

Sept. 5, 1961

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2,998,708

CONTAINER FOR LOW TEMPERATURE LIQUIDS

Filed Nov. 25, 1959

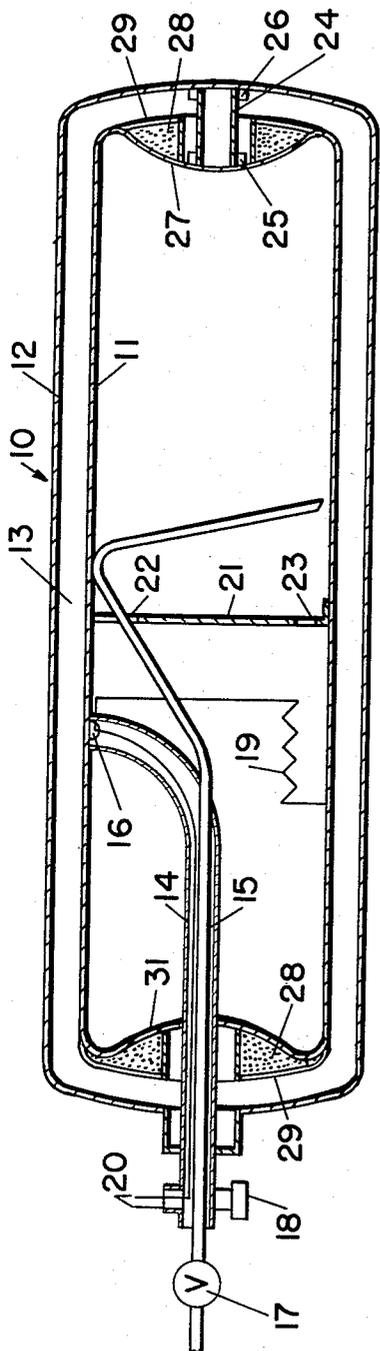


Fig. 1.

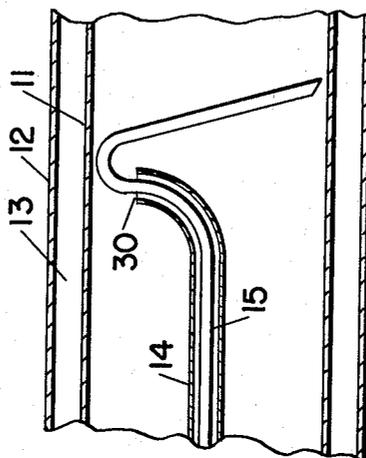


Fig. 2.

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**CONTAINER FOR LOW TEMPERATURE LIQUIDS**  
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 Filed Nov. 25, 1959, Ser. No. 855,397  
 12 Claims. (Cl. 62-45)

This invention relates to an improved container for storing low temperature liquids and more particularly relates to a container having improved means for filling and venting the contents.

Low boiling liquefied gases having boiling points below about 233° K. (-40° C.) are widely used in industrial laboratories and other locations primarily as low temperature refrigerants. Infra-red detection cells and electronic amplifiers such as masers, for example, operate most effectively if cooled to low temperatures. Liquid nitrogen, for example, has been used to supply such refrigeration. When liquid nitrogen or other low temperature refrigerants, such as liquid hydrogen and liquid helium, are used in such service, it is often desirable that the refrigerant be stored for relatively long periods of time and then be supplied in a controlled amount to a device to be cooled. It is also desirable for many applications that the storage container have minimum volume and weight and be mounted in a horizontal position. Such conditions are required, for example, for a refrigerant storage container employed for supplying refrigerant to an infra-red detection cell in an air-borne missile.

It is, therefore, an object of the present invention to provide a container for storing low temperature liquid refrigerants, such container having improved filling and vent means.

It is a further object to provide a refrigerant container capable of storing the refrigerant for relatively long periods of time and then supplying the refrigerant in a controlled amount to a device for using the refrigerant.

It is still a further object to provide an elongated, double-walled refrigerant container intended to be mounted and used in a horizontal position, such container having improved means for supporting the inner vessel within the outer vessel.

Other objects and advantages will be apparent from the specification and drawings, in which:

FIG. 1 is a cross-section of a cryogenic liquid container of the present invention,

FIG. 2 is a cross-section of a modification of the filling and vent means.

In accordance with the present invention a novel container has been developed comprising in general a double-walled vessel having an evacuated insulation space between the walls. Concentric vent and filling lines enter one side of the container and extend into the inner vessel where they then bend upward toward the top of the inner vessel. The outer concentric line terminates near the top of the inner vessel and provides a means for venting refrigerant or air vapors from the vessel. The inner concentric line passes up near the top of the vessel and then is bent around until it is directed toward the bottom of the inner vessel where it terminates. This inner line is employed to fill the inner vessel with liquid refrigerant and also to act as a discharge line when stored liquid is withdrawn. The inner vessel is supported within the outer vessel by the vent line at one end and at the other end by means of a hollow support member positioned between the inner and outer vessels.

