Aug. 24, 1965 R. S. PAULIUKONIS 3,201,946

CRYOGENIC CONTAINER SUPPORT AND FLUID CONDUIT STRUCTURE

Filed March 13, 1964

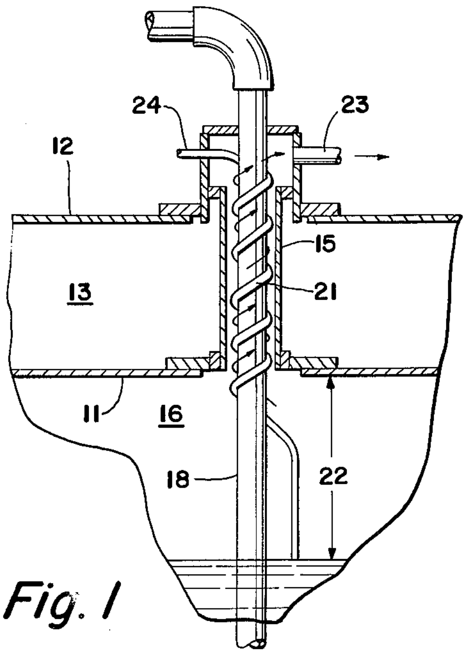

Fig. 1

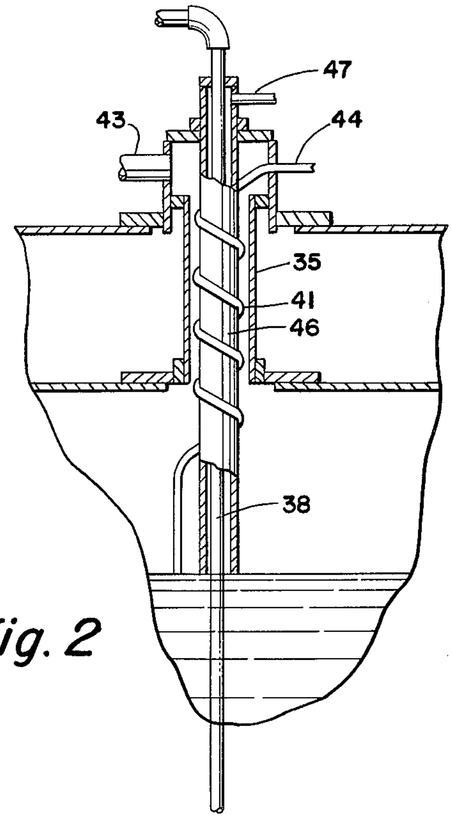

Fig. 2

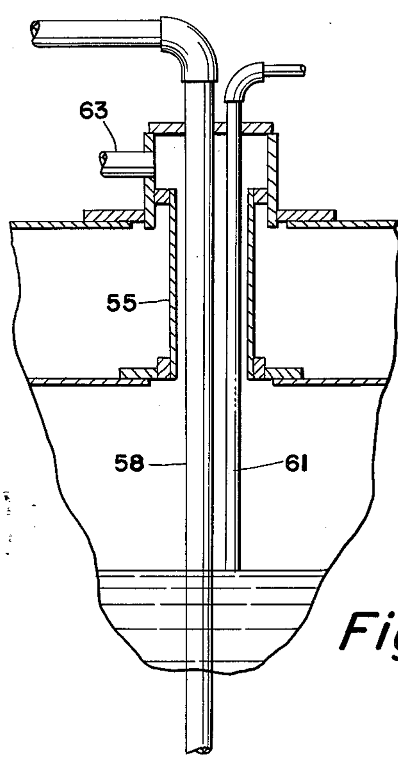

Fig. 3

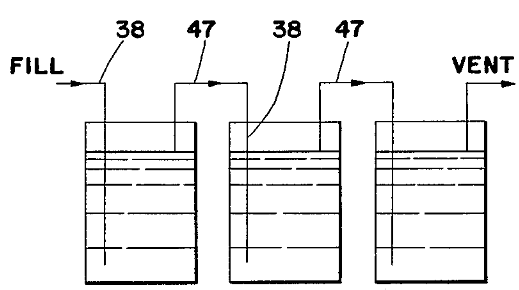

Fig. 4

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United States Patent Office

3,201,946
Patented Aug. 24, 1965

3,201,946
CRYOGENIC CONTAINER SUPPORT AND FLUID CONDUIT STRUCTURE

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Filed Mar. 13, 1964, Ser. No. 351,774
4 Claims. (Cl. 62—45)

This invention relates to cryogenic containers for storing and transporting liquified gases.

