May 1, 1951 L. V. GROGAN 2,551,435

TRANSPORT CONTAINER FOR LIQUEFIED GASES

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Fig. 1.

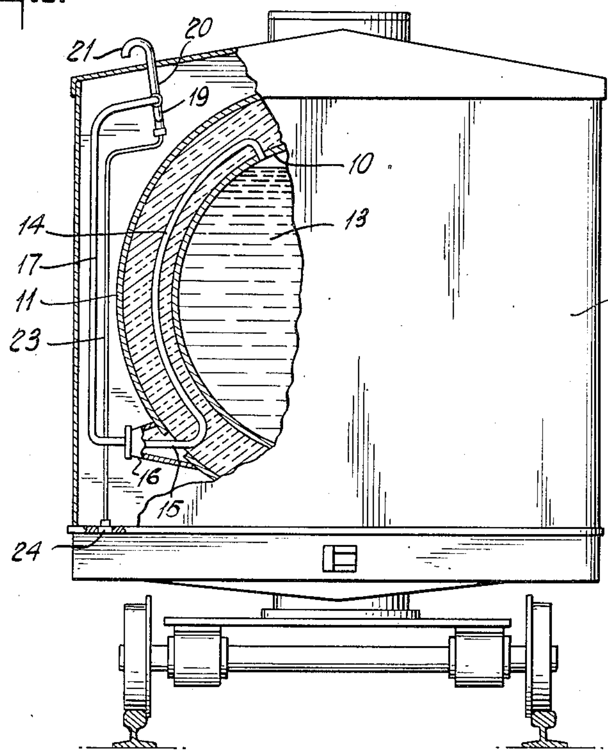

Fig. 2.

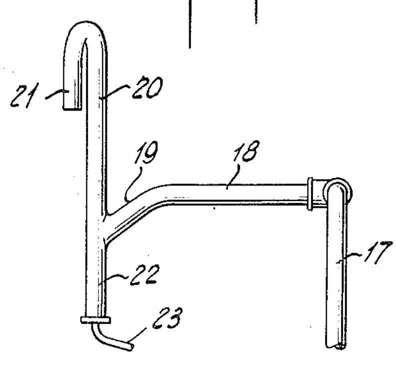

Fig. 3.

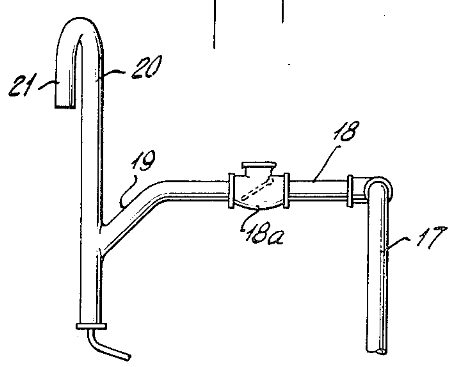

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Fig. 4.

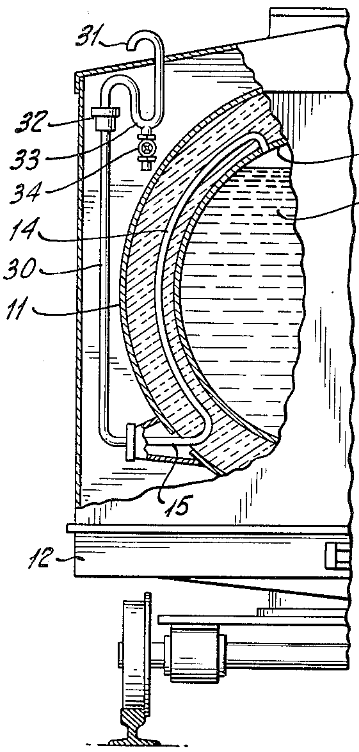


Fig. 6.

