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THERMALLY INSULATED WALL STRUCTURE

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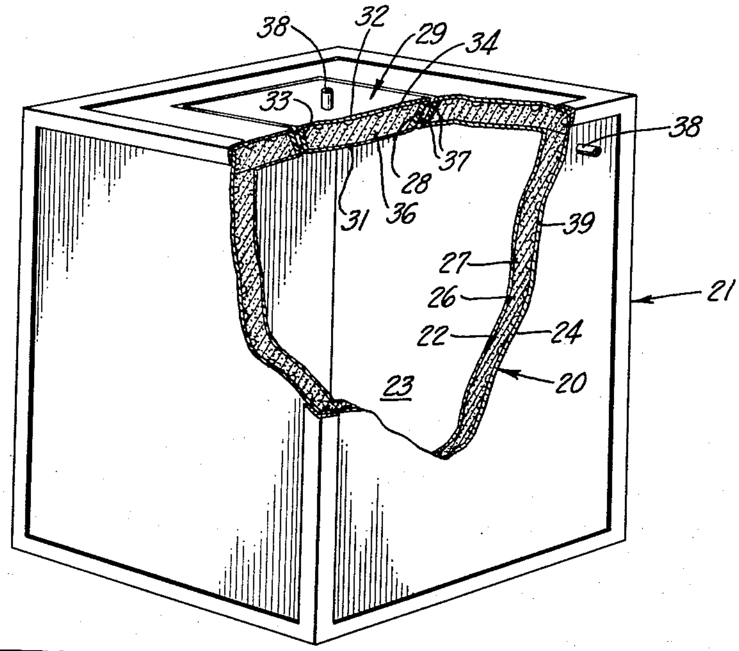

FIG. 1

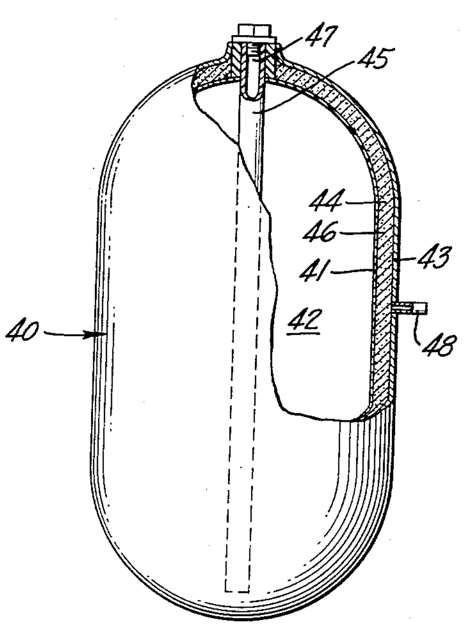

FIG. 2

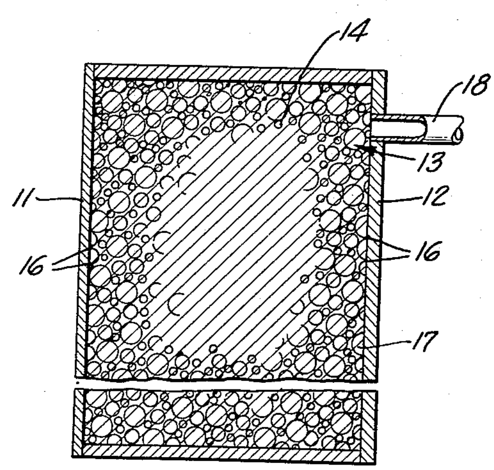

FIG. 3

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THERMALLY INSULATED WALL STRUCTURE

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The invention relates to methods and means for insulating structural elements against the passage of heat therethrough, and more particularly to elements employing vacuum as a thermal barrier.

Modern shipping and construction techniques have created a need for light weight wall structures combining highly efficient heat insulating qualities with strength and rigidity. For example, new methods of shipping frozen foods include super-freezing the foods with liquid nitrogen and shipping them in insulated containers without any additional refrigeration en route. The containers utilized in such methods of shipping should provide extremely efficient heat insulation for the super-frozen contents, minimum wall thickness to conserve space, sufficient strength to withstand the hazards of shipping, and as light a weight as possible. A wall structure incorporating these characteristics may also be valuable in the construction of articles suitable for airborne and shipboard use and especially when very high or low temperatures are to be anticipated.

