

DEVICE FOR TRANSFERRING MATERIAL

BACKGROUND

[0001] Cryogenic materials are very cold substances that are used in a wide variety of processes and treatment. By definition, cryogenic liquids have boiling points below minus 90° C. For example, liquid nitrogen at -196° C, liquid helium at -269° C, liquid argon at -186° C and liquid methane at -161° C, etc. Hence, before handling cryogenic materials, personal protection, such as cryo-gloves, cryo-apron, safety goggles and shoes must be used.

[0002] Cryogenic materials are often employed for applications such as freezing, cooling, flushing, and purging of machines/equipment. Other applications include deep freezing of biological organs, cryo-ablation of cancerous cells or tumor, targeted cryo-ablation of prostate enlargement and warts, and medical application or preservation of viruses, bacteria, microorganisms, DNA, etc.

[0003] As the cryogenic materials are often stored in bulk storage tank, such as an intermediate vessel or container, there is a frequent need to transfer smaller amounts of the cryogenic materials into various smaller double-walled vacuum-sealed containers, like the Dewar flasks, cryo-vessel or indirectly onto the cancerous tumor, wart or prostate. These handling operations are carried out in environments, such as laboratory, process room, for organs, sperms, and other specimens in frozen storage rooms, or in hospital clinics and surgery operation rooms.

[0004] Owing to its volatile nature, safety considerations during the transferring and handling of the cryogenic materials are of great concern. For example, over pressurization or rupture of the Dewar flasks, columns, or cryogenic equipment can occur during the filling, the phase change from liquid to gas, or the accidental mixing with water (such as rain water) in the Dewar flask resulting in rupture of the equipment. All cryogenic materials produce large volumes of gas when the liquid is raised to ambient temperature and vaporizes. Excessive vapor

and hazards may also be produced during the process of transferring, such as air bubbling, overfilling and splashing, especially in an enclosed environment when the cryogenic material is discharged.

[0005] In view of the foregoing, it is desirable to provide devices for safe handling and transfer of cryogenic materials from bulk storage to smaller containers. Furthermore, it is desirable to provide a medical device for cryogenic medical applications.

SUMMARY

[0006] A device for transferring material is presented. The device includes a cap. The cap includes a plurality of concentric ringed sections stacked together for engaging to an opening of a container. The cap has a feed opening for inserting a transfer tube into the container and a vent extending from a bottom surface to a top surface of the cap.

[0007] These and other objects, along with advantages and features of the present invention herein disclosed, will become apparent through reference to the following description and the accompanying drawings. Furthermore, it is to be understood that the features of the various embodiments described herein are not mutually exclusive and can exist in various combinations and permutations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] In the drawings, like reference characters generally refer to the same parts throughout the different views. Also, the drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, various embodiments of the present invention are described with reference to the following drawings, in which:

[0009] Figs. 1a-b show vertical cross-sectional and bottom views of an embodiment of a cap;

[0010] Figs. 1c-d show various arrangements of vents on the cap;

[0011] Figs. 2a-c shows an embodiment of a cap as adapted for use with various containers;

- [0012]** Fig. 3 shows an embodiment of a cap and transfer tube;
- [0013]** Figs. 4a-c show various embodiments of cap and transfer tubes; and
- [0014]** Figs. 5a-c show various embodiments of transfer tubes.

DETAILED DESCRIPTION

[0015] Cryogenic materials include, for example, liquid nitrogen, liquid helium, liquid argon or liquid methane. Other types of materials, such as non-cryogenic materials, can also be useful. Typically, cryogenic materials are stored in bulk storage tank. Containers, such as double-wall vacuum canisters, or intermediate vessels, gas cylinders or storage canisters are filled from the storage tank for portability. The containers can be provided in different sizes. Embodiments relates generally to devices for safe handling and transfer of cryogenic materials from, for example, bulk storage tank to a container.

[0016] Figs. 1a-b show vertical cross-sectional and top planar views of an embodiment of a filler cap 110. The filler cap facilitates transfer of cryogenic materials from, for example, a static or bulk storage tank to a portable container. Portable containers can have fill openings of different sizes. In one embodiment, the filler cap is adaptable to fill containers with different fill openings or opening types.

