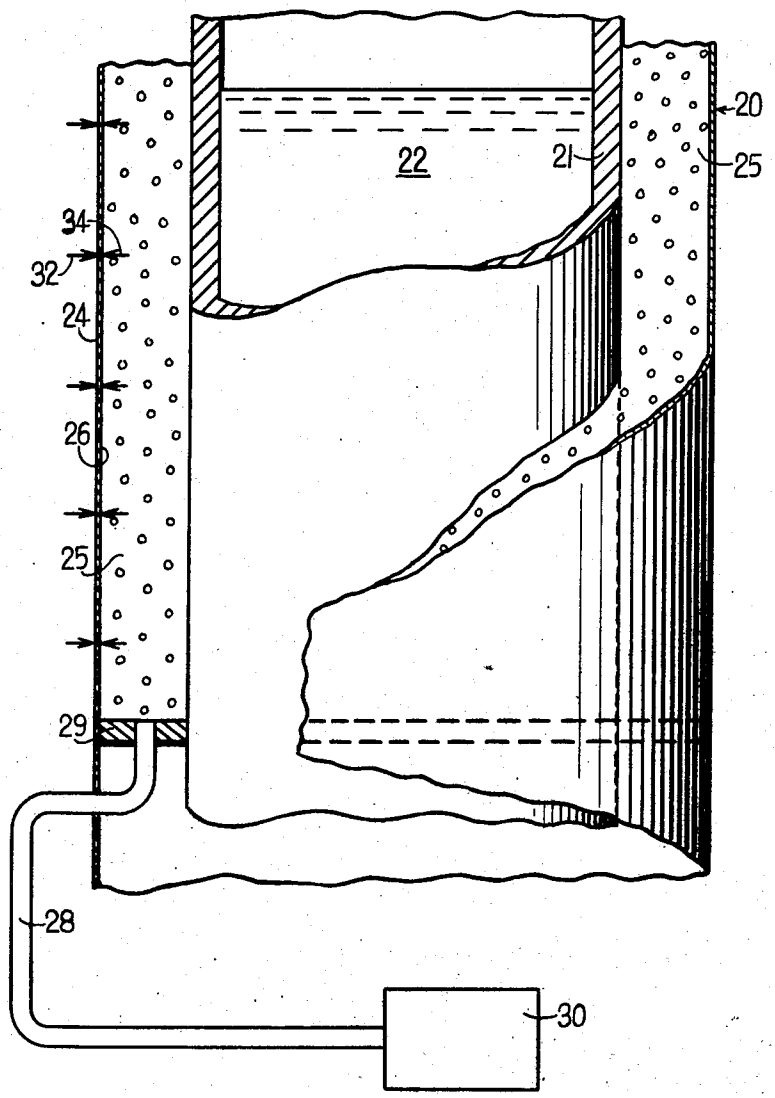
Jan. 24, 1961 H. L. JOHNSTON 2,969,092

METHOD AND APPARATUS FOR CONTAINING A LIQUIFIED GAS

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Fig. 1.



