

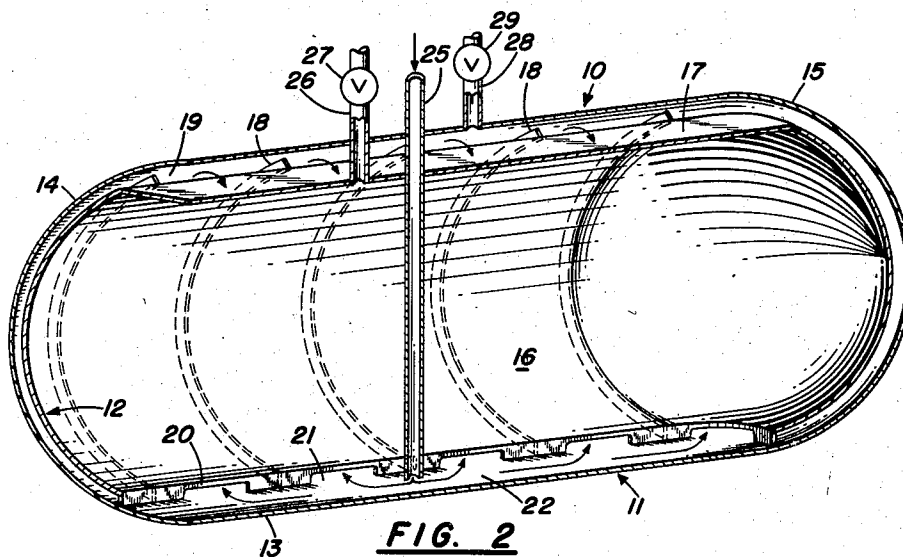
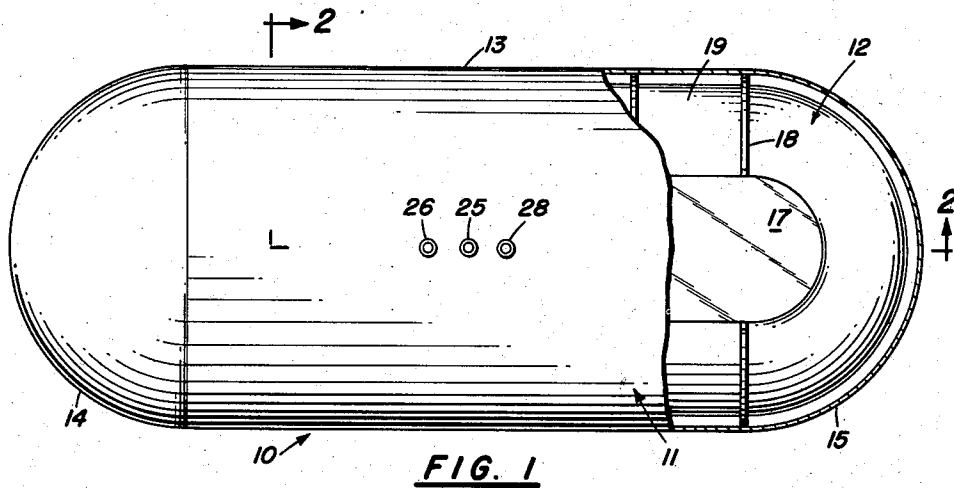
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COOL-DOWN APPARATUS FOR CRYOGENIC LIQUID CONTAINERS

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1

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COOL-DOWN APPARATUS FOR CRYOGENIC LIQUID CONTAINERS

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to cryogenic apparatus, with special reference to means for cooling down receptacles for liquid gases, such as those of oxygen, nitrogen, helium and hydrogen.

The general arrangement of a storage container for liquefied gases consists of a number of concentric shells with a suitable insulation separating these shells. The inner shell of the container holds the liquefied gases, the outer shell or shells usually serving to confine the insulating medium. For liquid oxygen, nitrogen or other cryogenic liquids, only two shells are usually employed, while for liquid hydrogen and helium at least three shells are generally used, the outer shell in each case being at room temperature, and in the three shell type, the intermediate shell being at an intermediate temperature to reduce the heat leak to the liquid in the inner container.

In either type of container, prior to filling the inner shell with the cryogen, it is desirable to cool the container and this is done in the two shell type merely by pouring some of the liquefied gas into the inner shell and thus boiling off the liquid. For the hydrogen three shell type, however, it has been found more efficient to use two stages; first, cooling down the chamber to the temperature of liquid air, and second, cooling the chamber to the liquid hydrogen (or helium) temperature, thus conserving the amount of liquid hydrogen boiled off in the cooling process.

The above cooling methods have one important disadvantage, very little use is made of the cold vapor resulting from the boiling or evaporation step, practically all of the cooling resulting from heat extraction by the heat of vaporization of the boiling liquids. The amount of heat which may be absorbed by the liquid vapor is very large compared with the heat of vaporization; and hence it becomes important that this vapor be utilized to accelerate the cool-down process as well as reduce the cost of the procedure.

