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THERMAL INSULATED CONTAINER

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Fig.1.

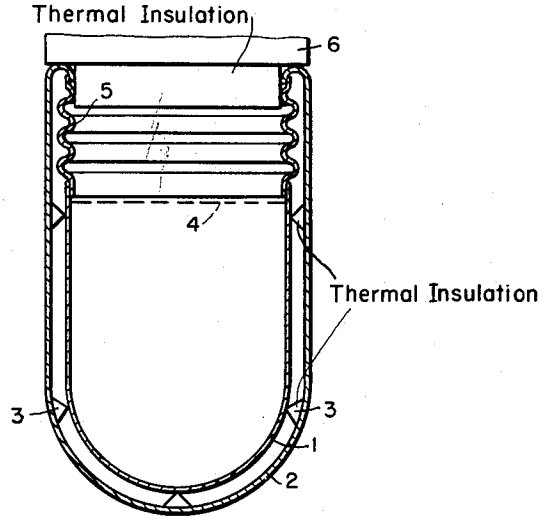
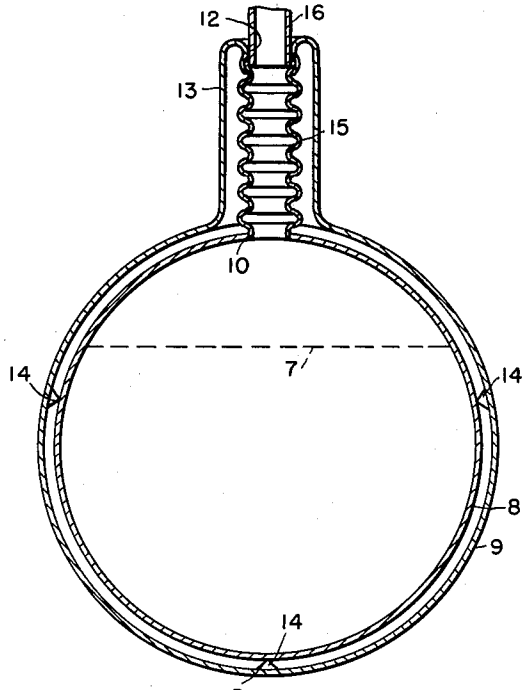


Fig.2.



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THERMAL INSULATED CONTAINER

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1 Claim. (Cl. 220—14)

This invention relates generally to containers and more in particular to thermal insulating containers.

The development of thermal insulating containers has resulted in a structure embodying a double jacket or wall assembly arranged in spaced relation and forming a hermetically sealed unit. The space between the jackets is usually evacuated to a high vacuum to minimize the conduction of heat across the jackets. Heat loss due to radiation is sometimes minimized by providing polished reflecting surfaces on the inner jacket. Access to the storage chamber within the inner jacket is had through an opening through both of the jackets, the size of this opening depending upon the requirements. In some instances, this opening may be as large as the inner dimension of the inner jacket, while in others the opening may be very small, usually protruding from the container assembly as a neck of small diameter.

When used to store liquefied gases, such containers are usually made of thin sheet metal. Copper, for example, is frequently used in the body of the container. When copper is employed the neck or opening into the container is often made of a metal which has lower heat conductivity, such as stainless steel. However, such a measure is insufficient and the efficiency of containers of the general type described is relatively low. A study of this problem indicates that a substantial percentage of the losses is due to heat exchange between the vacuum insulated container and the environment which is effected in conventional constructions by thermal conduction in the material defining the neck or opening into the container.

For wide mouth liquid air containers, such expedients as forming the walls of the opening or neck of low thermal conductivity material, under the best conditions, still permit losses due to thermal conduction in the walls of the mouth or opening which represent a larger portion of the total heat losses. For liquids having lower boiling points than liquid air, such as liquid helium, this factor is always large irrespective of the geometry of the vessel.

Accordingly, one object of this invention is to provide a thermal insulating container in which the heat insulating efficiency is improved.

More specifically, it is an object of this invention to provide a thermal insulating container in which heat conduction in the mouth or opening of the container is minimized.

The foregoing statements are merely illustrative of the various aims and objects of this invention. Other objects and advantages will become apparent upon a study of the following specification when considered in conjunction with the accompanying drawing, in which:

Figure 1 is a sectional view schematically illustrating a double wall container embodying the principles of this invention; and

Fig. 2 is a sectional view schematically illustrating a double wall container of modified form and embodying the principles of this invention.

In the interest of simplicity, the container structures illustrated in Figs. 1 and 2 are represented schematically.

It should be appreciated that the structure shown is adapted for mounting inside a protective jacket which usually is also provided with thermal insulating properties. In some instances, vacuum jackets of the general character herein illustrated are adapted for support inside a second vacuum jacket container which may also be filled with a liquefied gas for the purpose of additionally thermally insulating a liquefied gas, such as helium, which is stored in the inside container. Such expedients, as mentioned, are conventional and per se form no part of this invention.

