Oct. 17, 1950 R. H. GODDARD 2,526,221

GAS-OPERATED APPARATUS FOR PUMPING VERY COLD LIQUIDS

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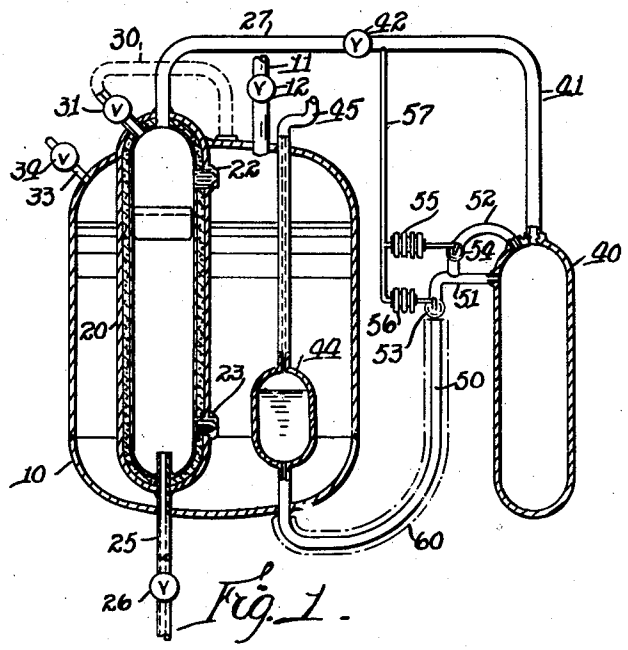


Fig. 1.

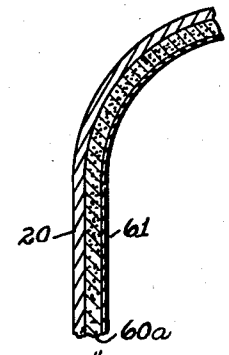


Fig. 2.

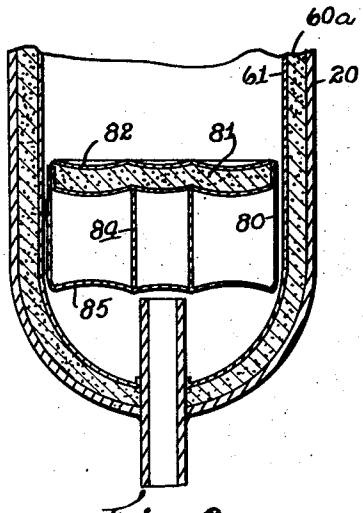


Fig. 3.

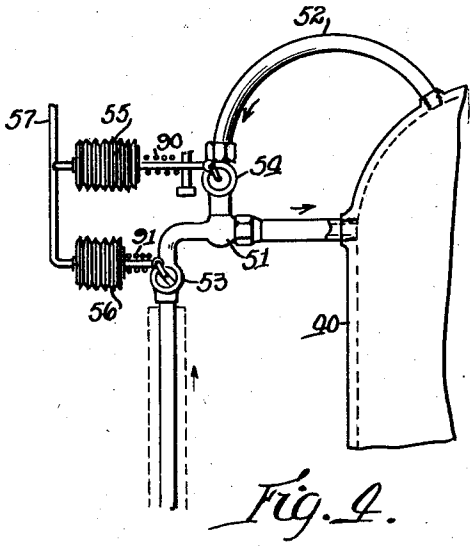


Fig. 4.

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2,526,221

GAS-OPERATED APPARATUS FOR PUMPING VERY COLD LIQUIDS

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1 Claim. (Cl. 62—1)

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This invention relates to apparatus for pumping very cold liquids, such as liquid oxygen.

It is the general object of the invention to provide apparatus in which the pumping action is effected by the action of a pressure gas produced by evaporation of another very cold liquid, such as liquid nitrogen.

A further object is to provide apparatus in which the evaporated pressure gas is automatically supplied at a regulated pressure and only in such amounts as are required for use.

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

A preferred form of the invention is shown in the drawings, in which

Fig. 1 is a sectional side elevation of apparatus embodying the invention;

Fig. 2 is a detail sectional view of a portion of an insulated inner tank casing;

Fig. 3 is a partial sectional elevation of the inner tank and a heat-insulating float; and

Fig. 4 is an enlarged side elevation, partly in section, of certain parts shown in Fig. 1.

Referring to the drawings, a tank 10 is shown in which a very cold liquid, as liquid oxygen, is stored at atmospheric or relatively low pressure. The tank 10 may be filled through a pipe 11 and valve 12.

A high-pressure tank 20 is mounted within the low-pressure tank 10 and is provided with check valves 22 and 23 opening inwardly to the tank 20 but yieldingly closed outwardly by very light springs. The tank 20 has a delivery pipe 25 provided with a valve 26 and also has a supply pipe 27 through which gas under pressure may be admitted to eject the cold liquid from the tank 20 through the discharge pipe 25.

