

Jan. 1, 1952

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2,580,649

LIQUEFIED GAS DISCHARGE PUMP

Filed Jan. 8, 1948

3 Sheets-Sheet 1

Fig. 1.

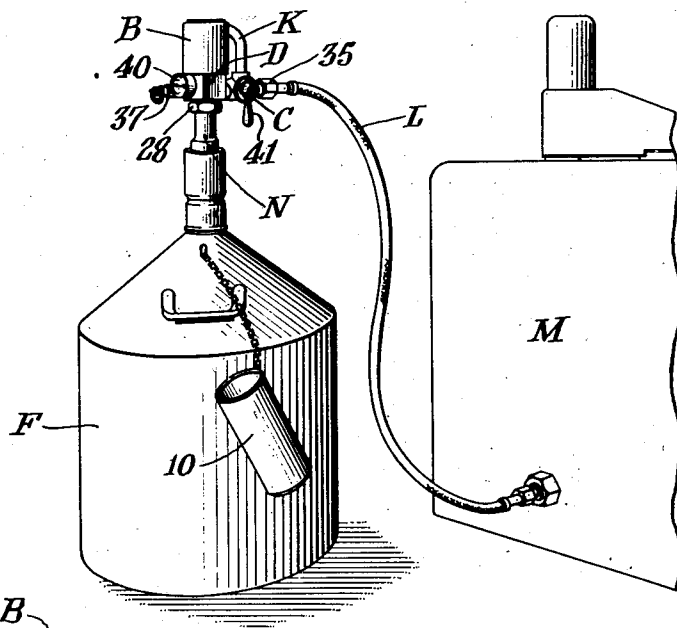


Fig. 2.

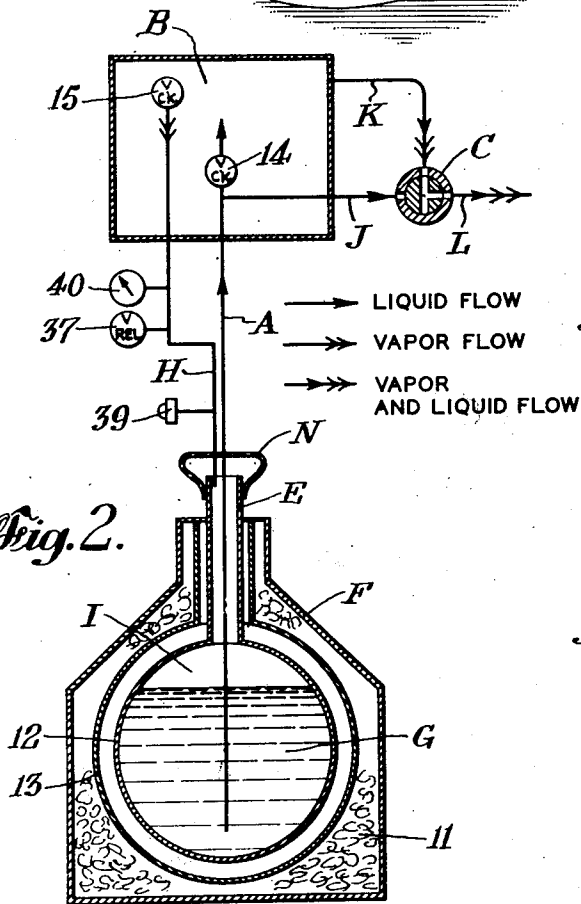
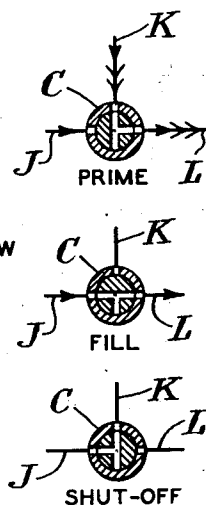


Fig. 3.

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Fig. 6.