The invention will be described in more detail with respect to the accompanying figures. In FIG. 1 the container 10 is formed from an inner vessel 11 and an outer vessel 12, both preferably constructed from aluminum or aluminum alloys. The space 13 between the vessels is

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evacuated to form a vacuum insulation for the inner vessel. This space preferably contains an opacified insulation in addition to being evacuated.

The term "vacuum" as used herein 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 term "opacified insulation" as used herein refers to a two-component insulating system comprising a low heat conductive, radiation-permeable material, such as silica powder or fiber glass, and a radiant heat impervious material, such as aluminum or copper flakes or foil, which is capable of reducing the passage of infra-red radiation without significantly increasing the thermal conductivity of the insulating system.

The improved vent and filling means used with this container consist of concentric outer vent tube 14 and inner filling-discharge tube 15. These concentric tubes enter one side of the container, pass through the walls of the inner and outer vessels and extend into the inner vessel. They then bend upward toward the top of inner vessel 11. As shown in FIG. 1 the outer tube 14 terminates substantially at the vessel wall and contains slots 16 providing vents for vapors to be discharged from the container. Inner tube 15 extends through the wall of outer vent tube 14 and separately passes up toward the top of inner vessel 11 where it is bent around until it is directed toward the bottom of inner vessel 11. This fill line then terminates near the bottom of the inner vessel so that it can remove substantially all the refrigerant when this line is used to discharge refrigerant. When the container is being charged with liquid refrigerant, the liquid passes in through valve 17 and line 15 while any gas previously in the container and any vapors formed during filling pass out through vents 16, line 14 and vent device 18. This novel combination enables the container to be filled to designed capacity without danger of liquid flowing into the vent line. Under sloshing conditions some liquid refrigerant might get into the vent line, but it would vaporize in the external portions of the vent line 14 before it could pass out through vent device 18. This vent device can also act as a relief valve to allow escape of vapors if excessive pressure is developed in the inner vessel.

When refrigerant liquid is desired to be withdrawn from the container, valve 17 or other appropriate control means is opened and the vapor pressure in the inner vessel forces liquid out through line 15. If insufficient vapor pressure is present to produce adequate flow, electrical heater 19, which is preferably included, is energized by a power source (not shown) through electric leads 20 to warm up some of the liquid and produce the desired internal pressure.

In the form of the invention shown in FIG. 1, a baffle 21, having a slot 22 located at the top portion thereof and at least one opening 23 located near the bottom of the baffle, is used to restrict rapid liquid flow through the inner vessel and minimize sloshing whenever the container is subjected to motion. Such conditions could be readily achieved in an air-borne application of the present invention. Inner tube 15 conveniently passes through slot 22 of baffle 21 and can be partially supported thereby.

The inner vessel 11 is supported within outer vessel 12 at one end by vent line 14 which is attached to inner vessel 11 and extends through and is attached to outer vessel 12 and at the other end by hollow support member 24 positioned between inner vessel 11 and outer vessel 12. Support member 24, preferably constructed from high strength, low thermal conductive material, such as phenol-formaldehyde resin reinforced with fabric or paper, can be mounted in several ways. Member 24 could be attached to either inner vessel 11 or outer vessel

12 by means of adhesive, for example, and then slidably engage a support ring 25 or 26 attached to the opposite vessel. Such sliding engagement could also employ a depression in the opposite vessel. Alternatively, support 24 could be maintained in constant compression for additional structural rigidity.

In the preferred form of the apparatus, the inner and outer vessels are generally cylindrical in shape and are mounted and employed so that the main axis of the container is in the horizontal direction. The inner vessel preferably has depressed ends 27 and 31, for structural rigidity and also to form storage areas for adsorbents to be described below. The vent line 14 and fill line 15 enter at the center of one end of the container in order to prevent undesirable heat leak distribution throughout the end of the container and also to simplify fabrication.

The relatively small containers of the present invention have no provision for re-evacuation of the insulating space 13. Therefore an adsorbent 28, either in powder or pellet form, is preferably used in the insulation space to remove by adsorption any gas which may leak into such space. In particular, zeolitic molecular sieves of the type described in U.S. Patent Nos. 2,882,243 and 2,882,244 are preferred as the adsorbent since they have extremely high adsorptive capacity at the temperature and pressure conditions existing in the insulation space and are chemically inert toward any gases which may leak into the insulation space. However, other adsorbents such as silica gel, activated alumina and activated charcoal may also be used if so desired. Alternatively, active metal "getters" that function by chemically combining with in-leaking and residual air may be used. The adsorbent material 28 is conveniently contained within screens 29 and mounted in the depressions at each end of vessel 11.