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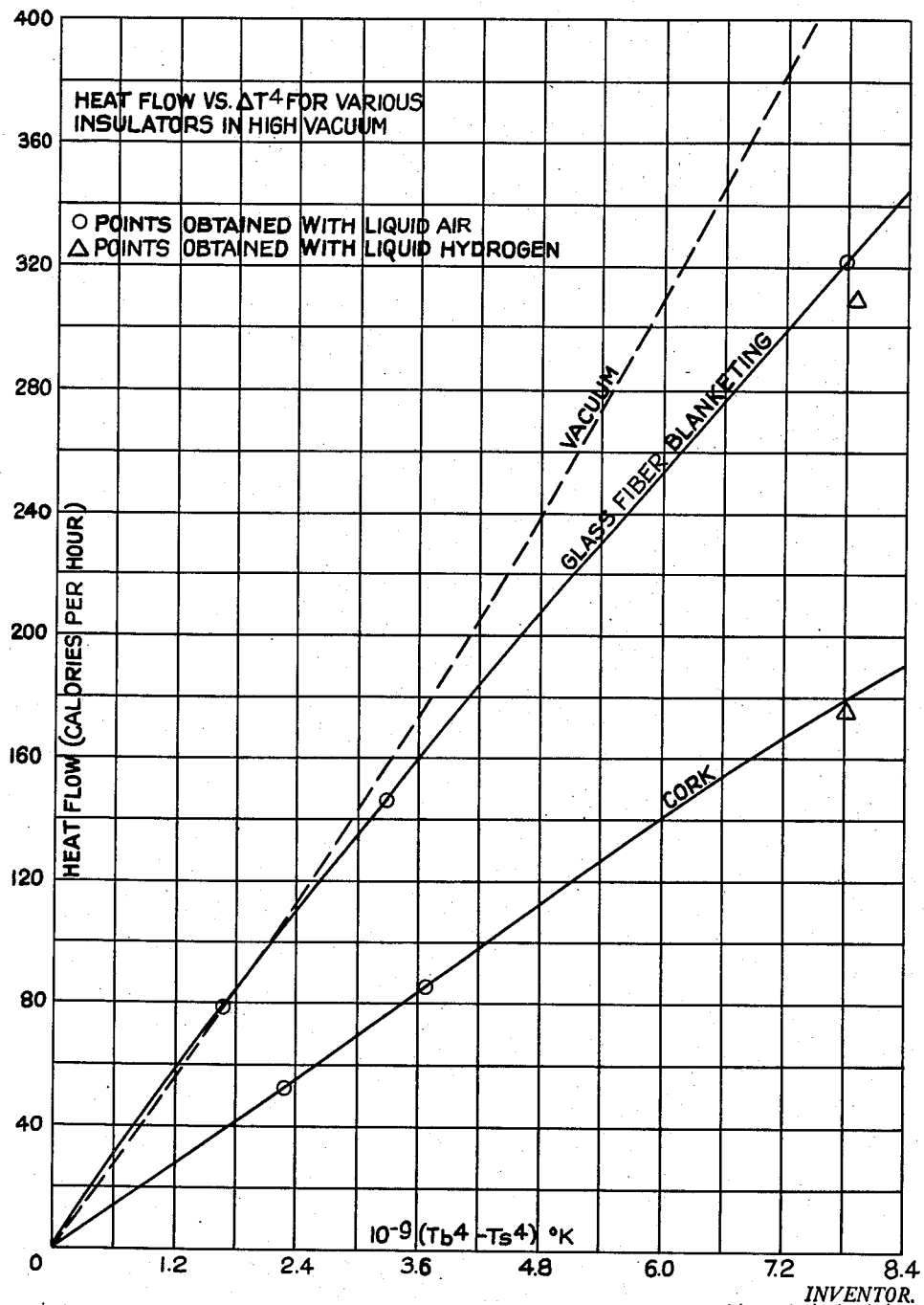


Fig. 2

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2,969,092

METHOD AND APPARATUS FOR CONTAINING A LIQUIFIED GAS

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1 Claim. (Cl. 138—64)

The present invention relates to conduits for liquified gases having boiling point temperatures below 273 degrees Kelvin at atmospheric pressure and particularly to a novel light weight insulating wall construction for such apparatus.

In apparatus of this type it is common practice to surround the container or conduit, which directly contacts the liquid being contained, with a surrounidng wall spaced from the inner container or conduit to form an insulating space. Such insulating space is generally provided with insulation consisting of finely divided particles of low heat conductivity, or such space is connected to a source of vacuum, or, in some instances, both are incorporated. Although such constructions are thermally efficient they present the disadvantage of requiring relatively strong wall constructions and hence have been heavy in weight and relatively expensive to construct.

It has been discovered, according to the present invention, that the above disadvantages can be eliminated by a novel wall construction which utilizes insulating material combined with vacuum action to contribute to the structural strength of the wall. Such novel construction comprises a relatively thin flexible outer wall member formed of suitable thin material such as stainless steel foil. Such outer wall construction is combined with an underlying layer of gas-permeable insulating material, such as cork block or glass fiber blanketing, and by supporting substantially the entire inner surface of the outer wall with such material, a source of vacuum can be connected to the insulating space and vacuum created in the interstices of the insulating material. With this arrangement the thin outer wall of metallic foil is constantly subjected to an inwardly directed pressure differential which constantly urges the thin outer wall against the insulating material with the result that such material becomes a structural component of the vessel or conduit and prevents the thin outer wall from collapsing under in the inwardly directed force imposed by atmospheric pressure. Moreover, the insulating material cooperates with the thin outer wall in contributing to the overall strength of the combination since the outer wall is maintained in a structurally desirable designed configuration throughout its entire extent whereby such wall means, itself, can most effectively contribute to the structural strength of the combination.

As an additional feature of the construction, when the sealed insulating space is subjected to a source of low pressure, air is withdrawn from the gas-permeable portions of the insulating material to form evacuated interstices which contribute to the insulating efficiency of the construction.

