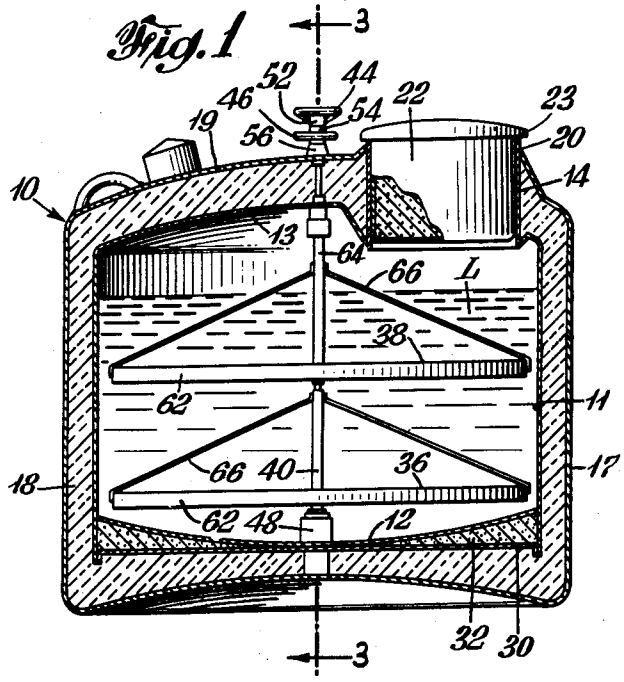
May 7, 1963 W. E. PERKINS 3,088,787

THERMALLY INSULATED BULK STORAGE CONTAINERS

Original Filed April 26, 1956

Fig. 1



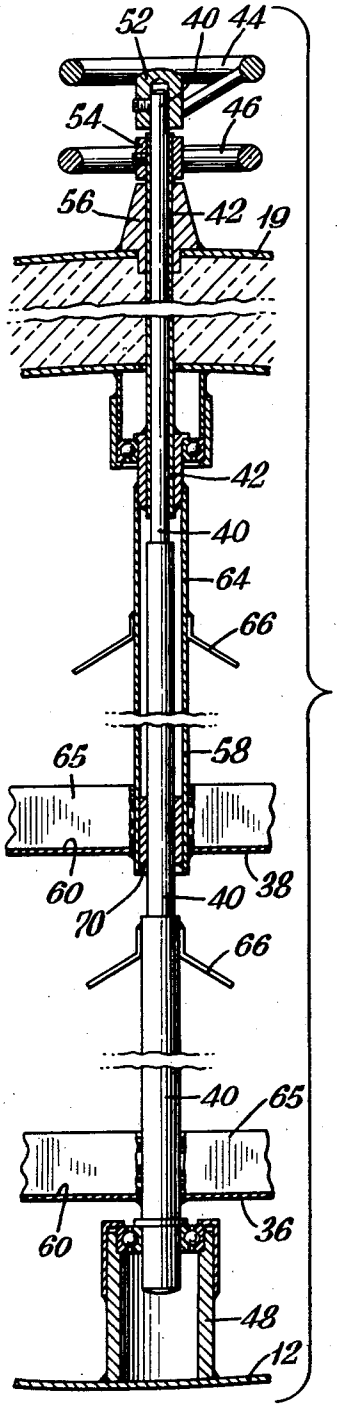


Fig. 3.

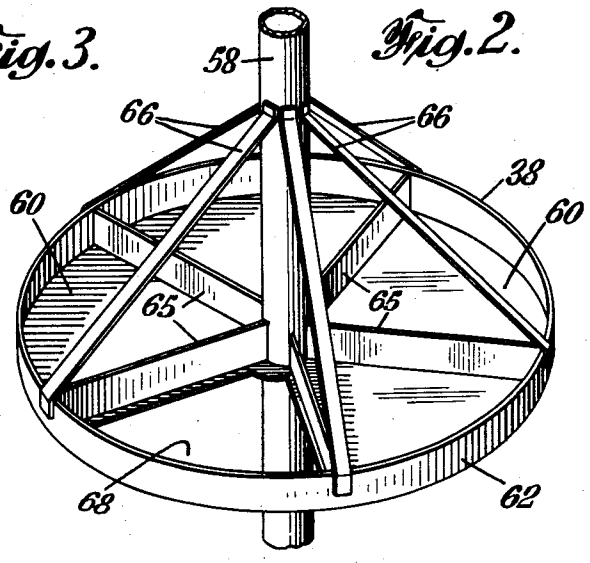


Fig. 2.

