Oct. 24, 1967 K. KUHLMANN 3,348,387

METHOD AND APPARATUS FOR EVAPORATING LIQUEFIED GASES

Filed Feb. 9, 1966

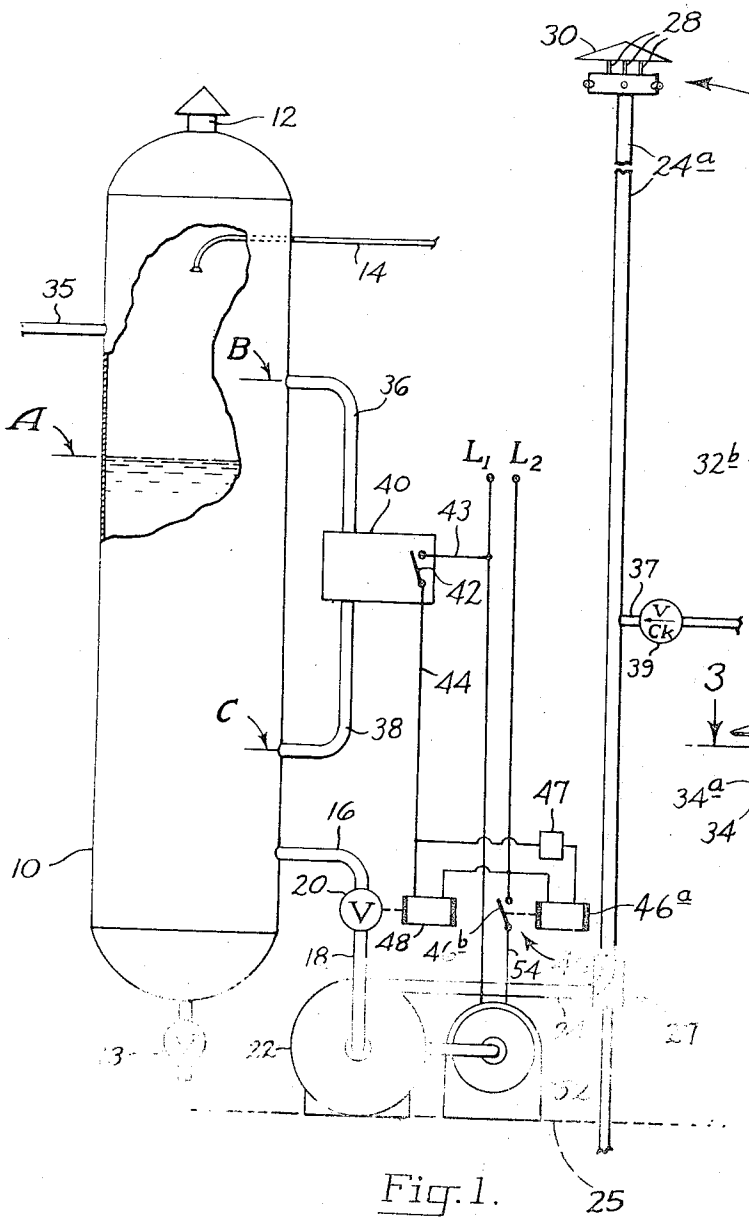


Fig. 1.

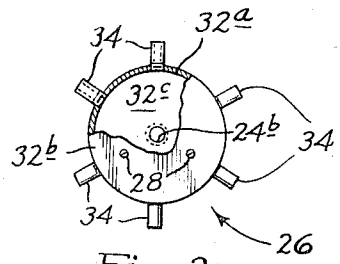


Fig. 3.

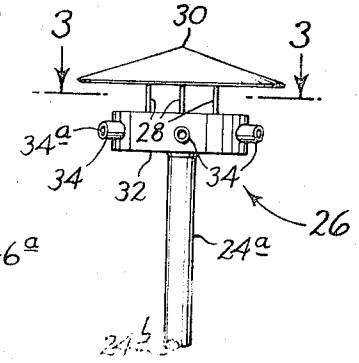


Fig. 2.

Kurt Kuhlmann
INVENTOR

BY
Kolisch & Hartwell

Attys.