One of the most efficient known methods of insulating a wall structure against heat transfer is to construct it with spaced wall members having a vacuum therebetween in the nature of the well known Dewar flask or vessel. Perhaps the greatest problem in attempting to utilize such construction in any but relatively small containers is the necessity of providing comparatively thick and heavy walls strong enough to prevent collapse of the structure when evacuated. Various contrivances have been proposed for diminishing the required wall thickness, among which are devices intended to fit within the vacuum space and brace the walls against collapse. Such contrivances have heretofore been found impractical in that they do not provide adequate reinforcement, greatly lower the insulation qualities of the structure by providing increased heat conductivity between the double walls, and also in that they are complicated and expensive to manufacture and are relatively heavy in weight.

The main types of heat transfer present in reinforced vacuum wall construction are transfer by conduction and by radiation. The present invention contemplates a structure incorporating a sturdy and lightweight reinforcing means which will provide an effective barrier to heat conduction and radiation in combination with improved evacuation methods. Use is made of the fact that heat transfer by conduction between two bodies in physical contact can be practically eliminated by making the contacting areas as small as possible and removing substantially all the air or other gases at such areas. Prevention of heat transfer between the double walls by radiation may be and is effected by placing insulating material between the walls so that heat radiated from one wall will be intercepted by the insulation, the heat then having to pass through the insulation, where it will be impeded by the resistance to thermal conduction of the insulation, and finally be re-radiated from the insulation to the other of the double walls.

Accordingly, a principal object of the present invention is to provide a double wall evacuated heat insulated structure which is amply strong and sturdy for use in large containers and the like and at the same time is light in weight so as to reduce shipping and handling costs.

Another object of the present invention is to provide a structure of the character described which is simple and easy to construct, incorporates a minimum number of parts, and is inexpensive to produce.

A further object of the present invention is the provision of a heat insulating structure of the character described which utilizes a novel reinforcing means affording exceptionally efficient heat insulating characteristics.

A still further object of the present invention is the provision of a double wall evacuated heat insulating structure adaptable to a variety of applications such as containers of various sizes and shapes designed to accommodate different types of contents, and applications requiring diverse forms of heat insulating wall structures.

Another object of the present invention is to provide a method of effecting an efficient heat insulation of a double wall heat insulating structure of the nature described.

A further object of the present invention is to provide a method of effecting heat insulation in a structure of the character described which will afford an effective barrier against heat conduction through improved evacuation, the method being cooperative with the physical characteristics of the wall reinforcing means.

Other objects and features of advantage within the scope of the invention will be apparent from a consideration of the following description and the accompanying drawing, wherein:

Figure 1 is a perspective view of a heat insulated container having walls constructed in accordance with the present invention, portions of the walls being broken away and shown in section for clarity of illustration.

Figure 2 is a side elevational view of a heat insulated container having walls constructed in accordance with the present invention and particularly adapted for containing fluids.

Figure 3 is a typical enlarged cross-sectional view of a heat insulated wall structure constructed in accordance with the present invention.

The heat insulating wall construction of the present invention, and as illustrated in the accompanying drawing, includes a pair of rigid members **11** and **12** of sheet-like form positioned in spaced relation and joined at their edges to define an air tight chamber **13**, and a core **14** of rigid, expanded material mounted in the chamber and formed to provide a plurality of points **16** extending into supporting engagement with the rigid members **11** and **12**, the chamber **13** being evacuated to provide effective thermal barriers between the members **11** and **12** and the core **14**. In accordance with the invention, the core **14** is formed of a rigid, expanded insulating material which is light in weight and at the same time sufficiently resistant to compression to reinforce the rigid members **11** and **12** against collapsing under surrounding pressures when the compartment **13** is evacuated.

The wall construction of the present invention is adapted for a variety of applications where a wall-like structure providing an effective thermal barrier is required, such as insulating areas or entire compartments of airplanes, land vehicles, ships, submarines and the like. The rigid wall members **11** and **12** may be planar or curved in form to accommodate the construction desired, with the core **14** formed in like manner, and the structure divided into one or more air tight chambers which may be evacuated in the manner to be described later. The rigid members **11** and **12** may be formed of any material suitable for the use intended, it being noted in this connection that relatively weak and frangible materials of minimum thickness may be used in one of the members, such as the lining of a container, because of the reinforcing action of the core **14**. In this manner, thin walls of collapsible or even relatively brittle substances such as glass or the like can be used, particularly wherein the materials contacting such walls dictate the use of corrosive-resistant substances. In such cases, thin, light-weight materials may be used for walls while still maintaining the desired structural rigidity and strength not otherwise possible without support by a core member. Figure 3 of the accompanying drawing illustrates a typical section through a wall structure constructed in accordance with the present invention. Here the wall member **11** is indicated as being of thin sheet metal, while the opposed member **12** is of a thicker gauge. The core **14** is interposed between the wall members and transmits pressures imposed on the thinner wall **11** to the more sturdy wall **12**.

