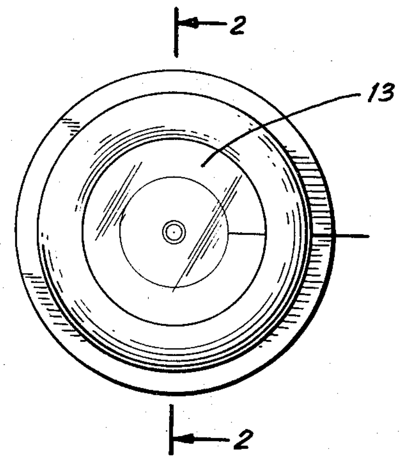
Jan. 9, 1968 G. J. DAMSZ 3,362,176

APPARATUS FOR SUPPLYING LIQUID TO AN UPSIDE-DOWN DEWAR
IN A CLOSED LOOP COOLING SYSTEM

Filed Sept. 16, 1965

FIG. 1



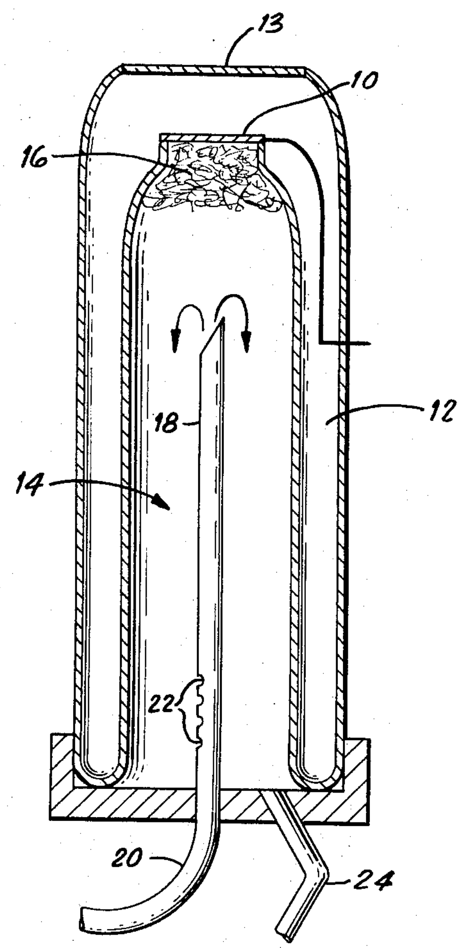


FIG. 2

INVENTOR
GEORGE J. DAMSZ
BY
AGENT

United States Patent Office

3,362,176
Patented Jan. 9, 1968

1

3,362,176

APPARATUS FOR SUPPLYING LIQUID TO AN UPSIDE-DOWN DEWAR IN A CLOSED LOOP COOLING SYSTEM

George Jerzy Damsz, North Tarrytown, N.Y., assignor to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Filed Sept. 16, 1965, Ser. No. 487,685
3 Claims. (Cl. 62—45)

The present invention relates to a closed-loop, two-phase flow, cryogenic system in which a cryogenic liquid is supplied to a Dewar positioned upside-down.

In closed-loop cryogenic systems for cooling, for example, infrared detectors, it is often necessary to supply cryogenic cooling liquid to a Dewar mounted in an upside-down position. It is an object of the present invention to provide a simple but reliable apparatus for effectively supplying cryogenic liquid to a Dewar.

A further object of the present invention is to diminish the evaporation losses in the Dewar due to the warm gas propelled from the end of a two-phase flow tube.

Another object of the present invention is the improvement in the supply of cold to the upside-down Dewar thereby causing the detector to operate more efficiently.

The above and other features, objects and advantages of the present invention will be fully understood from the following description considered in connection with the accompanying illustrative drawings.

FIGURE 1 is a top view of the infrared detector of the invention.

FIGURE 2 is a view taken along lines 2—2 of FIGURE 1.

Referring more particularly to the drawing, an infrared detector **10** is mounted in such a manner that the cooling arrangements therefor in the form of a Dewar **12** is positioned in an upside-down relationship. The detector **10** faces a window **13** in the Dewar. A two-phase flow tube **14** supplies the detector Dewar with small droplets of cryogenic liquid suspended in the gas carrier. In the bottom of Dewar which, because of the upside-down position thereof, is now in the top of the Dewar, a small amount of fibrous material **16** is positioned, such as glass wool or cotton which retains the liquid propelled therein.