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3,088,787
Patented May 7, 1963

3,088,787

THERMALLY INSULATED BULK STORAGE CONTAINERS

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Original application Apr. 26, 1956, Ser. No. 580,898. Divided and this application Oct. 4, 1960, Ser. No. 60,506

4 Claims. (Cl. 312—214)

This application is a division of Serial No. 580,898, filed April 26, 1956.

This invention relates to an improved container for the storing and conveying of perishable commodities, and more particularly concerns a portable container for the conservation of products which must be held at low temperatures for substantial periods of time.

In the past, several difficulties have been encountered in the conservation and conveyance of low temperature products, for example, perishable commodities such as whole blood, pharmaceuticals, enzymes, semen, living tissues, or other biological specimens, which must be held at low temperatures for sustained periods of time.

One of the important difficulties concerns the provision of a light-weight, portable storage container capable of being easily handled for shipment by modern transportation, including automotive passenger car. Another problem is the provision of a compact transporting container for maintaining the stored product for a considerable length of time at the low temperature necessary to avoid spoilage.

Still another problem involves the provision of a portable container having a relatively large opening to adapt it for use in the conveyance of packaged liquid products, as well as solid products of various shapes and sizes, which cannot be simply introduced and withdrawn as can a free-flowing fluid.

Yet another problem involves the efficient utilization of the storage capacity, so that a maximum amount of material may be assembled and stored in an orderly arrangement in the container without damage by squeezing or packing down.

Such problems are very difficult to solve in portable-type containers, primarily because the heat leak problem is exceptionally critical in small vessels. The ratio of surface area to storage volume in small containers is very large compared to the large stationary-type, conventional storage containers. In addition, the efficient utilization of space for product storage places a severe limit on the volume available for the refrigerant.

In the present process for storing and shipping perishable commodities in small quantities, such as bull semen for the artificial insemination of cattle, the semen is shipped in ampules or similar receptacles, refrigerated by direct immersion in water and ice. The difficulty with using solid refrigerant is that it restricts the mobility of any mechanical equipment or parts that might be used inside the container. Furthermore, much of the stored semen may be wasted by spoilage due to the short term virility of semen at such relatively warm temperatures.

If the semen material could be stored in frozen condition, and transported in portable containers at very low temperatures, such as liquid air or liquid nitrogen temperatures, the material would retain its potency indefinitely, and there would be little or no wastage. The prime advantage of such a system is, of course, that close scheduling of individual semen ampule shipments will no longer be required. Another advantage is that a full and complete selection of different breeds and strains may be made available at all times, independently of the time the semina of such breeds and strains were collected.

In order that such a refrigerated container have the requisite portability, and still operate with maximum efficiency and economy, it is necessary that certain inherent probems in design and construction be overcome.

To illustrate by way of example the difficulties that are inherent in the provision of a portable low temperature container, suppose for example that it is desired to store several hundred ampules of semen specimens by immersing them in a bath of liquid nitrogen. Assuming that the contents must be stored in a double-walled container at liquid nitrogen temperature (—320° F.) for about four weeks without an excessive volume of refrigerant, and without replenishment of refrigerant, this will require the provision of a highly efficient insulation such as, for example, a high vacuum polished metal surface system, or other suitable insulating material. This will mean that a major path of heat transmission into the container will be through the neck tube of the container and other supporting members. Assume further that the height of the container does not exceed 22 inches, in order that the container may fit in the rear trunk compartment of an automobile.

To more fully appreciate the problems involved in fulfilling the above conditions, it should be pointed out that using a conventional small diameter, thin-walled neck tube to support the inner container inside the outer shell, the contribution of the neck tube to the overall heat transmission will be of such magnitude that attainment of a four week refrigerant holding time without replenishment of refrigerant will be for all intents and purposes, impossible to achieve. Obviously for large neck tube openings, even greater heat leak will be experienced, since a significant portion of an otherwise well insulated area is thus replaced by an uninsulated opening. As a consequence, refrigeration losses by all modes of heat transfer will be considerably greater.