United States Patent Office 3,348,387 Patented Oct. 24, 1967

3,348,387

METHOD AND APPARATUS FOR EVAPORATING LIQUEFIED GASES

Kurt Kuhlmann, Portland, Oreg., assignor to Industrial Air Products Co., Portland, Oreg., a corporation of Oregon

Filed Feb. 9, 1966, Ser. No. 534,602
10 Claims. (Cl. 62—52)

ABSTRACT OF THE DISCLOSURE

A method and apparatus for disposing of liquefied gas, where gas in the liquid state is elevated above the ground and dispersed as droplets into the atmosphere.

The present invention relates to the disposal of liquefied gases having boiling temperatures substantially below 0° F. More particularly, the invention relates to a method and apparatus for disposing of such gases by evaporation. Exemplary of gases which may be handled as contemplated herein are oxygen, nitrogen, argon, hydrogen, helium, methane, etc.

In the making of certain products, liquid gases of the above description, oftentimes for one reason or another, must be discarded. Such gases are difficult to handle because of the extremely low temperatures at which they persist in a liquefied state. Many are hazardous also because of their flammability. To further complicate the problem, with modern production facilities, waste streams of such gases may be quite large, as much as 50,000 pounds per hour or more. Known methods for disposing of such a gas by evaporation have included introducing heat into the gas with electrical heating elements. Electrical heating, however, may be expensive because of the amount of electricity needed to produce the required amount of heat to vaporize a waste stream of any significant size. Evaporation by circulating a gas through an air cooler heat exchanger has also been proposed. This also may prove to be an expensive procedure, due to the high cost of the rather extensive heat exchanging equipment needed.

A general object of the present invention, therefore, is to provide a novel method and apparatus for disposing of a liquefied gas by evaporation, whereby a relatively large quantity of gas may be disposed of economically and relatively safely.

More particularly, an object is to provide such a method and apparatus characterized by the feature that the liquefied gas is elevated, while in a liquid state, above the ground, and then dispersed as liquid droplets into the atmosphere, with the droplets then absorbing heat from the atmosphere and evaporating.

A related object is to produce dispersion of a liquefied gas into the atmosphere as liquid droplets in such a manner, that under prevailing atmospheric conditions the droplets vaporize completely before dropping to the ground.

To accomplish these objects, the invention features novel dispersing means supported out in the open above the ground adapted to disperse liquefied gas as a liquid spray directly into the atmosphere. An important feature of the invention also comprises novel means for supplying liquefied gas under pressure to such dispersing means.

A further object is to provide apparatus for the purposes indicated which is relatively inexpensive and simple to use.

These and other objects and advantages attained by the invention will become more fully apparent when the description which follows is read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic diagram illustrating apparatus as contemplated herein for evaporating a liquefied gas;

FIG. 2 illustrates dispersing means constructed according to the invention and employed in the apparatus of FIG. 1; and

FIG. 3 is a view taken along the line 3—3 in FIG. 1, with portions of the dispersing means broken away to illustrate details of construction.

Turning now to the drawings, and with reference first to FIG. 1, at **10** is shown a catch drain or tank, also referred to as a collector, for holding a liquefied gas, such a gas being shown in the collector having a level indicated A. At its upper end, the collector has a vent **12** through which it vents to the atmosphere, and at its lower end it has a drain cock **13** for draining liquid therefrom.

Liquefied gas to be disposed of is carried to the collector by means such as conduit **14**. The collector is connected adjacent its base through conduits **16**, **18** and a normally closed valve **20** to the intake side of an intermittently operated centrifugal pump **22**. Pump **22** is of a type readily available adapted to pump low temperature fluids, and constitutes means for forcing gas herein while such is in the liquid state. The collector and pump together in the apparatus form what is referred to herein as a supply of liquefied gas.

A conduit **24** connects the discharge side of pump **22** to a dispersing means **26**. Conduit **24** includes a hollow, stiff stand pipe portion **24***a*, held in a vertical position as by support structure **27**. The stand pipe portion constitutes support means for the dispersing means, and in the embodiment illustrated in FIG. 1, supports the dispersing means out in the open a substantial distance above ground level, indicated at **25**. The hollow interior of conduit **24** (seen at **24***b* in FIG. 2) provides a fluid passage, connecting dispersing means **26** to the supply of liquefied gas mentioned above.