As an important feature of the invention, the core **14** is formed to afford a minimum of contact area with the wall members **11** and **12** in order to cut down to a minimum the transmission of heat by conduction between the wall members and core. This is accomplished by forming the core with a plurality of points **16** extending therefrom and into contact with the rigid wall members; a relatively great number of these points being scattered uniformly over the surface of the core member so as to provide effective support over the entire area of the rigid members **11** and **12**. To provide such a plurality of points in a simple and economical manner, the core **14** is preferably formed of a foamed material of unicellular construction as illustrated in Figure 3, in which the upstanding walls of the cells **17** will afford the points **16** when the material is cut to conform to the shape of the members **11** and **12**.

In accordance with the method of insulating the wall of the present invention, the chamber **13** is evacuated as through tube **18** to remove substantially all of the gases and/or vapor present at the points **16** where they contact the rigid members **11** and **12** so as to provide a more efficient heat barrier than would be the case if such gases or vapor were present. While an ordinary high vacuum would be quite effective in this connection, the efficiency of the heat barrier increases in inverse ratio to the amount of gases present and, therefore, it is desired to remove all the surface gases possible. As an important feature of the invention, the wall structure is heated so as to bake off surface gases. In carrying out the method, the structure is first assembled to create the air tight chamber **13** between wall members **11** and **12** and with the core **14** positioned in the chamber and in supporting engagement with the wall members. The air is then evacuated from the chamber and heat is applied to the structure to bake out and remove the surface gases. If desired, the chamber may be flushed out with hydrogen or a forming gas such as a non-explosive mixture of nitrogen and hydrogen to aid in stripping surface gases, prior to the final evacuation in the presence of heat. In order to maintain the vacuum barrier between the core and wall members, a small amount of a gas absorbing material may be sealed within the chamber **13** after evacuation.

The material from which the core **14** is formed naturally must not soften or melt during heating of the structure for driving off surface gases. For effective baking out, temperatures on the order of 800° F. are desired. The core material chosen, therefore, must not soften at this temperature and also must possess the desired qualities of lightness and strength. It has been found that expanded mineral materials such as porous and/or foamed ceramics or glass will afford the desired qualities. One product particularly suited for use as a core material is a foamed glass insulating material known as Foamglas and produced by the Pittsburgh Corning Corporation, 1 Gateway Center, Pittsburgh 22, Pennsylvania. This material is formed of inorganic glass, has a compressive strength of 100 lbs. per square inch, a density of 9 lbs. per cubic foot, and will not soften at 800° F. The thermal conductivity of the material is comparatively low, on the order of 0.38 B.t.u./hr./sq. ft./° F./in., and therefore the material itself is a rather good heat insulator.

The passage of heat through the structure of the present invention by conduction is effectively blocked by the point contact of the core with the rigid wall members in a substantially gas and vapor free environment. Passage of heat by radiation is effectively reduced to a low value by the fact that the heat must radiate from one of the wall members **11** or **12** to the core **14**, must then pass by conduction through the insulating material of the core, and then be radiated from the core to the other of the walls.

The heat insulated wall structure of the present invention is particularly adapted for the construction of containers designed to maintain their contents at either high or low temperatures. One such container **21** is shown in Figure 1 of the drawings, this container being especially suited for use with articles such as packaged frozen foods and the like. The container **21** is here of generally rectangular form and has an insulated wall **20** which includes a rigid inner shell **22** formed to define a storage compartment **23** for the contents to be thermally insulated. A rigid outer shell **24** is formed in surrounding spaced relation to the inner shell **22** so as to define an air tight chamber **26** between the inner and outer shells. Mounted in the chamber **26** is a rigid core **27** of expanding insulating material having surfaces substantially coextensive with the inner and outer shells, these surfaces being formed with a plurality of points extending into supporting engagement with the shells in the same manner as the points **16** of Figure 3 for supporting the shells when the chamber **26** is evacuated. Means providing an opening **28** is formed through the wall **20** for access to the storage compartment **23**, and the container is provided with a lid **29** which preferably also comprises a section of the insulated wall structure of the present invention. The lid **29** includes sheet-like rigid inner and outer members **31** and **32** respectively which are joined at their edges, as by member **33**, to provide an air tight chamber **34** in which is positioned a core **36** having a plurality of points extending into supporting engagement with the members **31** and **32** for reinforcing the structure against collapse when evacuated. The lid **29** is preferably formed to provide an air tight seal with the opening **28** by means of gaskets **37** which may be in the form of rubber O-rings or other similar materials such as polyethylene or the like. The chambers **26** and **34** are evacuated by the method previously described to insulate the structure against passage of heat between the container exterior and the storage compartment **23**. Evacuation may be effected through suitable tubes **38** passing through the outer shell and communicating with the air tight chambers, the tubes being closed off and sealed shut by any suitable means when the evacuation is complete. As an aid in evacuating, the core **27** may be formed with a series of spaced grooves **39** in the core surfaces adjacent to the inner and outer shells.