[0017] Referring to Figs. 1a-b, the filler cap comprises a plurality of x concentric ringed sections $101_1 - 101_x$ stacked together. In one embodiment, the ringed sections comprise a circular shape. Other geometric shapes, such as octagonal or hexagonal, are also useful. It is also understood that not all the ringed sections need to have the same shape. The ringed sections generally have diameters $D_1 - D_x$ wherein the diameter (D_1) of top section has the largest and decreases with each successive section toward the bottom, with the diameter (D_x) of the bottom ring section being the smallest. Such an arrangement forms a step-like profile. In one embodiment, the filler cap comprises a profile having a plurality of steps.

[0018] A step comprises first and second step surfaces. The first step surface is formed by the bottom surface of a ringed section (x) and a second step surface is formed by the side surface of a ringed section below (x+1). For example, the first step surface of the top step is formed by the bottom surface 132₁ of the top ringed section and the second step surface of the top step is formed by the side surface 133₂ of the ringed section below. The steps, for example, comprise straight surfaces which are orthogonal. Non-straight and/or non-orthogonal surfaces are also useful. For example, the side surfaces can be tapered inwards from the top towards the bottom of the step. It is understood that not all the steps need to have the same configuration. For example, some steps can be orthogonal and straight surfaces while others do not.

[0019] As shown, the cap includes four ringed concentric sections stacked together (x= 4). The four ringed sections form three (x-1) steps 108₁-108₃. In one embodiment, the top ring section includes a top surface which forms the top surface of the cap. The top surface of the cap comprises a surface generally along a first direction, for example, horizontal. The bottom surfaces of the ringed structures are generally along the first direction. The ringed sections comprise side surfaces generally along a second direction. In one embodiment, the first and second directions are orthogonal. Providing non-orthogonal bottom and side surfaces are also useful.

[0020] The diameters of the ring sections are selected to fit the openings of containers to be filled. The ring sections, for example, comprise a circular shape. Other geometric shapes are also useful. The shape of the ring sections can also be selected to match the shape of the container openings to be filled. The cap should be loosely fitted to the container opening to allow, for example, easy release of vapor.

[0021] The number of steps can be selected to adapt to the number of different types of containers which to be filled. Providing a cap which is adapted to a subset of portable containers used is also useful. In this case, different caps can be provided to fill different subsets of

portable containers. In one embodiment, a cap comprises 2-5 steps. Providing a cap with other numbers of steps is also useful. The number of steps can depend on the number of different size containers to be filled. For example, if it is desired to fill three different container sizes, a cap with 3 steps would be used.

[0022] In one embodiment, the cap comprises a feed opening 105. The feed opening 105 allows an elongated transfer tube (not shown) to be inserted into the container. The transfer tube is coupled to a supply source for filling the portable container. The supply source, for example, comprises a bulk storage tank for a cryogenic material. Other types of storage tank and materials are also useful.

[0023] In one embodiment, the cap includes at least one vent opening 120. The vent opening extends from the bottom to the top of the cap filler. The vent opening is provided to vent, for example, cryogenic vapors during filling. The vent opening should sufficiently release pressure in the portable container due to the filling process. Vapor releasing can be used to indicate the fullness of the container. In another embodiment, the cap comprises a plurality of vent openings. As shown, the cap comprises first and second vent openings. The vent openings, for example, are oval shape and are arranged in a balanced configuration around the cap. For example, the vents are located on opposite portions of the cap. Vent openings, for example, overlap the different steps. Providing vent openings which overlap one or some of the steps is also useful. Preferably, the vent openings overlap all the steps of the cap. Other shape, size or number of vent openings, and arrangements, as shown in Figs. 1c-e, are also useful. For example, the vents can be circular, crescent, rectangular, slot-like, triangular, oval or any suitable shape or combination thereof.

[0024] By monitoring the release of vapors from the vent, one can determine the fullness of the container. For example, vapors or the intensity of the vapors being visible from the vents may indicate that the amount of fullness of the container. Filling can terminate once the

container is filled to the desired level. For example, filling can terminate when it reaches 70-80% of the maximum volume of liquid in the container. In one embodiment, a whistling device is fitted over the cap to warn the user when the storage container is filled to the desired level. Other level indicators, such as photo sensors, pressure gauges or light emitting diodes (LEDs), can also be used.