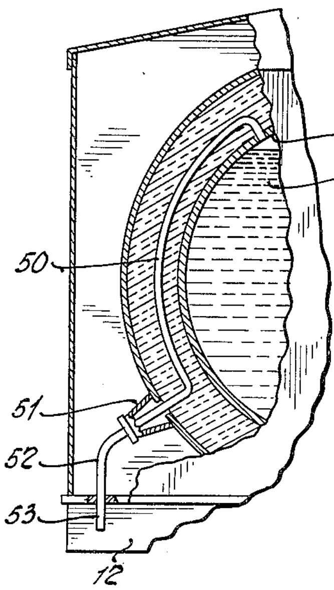
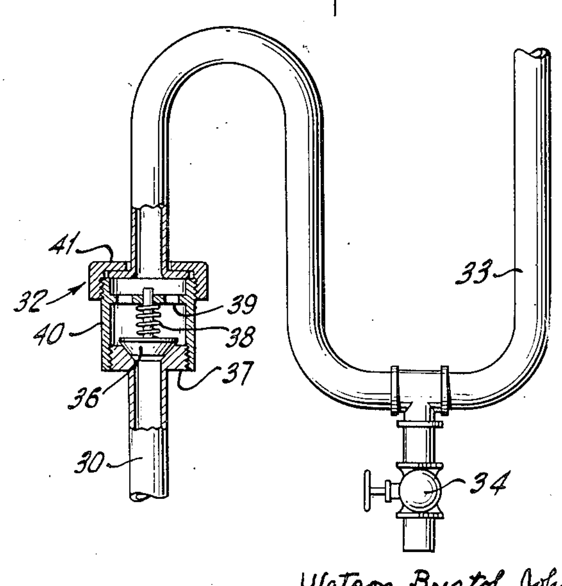


Fig. 5.



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TRANSPORT CONTAINER FOR LIQUEFIED GASES

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Application July 10, 1946, Serial No. 682,466

5 Claims. (Cl. 62—1)

The present invention relates to transport containers for liquefied gases, and particularly to an arrangement which operates to retain the purity of the liquid material while permitting release of generated gas to prevent building up of excessive pressure within the container. In this respect it constitutes an extension of the subject matter of my copending application Serial No. 464,143, filed October 31, 1942, now abandoned, of which this application is a continuation in part.

Such materials as liquid oxygen or nitrogen are commonly transported in insulated containers at substantially atmospheric pressure or at least relatively low pressure. While this entails some loss due to heat leakage into the container and consequent vaporization, yet the arrangement is preferred since to transport the liquid in closed pressure containers requires special constructions capable of withstanding the higher pressure and adapted to conform with governmental regulations, which are thick-walled and correspondingly expensive and involve considerable dead weight.

The practice has been, accordingly, to provide such containers with a breather pipe permitting the gas as generated to escape through an upwardly extending pipe to the atmosphere. It has been found, however, that in some cases at least the liquid has become contaminated with impurities and also that the operation of certain valves and lines has been interfered with. The present invention is directed to an arrangement which functions to avoid these difficulties. It is based on the discovery that the difficulties arise from special conditions in which the flow through the release pipe is at times in the reverse direction and air passes into the container, carrying with it impurities and moisture which become mixed with the liquid material, particularly through constant agitation of the liquid in transit. In addition to the contamination, the moisture freezes out in contact with the cold container and pipes, causing ice and frost to accumulate at various places with consequent clogging of the lines and freezing of the valves.

In the case of liquid oxygen, for example, the atmosphere is always at a much higher temperature than the liquid, and even with the best of insulation there is a slow leak of heat into the liquid which causes evaporation, and under such circumstances and with a restricted outlet the gas space in the container will be maintained at a pressure sufficiently higher than that of the surrounding atmosphere to force the evaporated quantities through the outlet line to the atmosphere. Therefore, when the pressure of the surrounding atmosphere changes, the pressure of the gas space of the container tends to change also to a new value again sufficiently higher than atmospheric to force out evaporated quantities. However, there is some considerable time lag involved in such a readjustment of gas space pressure, for it is also necessary to change the sensible heat of the entire body of liquid in the container to bring the temperature of the liquid to the boiling temperature corresponding to the new gas space pressure. Thus, it appears that if the transport has reached a high altitude where the atmospheric pressure is materially below its normal value of about 14.7 lbs. per square inch and the pressure within the container has correspondingly decreased to below normal atmospheric, and the transport then starts down a steep decline continuing for a considerable distance and period of time, the pressure may be built up outside the container faster than inside. Under such conditions with a pipeline open to the atmosphere there results a flow of air into the container carrying with it moisture and impurities of various sorts. Railroad tank cars, for example, pass over high points where the pressure is several pounds per square inch less than that existing at other points. The inflow of air may occur while an empty tank is en route back to the plant for recharging, in which case it contaminates the vapor in the cold tank and may also contaminate the liquid contents if any of the latter remains in the tank, resulting in a loss of purity of the liquid forming the next charge or necessitating an expensive cleaning of the tank or an excessive amount of purging with the liquid material being transported. Also, the inflow of air may occur while the tank is en route fully or partially charged and the contents accordingly become contaminated particularly as a result of the constant agitation of the liquid.

