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METHOD AND APPARATUS FOR HANDLING CRYOGENIC LIQUIDS

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Fig 1

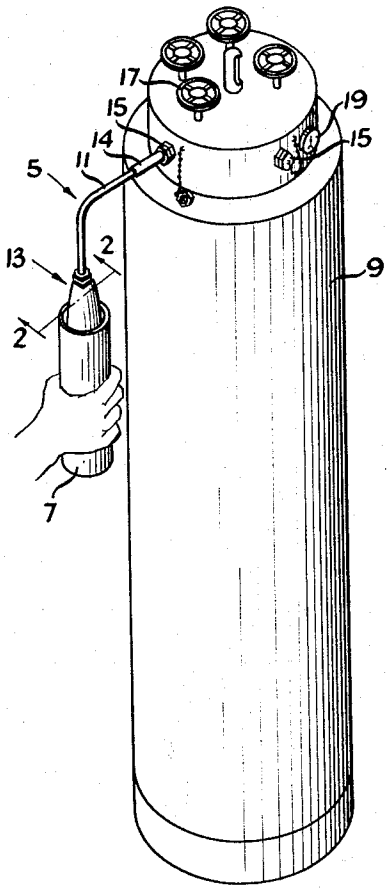
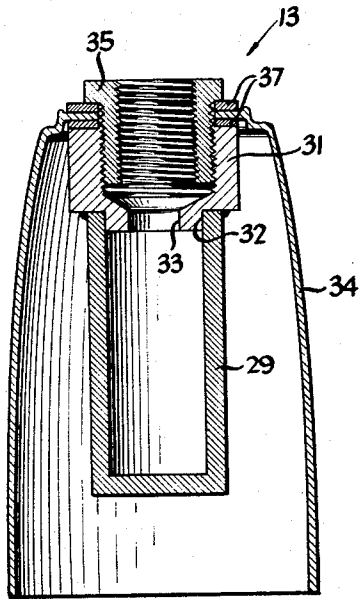


Fig 2



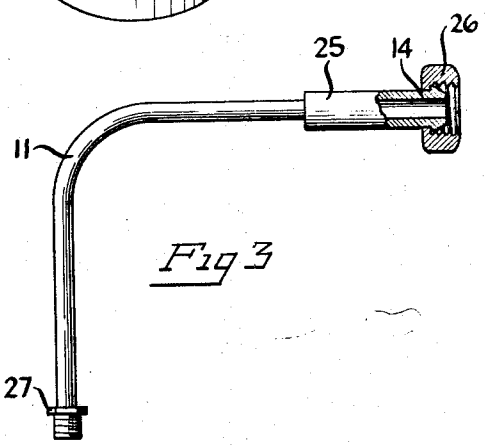


Fig 3

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METHOD AND APPARATUS FOR HANDLING CRYOGENIC LIQUIDS

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The invention relates to the handling of cryogenic liquids and more particularly to filling small containers with cryogenic liquids from larger supply reservoirs.

When one fills a relatively small container with a cryogenic liquid, such as liquid oxygen, liquid argon or liquid nitrogen, from a pressurized supply container, it is important that he use extreme caution lest the cryogenic liquid splash. The danger of careless or inadvertent splashing of a fluid having the freezing power of a liquid at a temperature of about —160° C. is obvious. Furthermore, because it is not usually economical to attempt to recover vapors given off when a cryogenic liquid of this type evaporates, it is also important that evaporation be minimized to reduce loss of the cryogenic fluid and keep the cost of using such a fluid as low as possible.

It is an object of the present invention to provide an improved method for handling cryogenic liquids and apparatus for carrying out such a method. It is another object to provide an improved method for filling containers from pressurized supply reservoirs of cryogenic liquids and apparatus for carrying out such a method. It is a further object of the present invention to provide improved apparatus for filling containers with cryogenic liquids which is simple in construction and operation and inexpensive to manufacture.

These and other objects of the invention are more particularly set forth in the following detailed description and in the accompanying drawings wherein:

FIGURE 1 is a perspective view of apparatus embodying various features of the invention shown being used in filling a small container from a large pressurized cylinder of a cryogenic liquid;

FIGURE 2 is an enlarged sectional view of a portion of the apparatus shown in FIGURE 1 taken along line 2—2 of FIGURE 1; and

FIGURE 3 is an enlarged view, partially in section of another portion of the apparatus shown in FIGURE 1.

Generally, the invention comprises throttling the flow of a stream of cryogenic liquid which is under superatmospheric pressure in order to discharge cryogenic liquid to the atmosphere in a manner so that splashing and evaporation of the cryogenic liquid is minimized. In the apparatus contemplated, a throttling device including a porous throttling element is interposed in the flow of cryogenic liquid so that the liquid must pass through the throttling element to be discharged to the atmosphere.