Another modification of the combination vent and filling means of the present invention is shown in FIG. 2 wherein vent line 14 and filling line 15 are substantially concentric along the full extended length of line 14 within inner vessel 11. Vent line 14 thus terminates below the top of inner vessel 11 and forms a vent space 30 between the vent line 14 and filling line 15. As shown in this modification, filling line 15 extends beyond vent line 14, passes up toward the top of inner vessel 11 and then is bent toward the bottom of the vessel.

It is noted that the structural relations shown for the present invention enable a light-weight, minimum volume container to be fabricated for a given storage volume. The evacuated insulation and especially the preferred opacified insulation used with the storage container enables the refrigerant to be stored for several days without appreciable vaporization loss caused by heat inleak.

While certain preferred embodiments of the invention have been set forth and described, it is to be understood that certain modifications could be made by a person skilled in the art without departing from the spirit and scope thereof.

What is claimed is:

1. A container for storing low temperature fluids which comprises a storage vessel and a combination filling-vent-discharge means which enters the side of the storage vessel, such filling-vent-discharge means comprises a filling-discharge tube and a vent tube positioned so as to surround and be substantially concentric with said filling-discharge tube at the point where the combination means enters the side of the storage vessel, both the filling-discharge tube and the vent tube extend upward toward the top of the storage vessel, said vent tube terminating near the top of the storage vessel and said filling-discharge tube being bent around to be directed toward and to terminate near the bottom of the storage vessel, such combination fill-vent-discharge means enables the storage vessel to be substantially filled and emptied without appreciable quantities of low temperature fluid passing out the vent line.

2. A container for storing low temperature fluids of the

type defined by claim 1 wherein the filling-discharge tube and the vent tube are concentric at the point where they enter the storage vessel and as they both extend into and toward the top of the storage vessel the filling-discharge tube passes through the wall of the vent tube and separately extends up to the top of the vessel.

3. A container for storing low temperature fluids of the type defined by claim 1 wherein the filling-discharge tube and vent tube remain substantially concentric along the entire extended length of the vent tube inside the storage vessel.

4. A container of the type defined by claim 1 having reduced sloshing properties wherein a baffle having a plurality of apertures is positioned vertically across the storage vessel cross-section in order to reduce overall flow of stored fluid when the storage container is moved.

5. A container of the type defined by claim 1 wherein a heater is positioned within the storage vessel to warm some of the stored refrigerant and increase refrigerant discharge rate by increasing internal vapor pressure.

6. A double-walled container for storing low temperature fluids which comprises an inner vessel and an outer vessel with an evacuated insulating space therebetween and a combination filling-vent-discharge means which enters the side of said double walled container and extends into the inner vessel, such filling-vent-discharge means comprises a filling-discharge tube and a vent tube positioned so as to surround and be substantially concentric with said filling-discharge tube at the point where the combination means enters the inner vessel, both the filling-discharge tube and the vent tube extend upward toward the top of the inner vessel, said vent tube terminating near the top of the inner vessel and said filling-discharge tube being bent around to be directed toward and to terminate near the bottom of the inner vessel, such combination fill-vent-discharge means enables the storage vessel to be substantially filled and emptied without appreciable quantities of low temperature fluid passing out the vent line.

7. A double-walled container of the type defined by claim 6 wherein the inner vessel is supported within the outer vessel at one end by means of the vent line which extends through and is attached to the inner vessel and extends through and is attached to the outer vessel and at the other end by a high strength, low thermal conductive support member positioned between said inner and outer vessels.

8. A double-walled container of the type defined in claim 7 wherein said support member is a hollow tube fabricated from phenolformaldehyde resin reinforced with fabric or paper.

9. A double-walled container of the type defined by claim 7 wherein the supported ends of the inner vessel are inwardly depressed.

10. A double-walled container of the type defined by claim 9 wherein an adsorbent for residual gases is positioned in the insulation space within the depressed portions of the inner vessel.

11. An elongated cylindrical double-walled container for storing low temperature fluids and intended for mounting and use with the major axis of the container in a horizontal direction which comprises an inner vessel and an outer vessel with an evacuated insulating space therebetween containing an opacified insulation, said inner vessel having depressed end portions, said container having a combination filling-vent-discharge means which enters the center portion of one end of the container and extends into the inner vessel through a depressed end thereof, such filling-vent-discharge means comprises a filling-discharge tube and a vent tube positioned so as to surround and be substantially concentric with said filling-discharge tube at the point where the combination means enters the inner vessel, both the filling-discharge tube and the vent tube extend up-

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ward toward the top of the inner vessel, said vent tube terminating near the top of the inner vessel and said filling-discharge tube being bent around to be directed toward and to terminate near the bottom of the inner vessel, said inner vessel being supported within the outer vessel at one end by means of the vent tube which extends through and is attached to the inner vessel and extends through and is attached to the outer vessel and at the other end by a hollow tube constructed of phenal-formaldehyde resin reinforced with fabric or paper, said tube being positioned between the inner and outer vessels.

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12. A container according to claim 4 wherein said baffle is a support means for said filling-discharge tube.

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