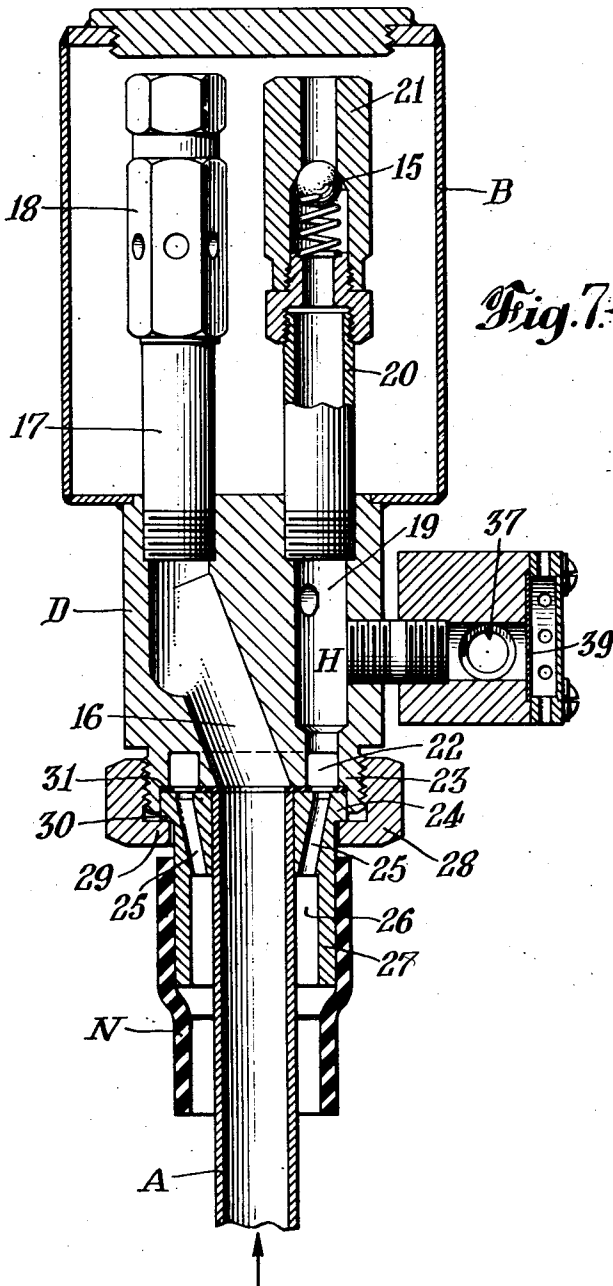
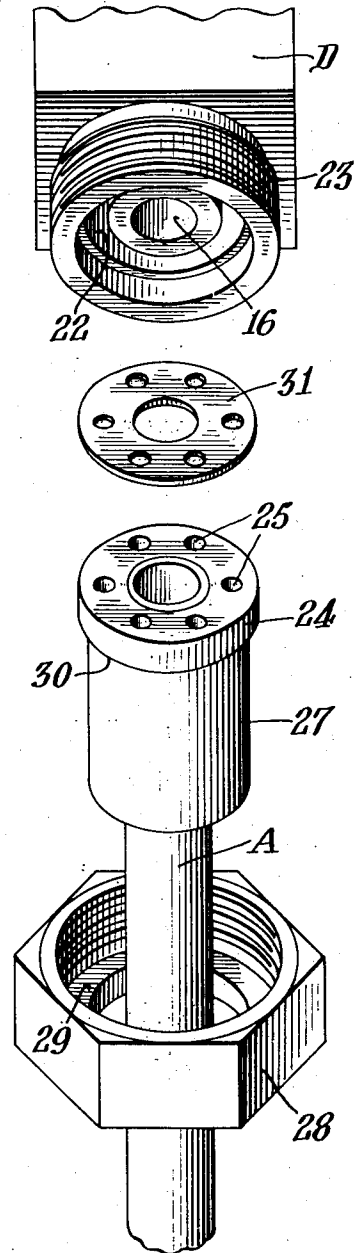


Fig. 7.



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UNITED STATES PATENT OFFICE

2,580,649

LIQUEFIED GAS DISCHARGE PUMP

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Carbon Corporation, a corporation of New York

Application January 8, 1948, Serial No. 1,095

17 Claims. (Cl. 62—1)

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This invention relates to a process and apparatus for causing vaporizable liquid to be forced out of a container in which it is stored and transported. An object of this invention is to provide a simple and inexpensive device adapted for this purpose so that it will not be necessary to lift or tilt a heavy container. Another object is to provide a process and apparatus of the sort mentioned in which there will be no danger of oil or moisture contaminating the liquid or gas when the same is oxygen. Still another object is to accomplish the intended purpose of pumping cold vaporizable liquid out through the top of a container without having to turn the same upside down and without having to use a pump having moving parts, the same being accomplished here by using pressure generated by vaporizing a small portion of the cold liquid.

Heretofore no satisfactory process or apparatus has existed for emptying a container of the type in which a liquefied gas such as nitrogen, oxygen, air or other vaporizable liquid is contained. It has been suggested that compressed air be supplied to the upper part of the liquid container to force out the contents. One difficulty is that the available compressed air is not usually dry enough with the result that moisture may freeze in the air inlet of the container forming enough ice to interfere with the supply of air pressure and discharge of liquid. Should any moisture get into the gas it may be objectionable because for example oxygen for breathing is required to be relatively dry. Another objection to the use of compressed air with liquid oxygen is the danger of a little oil being carried along with the compressed air when an explosion might occur due to the presence of oil with liquid oxygen.