It is therefore an important object of the present invention to provide an improved portable container having a sufficiently low rate of heat transfer to enable perishable products such as semen and the like to be stored therein in the refrigerated state at lower temperatures and for longer periods of time than has heretofore been possible.

Another object of the present invention is to provide in a low temperature storage container, an enlarged neck opening for affording easy access into the container for storing unitized or bulky solids, as well as liquids, at low boiling liquefied gas temperatures for sustained periods of time.

Still another object of the present invention is to provide in a low temperature storage container employing as a refrigerant, a low boiling liquefied gas, an improved neck tube construction for utilizing the sensible refrigeration in the escaping refrigerant vapors to reduce the net flow of conductive heat along said tube.

Yet another object of the invention is to provide in a storage container for products at low temperature, improved means for more effectively utilizing the available storage space.

Other objects, features and advantages of the present invention will be readily apparent from the following detailed description of certain preferred embodiments thereof, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a view in vertical section of an improved container having internal product handling means embodying the principles of the present invention;

FIG. 2 is a detail perspective view of the upper tray assembly shown in FIG. 1; and

FIG. 3 is an enlarged segmentary vertical sectional view taken along line 3—3 of FIG. 1.

To attain the above objects, use is made in the present invention of highly efficient insulation, such as, for example, a high vacuum polished metal surface system or

a suitable insulating material. According to the broad aspects of the invention, a heat insulated vessel is partly filled with a liquefied gas material, such as liquid nitrogen, which acts as a refrigerant for the storage of products at low temperatures. The invention will be described in connection with a portable container having approximately 25 liters storage capacity for storing frozen ampules or receptacles of bull semen, but it is to be understood that the same principles apply, regardless of the size of the portable container and the nature of the specific material which is stored. The ampules are conveniently grouped and arranged on ampule-holding trays which are supported so as to be immersed in the refrigerant of the container. The respective trays may be rotated about a center shaft to provide easy removal of the ampules as required from an opening in the container top.

In FIG. 1 is shown a liquefied gas holding container or double-walled liquid cylinder **10** including a material supporting means embodying the principles of the present invention. The double-walled liquid cylinder comprises an inner vessel **11** of impervious metal, which is not embrittled at low temperatures, such as stainless steel, for holding liquefied gas refrigerant L, preferably liquid nitrogen. The inner vessel is generally cylindrically shaped, having at its lower end an inwardly dished bottom wall **12**, and at its upper end an annular shoulder portion **13**, which terminates in an elongated, tubular, supporting neck **14**. The inner vessel **11** is surrounded by a cylindrical gas-tight shell or jacket **17** of suitable metallic material, completely encompassing the inner vessel, and providing an intervening evacuable insulating space **18** to provide substantial resistance to heat leakage therethrough.

The outer shell **17** includes a shoulder portion **19** and a tapering neck portion **20**, which partially supports the inner vessel **11** at the neck end **14** which is offset from the container longitudinal axis. For ease of portability and transportation, it is desirable to restrict the weight of the container with its several trays, and to dimension the container so that it can be carried in the trunk of a car. I have found that in a 25 liter container, an inner and outer vessel diameter of 14 inches and 18 inches, respectively, and an overall container height of 22 inches are most satisfactory. For a larger portable container where manual handling is not essential, on the order of 640 liters, an inner and outer vessel diameter of 42 inches and 48 inches, respectively, and an overall container height of 46 inches have been found to be suitable.

It is to be understood, however, that the invention is not limited to the above dimensions, and that the specific dimensions employed are determined by the conditions to which the container is to be subjected.

The container access opening defined by neck tube **14** is provided with a thermally insulated removable stopper or neck plug **22** having a peripherally protruding shoulder **23** in supported relation with the upper edge of said neck tube. The plug as shown may be filled with a low conductive insulating powder to prevent the transfer of heat therethrough. Preferably, the plug fits loosely in the neck tube **14** with a free clearance of about 1/16 inch, to define an annular passage therebetween.

