radiant heat reflecting shield being disposed in contiguous relation on opposite sides with a layer of the fibrous sheet material, the fibers of said fibrous sheet material being oriented substantially perpendicular to the direction of heat inleak across the insulating space, said fibrous sheet material being an elastically compressible web composed of fibers having diameters between 0.2 and 5 microns, said radiant heat reflecting shields having a thickness less than 0.2 mm. and said multi-layered composite insulation being generally spirally wound in the insulation space to provide more than 5 radiant heat reflecting shields per inch of said composite insulation.

14. The insulated container of claim 8 wherein the inner cylindrical vessel is covered with at least thirty of said layers and wherein the insulating material is metal-coated-non-metallic, flexible plastic material, said plastic material being essentially free of any substance having an equilibrium vapor pressure at 20° C. of greater than 10 microns mercury absolute, there being between 12 and 120 layers of flexible material per centimeter of thickness of insulation space occupied by the layers, the metal coating on the flexible material having a thickness less than .25 micron and being sufficiently thick to have an emissivity less than .06, the flexible material having a low heat conductivity to give a low lateral heat conductivity to the metal-coated flexible material of less than 10×10^{-6} watts per square per ° K. at 300° K., the layers of flexible material being permanently deformed, as by crumpling, so that they are free of extensive areas of planar contact while having numerous point contacts therebetween, said layers being essentially free of spacer elements therebetween, the major portions of said layers being held in spaced relation by said point contacts between layers, the apparent thermal conductivity of the insulation being less than 1 microwatt/cm. ° K.

15. The insulated container of claim 1 wherein each layer of the insulating material is attached to both of said headers.

16. The insulated container of claim 1 wherein the outer surface of the inner cylindrical vessel is covered with a plurality of said insulating layers, the overlapping portions of the successive layers being in superimposed relation to each other.

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