Suggestions have been made for the vaporization of enough liquid to create pressure sufficient to force all of the liquid out of the container. One such suggestion contemplated the removal of some of the liquid by gravity to a vaporizer for generation of vapor pressure to drive out the main portion of liquid. This idea is not feasible here because the liquid containers are too heavy and cumbersome to lift or turn upside down. Another suggestion also impractical here requires suitable suction means for getting an initial amount of liquid out through the top of a container and into a vaporizer where heat is applied from a steam pipe.

According to the present invention neither gravity nor suction is necessary to eject an initial portion of liquid from an upright container and pass the same into a vaporizer. It has been

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found practicable to generate enough vapor pressure in the container by utilizing the residual heat in a metal ejection pipe inserted into the liquid in the container, to initially force enough liquid out of the container into a vaporizer to start vaporization of a small portion of liquid by heat derived from the atmosphere. Vapor so produced is returned to the vapor space in the container to provide the necessary vapor pressure for the ejection of all the liquid from the container. The vaporizer is preferably mounted on the ejection pipe and on top of the liquid container, and is always exposed to the ambient atmosphere. To insure liquid flow being initiated and maintained a check valve is provided to prevent pressure in the vaporizer from being exerted on liquid surface, thereby preventing flow of liquid down the ejection pipe. To guard against loss of vapor pressure in the container when venting or priming the vaporizer chamber, a check valve is located in the vapor return connection between vaporizer and container. A three-way valve is provided for priming the vaporizer by leading out gas from it to allow liquid to rise easier into it. In normal discharge position (operation) of this three-way valve, the heat of the atmosphere maintains enough vaporization and vapor pressure in the vaporizer and the vapor space in the container to continue the flow of liquid out through the top of the container and past the vaporizer to the place where liquid is to be utilized. At the end of the liquid discharge operation before disconnection of the vaporizer a manually operable pressure relief valve reduces any gas pressure in the container.

Referring to the drawings:

Fig. 1 is a perspective view showing a preferred embodiment of this invention;

Fig. 2 is a line diagram of the apparatus shown in Fig. 1;

Fig. 3 illustrates the three positions of the three-way valve shown in Fig. 2;

Fig. 4 is a vertical longitudinal section through a pump embodying this invention;

Fig. 5 is a top plan view of the pump as shown in Fig. 4;

Fig. 6 is an enlarged section on the line 6—6 of Fig. 5;

Fig. 7 is an exploded view, partially in perspective, of parts of the ejection tube and its supporting block, showing the liquid and gas passages therein and the means for connecting them.

An improved pump embodying this invention and as diagrammatically illustrated in Fig. 2

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includes a liquid ejection tube A, a liquid vaporizer B, and a three-way valve C, all desirably secured to a coupling block D shown in Figs. 4 and 6. The tube A is constructed so that one end thereof may be inserted through the mouth E of a liquefied gas container F into the body G of liquefied gas therein, and the other end of tube A communicates through passages in the block D with both the vaporizer B and the valve C. The vaporizer B communicates through a tube or passage H to the mouth E with the vapor space I above the liquid G. The tube A and the vaporizer B also are connected through pipes or conduits J and K respectively with the valve C. As also shown in Fig. 1, the liquid discharge port of the valve C is connected by a conduit L to the inlet of a tank or apparatus M in which the discharged liquefied gas is to be stored or used. The pump is gas-tightly secured to the container F by a rubber connection or stopper N through which both of the tubes A and H extend.

The container F is of the ordinary portable type customarily used in transporting liquefied gases such as nitrogen, oxygen, air, etc., the same being thermally insulated according to custom. Such portable containers vary in size from about 5 liter capacity to a 100 liter size. The difficulty of turning these containers upside down for gravity discharge of the liquid therein will be appreciated when it is said the weight of the 100 liter container when filled is about 400 pounds. As shown in Fig. 1 the usual cap 10 for such a container is removed before the pump of this invention having no moving parts is put into position preferably on top of the container. From Fig. 2 is may be seen the usual container F is provided with suitable insulation 11 or the space between the container F and wall 13 may be evacuated. Within the insulation are spaced inner and outer walls 12 and 13 respectively, the liquefied gas G being contained within the inner receptacle as illustrated.

