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W. F. MESINGER

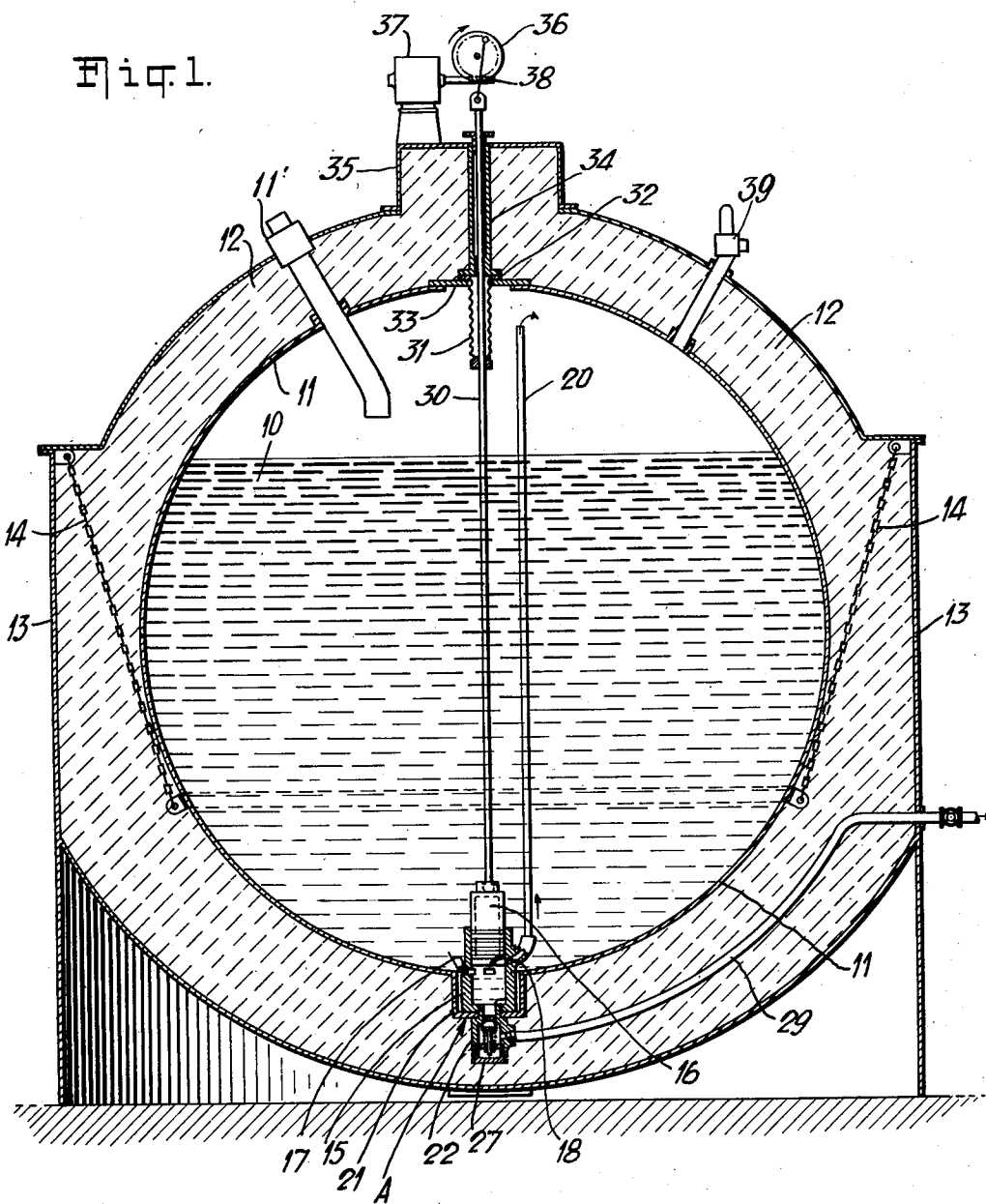
2,018,144

METHOD AND APPARATUS FOR TRANSFERRING GAS MATERIAL

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3 Sheets-Sheet 1

Fig. 1.



INVENTOR

William F. Mesinger

BY

Watson, Bristol, Johnson & Leavenworth

ATTORNEYS

Oct. 22, 1935.