An important object of the invention, therefore, is to speed up the abstraction of heat from a container prior to the insertion of liquefied gases therein.

An object, also, is to reduce the cost of pre-cooling a container for liquefied gases.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a plan view, with parts broken away, of a two shell container for low temperature liquefied gases; and

Fig. 2 is a perspective, sectional view of the two shell container of Fig. 1, showing the disposition of the inner shell for channelling the gases during the pre-cooling step.

Referring to the figures, the container is indicated generally by the numeral 10, and is formed of two shells, the outer shell 11 and the inner shell 12. The outer shell 11

2

includes a central cylindrical section 13 and end sections 14 and 15, the end sections being in the form of hemispherical members having edges aligned and fixed, as by welding, to the cylinder section ends.

The inner shell 12 closely conforms in contour to the outer shell 11, the chief distinctions being that the central section 16 has a paraxial section cut out in the base area to form an elongated passageway between the two shells, and the top section 17 is flattened to form an outlet manifold. Also, transverse ribs 18 are fixed to the external surface of the central section 16 of the inner shell, at spaced intervals along the length thereof to form plural channels 19 between the shells, extending from the flat upper plate 17 to shell edges 20 at the base of the container on both sides thereof. To facilitate the guiding function of the channels 19, the inner shell edges 20 are flanged and cut away opposite each channel end, as at 21, to form guide openings from the space 22 directly at the container base and between the inner shell edges 20.

Communication to the space 22 from the container exterior is by means of tube 25, which extends from space 22, at a point above the outer shell wall, vertically through the inner container through the flattened shell of inner shell plate 17 and through outer shell section 13 to a point of access for insertion of liquefied gases. A valve (not shown) is included in the exposed section of tube 25. Access to the interior of the inner shell is by way of the tube 26 attached to flat plate section 17, this tube being provided with valve 27, for venting gases formed during container filling. Tube 28, connected to the top of container section 13, provides a vent during the cool-down operation, a valve 29 being indicated.

In the operation of the pre-cooling apparatus, a restricted predetermined amount of liquefied gas is passed through the tube 25 to space 22 in the base of the outer container, flowing over this space and through channels 21 into the space between the container shells. The liquid rapidly evaporates, the heat of evaporation extracting considerable heat from the container walls, and the highly cooled gases flowing in part into the inner shell and also in large volume between the shells along the channels 19 to the space above the flattened shell section 17, where it moves out through tube 28, valve 29 being open. Thus, it is seen that all sections along the inner shell section are simultaneously cooled by convective flow of the low temperature gases, this cooling effect being directly operative on both shells, which at the same time are being subjected to heat abstraction through action of the heat of vaporization of the liquid. Thus, the container is quickly and efficiently cooled by the initial charge of liquefied gases.

A comparison of the described procedure with that where guided vapor is not used would be of interest at this point. Using a container of 50,000 liters capacity and 22,000 pounds weight and assuming a cool-down step from 80° K. to 4° K., a total of 16,500 liters of liquid helium is required where the liquid is merely dumped within the container, whereas for the same capacity container but using the shell guides as hereinabove described, only 1250 liters of liquid helium are required for the same temperature reduction.

It is apparent that the ribs 18, while definitely advantageous in securing a more uniform cool-down along the container length, are not essential to the specific process. Also, the action is not particularly limited to container size, the procedure being successfully applicable to large or small units.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A cool-down apparatus for cryogenic containers comprising a first tubular closed shell for reception of a cold liquid, a second tubular closed shell within said first shell with the outer wall surface of the second shell conforming generally to the inner wall surface of the first shell but having a paraxial passageway along one side thereof adjacent the first shell, said shells being displaced from each other to form an intervening channel space therebetween, a tube extending from said second shell passageway through the opposite walls of said shells to permit supply of liquid to the container at said passageway only, normally open vent tubes for each of said shells, and ribs formed in the channel space between said shells transversely to the container axis, said ribs extending from said paraxial passageway in the second shell on both sides thereof to a point terminating adjacent but displaced from a plane including the container axis and vent tube passageway for said outer shell.

2. The cool-down apparatus as defined in claim 1 with said ribs which extend from the passageway in said second shell on both sides thereof lying in a common plane transverse to said container axis.

3. The cool-down apparatus as defined in claim 1 with said second shell flattened lengthwise in the area opposite

the shell slot and adjacent the vent passageway of the first shell, whereby an enlarged outlet manifold channel is provided for said channel space.

4. A cool-down apparatus for cryogenic containers comprising a first tubular closed shell for reception of a cryogen, a second shell within said first shell and forming therewith a channel space, a paraxial passageway on one side of said second shell, an inlet tube extending from said passageway through the shell walls opposite to said passageway, a vent tube for each of said shells, an outlet manifold extending from end to end between said shells on the side opposite to said passageway, and means for dividing said channel space into a plurality of parallel channels transverse to the container axis.

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