Referring now to FIGS. 2 and 3 which illustrate a form of dispersing means in detail, the dispersing means comprises a hollow housing **32**, including a cylindrical wall portion **32***a*, and integral top and bottom portions **32***b*, **32***c*, respectively. Suitably secured to and projecting out from wall portion **32***a* at circumferentially distributed locations are spray nozzles **34**, six of such nozzles being shown in the embodiment illustrated. These nozzles have their inner set of ends communicating with the hollow interior of the housing, and discharge openings for the nozzles, shown at **34***a*, communicate with the surrounding atmosphere. The housing is suitably fastened to the upper end of stand pipe portion **24***a* of pipe **24**, with passage **24***b* communicating with the interior of the housing.

Suitably mounted on top of dispersing means **26**, through posts **28**, is a hood **30**. The hood serves to prevent moisture from collecting on the dispersing means. Liquefied gas on being ejected from the nozzles cools the nozzles to a low temperature, and if water is allowed to collect on the nozzles it freezes and may cause clogging.

In FIG. 1 a conduit **35** is shown which connects with tank **10** at a point above the usual liquid level in the tank. This conduit is used to introduce continuously dry waste gas at a moderate pressure into the empty portion of the tank. The gas escapes through vent **12**, and on flowing through the tank serves to purge the system upstream of valve **20** of any moisture.

Connecting with stand pipe **24***a* is a conduit **37**, provided with a check valve **39**. In practice, a source of dry waste gas at a moderate pressure is connected to the conduit which gas, during nonoperating periods of the pump and when liquefied gas is not flowing through the stand pipe, flows through the check valve into the

stand pipe, thence to escape to the atmosphere through nozzles **34**. This gas also functions to purge the system of moisture. The waste gas streams introduced by conduits **35**, **37** by inhibiting water accumulation, tend to insure reliable operation of the disposal apparatus.

Referring again to FIG. 1, shown at **36**, **38** are two conduits with a set of ends joined to collector **10** at vertically spaced levels indicated at B and C. The interiors of the conduits communicate with the inside of the collector where the conduits join the collector. A conventional fluid level indicator and switch assembly **40** interconnects the other set of ends of conduits **36**, **38**. Assembly **40** includes a switch shown schematically at **42** which is actuated to close when the level of fluid in collector **10** rises to level B, and to open when the level of fluid drops to level C.

Switch **42** is connected in a series circuit between a pair of source conductors shown at L_1, L_2, this series circuit comprising a conductor **43**, switch **42**, a conductor **44**, and a solenoid **48**. Connected in parallel with solenoid **48** is the series combination of a solenoid **46***a* and a time delay mechanism **47**. Solenoid **46***a* forms part of a relay **46** which also includes a normally open switch **46***b*. Time delay mechanism **47** normally opens the circuit between conductor **44** and solenoid **46***a*, but is operable after closing of switch **42** and a predetermined time delay to complete a circuit between conductor **44** and solenoid **46***a*.

At **52** is an electric motor which is connected directly to source conductor L_1 as shown, and is connected to source conductor L_2 through a conductor **54** and normally open relay switch **46***b*. The motor is suitably coupled to pump **22**, and is adapted to drive the pump.

The apparatus just described, including switch **42** of level indicator and switch assembly **40**, relay **46**, solenoid **48**, and motor **52**, comprises what is referred to herein as means for automatically controlling the operating periods of pump **22**. Explaining how this means operates, when liquefied gas in the collector reaches level B, level indicator and switch assembly **40** operate to close switch **42**. On closing of this switch, power is supplied from the source conductors to solenoid **48** whereby the solenoid is energized. Solenoid **46***a* remains deenergized, however, until such time as time delay mechanism **47** completes a circuit from conductor **44** to solenoid **46***a*. On energizing of solenoid **48**, valve **20** opens. With valve **20** open, liquefied gas in the collector flows to the intake side of pump **22** through conduits **16**, **18** and the valve. This produces an initial cooling of the pump before start up of the pump. After the time delay period of delay mechanism **47** has elapsed, solenoid **46***a* energizes and switch **46***b* closes, with power then being supplied to motor **52**. The motor then operates pump **22**, whereby liquefied gas is pumped from the collector into conduit **24**. The reason for admitting liquefied gas to the intake side of pump **22** before operating the same, is that a cryogenic pump will experience better wear if operated only after precooling and with the fluid to be pumped present.