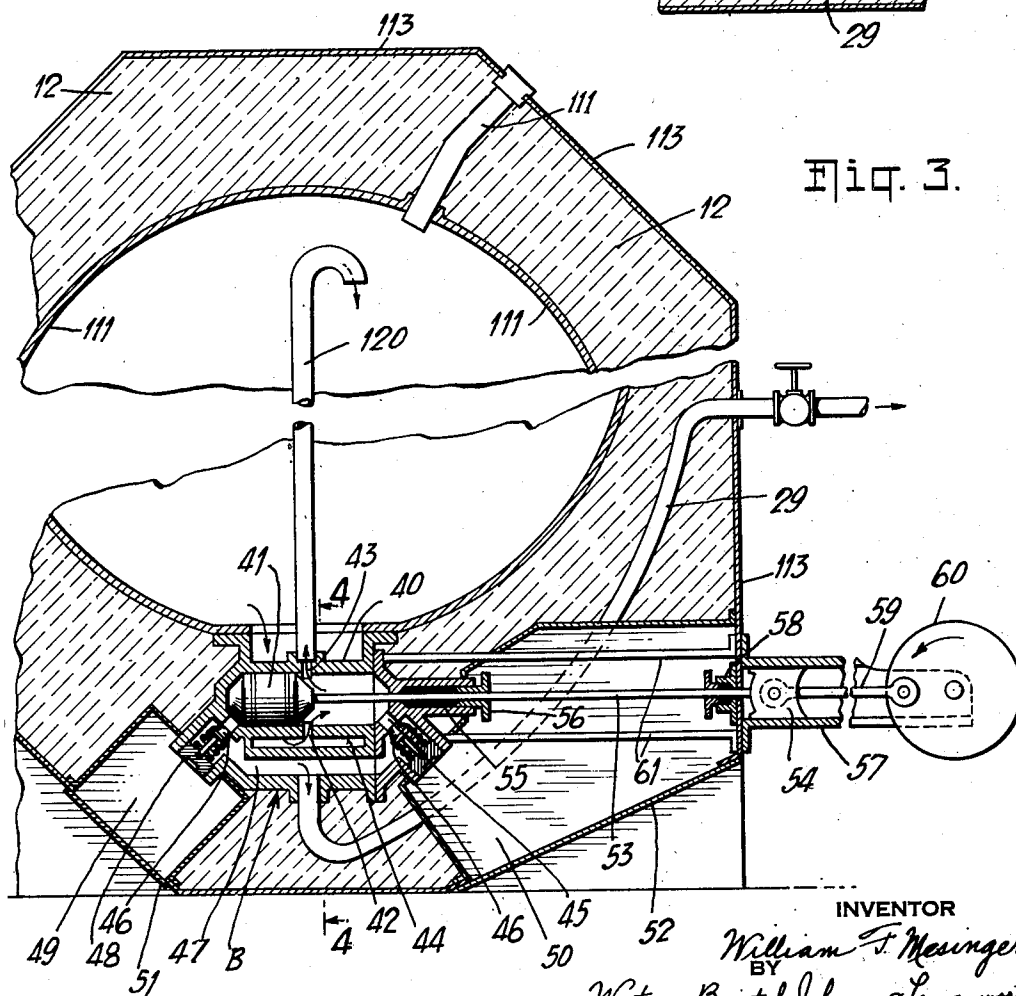
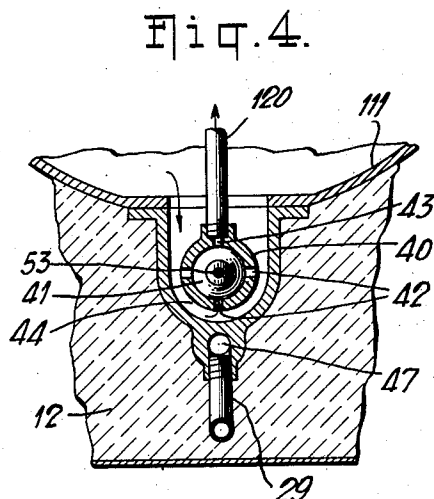
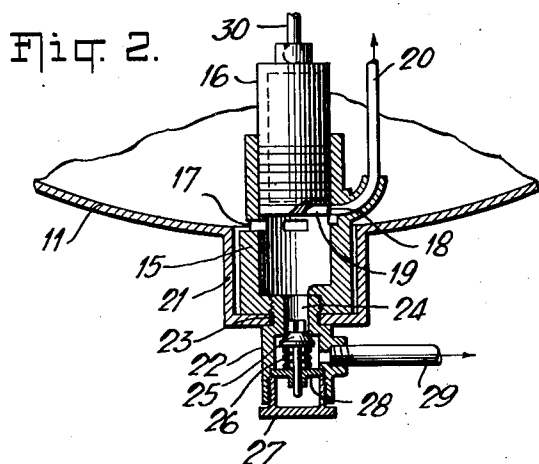
W. F. MESINGER