The two-phase flow tube **14** is constituted of an entry tube portion **18** for the gas with the small droplets of liquid suspended therein. The entry tube has a sharp bend **20** before entering the Dewar **12**. In addition, the entry tube **18** extends a considerable distance within the Dewar **12**, however, adjacent to the top of the Dewar which in the present condition is the bottom thereof are a series of openings **22** located in entry tube portion **18**. An outlet tube **24** extends to a much smaller degree in the Dewar **12** and conducts away the gas present therein.

The transporting gas is at a much higher temperature than the liquid droplets, in fact, at close to ambient temperature, and the openings **22** in the entry tube portion **18** are the means by which the stream of gas is prevented from blowing against the fibrous material **16** soaked with cryogenic fluid. Thus, to cut down on the evaporation losses due to the projection of relatively warm gas in the Dewar, it is necessary to remove most of the carrying gas from the entry tube portion **18** before it blasts out of the end thereof and into contact with the fibrous material soaked with cryogenic fluid. Bend **20** functions to propel the droplets of liquid in the gas to the side of the entry tube portion **18** opposite to the openings **22**. Moreover, immediately after the aforesaid bend, the series of openings **22** are located through which part of the carrying gas escapes to the outlet tube **24**. The remainder of the carrying gas is propelled through the end of the tube together with the droplets of cryogenic liquid. Since the portion of the escaping gas from the end of entry tube portion **18** has a much smaller velocity, then the evaporation rate of the cryogenic liquid in the fibrous material is diminished considerably.

2

The following factors must be taken into consideration when constructing a two-phase flow tube of the type contemplated by applicant:

(1) Total mass flow in the two-phase flow tube
(2) Relation between the mass of gas and liquid at the outlet from the tube
(3) Length of the two-phase flow tube
(4) Cross section of the tube and the velocity of gas at the outlet
(5) Size and inertia of droplets of cryogenic liquid at the outlet
(6) Temperature of the gas phase at the outlet from two-phase flow tube which is related to the ambient temperature and pressure
(7) Inside diameter and total length of the detector Dewar
(8) Degree of inclination to the vertical of the detector Dewar
(9) Radius of the bend of the two-phase flow tube just before entering the detector Dewar
(10) Location and size of the suction line from the detector Dewar
(11) Amount of the absorbing material at the bottom of the Dewar

One example of the foregoing invention involved three infrared detectors cooled by a single Sterling Cycle refrigerator. One of the detectors was inclined upwardly 10° to 45° from the horizontal plane and had the following characteristics:

(1) Mass flow in the one two-phase flow tube was from .085 to .095 lb./hr. of N_2
(2) Length of the two-phase flow tube was from 1½ to 2⅓ feet
(3) Inside diameter of the tube was from .075" to .105"
(4) Inside diameter of the detector Dewar was from 0.350" to .450"
(5) Total length of the detector Dewar was from 3" to 4"
(6) Radius of the bend of two-phase flow tube was from 1.5" to 2.5"
(7) Amount of compressed cotton wool was from 60 to 100 mg.
(8) Total cross section of openings drilled in the tube close to the suction line from the Dewar was more than 60% of the cross section of the tube
(9) The distance from the "bottom" of the Dewar to the tip of the two-phase flow tube was from ½"–¾"
(10) Distance between openings and tip of the flow tube was from 2¾"–3"

In the above working example, the supply of cold to the Dewar positioned upside down was from 20% to 45% higher than in prior art constructions.

What I claim is:

1. A device for supplying cryogenic liquid in the form of droplets suspended in a gas carrier to a Dewar mounted upside-down and having a fibrous material in the bottom thereof comprising a two-phase flow tube with an entry tube and an outlet tube, said entry tube having a bend therein adjacent to the entrance to said Dewar, and a plurality of openings in said entry tube at the location in said Dewar remote from the location of said fibrous material

therein and adjacent to said bend whereby a part of said gas carrier is expelled through said openings and the cryogenic liquid is separated therefrom and flung by centrifugal force against the wall opposite to said openings while the other part of said gas carrier with said cryogenic liquid are propelled out of the end of the entry tube, said cryogenic liquid being retained by said fibrous material.

2. A device as claimed in claim **1** wherein said entry tube extends further into the interior of said Dewar than said outlet tube.

3. A device as claimed in claim **1** wherein said openings have a diameter of approximately .030 inch.

References Cited

UNITED STATES PATENTS

966,076	8/1910	Bobrick	62—48 X
2,470,228	5/1949	Aksomitas	62—64 X
2,892,250	6/1959	Bartels	62—514
2,939,938	6/1960	Ravich	62—514
2,973,434	2/1961	Roberts	62—514
3,016,716	1/1962	Walker	62—48
3,064,451	11/1962	Skinner	62—514
3,201,947	8/1965	Post et al.	62—514 X

LLOYD L. KING, *Primary Examiner.*