The arrangement shown in Fig. 1 covers a vacuum jacketed vessel having a mouth or opening which is essentially of the same dimension as the inner dimension of the jacket. Containers of this general type are frequently used in the storage of liquid air. As earlier noted in this disclosure, the heat losses in such a container by heat conduction adjacent the mouth of the container may be considerable. This embodiment includes a structure of the wall area defining the mouth or opening of the container which is of such character as to minimize heat exchange at the opening. The structure comprises an inner jacket 1 which may be of cylindrical cross-section and which in practice is usually provided with a hemispherical bottom. A correspondingly shaped outer jacket 2 of larger diameter is fitted about the inner jacket 1 in spaced relation thereto. The length of the outer jacket in this instance is longer than that of the inner jacket and consequently the inner jacket fits entirely within the outer jacket. Means for properly spacing the jackets may be of any suitable form. The means herein illustrated is represented in a plurality of spacers 3 which are disposed between the jackets in engagement therewith to properly support the inner jacket with respect to the outer jacket. The particular form of support means which is employed, whether it be by some spacing means as illustrated or by some other conventional means, is believed to be within the purview of this invention. Depending upon the geometry of the containers, the usual practice is to fabricate each jacket in two pieces, one piece being the cylindrical section forming the side wall of the jacket, and the other piece being the hemispherical bottom of the jacket. Such a two-piece structure is not illustrated. The two pieces comprising the jacket are then fitted together and suitably soldered or welded to form a hermetically sealed joint.

The dotted line 4 illustrates a practical level for a liquefied gas in the jacket 1. This level, it will be appreciated, is slightly below the upper end of the inner jacket 1. The mouth of the container is formed by means of a sheet metal bellows 5 which is of circular cross-section and which is provided with a plurality of circumferential corrugations which are arranged in axially spaced relation along the length of the bellows section. The bottom end of the bellows 5 is mechanically engaged with the upper end of the inner jacket 1 and is hermetically sealed thereto as by soldering or brazing. The upper end of the bellows 5 is mechanically engaged with the inwardly rolled or turned upper end of outer jacket 2, and is also hermetically sealed as by soldering or welding thereto. Depending upon the requirements, the hermetically sealed space between the inner and outer jackets may then be evacuated to provide a relatively high vacuum therewithin to minimize thermal conduction through a gaseous medium between the walls of the jackets. Whether or not the jacket will be evacuated will depend largely upon the intended application. In practice, a suitable cover, such as 6, which is formed of thermal insulation, is fitted over the open end of the container in order to seal the chamber within the container from the environment. This cover 6 may be of conventional construction. The bellows may be made of any suitable sheet metal. It is preferred that

such sheet metal be of low thermal conductivity material.

The illustration of Fig. 2 covers the application of the principles of this invention to a container having a relatively small opening. Containers of this general configuration are usually employed for storing liquid helium, and are frequently adapted for positioning within a container, such as illustrated in Fig. 1. When so positioned, the liquid level line **7** in the container of Fig. 2 is positioned beneath the surface of the level **4** of the liquefied gas in a container of the type of Fig. 1. In fact, usually the entire neck of the container of Fig. 2 is submerged beneath the liquid level **4** to provide a high degree of thermal insulation for the liquefied gas in the container of Fig. 2.

The container of Fig. 2 is generally of spherical configuration comprising an inner spherical jacket **8** and an outer spherical jacket **9**. These jackets, while not so illustrated, are usually formed of two pieces, each of hemispherical shape, the line of the split extending transversely of the longitudinal axis of the neck of the container at the point of maximum diameter. Such a construction provides ease of fabrication of the parts and facilitates the assembly of the structure. Each of the jackets is provided with an opening, the opening into the inner jacket being designated **10** and the opening into the outer jacket being designated **12**, and being formed of a tubular section **13** which for practical reasons is a separate tubular section from the spherical jacket **9**, which is welded thereto. These openings are axially aligned during the assembly operation, and the jackets are properly spaced by thermal insulating spacers **14** which are disposed between the spaced jacket walls. A bellows **15** of the same general character, as illustrated in Fig. 1 but of smaller diameter, is welded at its bottom end adjacent the opening **10** to the inner jacket **8** and is welded at its upper end to a small diameter tube **16** of low thermal conductivity. The upper end of the tubular section **13** forming a part of the outer jacket **9** is rolled or turned inwardly, and is in turn secured by soldering or welding to the tubular section **16** and the bellows **15** to provide a hermetically sealed joint and seal the space within the containers or jackets **8** and **9** from the environment. The structural details shown are only illustrative. Others may be employed. Again depending upon requirements, the space between the jackets **8** and **9** may be evacuated.