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3 Sheets-Sheet 2



INVENTOR

William F. Mesinger

BY

Watson, Bristol Johnson & Leavenworth

ATTORNEYS

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W. F. MESINGER

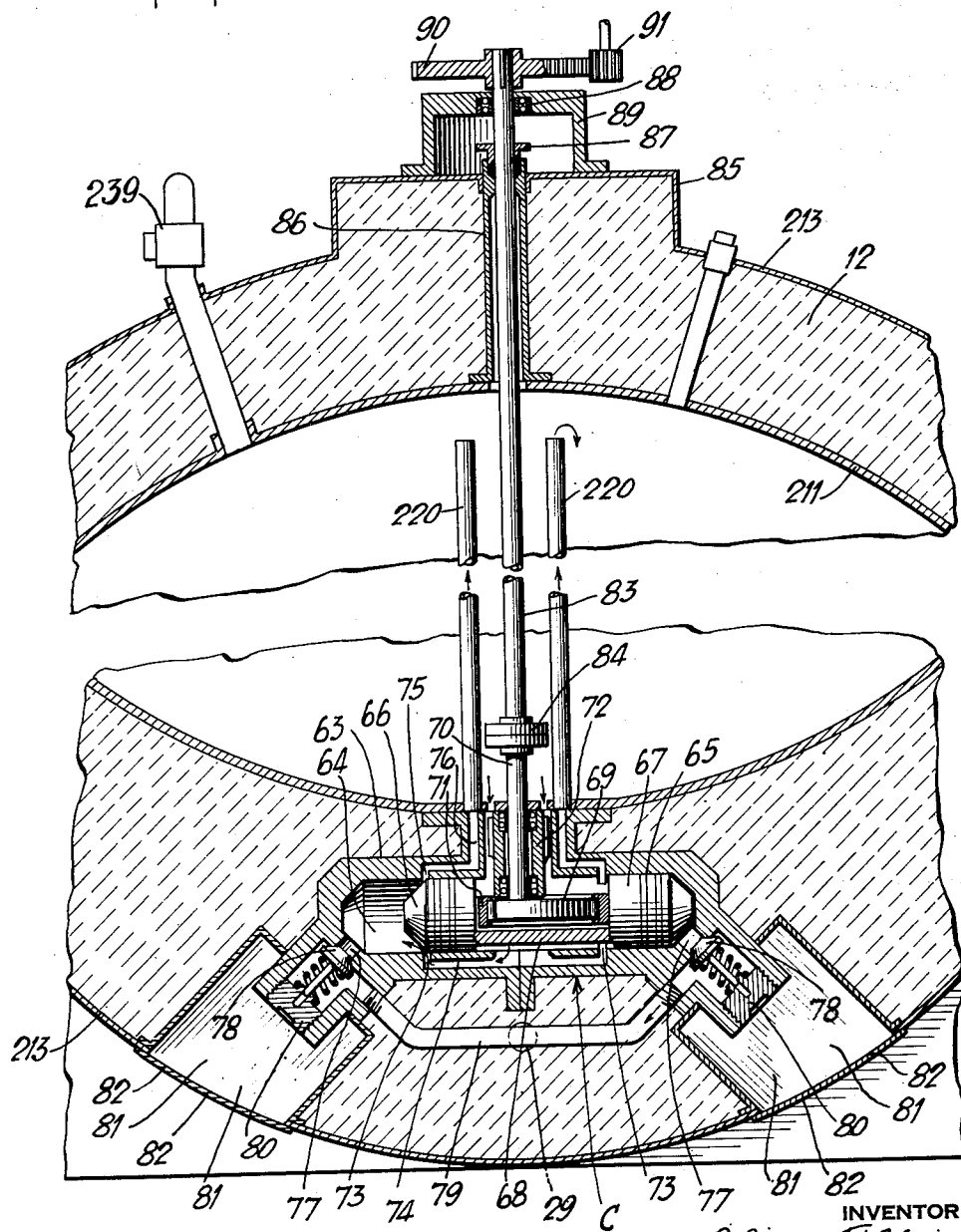
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3 Sheets-Sheet 3

Fig. 5.