With pumping of fluid out of collector **10**, the level of liquefied gas in the collector drops, and when this level reaches level C, switch **42** of the level indicator and switch assembly reopens. With reopening of this switch, solenoids **46***a*, **48** are deenergized, and valve **20** again closes, and motor **52** stops. This condition remains until such time as the level of liquefied gas in the collector again reaches level B.

Considering now how the apparatus as a whole operates to evaporate a liquefied gas fed into collector **10** through conduit **14**, the liquid is collected in the collector until its level reaches level B, whereupon liquefied gas is pumped out of the collector in the manner described above. Such gas is pumped through conduit **24** to dispersion means **26**, whence it is ejected through nozzles **34** directly into the atmosphere as a spray. The liquid droplets in the spray, on being dispersed in the atmosphere, extract and absorb heat from the atmosphere and quickly evaporate. The pressure at which liquefied gas is pumped by the pump, and the elevation of the dispersing means, are selected so that the droplets formed in the spray will completely evaporate before striking the ground.

Thus, the invention provides a relatively simple method for disposing of liquefied gas where neither electrical heating coils nor expensive heat exchanging equipment is required. The apparatus is easy to construct, and is capable of evaporating liquefied gas at a relatively high rate. For example, where the interior of pipe **24** has a diameter of about ¾ inch, and where the pressure at which gas is pumped in this pipe is about 200 lbs. per square inch, an evaporation rate of 4,000 lbs. of liquefied gas per hour is possible.

Moreover, the method disclosed herein is a relatively safe one to carry out. Fire hazard is minimal, particularly in view of the fact that heating equipment is not necessary. With complete vaporization in the air, no liquid concentrations ever collect on the ground.

While the invention has been described in connection with a preferred embodiment, it will be obvious to those skilled in the art that modifications and changes may be made without departing from the spirit of the invention, and it is intended to cover all such modifications and changes which come within the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. Apparatus for evaporating a liquefied gas comprising

liquid dispersing means located above the ground for dispersing the liquefied gas while such is in the liquid state into the atmosphere, including a discharge opening communicating with the atmosphere,

support means supporting said dispersing means above the ground,

a supply of liquefied gas under pressure spaced from said dispersing means, and

fluid passage means connecting said supply with said dispersing means for conveying gas in a liquid state from the former to the latter, said supply including means forcing gas while in a liquid state through said fluid passage means to said dispersing means.

2. The apparatus of claim **1**, wherein said dispersing means comprises at least one spray nozzle for directing dispersed liquefied gas into the atmosphere, and said support and fluid passage means comprise a hollow pipe.

3. The apparatus of claim **2** which further comprises means inhibiting the collection of moisture on said nozzle.

4. The apparatus of claim **1**, wherein the supply comprises a collector and an intermittently operated pump for pumping liquefied gas from the collector into said fluid passage means.

5. The apparatus of claim **4**, which further comprises means controlling operating periods of the pump automatically, depending upon the volume of liquefied gas in the collector, and wherein a valve is included between the pump and the collector controlling flow of liquefied gas from the collector to the pump, and said valve is opened to admit liquefied gas to the pump automatically at a predetermined time before operation of the pump.

6. A method of evaporating a liquefied gas comprising

elevating the liquefied gas above the ground,

dispersing the elevated gas as droplets into the atmosphere,

extracting heat from the atmosphere with such droplets,

by such extracted heat, vaporizing the droplets, and mixing the vaporized product with atmospheric gases.

7. The method of claim **6**, wherein said dispersing of the liquefied gas is accomplished by pumping the liquefied gas under pressure through a nozzle.

8. The method of claim **6**, wherein the elevation at which the droplets are dispersed, and the size of the

droplets produced in the dispersion, are selected so that under prevailing atmospheric conditions the droplets completely vaporize before striking the ground.

9. The apparatus of claim **3**, wherein the means inhibiting the collection of moisture comprises a conduit connecting with said fluid passage means for introducing a stream of dry gas into said fluid passage means.

10. The method of claim **7**, wherein pumping is done intermittently, and a stream of dry gas is passed through the nozzle during nonpumping periods.

References Cited

UNITED STATES PATENTS

2,166,911	7/1939	Little	62—50
2,760,343	8/1956	Reed	62—50
3,121,999	2/1964	Kasbohm et al.	62—50
3,140,740	7/1964	Lagreid et al.	62—50
3,175,601	3/1965	Kuapp et al.	62—50

LLOYD L. KING, *Primary Examiner.*