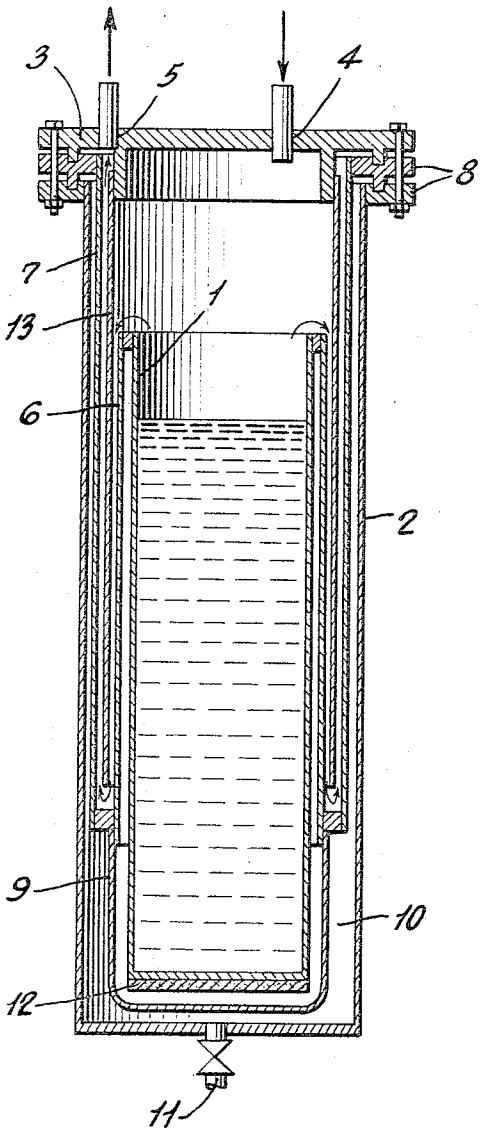
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CRYOSTAT

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The present invention relates to cryostats that are employed, for example, for carrying out low-temperature experiments, and more particularly to cryostats with vacuum insulation, intended for operating with liquid hydrogen or helium.

There are known cryostats with vacuum insulation, intended for use with liquid helium, comprising a working chamber, filled with a refrigerant, and an external case, having in its upper part a cover with holes to supply the liquid refrigerant, to vent vapors, and for other purposes. Heat shields, cooled with liquid nitrogen or with vapors of the refrigerant, are mounted in a vacuum space between the external case and the working chamber of the cryostat. When using evaporated refrigerant for cooling the shields these shields are secured to a neck of a comparatively small diameter, which provides for a fairly good heat exchange between the evaporated refrigerant, the walls of the neck, and the heat shields.

A disadvantage of the existing cryostats is in their design not allowing for increasing the diameter of the neck of the working chamber when operating with a large-size specimen, since such an increase involves a corresponding increase in the evaporation rate of the refrigerant, said increase being caused by the heat influx through the neck of a greater cross-section and the degradation of conditions of the heat exchange between the evaporated gas, the walls of the neck, and heat shields. In such a case, even when using an additional shield, cooled with liquid nitrogen, a large cross-section of the neck provides for a rapid evaporation of the refrigerant, especially of liquid helium.

An object of the present invention is to reduce the evaporation rate of the refrigerant when operating with a large-size specimen that requires an increase in the diameter of the neck of the working chamber of the cryostat.

A further object of the present invention is to provide for the operation of the cryostat with a large-size specimen without the use of shields, cooled with liquid nitrogen, which complicate the operation.

According to these and other objects, a cryostat of the proposed design comprises a working chamber, filled with refrigerant, for example, liquid helium, and an external case, having in its upper part a cover with holes to pour in liquid refrigerant, to vent vapors, and for other purposes. Between the working chamber and the external case are mounted heat shields, one of which is made of a plurality, for example, of two, coaxial partitions, the ends of which are consecutively connected, with the upper part of the internal partition connected to the wall of the working chamber while the upper part of the external partition is connected to the external case. It is recommended to make the partitions of a low conductivity material, for instance, stainless steel. All the interconnections of the partitions, as well as their connections to the external case and the wall of the working chamber are made vacuum-tight.