It is therefore the principal object of the present invention to provide a novel insulating wall construction for containing a liquified gas which construction incorporates insulating material that contributes to the structural strength of the construction to provide high insulating efficiency and strength in a light weight insulating wall of simple and relatively inexpensive construction.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the drawing:

Figure 1 of the drawing comprises a view, partially in section, which illustrates an insulating wall construction for confining a liquified gas, said construction being fabricated according to the present invention. The section is taken along a vertical plane through and perpendicular to the surface of the wall construction.

Figure 2 is a graph illustrating the rates of radiant heat flow vs. various temperature differences for suitable insulating materials incorporated in the insulating wall construction of the present invention.

Referring next to the drawing, an inner containing means for a liquified gas, which containing means may be in the form of a storage chamber or conduit, is indicated generally at **20**. Containing means **20** includes an inner wall **21** which directly encloses the liquified gas **22**.

The inner wall **21** is surrounded by a thin light-weight outer wall **24** formed of metallic foil or the like. As a practical example, stainless steel foil of between .010 and .020 inch thickness has been found to be satisfactory.

The outer wall **24** is spaced from the inner wall **21** to provide an insulating space containing insulating material **25**. The insulation **25** consists of a suitable gas-permeable material such as cork block or glass fiber blanketing and fills substantially the entire volume of the insulating space to provide support for the thin metallic foil wall **24** throughout substantially the entire inner surface **26** of such wall.

A vacuum line **28** is connected to the insulating space **25** through an end closure **29** for such insulating space, with the vacuum line **28** leading to a suitable source of low pressure indicated schematically at **30**.

According to the present invention air is exhausted from the insulating space and from within the interstices of the gas-permeable insulating material **25** whereby an inwardly directed force, produced by the differential between atmospheric pressure and the lower pressure in the insulating space, constantly urges the metallic foil wall **24** inwardly against insulating material **25**. Such inwardly directed force is diagrammatically represented by the force arrows **32**.

The insulating material **25** exerts force outwardly against the inner surface **26** of metallic foil wall **24** as is diagrammatically represented by the force arrows **34**.

The outwardly directed arrows **34** are of equal magnitude and oppositely directed as compared to the inwardly directed arrows **32** since the metallic foil wall **24** is maintained in a designed configuration when the outwardly directed force **34** exerted by insulating material **25** is in equilibrium with the inwardly directed force **32** exerted by atmospheric pressure.

It will be understood that the light weight outer wall **24** is constructed of such thin material, as compared to the area of its extension, that such outer wall **24** would bow inwardly, or actually collapse, were the outwardly directed structural support not provided by the insulating material **25**. Hence it is seen that the source of vacuum **30** and the insulating material **25** cooperate in maintaining the thin outer wall **24** in a rigid designed configuration whereby the outer wall **24** can be formed of much thinner, and hence much lighter, material than could otherwise be used were the insulating material **25** not utilized as structural support.

Reference is next made to Figure 2 which graphically illustrates radiant heat flow in calories per hour for two insulating materials, in high vacuum, which materials are suitable for the insulating wall construction of the present invention. The values on the ordinate of the graph represent calories per hour and the values on the abscissas represent various differences between the fourth powers of the absolute temperatures T–*b* and T–*s* existing on opposite sides of the insulating material in high vacuum, multiplied by ten to the minus ninth power.

Both cork and glass fiber blanketing represent examples of suitable materials for the insulating wall construction of the present invention, since these materials provide both structural support and evacuated interstices as described herein. It will be noted from the graph, however, that, for any given temperatures T–*b* and T–*s*, the heat flow in calories per hour will be less for cork in high vacuum than will be the heat flow through glass fiber blanketing in high vacuum. Both of these, however, provide a lower rate of heat flow than does high vacuum alone.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claim which follows.

I claim:

In cryogenics, an insulated conduit construction for a cold liquefied gas, comprising, in combination, a rigid

transfer conduit having an inner surface in contact with said liquefied gas and an outer surface exposed to and partially bounding an insulating space, a flexible collapsible outer concentric jacket of metallic foil spaced from said conduit, said jacket having an inner surface bounding said insulating space and an outer surface exposed to atmospheric pressure, gas permeable low temperature insulating material in said insulating space and in direct contact with the outer surface of said conduit and the inner surface of said jacket, and means for producing a vacuum in said insulating space whereby atmospheric pressure on the outer surface of the jacket urges the jacket inwardly so that the insulating material provides structural support for the jacket.

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