[0025] In another embodiment, the level indicator can comprise, for example, a plurality of thin circular plates covering the top of the cap, overlapping the vents. For example, two to three plates can be disposed on the cap surface. Providing other number of thin plates, including one, is also useful. The plates can include a plate feed opening for aligning centrally along the elongated transfer tube. The plates comprise a plurality of plate openings which are smaller than the vent openings. In one embodiment, the plate openings at the lower plate are smaller than those in the upper plates. The holes, for example, can be arranged in different configurations, gradually reducing in size from the bottom to the top plate. Depending on the vapor pressure, different plate or plates will be lifted or floated, indicating different level of fullness of the container.

[0026] The cap can be formed from, for example, stainless steel. Other types of materials which can withstand the temperatures of cryogenic materials, such as carbon steel or metal alloys like titanium alloy, nickel alloy, zinc alloy or copper alloy, are also useful. The cap can be formed from a single piece of material or multiple pieces of materials. For example, milling, lathing, molding, welding and/or other types of bonding or machining techniques can be used to form the cap. In one embodiment, the cap is formed from a steel rod which is lathed and drilled.

[0027] Figs. 2a-c show a cap adapted for use with various types of containers 220. The container, for examples, includes a body portion 220b and a neck portion 220a with an opening 230. The neck portion comprises a smaller corss-sectional area relative to the body portion. The containers, for example, comprise doubled-wall vacuum sealed type containers. Other types of

containers are also useful. As discussed, containers can comprise different size or shaped openings. A cap 110 is fitted to the opening of container 220. As shown, the cap includes three steps formed by a stack of four ringed shape structures 101₁-101₄. Depending on the size of the opening, a different step rest thereon.

[0028] Fig. 3 shows a cap 110, as described in Fig. 1a. A transfer tube 370 is provided for the cap. The transfer tube, for example, comprises a hollow tube having first and second ends 345 and 350. The transfer tube, in one embodiment, comprises a circular cross-sectional shape. Other cross-sectional shapes are also useful. The transfer tube facilitates filling of the container on which the cap is adapted.

[0029] The first end is coupled to a supply source. The supply source, for example, provides cryogenic material to the transfer tube to fill the container. Filling the container with other types of materials is also useful. For example, the transfer tube is in fluid communication with the bulk storage tank via a connecting tube. The connecting tube can be, for example, a flexible hose or a pipe. In one embodiment, the connecting tube is coupled to the transfer tube using a coupling nut. For example, the top part of a male connecting tube can be coupled with a flared female locking nut. Other coupling configurations or devices are also useful.

[0030] The second end, in one embodiment, comprises a sealed end. The second end can be sealed by, for example, spot welding. Other sealing techniques are also useful. The second end can be rounded to provide a smooth and rounded finish. Providing a sealed end prevents, for example, cryogenic material from exiting through the tip. This has been found to avoid violent splashing and/or air bubbling which may potentially result in creation of excessive vapor and/or vapor escaping through the opening of the container. As such, wastage is reduced while increasing health and safety of handlers.

[0031] A second end portion 352 of the transfer tube toward the second end comprises at least one fill opening 340. Providing a plurality of openings in the end portion is also useful. In

one embodiment, the end portion includes a plurality of fill openings. In one embodiment, the fill openings are arranged in a plurality of columns on the circumference of the transfer tube along the length direction. Other fill opening arrangements are also useful. The diameter of fill openings, for example, may range from about 0.3 cm to about 0.5 cm with a spacing of about 1 cm. Other sizes and spacing are also useful. Fill material entering the transfer tube from the supply exits through the fill openings into the container. Providing fill openings on the side of the tube facilitates smoother flow and efficient filling of the cryogenic liquid into the container.

[0032] A first end portion 347 of the tube from the second end portion to the first end does not contain any fill openings. The first portion should be sufficient in length to locate the second portion near the bottom or body of the container and not the neck. The transfer tube is slidably mated to the cap via the entry opening. When mated, the tube can be adjusted by positioning the first end portion appropriately to locate the fill openings at the bottom or body of the container, as shown in Figs. 4a-c. This allows the tube to be adjusted based on the size or height of the container. When the cap is adapted to the container, the transfer tube hangs inside the container without touching the inner surface thereof.