When the improved pump is mounted in operating position on the container F, the ejection tube A of brass or other metal or other heat absorbing material extends from the vaporizing chamber B down into the liquid G to adjacent the bottom thereof. After the tube A has stood in the air and been brought to atmospheric temperature it will have enough residual heat contained within it so that when this tube A is thrust into the liquid enough of the cold liquid will be vaporized into the vapor space I above the liquid to force an initial portion of the liquid up through the tube A into a vaporizing chamber B. A brass tube A for a 100 liter size container F has a heat content of approximately 350 B. t. u. imparted to liquid nitrogen at -320° F. which is capable of forming about 15 cubic feet of vapor at atmospheric pressure and at -320° F. The tube A for the 25 to 50 liter size container gives up around 75 B. t. u. on immersion in liquid nitrogen and dropping from room temperature. This quantity of heat generates about 3 cubic feet of nitrogen vapor at atmospheric pressure. Since the pressure generated in the container F is above that of the atmosphere somewhat less vapor is formed than is possible at atmospheric pressure. After being at room temperature again for 10 or 15 minutes the tube A absorbs enough heat to initiate vaporization in another container F.

The vaporizing chamber B is constructed of copper or brass about $\frac{1}{8}$ " thick so that heat of the atmosphere will progressively vaporize enough

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liquid in the chamber B to maintain sufficient pressure in the container to force the entire liquid contents out of the container. The vaporizing chamber B in the embodiment illustrated in Figs. 4 to 6 has a capacity of about 13.3 cubic inches. Where greater heat transmission and rate of vaporization is needed the walls of this chamber may have heat conductive fins not shown. During its passage out of the container F through the top thereof the rest of the cold liquid being discharged rises to adjacent the chamber B but bypasses the same and is forced out through the valve C and the flexible conduit L to a tank or apparatus M in which the liquefied gas is intended for use.

As shown in Figs. 2 and 4 a ball check valve 14 is provided to prevent the pressure established in chamber B by virtue of vaporization of a portion of the liquid, from exerting a force on the liquid in the container F through tube A. In other words, if the check valve were not provided, the pressure in chamber B and in the gas phase of the container F would be equal, and hence liquid flow could not be initiated, or maintained. The three-way valve C is located at the junction of the pipe K leading from the upper portion of the chamber B to the liquid discharge tube L. As shown in Figs. 2 and 6 another ball check valve 15 is located in the vapor line H to prevent loss of pressure in the gas phase of container F when the valve C is moved to Prime position for refilling chamber B during a liquid transfer operation. If the pressure in the gas phase were lost, then there would be no way of obtaining liquid in the chamber B, because during a transfer operation, the liquid ejection tube would be already at the temperature of the liquid, and could provide no heat for vaporization. The check valves 14 and 15 require only a few ounces of pressure to operate.

In the unitary pump illustrated in Figs. 1 and 4-6, the vaporizer B preferably is permanently secured in thermally conductive relation to the top of the coupling block D which desirably is polygonal and made of copper or brass; the ejection tube A and elements constituting the lower vapor return passages H are detachably secured to the bottom of the block D; and the three-way valve C is detachably secured to one side of the block D.

The block D has a passage 16 extending there-through to provide communication between the upper end of the ejection tube A and a nipple 17 secured to the block D at the exit end of the passage 16. The nipple 17 extends into the vaporizer B and carries the check valve 14 which is located in a perforate housing 18 mounted on the nipple 17. The block D has another passage 19 extending there-through to provide communication between a nipple 20 secured to the block D at the entrance of the passage 19 and extending into the vaporizer B to support the housing 21 of the check valve 15. At its lower end the passage 19 opens into an annular recess 22 which is concentric with the entrance end of passage 16 and is encircled by an externally threaded flange 23 integral with the block D. This block D carries a pressure relief valve or bursting disc 39.

A vapor return connector 24 of thermally conductive metal is internally gas-tightly secured to the outside of the upper end of the ejection tube A, with the upper ends of the connector 24 and tube A disposed in the same plane. A plurality of passages 25 extend from the upper end

of the connector 24 into an annular chamber 26 formed between the tube A and an annular skirt portion 27 of the connector 24. This ejection tube A and connector unit 24 are detachably secured to the block D by an internally threaded nut 28 of thermally conductive metal secured to the flange 23 and by an inturned flange 29 which engages an external shoulder 30 on the connector 24, thereby establishing communication between the tube A and passage 16, and also between passages 25 and the annular recess 22 which is connected to passage 19. A suitable gasket 31 desirably is clamped between the block D and the ejector tube and connector unit to prevent leakage of liquid and vapor.

