Pumping Apparatus For Very Cold Liquids

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PUMPING APPARATUS FOR VERY COLD LIQUIDS

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This invention relates to apparatus for pumping very cold liquids, such as liquid oxygen or liquid hydrogen. It has been customary to force such liquids out of a closed container by injecting an inert gas, such as nitrogen, under the required pressure. It is found, however, that the gases, when in direct contact with such very cold liquids and their metal containers, may be condensed and may thus dilute the liquid to be pumped. If not actually condensed, the gas may be substantially reduced in pressure by the excessive lowering of its temperature.

The object of the present invention is to provide improved pumping apparatus in which the gas under pressure has no direct contact with the cold liquid nor with any metal which is directly exposed to said cold liquid.

To the accomplishment of this general object, a pumping unit is provided in which the gas under pressure is out of contact with the cold liquid and is also effectively insulated from the cold liquid and from any metal in contact therewith, even when the pumping unit is entirely submerged in the cold liquid.

The invention further relates to arrangements and combinations of parts which will be herein-described and more particularly pointed out in the appended claims.

Two forms of the invention are shown in the drawings, in which:

Fig. 1 is a sectional side elevation of pumping apparatus embodying a preferred form of the invention; and

Fig. 2 is a side elevation of a modified pumping apparatus.

Referring to Fig. 1, one form of the improved pumping apparatus is indicated generally at P and is shown submerged in a very cold liquid, such as liquid oxygen or liquid hydrogen, contained in a tank or receptacle T.

The improved pumping apparatus consists of a spherical metal container having top and bottom members 10 and 11 and having an interposed flexible diaphragm 12 formed with annular concentric corrugations. A discharge pipe 13 is connected into the bottom member 11 of the metal container and is freely open to the space 14 below the diaphragm 12. An inwardly opening check valve 21 is mounted in an offset 22 of the pipe 13 and is normally held open by a light spring 24.

A pressure pipe 20 is mounted on the top member 10 of the metal container and is freely open into the space 15 above the diaphragm 12. The upper end of the pressure pipe 20 is connected to a supply of any suitable gas such as nitrogen gas, stored under the required pressure.

The upper side of the diaphragm 12, the under side of the top member 10 of the metal container, and the inner surface of the pipe 20 are all provided with a substantial layer L of a suitable heat-insulating material, and inside of each layer L a very thin flexible metal lining M is provided. Outside of the pressure pipe 20 a sleeve 33 is mounted in spaced relation to provide an air space 34 for additional insulation of the pipe 20.

The insulation L and the metal lining M for the diaphragm 12 are made of very flexible material, so as not to interfere with the movement of the diaphragm. Discs 35 and 36 may be provided below and above the diaphragm 12 to engage the inner ends of the pipes 20 and 30 and thus protect the diaphragm 12 from distortion or injury from excessive displacement.

A coil spring 37 may be inserted between the lower disc 38 and a shoulder 39 within the pipe 20, which spring will assist in restoring the diaphragm to raised position after each pumping stroke. If the tank T is open to the atmosphere, the diaphragm will not be raised much above the position shown in Fig. 1, but if the tank T is closed and the cold liquid is under pressure, the diaphragm may be moved upward until the disc 38 engages the lower end of the pressure pipe 20.

It will be understood that the check valve 21 is normally open but is promptly closed for the pumping stroke on any slight rise in pressure in the discharge pipe 20.

A modified construction is shown in Fig. 2, in which the pumping apparatus P' is of the bellows type and comprises an outer casing 40, an inner casing 41, a discharge pipe 42 securely mounted in a tank T', and an inwardly opening and normally open check valve 43 mounted in an offset 44 of the pipe 42.

A pressure pipe 45 is secured in the top of the outer casing 40 and extends freely into the space 46 between the casing 40 and a disc 50 mounted on a bellows connection 52. Springs 54 act to normally raise the disc 50.

Wire rings 55 may be mounted at the folds of the bellows connection 52 to facilitate bending and prevent distortion if found desirable.

The casing 40, disc 50, bellows connection 52 and pressure pipe 45 are all provided with substantial layers L' of suitable heat-insulating material and also with thin flexible metal linings M'. A solid disc 52 of insulating material constitutes a stop engageable with the inner end of
the discharge pipe 42, and a metal plate 63 may engage the inner end of the pressure pipe 45.

With this construction, the cold liquid in the tank T' flows into the space S3 outside of the inner casing 41 and within the bellows connection 52 as the disc 50 rises. When gas pressure is then applied through the pipe 45 to the space S2, the disc 50 is forced down and the cold liquid is forced out of the discharge pipe 42.

In this form also the gas under pressure is entirely out of direct contact with the cold liquid and is also fully insulated from contact with any metal exposed to the cold liquid. It is thus possible to submerge the pumping units P or P' in a very cold liquid and to pump the liquid by gas pressure, without diluting the cold liquid with condensed gas or substantially lowering the gas pressure by excessively lowering the temperature thereof.

Both pumping units are very simple in construction and require no bearings for moving parts, which is of substantial advantage in handling excessively cold liquids.

Having been thus described, the invention is not to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what is claimed is:

1. Pumping apparatus for cold liquids comprising a container for the cold liquid, a casing normally submerged in the cold liquid in said container and containing a liquid space and a gas space separated by a movable partition member, one-way means to admit liquid freely to said liquid space, means to supply gas under pressure to said gas space to move the partition member to discharge the liquid from the liquid space, and means to effectively heat-insulate the upper part of the casing, the partition member and the gas admission means to prevent excessive lowering of the temperature of the gas in said gas space by heat transfer to said cold liquid in which said parts are submerged.

2. The combination in pumping apparatus as set forth in claim 1, in which the movable partition member comprises a corrugated diaphragm clamped between top and bottom members of said casing, and in which said diaphragm has a flexible heat-insulating layer protected by a very thin flexible metal lining.

3. The combination in pumping apparatus as set forth in claim 1, in which the movable partition member has a bellows connection to the submersible casing located between inner and outer portions of said casing, and in which the bellows connection has a flexible heat-insulating layer and a thin flexible metal lining to prevent heat transfer therethrough.

4. The combination in pumping apparatus as set forth in claim 1, in which the movable partition member has a bellows connection to the submersible casing located between inner and outer portions of said casing, and in which the bellows connection has a flexible heat-insulating layer and a thin flexible metal lining to prevent heat transfer therethrough, and in which rings are provided in the folds of said bellows member to facilitate contraction and expansion thereof.

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Executrix of the Last Will and Testament of Robert H. Goddard, Deceased.

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

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,332,506</td>
<td>Corblin</td>
<td>Mar. 2, 1920</td>
</tr>
<tr>
<td>1,627,257</td>
<td>Stevens</td>
<td>May 3, 1927</td>
</tr>
<tr>
<td>1,915,833</td>
<td>Mantle</td>
<td>June 27, 1933</td>
</tr>
<tr>
<td>2,228,292</td>
<td>Wood</td>
<td>Jan. 14, 1941</td>
</tr>
</tbody>
</table>