The intervening space **18** may be filled with a low conductive thermal insulation, such as highly efficient vacuum polished metal surface of a suitable powder insulating material. For insulation filling purposes, the shoulder **19** of the shell **17** may be provided with a suitable opening, not shown in the figures, through which powdered insulation may be poured. To reduce heat leak from the outside to the body of liquid refrigerant in the vessel **11**, the shoulder **19** may also be provided with an evacuation connection through which the space between the container walls may be exhausted. Depending upon the type of insulation that is employed, and the degree of insulation desired, the pressure within the insulation space should be reduced to a value below 300 microns Hg, and preferably below 100 microns Hg. After exhaustion, the evacuation means may be sealed to preserve the desired reduced internal pressure.

The absolute pressure within the intervening space **18** may be further reduced and maintained at a low value by attaching an adsorbent container or blister **30** to the lower wall **12** of the inner vessel **11**. The blister may contain an adsorbent material **32**, for example, a zeolitic molecular sieve, either natural or synthetic, such as disclosed in U.S.P. 2,883,243. A filter or screen provided in the blister ensures the retention of the adsorbent in the event the insulation powder is removed, and prevents migration of the powder into the adsorbent blister.

Referring to FIG. 1, the neck tube **14** of the container is preferably constructed in certain critical proportions to satisfy commercial needs and conditions which might be encountered in the use of the container. Primarily, the neck tube should have an opening large enough for easy ingress and egress of the perishable commodity, yet presenting a small enough heat-conductive path to obstruct the flow of heat. As shown, it may support part of the weight of the inner container and contents, and yet be thin enough to provide a heat path or exceptionally small cross sectional area. It should be long enough to provide a lengthened heat path, while at the same time restricting the overall height of the container so that it may, if so desired, fit inside the trunk of a car. Further, the neck tube should be strong enough to resist stresses and strains in all positions including side position. Obviously, optimum neck tube dimensions must consider all the above discussed factors. Considering, for example, the previously mentioned 25 liter container, a 6 inch long neck tube made from a metal possessing high strength and relatively low conductivity, such as "Hastalloy" steel, and having a diameter of about 3 inches and a wall thickness of 0.010 inch, would be admirably suited to fulfill the above needs. For a larger container having a 640 liter capacity, a 12 inch neck tube having a diameter of 15 inches and a wall thickness of 0.010 inch would be satisfactory.

The provision of the neck plug **22** to occupy the majority of the free space in the neck tube **14** is both desirable and necessary for obtaining maximum advantage in the present invention. The function of the plug **22** is primarily to cause the refrigerant vapor, which is generated due to unavoidable heat leak to channel or flow upwardly close to, and in contact with the metal surface of the neck tube **14**. The vapor thereby absorbs any heat which otherwise would be conducted down the neck tube **14**, and in so doing is itself warmed to essentially atmospheric temperature. In this manner the sensible refrigeration in the refrigerant vapor is recovered, and the net heat conducting characteristic of the neck tube is effectively reduced. This permits the use of a large diameter access tube **14** without incurring serious heat losses, and thus results in minimum refrigerant consumption, while still permitting a greater portion of the container storage volume to be utilized.

As shown in FIGS. 1 and 3, the access tube opening **14** is offset from the container center position, to permit access to the rotatable trays **36** and **38**. The trays, as illustrated in FIGS. 1, 2 and 3, comprises a pair of trays **36, 38**, having a diameter slightly less than the inside diameter of the inner container **11**, and arranged in vertically spaced and aligned relation with respect to each other within the storage space of the container. It is to be understood that any number of trays may be used in the practice of the invention, two being shown and described herein for illustration purposes. The trays **36, 38** may be independently, adjustably rotated about the container axis by means of a longitudinal compound shaft or spindles **40, 42** preferably disposed concentrically with the container axis, and extending upwardly through the insulation space to separate control handles **44** and

46, respectively. The compound shaft is journalled at the container upper and lower walls respectively to permit free rotation whereby the entire tray may be passed beneath the access port, by actuation of the protruding portion of a particular shaft. The shaft, as shown, may be provided with roller bearings at the respective ends thereof with a sleeve bearing 70 interposed between the separately rotatable members.