A thick rubber tube N is adapted to be fitted around the mouth E at the neck of the container F and when suitably thick is capable of supporting the entire pump on top of the container outlet as shown in Figs. 2 and 6. This rubber tube N while stiff enough to support the connector 24, block D, and its connections should also be flexible enough to enable this pump apparatus to be attached to and removed from containers F by an operator without difficulty.

Leading off from the passage 16 is another passage J in the block D through which the main body of liquid from the container F passes without it entering the vaporizing chamber B on its way to the apparatus M. Welded or otherwise secured in passage J and to the block D is the fitting 33 to which the three-way valve C is secured. On the opposite side of the valve C is a nipple 34 to which a nut 35 secures the conduit L. Welded into the upper end of the vaporizing chamber B is a conduit K having its lower end threaded into the top of the valve C.

In operation after the pump has been placed on a liquid container filled with liquid nitrogen or other liquefied gas, the residual heat in the tube A vaporizes enough liquid to increase the vapor pressure in the vapor space I above the liquid level in the container F to force liquid G from the container F up the tube A into the vaporizing chamber B. Vapor pressure in this chamber B is maintained by the heat of the atmosphere penetrating the thermally conductive metal walls of the chamber B and vaporizing some of the liquid therein. To provide additional vapor pressure in the container F after the heat of the tube A has been largely absorbed, the vapor pressure in chamber B is transmitted to the vapor space I in container F through the tube H and vaporization in chamber B though at a slow rate is sufficient to maintain enough vapor pressure in the space I to force out substantially the entire body of liquid in the container F through the conduits J and L to the apparatus M in a continually flowing stream. Or of course the liquid in the container F may be pumped out intermittently instead of uninterruptedly if desired. As the initial body of liquid in chamber B is consumed more liquid may be needed. Since the vapor pressures in the chamber B and container F are equalized, no additional liquid automatically flows into chamber B. To raise the liquid level in chamber B the handle 41 of the three-way valve C is moved to the priming position shown for it in Fig. 4. As shown by the upper portion of Fig. 3, this connects conduit K leading from the upper portion of chamber B to the conduit L leading to the apparatus and causes vapor pressure in chamber B to fall gradually. The check valve 15 prevents vapor flowing from space I into chamber B with the result that pressure

in space I forces liquid up the tube A raising the liquid level in chamber B. The increased level of liquid in chamber B may be determined roughly by approximating the time during which the valve C is allowed to remain in the "Prime" position, by estimating the liquid flow to the apparatus M, or in any other desired manner.

After the level of liquid in chamber B has risen to the desired amount valve C is moved 90° clockwise as shown in Fig. 4 to the "Fill" position. The valve C remains in this position as long as the pump needs to force liquid into the apparatus M.

To shut off the liquid flow to apparatus M the valve C is moved to the "Shut-off" position 90° further in a clockwise direction from the "Fill" position as shown in Fig. 4. As illustrated in Fig. 3, this connects conduits J and K. The pull ring 38 is moved out or to the left in Fig. 4, venting pressure in the space I and in chamber B as valve 15 allows any higher vapor pressure in chamber B to flow into space I. Low vapor pressure in both chamber B and space I causes any small amount of liquid in the tube A and conduit J to flow back into the container. However, any liquid in chamber B does not flow back due to check valve 14 allowing liquid to flow only into and not out of chamber B. The pump is then removed from one nearly empty container F and put in place on a filled one. When the rubber connection has been put in place forming a gas tight connection then as vaporization occurs in chamber B, liquid rises due to vapor pressure in the vapor space I of the new container rather than from the heat of the tube A. The valve C should be in a "Prime" position on the new filled container until pressure recorded by the gauge 40 is sufficient to begin the pumping operation and while the liquid level in chamber B is below the top of housing 21. If desired the tube A may be exposed to the atmosphere long enough to utilize its heat in initiating vaporization of a filled container F, or it might be placed over or in a heater to raise its temperature.

Although vaporization in the chamber B from heat of the atmosphere is slow, it is sufficient to sustain enough vapor pressure in container F for the discharge of liquid to be continuous until the container is empty. When the chamber B and tube are at room temperature, only a few seconds are needed to fill chamber B with liquid from the container. When the pump apparatus is placed on a new or filled container after emptying a former one, then when enough liquid is retained in the chamber B, a few minutes delay is needed to cause vaporization in chamber B to generate sufficient pressure for continuous discharge of liquid from the container F to empty it.