INVENTOR-

William F. Mesinger
BY
Watson, Bristol, Johnson & Leavenworth
ATTORNEYS

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR TRANSFERRING GAS MATERIAL

William F. Mesinger, Flushing, N. Y., assignor to
The Linde Air Products Company, New York,
N. Y., a corporation of Ohio

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10 Claims. (Cl. 62—1)

This invention relates to a method and apparatus for transferring gas material, particularly gas material in the liquid phase which can be stored under atmospheric pressure only when the temperature is below 273° K.

The invention has for its principal object to provide an improved method and apparatus for transferring gas material of the character indicated from containers in which it is held to devices or vessels adapted for receiving the same at a relatively high pressure.

More particularly, it is an object to provide a method and suitable apparatus by which a liquefied gas may be transferred by means of a force applying device such as a pump, from a container in which the liquid has been stored or transported at a relatively low pressure, to a device adapted to cause vaporization of the liquefied gas at a relatively high pressure.

Another object is to provide improved apparatus for pumping liquefied gases in liquid phase of a character which avoids having the pumping means become gas bound and which provides for the reduction in number of the moving parts and for their lubrication.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the application of which 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 mainly in section showing an apparatus for holding a liquefied gas and for forcing it in the liquid phase to receiving means in accordance with the invention;

Fig. 2 is an enlarged fragmentary view mainly in section of a portion of the apparatus shown by Fig. 1 including the forcing means;

Fig. 3 is a view mainly in section with portions broken away of a modified form of apparatus constructed in accordance with the invention;

Fig. 4 is a view of a section taken on the line 4—4 of Fig. 3 through a portion of the apparatus; and

Fig. 5 is a view mainly in section with portions

broken away of another modification of apparatus constructed in accordance with the invention.

Heretofore, when it was desired to transfer liquefied gas from storage containers to receiving devices operating at a relatively high pressure, it was necessary to raise the pressure in the storage container to a value sufficiently higher than the pressure in the receiver to cause the flow to occur. To withstand this pressure, it was necessary to provide a storage container having very strong and thick walls, so that its cost and weight were great. Attempts to pump the liquefied gas from a low pressure container with pumps of the type commonly used for pumping liquids were not successful because of the tendency of the liquefied gas to flash into vapor in the pump casing whereby it became "gas bound".

By the method and with the apparatus of the present invention, a liquefied gas may be transported in a container at substantially atmospheric pressure and forced into vaporizing and receiving devices at the destination without incurring the disadvantages attending such prior methods. This is accomplished by providing the forcing device in the base of the storage and transport container, or in a container associated with the transport container, maintaining its walls at substantially the temperature of the liquefied gas, and effecting the venting of the vapors from the forcing chamber when it fills with a charge of liquefied gas in a manner to expedite the transfer.

Referring now to the drawings and particularly to Fig. 1, there is shown a body of liquefied gas 10 held within a container 11, which is surrounded by an envelope of heat insulating material 12. To support the insulating material and to furnish means by which the container 11 is supported within the insulating envelope with a desired degree of rigidity, there is provided an outer casing 13, preferably of metal and supports 14 attached at one end to the container and at the other to the casing. This container may be mounted upon a vehicle so that the liquefied gas material may be transported to a place where a desired portion is to be discharged to a receiving device, or it may be mounted as a stationary storage container for storing the liquefied gas during periods when no liquid is being discharged. Means for filling the container comprises a normally plugged filling connection 11' leading to the interior. Means for discharging material in the gas phase, draining off liquid,

and for indicating the quantity of liquid therein are provided but not shown in the interests of clearness of illustration.

Mounted in the base of container 11 is a liquid forcing means comprising a pump housing 15 within which a reciprocating fluid displacing element 16, here shown in the form of a fitted piston, is arranged to move. The housing 15 is provided with means for admitting liquid and for venting vapor which comprise, in this form of apparatus, inlet ports 17 uncovered by the piston 16 upon its up stroke and one or more vapor outlet ports 18 also uncovered by the piston when the inlet ports are uncovered. The relation of these parts is more clearly shown in the enlarged view of Fig. 2. The piston is shown in an extreme upper position and is provided with a recessed portion 19 registering with port 18 so that, in the position shown, liquid will freely enter the housing while vapors displaced are vented by way of port 18 and conducted by a conduit 20 to the vapor space above the body of liquid.