The invention contemplates a simple arrangement effective to meet the conditions described and accordingly adapted to permit escape of the gases generated within the container and avoid excessive pressure in the container, but operative to eliminate substantially the carrying of moisture and impurities into the container.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a view in end elevation, with parts broken away, of a railroad tank car type of transport embodying the invention;

Fig. 2 is a fragmentary showing of part of the venting line viewed from the left in Fig. 1;

Fig. 3 is a view similar to that of Fig. 2 of a venting line modified to embody a check valve;

Fig. 4 is a view similar to that of Fig. 1 but limited to a portion only of a tank car transport sufficient to disclose a modified arrangement of the venting means;

Fig. 5 is a fragmentary detailed view on an enlarged scale of a portion of the venting means of Fig. 4; and

Fig. 6, similarly to Fig. 4, is a view of a portion of a tank car but showing a still further modified form of venting means for the container.

The specific type of container may vary as to details and purpose and manner of transport, but as diagrammatically depicted in Fig. 1 the invention is embodied in a railroad tank car which may be conventional in many of its general features. It includes an inner liquid container **10** with an outer shell **11** spaced therefrom, the space in between serving as an insulating covering, and for this purpose may be evacuated or contain suitable material such as powdered magnesium carbonate, or both may be employed. The liquid container and its insulating cover are enclosed in an outer housing **12** of box-like character similar in general shape to an ordinary box car.

Connected with the inner liquid container **10** above the normal liquid level when filled, such as indicated by the line **13**, is a vent or breather line designated in general by the numeral **14**. The vent line comprises a small metal tube leading from its point of connection to the upper or gas phase portion of the liquid container **10** downwardly through the insulating space to a point near the bottom and emerges through the outer shell **11** as shown at **15**. The span of tubing within the insulating space will comprise normally several feet, and this length of tubing serves to maintain at low value the amount of heat leakage therethrough into the inner vessel through conduction. The tube is provided at the point where it passes through the wall of the outer shell **11** with a suitable sealing means which has relatively low thermal conductivity, for axample, with a conical sealing member **16** rigidly secured in place to the wall of the shell **11** and with the tube **14** by suitable means such as welding. From the sealing member **16** the tube extends upwardly through a vertical run **17** in the space between the outer shell **11** and the housing **12** to near the top of the transport, where it may have a short horizontal run **18** provided with a downwardly inclined portion **19** (see Fig. 2) communicating with a vertical section **20**. Tube **20** extends through the top of the car and has an outlet to the atmosphere at **21**. The container **10** will normally be sealed against communication with the atmosphere, other than through the breather pipe described.

A moisture trap is provided through the medium of the inclined pipe section **19** and a lower extension **22** of the pipe **20** which drains into a small tube **23** having a suitable discharge at the bottom as through an opening **24** in the floor of the car. The diameter of the tube **23** is a minor

fraction of the diameter of the tube constituting the main vent line as e. g. ¼ inch or less diametral bore, and accordingly the out and in flow of gases with respect to tank **10** occurs substantially through the larger pipe **20**.

In normal operation, as with the transport at rest or traveling along at a substantially constant elevation, the generation of gases in the tank **10** will cause a slow discharge thereof through the vent pipe out the opening **21**. If the car moves up a grade to a higher elevation, this discharge will be accentuated and the pressure within the tank will decrease in proportion, always remaining at a value but slightly higher than that of the ambient atmosphere. When, however, the car descends a steep grade, the ambient pressure will build up faster than within the tank, causing a reverse flow in the vent line. The inflowing air carries a substantial amount of moisture and entrained foreign particles which normally would flow into the tank, but with the arrangement and characteristics of the apparatus shown the air will be chilled by the cold pipe, causing the moisture to condense out and to collect in the moisture trap and discharge downwardly through the tube **23**. Any additional small amount of moisture which may be condensed on the inner surface of the vent pipe inwardly beyond the trap will be evaporated and picked up by escaping dry gases when the flow is reversed.