Among the advantages of this invention may be mentioned the provision of an inexpensive pump apparatus which is quickly and easily installed and removed from containers of liquefied gas of customary construction. The tube by which heat is supplied to the liquid and by which liquid is removed from the containers are one and the same. After the initial discharge of liquid due to the residual heat in the tube A, further pumping of liquid continues due to the supply of heat from the atmosphere through the thermally conductive walls to the chamber B causing vaporization of liquid and transfer of vapor pressure into the container F. After starting the ejection of liquid from the container by the residual heat of the tube A the gentle sup-

ply of heat needed to maintain the vapor pressure required in the top of the container F is preferably obtained in the simplest and least expensive manner from the atmosphere although of course should more heat be desired at any time a small additional heat supply such as the heat of a lamp or candle may be applied to the vaporizer. Pressure relief from the container and chamber is either automatic or manual by means of the relief valve 37. Movement of the three-way valve C to its priming position at any time enables liquid to rise in the chamber B. A noteworthy advantage of the present invention is the simple and inexpensive elimination of the hazard and disadvantages of oil or moisture in compressed air when using the latter to discharge liquid. This pump apparatus may be left on a container F overnight or over a weekend. When no liquid is being consumed there need be no similar vaporization of liquid in chamber B compared to what takes place during use. At night the pump may be kept in place due to the fact that on completion of vaporization in chamber B the only subsequent vaporization is that in container F due to heat transmission through the liquid ejection tube A. In operation or during the day, the flow of liquid from container F is due to the pressure head in the gas phase, which pressure can be regulated by adjusting the pressure relief valve 37 within safe limits. At a setting of 7 pounds per square inch maximum pressure this apparatus pumps liquid at a rate of 1.5 gallons per minute.

A shut-off valve in the vapor line H would be useful in holding vapor pressure in the vaporizing chamber when the pump is transferred to another container, although it would necessarily detract from the appearance. In its form illustrated the pump can be moved from one container to another with a full chamber of liquid nitrogen, which because of the ratio of expansion between liquid and vapor, will provide more pressure for the second container. For example, a full chamber of liquid is capable of producing approximately 450 times as much vapor, compared to a full chamber of vapor at 7 pounds per square inch.

I claim:

1. Apparatus for pumping vaporizable liquid from a container under vapor pressure which comprises a liquid ejection tube of thermally conductive metal adapted to extend into said container, a gas tight connection through which said tube is adapted to enter the top of said container, a closed chamber of thermally conductive metal exposed to the atmosphere outside said container and to which said tube is connected for the discharge of liquid from the container into said chamber, a vapor passage from an upper portion of said chamber and adapted to enter said container through said gas tight connection, a conduit from said tube through which said liquid is adapted to pass from said container to its place of use, and a check valve located in said tube between its discharge into said chamber and the connection of said conduit and tube, whereby liquid may flow from the container into said chamber but not from the chamber into the container or to its place of use.

2. Apparatus according to claim 1 in which a check valve is located in said vapor passage to pass vapor in only the one direction from the chamber into said container.

3. Apparatus according to claim 1 in which a

pressure relief valve is located in said vapor passage to prevent excessive vapor pressure in said chamber and in said container.

4. Apparatus for pumping vaporizable liquid from a container under vapor pressure which comprises a liquid ejection tube of thermally conductive metal adapted to extend into said container, a gas-tight connection through which said tube is adapted to enter the top of said container, a closed chamber of thermally conductive metal exposed to the atmosphere outside said container and to which said tube is connected for the discharge of liquid from the container into said chamber, a vapor passage from an upper portion of said chamber and adapted to enter said container through said gas-tight connection, a conduit through which said liquid is adapted to pass from said container to its place of use, the heat in said ejection tube being at room temperature, the volume of said container when filled with liquid oxygen, liquid nitrogen, or liquid air, the volume of container vapor space, and the height to which the liquid from said container must be raised in reaching said closed chamber being so proportioned that heat from said ejection tube is adapted to vaporize some liquid in the container and raise the vapor pressure in the container to force liquid into said closed chamber for starting vaporization therein from the heat of the atmosphere, valve means for opening and closing said conduit to the movement of liquid therethrough, and a second conduit between said chamber and valve means whereby said valve means is operable to vent vapor therethrough from said chamber.

5. An apparatus for pumping vaporizable liquid from a container under vapor pressure without danger of ice formation from moisture in the vapor under pressure which comprises, a liquid ejection tube of thermally conductive material adapted to extend through the top of and into said container to adjacent the bottom thereof, a closed chamber of thermally conductive metal outside said container connected to said tube, a vapor passage from an upper portion of said chamber adapted to extend into said container, a vapor-tight connection for said tube and passage where they are adapted to enter the top of said container, and a conduit from said tube through which a liquid from said container is adapted to pass to its place of use, said vapor passage and tube being substantially concentric where they are adapted to pass into the container, a check valve in the liquid line from the container to said chamber, a check valve in said vapor passage from the chamber to said container, and a relief valve connected to said gas passage whereby vapor pressure in the container may be vented before removal of the tube from the container.