The housing 15 is preferably mounted in a sump or depression 21 provided in the lower portion of container 11. The housing is here shown to be held in a fluid-tight manner to the floor of sump 21 by means of the valve housing 22, which has a threaded neck 23 of reduced diameter passing through the floor of the sump and threadedly engaging an opening in the base of the pump housing. The valve housing is provided with a passage 24 controlled by a valve element 25 that is normally held closed by spring 26. A cap 27 seals the end opening of passage 24 and holds in place the spring retaining and valve stem guiding means 28. A conduit 29 opening into the side of the valve housing 22 is provided to conduct gas material discharged to the outside of casing 11. The casing 11 may be provided with a hand hole and cover at a point opposite the cap 27 to provide for ready access to the discharge valve.

The piston 16 is preferably made hollow, the outline of the interior space being indicated by dotted lines. A long vertical piston rod 30, joined to the top of piston 16 preferably by a ball and socket joint for permitting the piston to have a degree of freedom for self alignment while transmitting the reciprocating motion, traverses diametrically the container, passing through its upper portion where a gas-tight seal 31 is provided. The seal 31 comprises an accordion-like corrugated metal bellows joined in a gas-tight manner to the rod at one end and at the other to a flange 32 which is clamped between a perforated closure plate 33 and the lower portion of guide sleeve 34. The closure 33 serves to seal an opening in the container wall large enough for the passage of pump housing 15. Sleeve 34 is made long enough to pass through the insulation 12 to the outside of casing 13 at the upper portion where it is provided with a monitor top 35 for the purpose of increasing the insulation thickness at that point. The increased thickness is desired to provide a longer path for the conduction of heat from the atmosphere to the container along the path comprising the sleeve 34 and the rod 30, since these parts, while made of materials having relatively low conductivity, conduct heat more readily than the insulating material where the paths for the conduction of heat are equal in length.

The rod 30 may be constrained to assume the desired reciprocating motion by various means, for example, as shown diagrammatically herein, where the end of rod 30 is reciprocated by a connecting rod and crank disk assembly 36 that is

driven by an electric motor 37 through the medium of a worm and wheel type of speed reduction gear 38. At the outer end of sleeve 34 there is provided a packing gland for retaining a packing that excludes moisture laden air from the chamber within the bellows 31. A pressure release valve 39 is provided in communication with the container 11 for releasing excessive pressure.

In operation, the piston and housing 15, being submerged in the liquefied gas, are maintained at substantially the temperature of the fluid and their surfaces are lubricated by the liquid. When the piston reaches the highest point of its stroke, liquid runs in at ports 17 while displaced vapor fluids escape through port 18, passing up through conduit 20 to the vapor space above the liquid 10.

Since it is desirable to avoid heating the liquid, the vapors are not permitted to bubble through the liquid, but are conducted direct to the vapor space above the liquid where they produce a relatively more rapid increase in pressure above the liquid for the purpose of assisting the flow of liquid into the pump housing 15 through inlet ports 17. Thus, heat generated in the pump housing is transferred to the gas space above the liquid where it becomes useful to assist the pumping. As the piston descends, the ports are gradually closed by the piston and when they are closed, the liquid that has been trapped in the pump housing will be forced out through the valve housing 22 into conduit 29 which conducts the fluid to the receiving device at the desired high pressure. The liquid that is trapped in the clearance space of the pump at the end of the stroke is moderately heated by the work of compression and partly flashes into vapor upon the up-stroke; this vapor being released to the gas space when port 18 is again uncovered. When pumping against high pressures, it will be desirable to provide the long unsupported portion of rod 30 with bracket bearing means or with stiffening means such for example as tubular columnar construction. When the piston has reached the lower limit of its stroke, the valve element 25 will be returned to its seat so that back flow of fluid from conduit 29 into the housing during the upstroke of the piston is prevented. As the piston moves upward, part of the liquid which remained in the clearance space or passage 24 being moderately heated by the work of compression, will flash into vapor due to the reduction of pressure. This vapor subsequently escapes at port 18 when the piston has returned to its upper limit and is conducted to the gas space above the liquid.

When it is desired to pump certain liquefied gases, for example, those which possess relatively poor lubricating properties, it may be desirable to provide the fluid displacing means in the form of a plunger, in which case the liquid inlet and the vapor escape ports are preferably controlled by valve means mechanically operated.

A modified form of container having in its base a liquid forcing means according to the invention is shown in Fig. 3. Here, the filling connection is shown at 111' leading into the container 111, while the casing 113 is made to have a modified shape. The forcing means designated generally by B here comprises a horizontal double acting pump having a housing 40 within which a fitted piston 41 is disposed and arranged to be reciprocated. Ports 42 and 43 opening into the bore of the housing are located midway between the ends of the bore. The piston 41 is made of such length that it substantially fills the bore at one side of the ports when it is at that end of its stroke, 75

so that the ports are uncovered by the ends of the piston each time it reaches an end of its stroke. The ports 42 when uncovered permit the flow of liquid into the portion of housing 40 that is vacated by the piston, while the upper port 43, to which is connected a conduit 20 for leading gas material to the vapor space of the container, permits the displaced vapors to escape.