A modified form of the container of the present invention is illustrated in Figure 2 of the drawings. This container **40** is particularly adapted to contain and thermally insulate materials in fluid form such as gases, liquids, molten metals, and powdered or granular substances. As here shown, the fluid container is of bottle form and includes a rigid inner shell **41**, defining a storage compartment **42**, and a rigid outer shell **43** formed in surrounding relation to the inner shell to provide an air tight chamber **44** between the shells. Mounted in the chamber **44** is a core **46** similar in nature and function to the core 27 of Figure 1, and serving to reinforce the structure upon evacuation of the chamber 44. Access to the storage compartment 42 is provided by means of a tubular member 45 joined to the inner and outer shells and affording an opening 47 for the passage of fluids therethrough. Evacuation of the chamber 44 may be effected through one or more tubes 48 passing through the outer shell and communicating with the chamber, the tube 48 being closed off and sealed shut by any suitable means when the evacuation of the chamber has been completed.

From the foregoing it will be apparent that the thermally insulated wall structure and method for insulating of the present invention is readily adaptable to a wide variety of uses and applications where a strong, light weight structure having a high resistance to heat transfer is needed. The use of the rigid, light weight core of insulating material to reinforce the structure, together with the highly effective means and method of creating a heat barrier at the points of contact of the wall members and core, result in a structure which can employ normally weak and frangible materials in a wall of minimum thickness and weight as compared to its highly efficient thermal insulating ability.

While certain preferred embodiments of the present invention have been shown and described in detail, other modifications and embodiments will be apparent to those skilled in the art, and accordingly it is not intended to limit the invention to the exact details shown except in the manner set forth and defined in the following claims.

What is claimed is:

1. A thermally insulating wall structure comprising, in combination, a pair of spaced apart parallel plates of gas impervious material, gas-tight means connecting said plates around the perimeter thereof to form a vacuum chamber therebetween, a sealable conduit communicating with said chamber for evacuation thereof, and a core member disposed within said chamber which core member is substantially co-extensive therewith, said core member being a rigid foamed insulative material having a multiplicity of minute cavities distributed throughout the body thereof and being characterized by exterior surfaces having a multiplicity of minute concavities and intervening sharp minute projections which surfaces abut said plates and provide support therefor.

2. A thermally insulating wall structure substantially as described in claim 1 and wherein said structure is formed into a container having an access opening and comprising the further combination of a removable closure for said opening.

3. A thermally insulating wall structure substantially as described in claim 1 wherein said structure is formed into a container and wherein the outermost of said spaced plates is of relatively high strength material and the innermost of said spaced plates is of corrosion resistant material.

References Cited in the file of this patent

UNITED STATES PATENTS

888,739	Reiber	May 26, 1908
1,436,458	Raymond	Nov. 21, 1922
1,615,649	Prindle	Jan. 25, 1927
1,942,162	Campbell	Jan. 2, 1934
2,108,212	Schellens	Feb. 15, 1938
2,202,714	Nash	May 28, 1940
2,304,233	Bergin et al.	Dec. 8, 1942
2,318,744	Brown	May 11, 1943
2,460,309	Rapp	Feb. 1, 1949
2,500,119	Cooper	Mar. 7, 1950
2,513,749	Schilling	July 4, 1950
2,521,080	Morrison	Sept. 5, 1950
2,552,641	Morrison	May 15, 1951
2,699,583	Kurtz	Jan. 18, 1955
2,714,971	Workman	Aug. 9, 1955
2,824,364	Bovenkerk	Feb. 25, 1958

FOREIGN PATENTS

8,509	Australia	July 30, 1932

OTHER REFERENCES

Publication, PC Foamglas, article in The Architectural Forum, May 1944, page 166, Div. 33, class 72, Insulation Block Digest.