[0033] In one embodiment, once the desired transfer tube position is obtained, it is welded to the cap. This permanently fixes the position of the tube relative to the cap. Alternatively, fixing the tube at the desired position can be achieved by, for example, using a stopper. The stopper, in one embodiment, can be a clip or bolt that is threaded to the tube. The stopper can be located in the desired position on the tube above the cap, preventing the tubing from sliding downwards. Providing stoppers on both the top and bottom of the cap is also useful. Other techniques for fixing the tube in position are also useful.

[0034] Using the cap to suspend the transfer tube at the desired height above the bottom of the container advantageously reduces or delays bubbling or turbulence to a later stage during filling. This facilitates efficient filling with shorter waiting time compared to a situation when

bubbling or turbulence occurred during the beginning stage of the filling. Additionally, the holder, in covering the container opening, prevents splashing, spilling or evaporation of the container contents, thereby reducing wastage and safeguarding the health and safety of the user.

[0035] The transfer tube can be made from materials such as stainless steel, carbon steel or metal alloys (e.g., titanium alloy, aluminum alloy, or copper alloy). Other suitable materials that are resistant to the low temperature of the cryogenic material, such as aeronautical alloys, low resistant alloys, plastic or quartz material, are also useful. When the filling device is fitted over a container opening, the transfer tube hangs inside the container. In one embodiment, the length of the transfer tube extends below the neck portion of the container.

[0036] Figs. 5a-c show various embodiments of transfer tubes 370. Referring to the Figs. 5a-c, the transfer tube comprises first and second end portions 347 and 352. The second end portion comprises fill openings through which fill material enter a container to be filled. As can be seen, the length of the second end portion can be selected to accommodate various types of containers to be filled. Furthermore, the fill openings can be of the same size (Fig. 5a) or different sizes (Figs. 5b-c). For example, Fig. 5b shows fill openings with alternating first 340a and second 340b sizes while Fig. 5c shows alternating groups of first 340c and second 340d size openings. Other fill opening configuration and first and second end portions are also useful.

[0037] The container, for example, the double-walled vacuum sealed vessel containing the filled cryogenic material from the bulk storage tank can make use of existing available pumping or purging system to automate the transfer of cryogenic material into the column or to maintain the temperature or the cooling of the various machines. The machines, for example, include vibrating sample magnetometer (VSM), Scanning Electron Microscope (SEM), X-ray microanalyzer, etc. Examples of the features incorporating the automated siphoning or purging of the cryogenic material include a vacuum pump, air supply line, vacuum tube, level gauge, purge and safety valves, quartz LED emitters and sensors, flowmeter gauge and suction tube.

[0038] The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The foregoing embodiments, therefore, are to be considered in all respects illustrative rather than limiting the invention described herein. Scope of the invention is thus indicated by the appended claims, rather than by the foregoing description, and all changes that come within the meaning and range of equivalency of the claims are intended to be embraced therein.

[0039] What is claimed is:

CLAIMS:

1. A device for transferring material comprising:
a cap, wherein the cap comprises
a plurality of concentric ringed sections stacked together for engaging to an opening of a container,
a feed opening for inserting a transfer tube into the container, and
a vent extending from a bottom surface to a top surface of the cap.
2. The device of claim 1 wherein the ringed sections comprise a circular shape.
3. The device of claim 1 wherein the diameter of a top section of the ringed sections is the largest and decreases with each successive section toward a bottom section.
4. The device of claim 3 wherein the cap comprises a profile having a plurality of steps.
5. The device of claim 1 wherein the cap further comprises a plurality of plates covering a top surface of the cap.
6. The device of claim 1 further comprises a transfer tube.
7. The device of claim 6 wherein the transfer tube comprises a first end for coupling to a supply source and a second end that comprises a sealed end.

8. The device of claim 6 wherein the transfer tube comprises a first end portion and a second end portion, wherein the second end portion comprises at least one fill opening toward the second end of the transfer tube.
9. The device of claim 6 comprises a stopper for adjusting a position of the transfer tube in a container.
10. The device of claim 1 comprises an indicator device for warning the user when the container is filled to a desired level.