This reverse or outward flow may occur whether or not the tank is "empty." If the "empty" tank car subsequently travels up an incline to an elevation where the ambient atmosphere is at a substantially lower pressure, some of the air, together with some vapor from the original liquid contents, will flow outwardly to balance the pressure. It should be noted in this connection that although the temperature of the interior of the tank may rise to some extent, nevertheless due to the efficient type of insulation employed, it normally still remains very low and gases which flow outwardly will cool the pipe below any outside temperature. Also the pipe may be cooled to some extent by conduction therealong from the interior and by its proximity to the container. Furthermore a so-called "empty" tank in normal usage on its return trip is rarely if ever completely free of the liquefied gas material since the tank cannot be drained dry through the liquid withdrawal line and in any event will contain vapor.

If it is desired to prevent altogether the reverse flow of air into the tank, a system embodying a check valve may be employed, such as is shown in Figs. 4 and 5. In this system the arrangement is generally similar to that of Figs. 1 and 2 and embodies a vent pipe leading from the tank **10** including a vertical run **30** leading to the top of the car, which has an outlet to the atmosphere at **31**. At an intermediate point, indicated generally at **32**, the pipe is provided with a check valve, and between it and the outlet with a moisture trap shown as comprising a U-portion **33** extending to a point below the check valve **32**, the U-portion being provided with a suitable drain valve **34**.

In Fig. 5 there is shown enlarged the upper part of the relief line of Fig. 4 embodying the check valve and moisture trap, the check valve being shown in cross-section. This check valve may be of any desired construction suitable to the purpose, that shown in Fig. 5 comprising a poppet type valve member **36** mounted on an appropriate seat here shown as formed in an enlarged portion 37 of the tube 30. The valve is urged to its seat by gravity, but advantageously this is supplemented by a light spring 38 inserted as shown between the valve member and a stationary spider 39 integral with or mounted in the sleeve 40, the upper portion of the tube 30 leading to the moisture trap 33 being secured to the sleeve member 40 in any suitable manner as by the nut 41 clamping the flared end of tube 30 to the upper surface of sleeve 40. The spring 38 aids in reducing the tendency of valve 36 to jiggle on its seat by vibration of the transport during transit and permit inappropriate leakage at times when the valve would otherwise be seated. The valve serves also to maintain a slight pressure in the container 10 above the surrounding atmosphere. The resistance to outward flow of gas, and the pressure within container 10, are augmented by the relatively long length of small tubing through which the gas may pass. From the standpoint of safety and government regulation there is, of course, no objection to the maintenance in the container of a few pounds of pressure above atmospheric, and it has the advantage of conserving gas material.

As heretofore noted, between the check valve 32 and the opening to the atmosphere there is located a moisture trap 33, here shown as a U-portion in the pipe, provided with a suitable manually operable drain valve 34 which may be opened at infrequent intervals to release any liquid which might collect therein. Any moisture which enters the open end of the pipe would normally condense in the pipe in the cooler surroundings and collect at the bottom of the U, and accordingly would not have an opportunity of getting into the check valve 32 and collecting there as frost or ice, with possible interference with the operation of the check valve. As an alternative, the drain valve may be replaced by a constantly open drain similar to the small tube 23 of Fig. 1.

Assuming that the container is employed to transport liquid oxygen e. g., accumulations of oxygen gas generated in the inner container 10 are permitted to escape to the atmosphere and no substantial pressure will build up in the container other than the small amount determined by the length and size of the vent tube and whatever restriction is imposed at the check valve by the weight thereof and the force of its spring. In this construction of Figs. 4 and 5, however, no gas will be permitted to flow back through the relief pipe past the check valve 32. As a specific example, if the transport rises in transit to a high elevation such as the top of a mountain range, the oxygen gas will continue to bleed out the pipe, particularly since the external atmospheric pressure will be decreasing. Correspondingly the pressure within container 10 will decrease, although not to the value that it may reach on the exterior. If it be assumed now that the tank car begins to move rapidly down a sharp decline, a point may be reached where for a time the external pressure will be in excess of that within the container 10. However, there will be no inflow of air into the relief line beyond the check valve 32, and all atmospheric air together with any impurities or moisture which might normally be contained or entrained therein will be barred from entrance into the container 10 and the purity of the contents maintained.

If desired, the system of Figs. 1 and 2 may embody a check valve functioning in a manner similar to that described in connection with that of Figs. 4 and 5, and Fig. 3 shows generally such a valve 18*a* inserted in the intermediate pipe section 18.