The lower tray 36 may be fixedly attached to the inner shaft 40, which extends the full vertical length of the inside container 11 and terminates in a loose fitting centering and guide ring 48, sealed to the bottom wall 12 of the container. The upper tray 38 may be fixedly secured to the outer spindle 42, which extends only part way into the inner storage container. Stop means 52 and 54 provided on the spindles 40 and 42, respectively, and filler member 56 surrounding spindle 42 and positioned between handle 46 and container shoulder 19 prevent vertical movement of either the upper or lower trays on their respective spindles.

As shown in FIGS. 2 and 3, each tray 36, 38 comprises a central hub 58, concentrically mounted on shaft 40, 42, and provided at its lower end with a substantially flat horizontal circular supporting surface 60, having an upturned marginal end forming a circular tray flange 62. The tray 36, 38 is divided into a number of smaller storage sections by means of suitably shaped radial ribs 65, extending from the hub 64 to the marginal flange 62. Tension straps 66 may be connected between the marginal flange 62 and the upper end of the hub 64 to hold the tray flat and perpendicular to the shaft, even under unbalanced loading conditions. A pie-shaped, cut-out sector 68 in the upper tray 38 allows access from the neck tube opening 14 to the bottom tray 36, when said sector is in registry with the neck tube opening.

A locking device (not shown) may be provided to hold either or both trays in a desired position. This may be desirable when the container is placed on a sloping surface, in which case unevenly loaded trays tend to rotate to a position such that the heavy side is lowest.

From the above description it will be seen that the present invention provides an improved portable container and storage means having a sufficiently low rate of heat transfer to enable perishable commodities such as bull semen to be stored in the refrigerated state for longer periods of time than has heretofore been possible. Using as a refrigerant a low boiling liquefied gas, such as liquid nitrogen, a perishable product may be stored therein indefinitely, and refrigeration need not be replenished frequently.

In conjunction with the described neck tube construction, a material handling device of the rotary tray type, affords means for effectively utilizing a large storage volume through a given diameter neck tube opening. The arrangement of the material handling devices provides for ready removal, insertion or replacement of any desired ampule or receptacle by merely rotating the proper shaft to align a particular portion of a tray beneath the access port.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

What is claimed is:

1. A product handling device for a low-temperature storage container having a top opening offset from the container axis and affording access into the large diameter portion of the container defining a low temperature storage area, said device comprising: a vertically disposed compound spindle extending longitudinally of the container and journalled thereto, said spindle comprising at least a pair of concentrically disposed shafts, the outermost and innermost of which are separately supported and journalled so that such shafts are independent and freely rotatable, a pair of vertically spaced trays in said container having a diameter slightly less than the diameter of said storage area, each of said trays separately engaging one of said shafts to be rotated thereby and a cut-out sector in the uppermost of said trays to permit the removal and addition of products on the lower tray, when said offset opening and said cut-out sector are in registry, whereby maximum utilization of the storage area remote from said offset container opening may be effected and means for rotating the spindle such that each of the concentric shafts are rotatable independently of the others.

2. A product handling device according to claim 1 wherein the outermost shaft is supported and journalled at the upper end portion thereof and the innermost shaft is supported and journalled at the lower end portion thereof.

3. In combination with a product holding device according to claim 1, a container for storing low temperature products including an insulated inner vessel having a cylindrical side wall, a circular top and bottom wall engaging said cylindrical wall to define a low temperature area in said vessel, and an opening in said top wall providing access to the storage area.

4. In combination with a product handling device according to claim 2 a container for storing low temperature products including an insulated inner vessel having a cylindrical side wall, a circular top and bottom wall engaging said cylindrical wall to define a low temperature storage area in said vessel, and an opening in said top wall providing access to the storage area, a portion of the spindle transversing the top wall to be rotatably actuated from a position outside the container.

References Cited in the file of this patent

UNITED STATES PATENTS

721,806	James	Mar. 3, 1903
1,032,989	Cawley	July 16, 1912
1,730,494	Dyer	Oct. 8, 1929
2,119,332	Kern	May 31, 1938
2,153,682	Vlcek	Apr. 11, 1939
2,695,729	Hornish	Nov. 30, 1954