As illustrated in FIGURE 1, cryogenic handling apparatus **5** is provided which is adapted to regulate the flow of a cryogenic liquid so that small containers, such as a Dewar flask **7**, can be safely filled from a large, pressurized cylinder **9** of cryogenic liquid. Basically, the apparatus **5** includes a tubular conduit **11** and a throttling device **13** attached to one end of the conduit **11**. The other end of the conduit **11** carries a connector **14** for connection with an outlet **15** on the supply cylinder **9**.

The conduit **11** is constructed in the illustrated embodiment with a 90° bend, so the discharge from the throttling device **13** is downward. After the connector **14** is secured to the cylinder outlet **15**, a valve at the top of the pressurized cylinder **9** is opened by a small handwheel **17** to allow cryogenic liquid to flow into the apparatus **5**. A gauge **19**, which is incorporated in the cylinder **9**, indicates the pressure in the cylinder and allows regulation of the valve handwheel **17** so that the pressure at which the handling apparatus **5** is operated is within desirable limtis. Cryogenic liquid flows downward from the bottom of the throttling device **13** in a tranquil stream, the velocity of which is little above that which results from the force of gravity. This stream can easily be caught in the open-mouth Dewar flask **7** without danger of splashing.

The conduit **11** may be of any material that is suitable for use with cryogenic fluids, such as copper tubing. As best seen in FIGURE 3, the connector **14** at the upper end of the conduit **11** is of standard design and includes a central stem **25** which is brazed to the end of the conduit **11**. A rotatable nut **26** rides on the stem **25** and contains internal threads which are matched to the threads on the outlet **15** of a standard pressurized cylinder. By tightening the nut **26**, the stem **25** is forced together with the internal bore in the outlet **15** creating a tight seal.

The opposite or lower end of the conduit **11** has a bushing **27** made of a material such as a brass brazed to it. The bushing **27** has a smooth internal bore and external threads by which the throttling device **13** is attached.

The throttling device **13** includes a porous throttling element **29** in the form of a hollow thin-walled cylinder, closed at its bottom, somewhat similar in shape to an ordinary drinking glass. The throttling element **29** is secured at its top to the bottom of an adapter **31**, generally cylindrical in shape, which has a lower circular seat **32** against which the throttling element is positioned. A central bore **33** extends through the adapter **31**; the bore **33** is threaded internally from the top.

A generally bell-shaped sheath **34**, having an open bottom and fairly flat top, laterally surrounds the throttling element **29** and is of sufficient length to extend below the bottom of the element **29**. The sheath **34** is attached to the cylindrical adapter **31** by a bushing **35** which extends through an aperture in the top of the sheath **34**. External threads on the bushing are matched to the internal threads in the bore **33** of the adapter **31**. A pair of washers **37** are disposed on each side of the top of the sheath **33**. The internal threads on the bushing **35** are matched to the external threads on the bushing **27**, attached to the bottom of the conduit **11**, and afford connection of the throttling device **13** to the conduit. Because the throttling device **13** is used with cryogenic fluids, Teflon tape is preferably used between the two bushings and between the bushing **35** and the adapter **31** to assure a tight seal at the threaded joints.

In the operation, the cryogenic fluid enters the internal cavity of the element **29** at the desired pressure and is herein throttled. The porosity of the element **29** is preselected so that, when the fluid enters the atmosphere outside the element **29**, the force driving the fluid as a result of the pressure differential between the pressurized cylinder and the atmosphere has been substantially dissipated in forcing the fluid through the interstices of the porous element **29**. Accordingly, the velocity of the cryogenic fluid is relatively low. Moreover, by passage through the porous element **29** the flow of cryogenic fluid from the cylinder **9** has been split from one main stream into an extremely large number of minute or extremely fine streams. The number of streams provided by the sintered throttling element **29** is at least many hundreds. It has been found that these minute streams of low velocity have a far less tendency to splash than a larger stream or streams.

The porosity of the throttling element **29** is pre-selected to split the singular stream of cryogenic liquid into a suitable number of minute streams and to reduce the force of the liquid to a level where splashing is inhibited when

cryogenic liquid is fed into the handling apparatus **5** within a desired pressure range. It has been found that a throttling element **29** made from a sintered metal is especially well adapted to carry out these functions. Accordingly, sintered metal is the preferred material, although other suitable materials such as porous cloths or plastics might be used. Examples of suitable metals include, but are not limited to, bronze, brass and stainless steel.

For pressures in the range of about 25 p.s.i.g. to 75 p.s.i.g., it has been found that sintered bronze element having a wall thickness of about one-eighth inch and having pores about 25 microns to about 40 microns in diameter is considered suitable. For higher and lower pressures, elements **29** having pores with lower and higher average pore diameters, respectively, are suitable, preferably in the range from about 5 microns to 50 microns. The wall thickness may also be altered.

A further advantage of the thin-walled sintered metal element is that it has a low mass and is thus quickly cooled to the temperature of the cryogenic liquid. Thus, evaporatoin of cryogenic liquid in order to cool the element to operating temperature is held to a minimum.