Vacuum-insulated double-walled cryogenic containers that are provided with a suitably high vacuum and with radiation barriers between the shells can achieve very low heat inleak across most areas of the container shell. Heat transfer by conduction is almost negligible across the vacuum slot, and radiation may be reduced to a low level by suitable radiation barriers and reflectors in the vacuum slot. Heat transfer losses remain relatively high however at the points of mechanical support of the inner shell. These supports are minimized as much as possible consistently with the mechanical strength requirements of the particular container application, and the supports are made as long as possible to provide a long thermal path and therefore reduce the rate of heat transfer.

In many applications, particularly where cylindrical containers are employed, the several conduits which must communicate with the interior of the vessel are passed through a single neck which constitutes the sole or the main mechanical support for the inner vessel. The conduits within the neck generally include a dip tube which extends nearly to the bottom of the container. A try cock line is also provided which extends partially into the interior of the vessel from the top. If this line discharges gas when opened, the vessel is below its full level. If liquid is discharged, the vessel is at its full level. The distance this line depends into the inner container determines the ullage of the inner container. A vent from the very top of the inner container is also generally provided. This desirably has a fairly generous cross-section to relieve excessive back pressure and allow quick and efficient filling.

Since there are no radiation barriers or reflectors within the neck structure, substantial radiation losses may occur through the neck. Furthermore, parts of the neck structure must be relatively massive in order to have sufficient mechanical strength. These parts include reinforcing plates and other reinforcing members that must be provided at the neck joint. These constitute heat reservoirs which must be emptied (at a cost in expensive liquified gas) when the vessel is put into use.

The present invention provides neck structure which costs little or no more to fabricate than conventional neck assemblies but which, in one important aspect, substantially reduces filling losses incidental to the necessity for cooling the massive structural portions of the neck. In another important aspect, the invention substantially reduces radiation losses through the neck.

In the drawings:

FIGURE 1 is a schematic fragmentary cross-sectional view of a portion of a double-walled vacuum-insulated cryogenic container showing a neck structure therefor that embodies the invention.

FIGURE 2 is a similar view showing another neck structure and showing other features contemplated by the invention.

For purposes of comparison, FIGURE 3 is included and schematically shows a typical neck structure of the prior art.

FIGURE 4 is a highly schematic diagram illustrating series filling of a plurality of containers.

In FIGURE 1 are shown the inner and outer shells

11 and 12 of a cryogenic container. The usual evacuated space 13 between the shells 11 and 12 may be filled with radiant heat inhibiting means (not shown), such as finely divided powder, fine glass fibers with interspersed layers of foil, or equivalents.

The illustrated neck structure includes a neck tube 15 bridging the evacuated space 13 and opening into the top of the container chamber 16. A dip tube 18 extends through the neck tube and far into the interior of the container chamber 16.

Tube means which is radially intermediate the dip tube 18 and the neck tube 15 concentrically surrounds the dip tube and extends through the neck tube. In FIGURE 1 this radially intermediate tube means comprises a helical tube 21. The fluid-flow cross-section defined within the tube 21 is radially exterior to the dip tube 18 but is inside the neck tube 15. The tube 18 depends downwardly from the neck structure through the ullage height 22 of the container chamber 16, and then opens into the interior of a container chamber.

The neck tube 15 may be vented, as at 23. The helical tube 21 may be connected to a try cock line 24.

When the container is being filled, the vent 23 may be opened. Cold gases escaping up the neck tube 15 are caused to flow in a helical path by the guiding effect of the helical tube 21. This helical path has a generous cross-section so that venting back pressure may be low for ready and efficient filling. At the same time, however, the longer path of travel and improved wiping action which results from the helical flow of the expanding and escaping gas assures that the heat being absorbed by the expanding and escaping gas will come largely from the heat-reservoir portions of the massive neck structure rather than from ambient atmosphere.

The try cock associated with the line 24 is opened in order to determine whether the liquid within the chamber 16 has reached the bottom of the tube 21, at which point the container is full. If gas alone escapes from the line 24, the container is not full. If some liquid escapes with the gas, the container is full.