6. Apparatus for pumping a vaporizable liquid out the top of a thermally insulated container which comprises a liquid ejection tube adapted to extend adjacent the bottom of the container, a vaporizing chamber connected to said tube, a liquid discharge passage leading from said tube, a vapor passage extending from an upper portion of said chamber and adapted to enter said container, a conduit leading from the upper end portion of said chamber to said liquid discharge passage adjacent the chamber, and a three-way valve at the junction of said chamber tube and liquid discharge passage adapted in one position to vent vapor from the upper portion of said chamber out the discharge passage, in another position to connect said liquid ejection tube with said discharge passage and in still another position to

connect said chamber conduit and liquid ejection tube.

7. Apparatus for pumping a vaporizable liquid out the top of a thermally insulated container which comprises a liquid ejection tube adapted to extend adjacent the bottom of the container, a vaporizing chamber connected to said tube, a liquid discharge passage leading from said tube, a vapor passage extending from an upper portion of said chamber and adapted to enter said container, a pressure relief valve in said vapor passage, a chamber tube leading from the upper end portion of said chamber to said liquid discharge passage adjacent the chamber, a three-way valve at the junction of said chamber tube and liquid discharge passage adapted in one position to vent vapor from the upper portion of said chamber out the discharge passage, in another position to connect said liquid ejection tube with said discharge passage, and in still another position to connect said chamber tube and liquid ejection tube, a check valve in the liquid ejection tube within the vaporizing chamber, and a second check valve in said vapor passage and in said chamber.

8. Apparatus for pumping a vaporizable liquid out the top of a thermally insulated container which comprises a liquid ejection tube adapted to extend adjacent the bottom of the container, a vaporizing chamber connected to said tube, a liquid discharge passage leading from said tube, a vapor passage extending from an upper portion of said chamber and adapted to enter said container, a pressure relief valve in said vapor passage, a chamber tube leading from the upper end portion of said chamber to said liquid discharge passage adjacent the chamber, a three-way valve at the junction of said chamber tube and liquid discharge passage adapted in one position to vent vapor from the upper portion of said chamber out the discharge passage, in another position to connect said liquid ejection tube with said discharge passage, and in still another position to connect said chamber tube and liquid ejection tube, and a spring responsive and manually operable pressure relief valve in said vapor passage between said chamber and container.

9. Apparatus for pumping a vaporizable liquid from a thermally insulated container through an opening in the upper portion thereof without having to tilt or invert the container, said apparatus comprising a liquid ejection tube adapted to extend into said container through said opening, a vaporizing chamber to which said tube is connected outside said container for receiving heat from the atmosphere and vaporizing a portion of said liquid received therein, a check valve in said tube allowing movement of the liquid from said container but not from the chamber to said container, a vapor passage from an upper portion of said chamber to an upper portion of the container, a gas tight connection where said tube and passage enter said container, a check valve in said passage allowing movement of vapor from said chamber to the container but not from the container to the chamber, means for venting vapor pressure from the container, means for venting vapor pressure from said chamber and a conduit from said tube between said chamber and container, leading to the place where said liquid is desired.

10. Apparatus for extracting a liquefied gas from a thermally insulated container under vapor pressure, which comprises a liquid ejection tube of thermally conductive metal adapted to extend

into a container having a reduced neck through the top thereof to adjacent the bottom of the container, means for effecting a gas-tight connection around the top of such a container and through which said ejection tube extends, a closed chamber of thermally conductive metal directly connected to the upper end of said ejection tube and exposed to the atmosphere on the sides of said chamber for absorption of heat from the atmosphere for vaporizing liquid within said chamber, a check valve in said ejection tube allowing liquid to be discharged into said chamber from a container but allowing neither pressure nor liquid to be discharged from said chamber into said container, a pressure discharge pipe extending from an upper portion of said chamber through said means for projecting into an upper portion of a container and a check valve in said pressure discharge pipe allowing pressure above a predetermined amount in said chamber to be transmitted into a container but not from said container into said chamber.

11. A method of pumping liquefied gas from a thermally insulated container without having to lift or tilt the container and without having to have a pump with moving parts, said method comprising initiating vaporization of some of the liquid by the residual heat in a thermally conductive metal liquid ejection tube, ejecting liquid by pressure of the portions of the liquid vaporized by the heat of said ejection tube, vaporizing outside of the container a portion of the ejected liquid by means of the heat of the atmosphere, transferring vapor pressure of the portion vaporized by heat of the atmosphere to said container, and ejecting liquid from the container through said ejection tube and out a discharge tube under pressure generated by the heat of the atmosphere vaporizing a small portion of the liquid.