The design of the throttling element **29** provides a large surface area in a relatively small space. The entire lateral surface and the bottom face of the element **29** provide throttling passageways, in which the flow of cryogenic liquid is broken into minute streams. In order to safely utilize the element **29** with tanks or cylinders at pressures above about 50 p.s.i.g., the sheath **34** is disposed in surrounding relation to the throttling element **29** to divert laterally directed streams, which may occur when working at such pressures, downward, out the open bottom and into the intended container.

The sheath **34** may be made of any material which is suitable for use with cryogenic liquids. Preferably, the sheath is made of a transparent material, such as clear polyethlene, so that the exit flow from the throttling element **29** can be observed, to further aid in keeping the pressure released to the throttling device **13** within the desired range. However, liquid nitrogen, liquid argon and liquid oxygen are among the cryogenic liquids with which the handling apparatus **5** is especially adapted to be used. Because of the ever present danger of combustion when pure oxygen is present, a sheath **34** made from a non-combustible material, such as stainless steel, may be preferred.

The sheath **34** has a large opening at the bottom and is designed for use in filling open-mouthed Dewar flasks. If the apparatus **5** is to be used to fill closed-mouth Dewar flasks, the sheath **34** can be made, in two-pieces, so that it narrows at its bottom in funnel-like fashion.

It is contemplated that the throttling device **13** will be used with conduits having different types of connectors adapted to fit different types of supply tanks. The throttling device **13** may also be used with flexible high pressure tubing instead of the generally rigid conduit illustrated.

Various features of the invention are set forth in the following claims.

What is claimed is:

1. Apparatus for filling containers with cryogenic liquids from larger tanks under superatmospheric pressure which apparatus comprises a throttling element made of a porous sintered metal, means attached to said throttling element for connecting said element to conduit means from a tank of cryogenic liquid so that cryogenic liquid from said tank is afforded a path to said throttling element and into a container at atmospheric pressure through said throttling element, said porous sintered metal throttling element having the shape of an upright cylinder closed at the bottom with its open top end in fluid communication with said conduit means, and sheath means laterally surrounding said porous throttling element for diverting lateral flow of cryogenic liquid from said element downward into an intended container.

2. Apparatus for filling containers with cryogenic liquids which comprises conduit means for passage of liquified gas, means for attaching one end of said conduit means to a supply of cryogenic liquid, a throttling element made of a porous material, means attaching said throttling element to the other end of said conduit means so that liquid which passes through said conduit means exits to a container through said throttling element, said porous throttling element having the shape of an upright cylinder closed at the bottom with its open top end in fluid communication with said conduit means, and sheath means laterally surrounding said porous throttling element for diverting lateral flow of cryogenic liquid from said element downward into an intended container.

3. Apparatus for filling containers with cryogenic liquids from a tank under superatmospheric pressure, which apparatus comprises a throttling element made of porous sintered metal, means attached to said throttling element for connecting said element to a tank of cryogenic liquid so that cryogenic liquid from said tank is afforded a path to said throttling element, said throttling element having a pre-selected porosity that reduces the force of said liquid to a level where splashing of the cryogenic liquid after passage therethrough is minimized, and shield means partially surrounding said throttling means and open to the atmosphere at one location to permit escape of vapor generated therethrough and to direct the cryogenic liquid passing through said throttling element into a container at atmospheric pressure.

4. Apparatus for filling containers with cryogenic liquids from a tank under superatmospheric pressure, which apparatus comprises a throttling element made of a porous sintered metal, means attached to said throttling element for connecting said element to a tank of cryogenic liquid so that cryogenic liquid from said tank is afforded a path to said throttling element, said throttling element having a pre-selected porosity that reduces the force of said liquid to a level where splashing of the cryogenic liquid after passage therethrough is minimized, and shield means partially surrounding said throttling means and open to the atmosphere at one location to permit escape of vapor generated therethrough and to direct the cryogenic liquid passing through said throttling element into a container at atmospheric pressure, said connecting means including a rigid conduit formed to support said throttling element and said shield oriented with said opening facing verically downward.

5. A method of filling a container with cryogenic liquid, which method comprises establishing a flow of cryogenic liquid from a source thereof under superatmospheric pressure, conducting said flow of cryogenic liquid to a filling means, throttling said cryogenic liquid at said filling means and splitting said flow into a multitude of small streams, and directing the flow of said multitude of small liquid streams into a container at atmospheric pressure to fill the container with minimal splashing of said liquid.

6. A method of filling a container with cryogenic liquid, which method comprises establishing a flow of cryogenic liquid from a source thereof under superatmospheric pressure, conducting said flow of cryogenic liquid to a filling means, throttling said cryogenic liquid at said filling means by passing it through a porous body having an average pore diameter of about 25 microns and thereby splitting said flow into a multitude of small streams, shielding the flow of said multitude of streams in other directions to direct all of said streams generally down-

ward, and filling a container at atmospheric pressure with said liquid with minimal splashing of said liquid.

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