The barrier means within the vacuum slot 13 minimizes radiant heat transfer to the contents of the container. There are no such barriers within the neck 15, but the invention does inhibit radiant heat transfer through the neck to a greater extent than conventional neck structures. This inhibition is accomplished by the helical tube 21 whose successive turns provide successive layers for inhibiting radiant transfer of heat from the vicinity of the top of the neck structure.

FIGURE 3 shows a conventional neck structure including a dip tube 58 and a try cock line 61, which separately depend through a neck tube 55. It will be seen that here there is substantially no barrier to the irradiation of heat from the vicinity of the top of the neck structure downwardly through the neck. Furthermore, when the neck tube is vented, as during filling of the container shown in FIGURE 3, by opening the vent line 63, the escaping and expanding gases absorb relatively little heat from the massive reinforcing members associated with the neck structure.

FIGURE 2 shows a neck structure which in many ways is similar to the neck structure shown in FIGURE 1. A neck tube 35 is provided through which extends a dip tube 38. However, in the FIGURE 2 structure, the radially intermediate tube means comprises both a jacketing tube 46 telescoped over the dip tube 38 and a helical tube 41 that is in surrounding relationship with the dip tube 38 and the jacketing tube 46. This neck arrangement is desirable for series filling applications, one of which is schematically illustrated in FIGURE 4. The neck structure shown in FIGURE 2 might be employed in the first and second containers in the series shown in

FIGURE 4. The exterior line **47** associated with the jacketing tube **46** could be connected to the dip tube of the succeeding vessel, as indicated at FIGURE 4. The exterior line **44** associated with the helical line **41** could be employed as the try cock line to determine whether or not the vessel of FIGURE 2 were filled. The neck **35** is provided with a fitting or tube **43** which can be used as an additional vent tube in the last tank of FIGURE 4, or for pressure gauge or liquid level service while the line **47** serves as the main vent line in the multiple tank assembly.

As the vessel shown in FIGURE 2 is filled, gases escaping through the vent **47** are guided up through the neck structure by the tube **46**. When the vessel becomes filled, the liquid is passed through the dip tube of the succeeding vessel through the line **47**.

The line **44** may be employed as a try cock for checking the liquid level of the individual tanks from time to time during filling of multiple tank assemblies, to thereby supplement the information provided by liquid level gauges and assure accuracy of the "full" readings.

In one aspect, the invention contemplates a neck structure like that shown in FIGURE 2, but without any helical line **41**. Such a neck structure would lack much of the radiation inhibiting advantage of the embodiments described above and would not as effectively remove heat from the massive parts of the neck during filling. Such structure would, however, in one or both respects compare favorably with conventional neck structures such as that shown in FIGURE 3.

The invention is not restricted to the slavish imitation of each and every one of the details described above which have been set forth merely by way of example with the intent of most clearly setting forth the teaching of the invention. Obviously devices may be provided which change, eliminate or add certain specific structural details without departing from the invention.

What is claimed is:

1. In cryogenic container means having inner and outer container shells with an evacuated space therebetween, and a supporting neck through which conduit means passes from the exterior of the outer shell to the interior of the inner shell, a neck structure comprising an exteriorly ventable neck tube bridging the evacuated space and opening into the top of the container chamber, a dip tube extending through the neck tube and depending downwardly far into the interior of the container chamber, radially intermediate tube means concentrically surrounding the dip tube and extending through the neck tube to define at least one additional fluid-flow cross-section that is radially exterior to the dip tube but is inside the neck tube, said radially intermediate tube means including at least one tube that depends downwardly through the ullage height of said container chamber and then opens into the interior of said container chamber.

2. Cryogenic container means as in claim **1** in which said radially intermediate tube means comprises a helical tube extending through the neck tube near the inner side thereof and in surrounding relationship with the dip tube.

3. Cryogenic container means as in claim **1** in which said radially intermediate tube means comprises a jacketing tube extending through the neck tube and telescoped over the dip tube.

4. Cryogenic container means as in claim **1** in which said radially intermediate tube means comprises both a jacketing tube telescoped over the dip tube and extending through the neck tube, and a helical tube in surrounding relationship with the dip tube and the jacketing tube and extending through the neck tube near the inner side thereof.

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