Around housing 40 is formed a passage 44 communicating at its top with the liquid space of the container 111. This passage is shown more clearly in the sectional view of Fig. 4. The liquefied gas thus surrounds the housing 40, maintaining its walls substantially at the liquid temperature and enters the ports 42. In each end or head of housing 40 there is a discharge passage 45 controlled by a spring closed valve 46. These valved passages discharge into a connecting passage 47 that leads gas material to a common discharge conduit 29 for conducting the gas material at higher pressure to the receiving device. Above the valves 46 are disposed removable closures 48 that permit ready inspection and adjustment of the valves. Access to these closures 48 is readily attained without removing the container 111 from its envelope by partitioning off compartments 49 and 50 which hold away the insulating material 12 and have covers 51 and 52. A piston rod 53 for transmitting the reciprocating motion of crosshead 54 to the piston is attached at one end to piston 41 and at the other to crosshead 45 and passes through one head of pump housing 40 through a packing box 55 containing a suitable packing which is compressed by gland 56. The crosshead 54 works between the guide members of a frame 57 that is mounted outside of the casing 113. At the point where rod 53 passes through the casing wall, there is provided a packing box 58 with packing to prevent access of untreated atmospheric air to the interior of the casing. The crosshead is reciprocated by means of the connecting rod 59 and crank disk 60, which is driven by any suitable power means such as an electric motor. Supporting struts 61 between the pump B and the frame 57 are provided for transmitting the thrust reaction of the piston to the crank disk bearings.

In the operation of this form of forcing means, the liquid fills one end, for example the crank end, of the pump housing through the uncovered ports when the piston is at the other end. When the piston returns, the ports are first closed off and then the liquid remaining in the crank end is forced out through the discharge passage to the receiving device. When the piston arrives at the crank end, the ports are again uncovered, but the gas material flows now into the vacant head end of the housing. All gas material that leaks by the piston is not lost, but flows into the opposite end of the housing.

In Fig. 5 is shown apparatus where another form of double acting liquid pump, indicated generally at C, is disposed in the base of a liquefied gas container 211 having an envelope of insulation 12 and casing 213. The pump housing 63 is provided with cylindrical bores 64 and 65 in each of which a head of the piston is adapted to operate. The piston comprises two head portions 66 and 67 connected by a portion 68 in a manner to allow an eccentric cam 69 to rotate between the rear faces of the heads. The cam 69 rotates about the centerline of shaft 70, to which it is attached by suitable means, as a key. To avoid rubbing friction, it is preferred to pro-

vide a roller bearing surrounding the cam having an outer ring 71. The cam 69 when rotated causes the piston to oscillate from side to side. The shaft 70 rotates in anti-friction bearings held in a hub 72 that is joined to the housing by supporting webs having passages for the flow of liquefied gas into the central portion of housing 63. The central chamber of housing 63 is formed with clearance pockets at each side to accommodate and provide clearance for the ring 71. Liquefied gas that flows into this chamber is conducted to separate inlet ports 73 for each end 63 and 65 of the housing by passages 74. These ports, as well as gas outlet ports 75, are so located that they are uncovered by the edge of the respective piston head when the piston is at an extreme limit of its travel. Vapors released at ports 75 are conducted by passages 76 to conduits 220 which conduct them to the vapor space above the liquid in the container 211. To better insure against heat transfer with the liquid, the conduits 220 may be disposed around the outside of container 211 to join same at its upper portion. Fluid is discharged from ends 64 and 65 through passages 77, which are normally closed by means of spring pressed valve elements 78. The fluid forced by the valve elements is conducted by a common connecting conduit 79 to the discharge conduit 29 leading to the outside of the casing. Access to the valve chambers for adjusting the valves is provided as in the previously described forms by removable closures 80, partitions 81, and closures 82.