The top of the tank 10 may be connected into the top of the tank 20 by a by-pass 30 having a shut-off valve 31. A vent pipe 33 and valve 34 are also provided.

The gas under pressure is supplied to the pipe 27 from a pressure tank 40 through a pipe 41 and valve 42. The gas in the tank 40 is derived from another very cold liquid, such as nitrogen, which is stored in liquid form in a small tank 44 mounted within the low-pressure tank 10 and normally immersed in the liquid oxygen.

The tank 44 may be filled through a pipe 45 which also serves as a vent pipe, so that the tank 44 is at atmospheric pressure.

The tank 44 is connected through a pipe 50 to an injector 51 which is operated by gas under pressure supplied from the tank 40 through a

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pipe 52. Valves 53 and 54 are provided in the pipes 50 and 52, and these valves are automatically controlled by bellows operators 55 and 56 which are jointly connected by a pipe 57 to the pipe 41 previously described. The pipe 50 is provided with an insulating covering 60 to prevent evaporation of the liquid nitrogen before it reaches the injector 51.

The tank 20 is provided with an insulating lining 60a (Figs. 2 and 3) inside of which is a very thin metal lining 61. This prevents the condensation of the nitrogen pressure gas within the tank 20 which might otherwise occur, as the tank 20 is in part immersed in liquid oxygen.

It is also desirable to substantially prevent contact of the nitrogen pressure gas in the upper part of the tank 20 with the liquid oxygen in the lower part of the tank. This is accomplished by providing a hollow metal float 80 (Fig. 3) having an insulating layer 81 on its upper face, protected by a thin metal covering 82. The float 80 may be reenforced by a tubular partition 84 to resist pressure.

With this construction, the liquid oxygen in the tank 20 may be quickly discharged through the pipe 25 by opening the valves 26 and 42. The gas pressure is applied against the top surface 82 of the float, and the pressure on the liquid is applied through the bottom surface 85 of the float.

The more-detailed operation of the apparatus is as follows:

Assume that the parts are in the position shown in Figs. 1 and 4, and that some nitrogen has flowed into the tank 40, due to the height of the liquid in the filler pipe 45. Evaporation of the liquid nitrogen in the tank 40 will then take place, as the tank 40 is not insulated. Pressure will thus build up in the pipe 41. If the valve 42 is closed, the gas pressure will then act through the bellows operators 55 and 56 to close the valves 54 and 53 respectively and in the order named. The bellows operators are so designed that the bellows 55 responds more quickly and closes the valve 54 ahead of the valve 53.

The tank 20 will have been largely filled through the check valves 22 and 23, during which time the pressures in the tanks 10 and 20 may be equalized by temporarily opening the valve 31. If the valve 31 is now closed and the valve 42 is now opened, nitrogen gas under pressure from the pressure tank 40 is supplied through the pipe 27 to the top of the tank 20, and liquid oxygen will be ejected through the pipe 25 when the valve 26 is opened.

As soon as the gas pressure in the tank 40 be-

gins to fall, the bellows operators will be deflated by their coil springs 90 and 91, thus successively opening the valves 53 and 54. Nitrogen gas under pressure from the tank 40 will then react through the pipe 52 and injector 51 to supply additional liquid nitrogen from the storage tank 44 to the pressure tank 40. A regulated gas pressure in the tank 40 is thus maintained so long as the storage tank 44 contains a supply of liquid nitrogen.

Pressure gas for discharging liquid oxygen from the tank 20 through the pipe 25 is thus automatically supplied by evaporation and will be so supplied so long as the liquid nitrogen in the tank 44 is not allowed to become exhausted.

The mechanism above described is simple in construction and operation and is particularly well adapted to its intended purposes. The apparatus may be used to supply liquid oxygen to a combustion chamber while starting the chamber in operation, and is also capable of other and quite general application.

Having described the invention and the advantages thereof, it will be understood that the invention is not to be limited to the details herein disclosed, otherwise than as set forth in the claim, but what is claimed is:

Pumping apparatus for a very cold liquid comprising an outer low-pressure tank containing said cold liquid, an inner tank mounted within said outer tank and with a substantial portion thereof immersible in said cold liquid, check valve means opening into said inner tank to admit a portion of said cold liquid from said outer tank to said inner tank and closable outwardly on relative increase in pressure in said inner tank, a pressure tank, means to supply a charge of a low-temperature, low-pressure liquid to said pressure tank for evaporation therein, and a valved connection from said pressure tank to the top of said inner tank through which the gas produced by evaporation in said pressure tank is effective to eject the cold liquid from said inner tank and still in liquid form.

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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

Number	Name	Date
1,878,317	Picard	Sept. 20, 1932
2,033,094	DeMotte	Mar. 3, 1936
2,117,819	Okada	May 17, 1938
2,271,022	Nelson	Jan. 27, 1942
2,394,852	Goddard	Feb. 12, 1946