As a practical example and referring to Fig. 1, the jackets **1** and **2** may be formed of sheet material, such as stainless steel of the order of 0.025 inch thickness. The bellows may also be formed of stainless steel and may have a thickness of the order of 0.012 inch thickness. The heat conducting capacity is measurably reduced by reducing the wall thickness of the bellows with respect to that of the walls, for example, of the jacket **1**, and more particularly due to the corrugations, by increasing, by a factor of the order of 5, the length of the conduction heat path between the ambient temperature and the liquefied gas. It should be noted that this is a practical expedient because the configuration of the wall of the bellows is such as to provide a high degree of strength transversely of the structure due to the ribbed effect. The arrangement provides approximately a ten-fold reduction in losses due only to neck conduction.

A further example will indicate the practical aspects of this invention. In this example, a conventional container of the general configuration of that illustrated in Fig. 1 is considered, but without the bellows construction **5**, the inside wall of the jacket **1** continuing up into mechanical engagement with the outer jacket **2** at which point the jackets are hermetically sealed. The inside diameter of the container presently under consideration is 13 inches, and the length of the container is 24 inches. Assume the container to be fabricated of 0.025 inch stainless steel. When the distance between the top of the container and the liquid level is 6 inches, the calculated losses due to evaporation amount to 10 liters per day of which

70% is due to conduction of heat along the wall adjacent the opening of the container. The insertion of a 6 inch section of stainless steel bellows, such as **5**, at the top of such a conventional container and having a wall thickness of 0.012 inch and a four-fold length increment, reduces the conduction loss adjacent the opening to about one-half liter per day as compared with 7 liters per day in the conventional container. The overall losses are then 3½ liters per day for the container made according to the present invention as against 10 liters per day for the conventional container.

The considerations hereinbefore made have been concerned primarily with heat losses due to thermal conduction. However, there is another source of heat loss which may contribute substantially to the overall loss by evaporation of the liquefied gas stored in the container. Such losses are due to heat radiation. While it has been the practice to fabricate the wall areas of vessels of this general character adjacent the mouth or opening of the vessel of low thermal conducting material, these wall areas have often had high reflecting characteristics and have frequently permitted an appreciable fraction of the radiation flux at the warm top of the neck or mouth of the container to reach the stored liquid. In connection with the container, such as illustrated in Fig. 2, as earlier noted herein, such a container is adapted for mounting within a container of the general configuration of that illustrated in Fig. 1. When so arranged, the lower boiling liquid within the jacket **8** is usually protected against thermal loss by a liquefied gas, such as liquid nitrogen, in the container in which it is immersed. This minimizes radiation heat exchange between the inner and outer jackets **8** and **9**. Since this heat exchange by radiation is minimized, the total heat leak which exists is primarily due to that at the mouth or neck of the container. If a container, such as that shown in Fig. 2, is not protected in the manner just described, then, of course, the relative contribution to the total heat leak by neck radiation is not large.

To minimize heat loss due to radiation at the neck or opening of the container, blackening of the inner wall of the neck or opening is indicated. In one particular case, this blackening of the inner wall of the opening was accomplished by applying an aqueous suspension of colloidal graphite. A material of this type is in effect a black body. When this material is applied, the radiation coming down the tube is effectively absorbed along its length by the black body coating, and the heat thus absorbed in the black body coating is effectively taken up by the cold effluent gas. This technique for minimizing heat loss due to radiation has been proved effective by observing that the same lower liquid evaporation rate obtained when a liquid nitrogen cooled well was inserted in the tube. Such a well, for example, may be a small test tube filled with liquid nitrogen which has an outside diameter sufficiently small to fit neatly within the tube **16** illustrated in Fig. 2. This well in effect functions as a "cold cork" to thereby minimize heat loss due to radiation. Since the observed results were essentially the same for the black body coating as for the liquid nitrogen cooled well, it will be appreciated that the simple expedient of the black body coating represents a measurable improvement in the thermal insulating properties of the container. As an alternative, radiation shields could be inserted in the neck to accomplish the same purpose.

In the case of wide mouth containers, such as illustrated in Fig. 1, the aqueous suspension of colloidal graphite may be brushed over the bellows arrangement **5**. In the case of a container, such as illustrated in Fig. 2, a swab may be utilized to apply such a coating to the tube **16** and the bellows **15**. Under certain conditions, it may be found feasible to utilize conventionally constructed containers having straight inner walls adjacent the mouth or opening thereof if the aqueous suspension

of colloidal graphite is to be used to minimize heat losses at the mouth or the opening.

While but two embodiments of this invention have been illustrated, it will be appreciated that numerous variations in structural details and in container configuration may be made without departing from the principles of this invention. Accordingly, it is intended that the foregoing disclosure and the showings in the drawing shall be considered only as illustrative of the principles of this invention and not interpreted in a limiting sense.

We claim as our invention:

A liquified gas thermal insulating container comprising, a pair of containers, each container having a body portion and a tubular neck, one container being disposed within the other with the body portion and tubular neck thereof in spaced relation with the body portion and

tubular neck of the other, means hermetically sealing said containers together adjacent the outer ends of said tubular necks to form a vacuum tight connection between the containers, the space between said containers being evacuated, and a coating of a material having the properties of a black body only over the inner wall of the tubular neck of the inner container.

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