Shaft 70 is driven by a vertical extension shaft 83, to which it is coupled by a flexible coupling 84. Shaft 83 passes to the outside of the casing, traversing the wall of the container, the envelope of insulation and the wall of the casing which is formed with a monitor top portion 85 for accommodating a greater thickness of insulating material 12 at this point. A tubular casing 86 for holding away insulation and for forming a gas-tight seal surrounds the portion of shaft 83 passing through the insulation space. Casing 86 is provided at its outer end with a packing and gland 87 for preventing the loss of gas material while allowing the shaft to rotate. The upper portion of shaft 83 is guided by bearing 88 held by a supporting bracket 89. The end of the shaft is keyed to a gear 90 that meshes with pinion 91 which is driven by any suitable power means, for example, an electric motor, or, when this container is mounted on a motor truck, the pinion may be driven from the truck engine through the medium of a power off-take and transmission device. This form of the apparatus has the advantage that the drive shaft does not reciprocate, and though double acting, the pump is driven from the low pressure side, that is, the drive shaft packing is subjected to relatively low pressures and may be located where it remains comparatively warm. The thrust reactions of forcing the liquid are counterbalanced within the pump itself. In cases where it is desired to transport the main body of liquefied gas at atmospheric pressure, it is desirable to construct the container of the present invention large enough to hold only the quantity of gas material to be pumped out at one locality and carry the main body of liquefied gas in a large transport container associated with the pumping container. The operation except for differences due to construction, is similar to that of the other forms.

Since certain changes in carrying out the above process and in the constructions set forth, 75

which embody the invention, may be made without departing from its scope, 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 method of transferring a liquefied gas, which can be stored under atmospheric pressure only when the temperature is below 273° K., by means of a pump having a fluid displacing element from a container adapted to be normally closed but open to the atmosphere during a filling operation to an external point, which method comprises positioning the pump so as to be subject to the temperature of the liquefied gas, excluding substantially all heat of external origin from the pump, and transferring heat or pumping generated by the pump by gas evolved therein to the upper part of the container where it assists in doing the work of transferring liquid, whereby the pump may be operated at a relatively high efficiency to force liquid to an external point against a relatively high head of pressure.
2. A method of transferring a liquefied gas, which can be stored under atmospheric pressure only when the temperature is below 273° K., by means of a pump having a reciprocating element clearing a space for the reception of a charge, from a container adapted to be normally closed but open to the atmosphere during a filling operation to an external point, which method comprises positioning the pump so as to be substantially at the temperature of the liquefied gas, excluding substantially all heat of external origin from the pump, venting the pump with the reception of each charge and transferring the gas together with any heat generated in the pump to the upper part of the container, whereby the pump operates without becoming gasbound at a relatively high efficiency to force liquid to an external point against a relatively high head of pressure.
3. A method of transferring a liquefied gas, which can be stored under atmospheric pressure only when the temperature is below 273° K., by means of a pump having a reciprocating element clearing a space for the reception of a charge, from a container adapted to be normally closed but open to the atmosphere during a filling operation to an external point, which method comprises positioning the pump so as to be substantially at the temperature of the liquefied gas, insulating said pump and container to exclude substantially all heat of external origin, venting the pump with the reception of each charge and transferring the gas together with the heat of pumping generated in the pump to the upper part of the container, whereby the pump may be operated without becoming gasbound at a relatively high efficiency to force liquid to said external point against a relatively high head of pressure.
4. Apparatus for transferring gas material in the liquid phase, which can be stored under atmospheric pressure only when the pressure is below 273° K., comprising, in combination, a heat insulated container adapted to hold the liquid to be stored, a pump casing disposed in said container and having an inlet communicating with the container at a point near the bottom thereof, a piston arranged to reciprocate in said casing and open said inlet when moved to a position such as to clear substantially a maximum space

for the reception of liquid from the container, a piston rod for said piston leading to a point on the exterior of said container, means for venting said pump casing leading from an opening therein substantially in the same plane as said inlet, mechanical means on the exterior of said casing for actuating said piston rod, a discharge connection leading from the bottom of said pump casing, and a normally closed discharge valve controlling the connection between said discharge and pump casing arranged to open under pressure.

5. Apparatus for transferring gas material in the liquid phase, which can be stored under atmospheric pressure only when the pressure is below 273° K., comprising, in combination, a heat insulated container adapted to hold the liquid to be stored, a pump casing having an inlet communicating with the container at a point near the bottom thereof, a piston arranged to reciprocate in said casing and open said inlet when moved to a position such as to clear substantially a maximum space for the reception of liquid from the container, a piston actuating means having a rod leading to a point on the exterior of said container, means for sealing said container at the point where said rod passes therethrough against the escape of gas, means for venting said pump casing leading from an opening uncovered by said piston at substantially the same instant said inlet is opened, said venting means leading to a point in the space in said container above the normal liquid level therein, mechanical means on the exterior of said casing for actuating said rod, a discharge connection leading from the bottom of said pump casing, and a normally closed valve controlling the connection between said pump casing and said discharge connection.