12. In an apparatus for pumping vaporizable liquid from a thermally insulated container, said apparatus including an ejection tube, a gas-tight connection through which said tube extends whereby liquid is raised out of the container, a vaporizing chamber connected to said tube and in which a portion of the vaporizable liquid is heated, and a vapor return passage from said chamber through said gas-tight connection to the container, the combination therewith of the improvement for simplifying said apparatus, said improvement including said ejection tube being of at least as highly heat conductive material as is brass and having a heat content of at least about 350 B. t. u. when at the temperature of the atmosphere for a 100 liter size container and about 75 B. t. u. for a 25 to 50 liter container, whereby the heat of said tube is adequate to vaporize some of the container liquid and create a vapor pressure to raise some of the liquid out of the container through said tube and into said chamber.

13. An apparatus according to claim 12 in which said vaporizing chamber is of a heat conductive material at least substantially as high as that of brass whereby heat of the atmosphere vaporizes liquid in said chamber to maintain pressure in the container for forcing out the liquid from said container, and a conduit for discharge of liquid from the container by-passing said chamber.

14. In an apparatus for pumping vaporizable liquid from a thermally insulated container, said apparatus including an ejection tube, a gas-tight connection through which said tube extends whereby liquid is raised out of the container,

a vaporizing chamber in which a portion of the vaporizable liquid is heated, and a vapor return passage from said chamber to said container, the combination therewith of the improvement for simplifying said apparatus, said improvement including said ejection tube being of heat conductive material to initiate vaporization of some of the container liquid and create pressure to force liquid into said chamber, said chamber being also of heat conductive material to utilize heat of the atmosphere and vaporize some of said liquid to maintain vapor pressure in the container for forcing all of said liquid out of the container, valve means in said tube responsive to high pressure in said chamber to prevent vapor pressure in said chamber forcing liquid in said tube back into the container, valve means in said vapor return passage responsive to high pressure in said container to prevent higher pressure in the container moving vapor into said chamber when at a lower pressure, and valve means for by-passing both of said previously mentioned valve means.

15. A light weight portable liquid pumping unit for mounting on and to be carried by and above an insulated container of liquefied gas, said unit comprising a gas-tight connection for attachment to the mouth of said container, a thermally conductive ejection tube passing through said connection whereby heat of said tube may initiate vaporization of liquid in said container, a thermally conductive vaporizing chamber surmounting said tube for receiving liquid initially forced out of said container by vapor pressure generated from the heat of said tube, and for vaporizing liquid in said chamber by the heat of the atmosphere, a vapor return passage from said chamber passing through said connection to extend into said container, and a liquid discharge conduit extending from said unit between said connection and said chamber.

16. A pumping unit according to claim 15 in which said connection includes an elastic sleeve through which said tube and passage are concentric, a valve being located in said discharge conduit at one side of said unit, a pipe connecting said valve and chamber, said valve having at least three positions, in one of which said discharge conduit beyond said valve is connected

with said pipe for priming said chamber, in another position of said valve the discharge conduit each side of the valve is connected, and in still another position of said valve said pipe is connected with the conduit leading to said unit, said conduit leading from said tube, a check valve in said tube between said conduit and chamber for preventing pressure in the chamber forcing liquid in said tube back into said container, and a check valve in the vapor return passage for preventing higher pressure in the container being transferred to said chamber.

17. A process of pumping a liquid having a vaporizing temperature adjacent that of liquid oxygen from a container without having to tilt or invert such container which comprises inserting an ejection tube of heat conductive material at a temperature well above that of the liquid into the liquid, transferring heat of said tube to said liquid to vaporize some of the liquid, creating a vapor pressure in the container from such heat transfer, forcing some of the liquid out of the container through said tube by said vapor pressure into a vaporizing chamber, absorbing heat of the atmosphere by heat conductive walls of said chamber, vaporizing some of the liquid in said chamber principally by the absorbed heat of the atmosphere, raising the vapor pressure in said chamber by the vaporization of liquid therein, transferring vapor pressure created in said chamber to said container for forcing liquid out of the container, and discharging liquid from the container by said transferred vapor pressure, a substantial portion of the liquid so discharged by-passing said vaporizing chamber in response to a higher pressure in said chamber than on said discharging liquid.

ROBERT EDWARD BLUDEAU.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,417,292	Andrews	May 23, 1922
1,459,158	Lisse	June 19, 1923
1,853,983	Leach	Apr. 12, 1932