Thus, this shield also provides a neck, connecting the working chamber with the external case. Evidently, the greater the number of partitions, of which the shield is composed, the less will be the heat influx from the environment to the refrigerant.

As the mean temperature of the shield partitions lowers with respect to the temperature of the working chamber, the heat influx to the liquid refrigerant through heat radiation also decreases. Between the partitions of said shield there may be mounted insertion pieces with a continuous surface of a low conductivity material, for instance, stainless steel, the upper ends of which are secured in the cryostat cover. The holes in the cover of said cryostat to vent vapors of the refrigerant must be arranged between the partition of the heat shield, adjacent to the external case, and the insertion piece, adjoining said partition. This allows improvement in the conditions of heat exchange between the vapors of the refrigerant and the partitions of the shield, which also contributes to decreasing losses of cold. There are also other possible ways of utilizing the evaporated refrigerant to cool the heat shield.

A more complete understanding of the new apparatus of the invention may be had by reference to the accompanying drawing, representing one of the possible designs of the proposed cryostat.

The cryostat comprises a working chamber **1**, filled with the refrigerant, enclosed in an external case **2**. In the upper part of said case is mounted a cover **3** with holes **4** and **5** to pour in the liquid refrigerant and vent its vapors, respectively. The external case **2** is connected to the working chamber **1** by means of a shield, which is also the neck of the working chamber and comprises two cylindrical partitions **6** and **7**, arranged concentrically. The internal partitions, **6** adjacent to the working chamber **1**, is connected in vacuum-tight relation to the upper end of the wall of the chamber **1**; the lower end of the internal partition **6** is connected to the lower end of the external partition **7**; the upper end of the partition **7** is connected to the external case **2** by flange means **8**, providing for the rapid and convenient assembly of the cryostat and for vacuum testing of the welds.

The partitions **6** and **7** are made of a low conductivity material, for example, stainless steel. The thickness of said partitions **6** and **7** is determined by the required strength and rigidity of the structure. All the main joints are made, as a rule, by welding in a protective gas atmosphere, for example, argon-arc welding. The lower part of the working chamber **1** is enclosed in a heat shield **9** of a high-conductivity and low emissivity material, for example, copper, which is in thermal contact with the shield partitions **6** and **7**.

The distance from the upper part of the external case **2** to the upper part of the working chamber **1** varies from 100 to 200 mm. In this space one can accommodate the heat shields or a vessel with liquid nitrogen between the cover and the surface of the liquid refrigerant. Depending on the size of the cryostat, the distance from the lower part of the partitions **6** and **7** to the bottom of the working chamber is practically equal to 100 to 400 mm.

The vacuum insulation is provided by pumping the gas from the vacuum space **10** through a valve **11** (final pressure about 1.10^{-3} mm. Hg). An adsorbent **12** is attached to the bottom of the working chamber **1** on the vacuum side for maintaining high vacuum during operation. The cryostat may be provided with additional heat shields that are mounted, for example, in the space between the chamber volume **1** and partition **6**, as well as with multilayer heat insulation (superinsulation), enclosing the partition **7**.

Between a couple of the partitions **6** and **7** of the shield or neck there is placed an insertion piece **13**, its upper end being hermetically secured, for instance, by means of a suitable seal to the cryostat cover. The hole **5** to vent the evaporated refrigerant is provided in the cover **3** situated between the insertion piece **13** and the partition **7**. In this case, the vapors of the refrigerant from the working chamber **1**, pass through a gap between the

partitions **6** and **7** of the shield-neck and the insertion piece **13**, before said vapors are discharged through the hole **5** into the surrounding atmosphere. Streaming along the partitons of the shield evaporated refrigerant cools said shield, thus decreasing the heat influx into the cryostat. To decrease the heat exchange through the wall of the insertion piece **13** between the gas, streaming downwards, and the gas, rising upwards, the insertion piece may be made as a two-wall vacuum space of a low conductivity material, for example, stainless steel.