6. Apparatus for transferring gas material in the liquid phase, which can be stored under atmospheric pressure only when the pressure is below 273° K., comprising, in combination, a heat insulated container adapted to hold the liquid to be stored, a pump casing disposed in said container and having an inlet communicating with the container at a point near the bottom thereof, a piston arranged to reciprocate in said casing and open said inlet when moved to a position such as to clear substantially a maximum space for the reception of liquid from the container, a piston rod for said piston leading to a point on the exterior of said container, an expansible bellows for sealing said container at the point where said piston rod passes therethrough against the escape of gas, means for venting said pump casing leading from an opening uncovered by said piston at substantially the same instant said inlet is opened, said venting means leading to a point in the space in said container above the normal liquid level therein, mechanical means on the exterior of said casing for actuating said pump piston, a discharge connection leading from the bottom of said pump casing, and a normally closed valve controlling the connection between said pump casing and said discharge connection.

7. Apparatus for transferring gas material in the liquid phase, which can be stored under atmospheric pressure only when the pressure is below 273° K., comprising, in combination, a heat insulated container adapted to hold the liquid being stored, a pump casing disposed in said container and having inlets communicating with the container at a point near the bottom thereof, a piston comprising two head portions

joined by a portion of reduced section arranged to reciprocate in said casing and to open said inlets for communication with spaces cleared by the head portions for the reception of liquid from the container, an eccentric cam element disposed between said head portions and arranged to cause reciprocation of said piston when rotated, a shaft for rotating said eccentric element leading to a point on the exterior of said casing, means for rotating said shaft, means for venting said casing leading from ports opened by said piston heads at the same instant that the corresponding inlets are opened, said venting means leading to the space in said container above the normal liquid level therein, and discharge openings in each end of said casing normally closed by non-return valve elements.

8. Apparatus for transferring gas material in the liquid phase, which can be stored under atmospheric pressure only when the pressure is below 273° K., comprising, in combination, a heat insulated container adapted to hold the liquid being stored, a pump casing horizontally disposed within heat insulation and having inlets communicating with the lower portion of said container, a piston comprising two head portions joined by a portion of reduced section and arranged to reciprocate within said casing so that said head portions open said inlets for communication with spaces cleared by the head portions for the reception of liquid from the container, an eccentric cam element disposed between said head portions and arranged to reciprocate said piston when rotated, a shaft joining said eccentric element for rotating same, power means for rotating said shaft, means for venting said casing leading from ports opened by said piston heads at the same instant that the corresponding inlets are opened, said venting means leading to the space in said container above the normal liquid level therein, discharge passages leading from each end of said casing to receiving means, and normally closed valve elements controlling said passages.

9. Apparatus for transferring gas material in the liquid phase, which can be stored under atmospheric pressure only when the temperature is below 273° K., comprising, in combination, a

heat insulated container adapted to hold the liquid to be stored having a filling opening provided with a closure whereby it may be closed against the atmosphere, a pump positioned to be maintained at the temperature of the liquefied gas material by thermal contact with stored liquid, said pump having a casing and a fluid displacing element reciprocating therein and provided with an inlet communicating with said container at a point near the bottom thereof, means for reciprocating said element, means for venting said pump casing to the upper part of said container when said element has moved to clear a space for the reception of liquid and opens said inlet whereby gas generated by the heat of pumping is supplied to the upper part of said container and builds pressure, and a discharge connection leading from said pump casing having a normally closed discharge valve controlling the same.

10. Apparatus for transferring gas material in the liquid phase, which can be stored under atmospheric pressure only when the temperature is below 273° K., comprising, in combination, a heat insulated container adapted to hold the liquid to be stored having a filling opening provided with a closure whereby it may be closed against the atmosphere, a pump positioned to be maintained at the temperature of the liquefied gas material by thermal contact with stored liquid, said pump having a casing and a fluid displacing element reciprocating therein and provided with an inlet communicating with said container at a point near the bottom thereof, means for reciprocating said element, means for venting said pump casing to the space above the normal liquid level in said container whereby pressure may be built within said container above the liquid discharging, said element being arranged within said casing so as to open both said inlet and venting means when said element has moved to a position which clears substantially a maximum space for the reception of liquid from said container, a discharge connection leading from said pump casing, and means for maintaining said discharge connection normally closed against return flow of fluid.

WILLIAM F. MESINGER.