The systems heretofore described all contemplate the discharge of the gases escaping from the tank at a point above the tank car. This is particularly desirable in the case of inflammable or obnoxious gases. In some cases, however, for example when transporting liquid nitrogen, it may be satisfactory and preferred to discharge the gases at a lower level, and Fig. 6 shows a system so adapted and which has the advantage of being extremely simple. In this figure the liquid tank 10, outer shell 11 and box car construction are shown fragmentarily only, but it will be understood that they may be of the general character of Fig. 1. Likewise, a vent pipe 50 similarly leads from the upper gas phase portion down through the insulation at the side of the tank, out through a conical sealing member 51, but from this point extends downwardly at 52 through an opening in the car floor, it being provided with an open lower end 53. It will be seen that the vent pipe in this system is continuously directed or inclined downwardly so as to be self-draining to the exterior throughout practically its entire length. Accordingly, when the tank is breathing inwardly, condensed moisture will have an opportunity to drain back through the same main vent pipe. Furthermore, as the main part of the pipe 50 is within the insulation, it is kept cold and will condense the moisture of any inflowing air, which moisture will be reevaporated and carried out by subsequently out-flowing dry vapors.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A transport container for highly volatile liquefied gases having a boiling point temperature at atmospheric pressure considerably below 273° K. adapted in its normal transfer to be subjected to considerable variation in atmospheric pressures, said container having in combination an inner liquid container, an insulating covering therefor, and conduit means for venting the pressure in the container but preserving the purity of the contents comprising a vent line to the atmosphere, said liquid container being otherwise normally closed from communication with the atmosphere during transport, and a moisture trap provided with a gravity drain in said vent line, said venting means being constructed and arranged normally to direct cold escaping gases outwardly therethrough and to direct pressure balancing gases from the atmosphere therethrough in the reverse direction when the container is in a region of relatively higher atmospheric pressure whereby the cooled conduit means abstracts heat from the inflowing gases, producing condensation of moisture from the atmosphere gases.

2. A transport container for liquefied gases having a boiling point temperature at atmospheric pressure considerably below 273° K. having in combination an inner liquid container, an insulating covering therefor, and means for vent-

ing the pressure in the container but preserving the purity of the contents comprising a vent line to the atmosphere, said liquid container being otherwise normally closed from communication with the atmosphere, a check valve in said vent line arranged to permit escape of gas outwardly from the container but prevent reverse flow, a moisture trap in said vent line between said check valve and the outlet to atmosphere and located outside of said insulating covering, and a drain leading from a low point of said moisture trap.

3. A transport container for liquefied gases having a boiling point temperature at atmospheric pressure below 273° K. having in combination an inner liquid container, an insulating covering therefor, a vent line to the atmosphere, said liquid container being otherwise normally closed from communication with the atmosphere during transport, a check valve in said vent line arranged to permit relatively free escape of gas outwardly from the container but prevent reverse flow, and a moisture trap in said vent line between said check valve and the outlet to atmosphere and located outside of said insulating covering.

4. A transport for liquefied gases having a boiling point at atmospheric pressure considerably below 273° K. having in combination a liquid container, an insulating covering therefor, and a vent line for said container to the atmosphere, said container being otherwise normally closed from communication with the atmosphere while in transit, a check valve in said vent line arranged to permit escape of gas outwardly from the container to the atmosphere but prevent reverse flow of gas into the container, and a moisture trap in said vent line between said check valve and the outlet to atmosphere, said vent line including the check valve being of a character to retard and prevent outward escape of gas except when the pressure within the container attains a predetermined value not in excess of 25 lbs. per square inch above the surrounding atmospheric pressure.

5. A transport container for highly volatile liquefied gases having a boiling point temperature at atmospheric pressure considerably below 273° K. adapted in its normal transfer to be subjected to considerable variation in atmospheric pressures, said container having in combination an inner liquid container, an insulating covering therefor, and conduit means for venting the pressure in the container but preserving the purity of the contents comprising a vent line connecting the upper portion of said container to the atmosphere, said liquid container being otherwise normally closed from communication with the atmosphere during transport, a moisture trap in said vent line comprising an intermediate section bent downwardly to a point below the horizontal level of the adjoining section and provided at the bottom with a constantly open drain but restricted in effective cross-sectional area to a minor fraction of the effective cross-sectional area of the vent line, said venting means being constructed and arranged normally to direct cold escaping gases outwardly therethrough and to direct inflowing gases from the atmosphere through at least portions of said vent line in the reverse direction when the container is in a region of relatively higher atmospheric pressure whereby the cooled conduit means abstracts heat from the inflowing gases, producing condensation of moisture and removal thereof through said trap.

LEO V. GROGAN.

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