Before putting the cryostat into operation, the specimen to be tested is placed into the working chamber **1**, which is thereafter filled with the refrigerant, such as liquid helium, through a hole **4** in the cover **3**.

When the cryostat is filled with the liquid helium, the specimen and working volume are preliminarily cooled with liquid nitrogen.

This cryostat allows use of large-size specimens. Despite a large diameter of the neck of the working chamber and absence of shields that are cooled with liquid nitrogen the evaporation rate of the refrigerant in these cryostats is comparable with that in the cryostats of an ordinary design with a neck of small diameter. Thus, for example, the tested cryostats of the proposed design possessed the working volumes of 2 to 30.1 with the neck diameter from 80 to 200 mm. With the shield comprised of two partitions, the evaporation rate of liquid helium was about 100 to 600 $cm.^3$ per hour. When the vacuum insertion piece **13** is utilized, the evaporation rate decreases by as much as 10 to 15 percent. As has been proved by the experiments and calculations, an increase in the number of couples of the partitions from one to two should result in a yet more marked decrease of the evaporation rate. The immersion of the cryostat into liquid nitrogen or the use of shields that are cooled with liquid nitrogen (placed, for example, between partitions **6** and **7**) leads to a further decrease in the evaporation rate. The cryostats of the proposed design are suitable for various kinds of low temperature investigations.

It will be obvious to those skilled in the art that various changes may be made in the invention without departing from the spirit and scope thereof and therefore the invention is not limited by that which is shown in the drawing and described in the specification, but only as indicated in the appended claims.

What is claimed is:

1. A cryostat comprising an external case having sidewalls and a bottom wall and open at the top, a working chamber having sidewalls and a bottom wall and open at the top for receiving a specimen, said chamber being disposed in said case in spaced relation to the side and bottom walls of said case and with the upper edge of the sidewalls of said chamber disposed below the upper edge of the sidewalls of said case, vacuum insulating means for said chamber comprising a partition surrounding the sidewalls of said chamber in spaced relation thereto and disposed in the space between said chamber and said case, the upper edge of said partition being secured in vacuum tight relation to the upper edge of the sidewalls of said chamber, said partition terminating in a lower edge disposed upwardly from the lower end of said chamber, a second concentric partition disposed outwardly of said first partition in spaced relation thereto and spaced inwardly from the sidewalls of said case, the lower edge of said second partition being secured in vacuum tight relation to the lower edge of said first partition, the upper edge of said second partition terminating adjacent the upper edge of the sidewalls of said case, and a heat shield surounding the sidewalls and bottom wall of said chamber below said partitions and spaced from said chamber and said case, a removable lid closing the upper end of said case, means providing a vacuum tight connection between said lid, the upper edge of said second partition and the upper edge of the side walls of said case, a fitting on said lid for admitting a liquid refrigerant into said chamber, a vent fitting on said lid for venting refrigerant vapors, and a vacuum fitting on said case communicating with the space between said case and said chamber to facilitate evacuation of said last named space.

2. A cryostat as defined in claim **1** and including a second heat shield comprising a third partition disposed between said first and second partitions in spaced concentric relation thereto, the upper end of said third partition being secured to said lid in vacuum tight relationship, the lower end of said third partition terminating upwardly of the lower ends of said first and second partitions, and said vent fitting communicating with the space between said second and third partitions, whereby refrigerant vapors will flow from said chamber downwardly between said first and third partitions, around the lower end of said third partition, upwardly between said second and third partitions and escape through said vent fitting.

References Cited by the Examiner

UNITED STATES PATENTS

2,329,765	9/1943	Jackson et al.	62—45 X
2,671,154	3/1954	Burstein	62—514
2,967,961	1/1961	Heil	62—514
3,097,084	7/1963	Putman	62—45
3,110,156	11/1963	Niemann	62—45
3,176,473	4/1965	Andonian	62—45
3,182,462	5/1965	Long et al.	62—45 X

FOREIGN PATENTS

1,260,084	3/1961	France.

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