

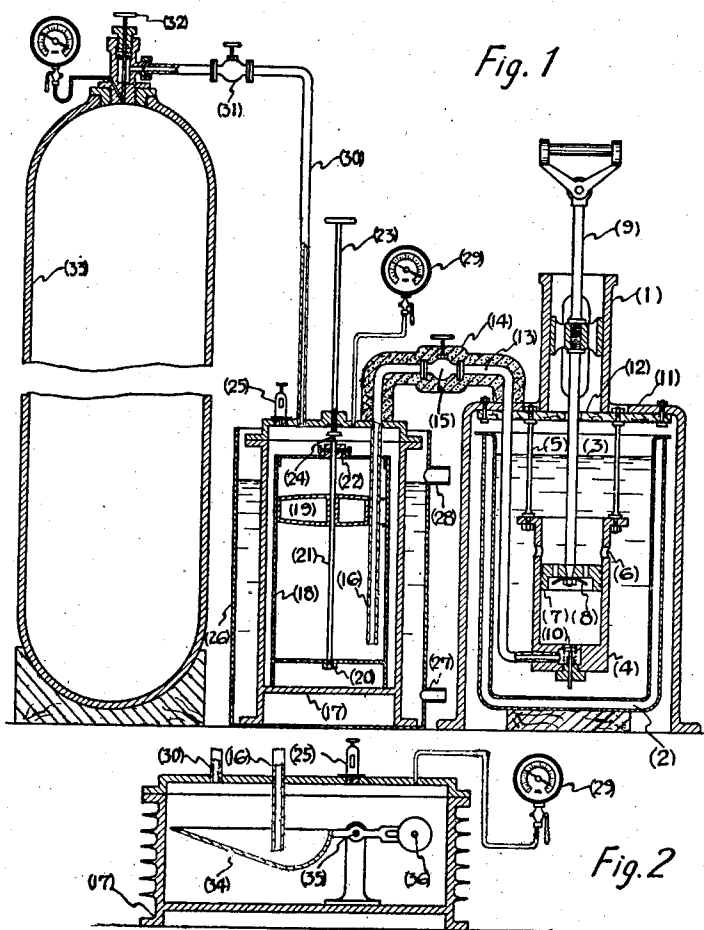
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APPARATUS FOR FILLING HIGH PRESSURE GAS CONTAINERS

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APPARATUS FOR FILLING HIGH PRESSURE
GAS CONTAINERS

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This invention relates to improvements in or relating to filling high pressure gas into a bottle, wherein are provided a liquid pump submerged in low temperature liquid and especially designed to discharge a definite quantity of liquid, a vaporizer containing a thin-walled vessel of a definite volume and a pressure-proof bottle. Furthermore, liquid which is easily vaporized at an atmospheric temperature is injected at low pressure, into the thin-walled vessel arranged in the vaporizer by a liquid pump so that a definite quantity of the liquid is filled into said vessel, and then the liquid is let out to the vaporizer where the liquid is vaporized and a high pressure gas at atmospheric temperature is generated by self-compression. The filling of the high pressure gas thus generated into the bottle at a desired pressure is effected by making the capacity of the thin-walled vessel of a definite ratio with that of the bottle, according to the desired pressure of filled in gas. The invention has moreover for its object to fill gas economically into the bottle in such a manner as to generate high pressure gas under a low delivery pressure at the pump side and minimizing the loss due to vaporization of liquid when pouring the liquid into the vaporizer.

In the annexed drawing is illustrated an apparatus for filling high pressure gas into a bottle and Fig. 1 shows in vertical section a general arrangement thereof and Fig. 2 shows also in section one example of the vessel in the vaporizer.

In filling high pressure gas into a bottle according to this invention, a low temperature liquid such as liquid oxygen which is easily vaporized at atmospheric pressure is forced into a thin vessel in a vaporizer through a valve by means of a liquid pump which is submerged in the low temperature liquid and is operated by hand or other power at a low pressure and without working the pump against high pressure of the gas filled into the bottle, said vessel being made of thin material and having a definite volume, and after a definite quantity of liquid is pumped into the vessel, said liquid is discharged into the vaporizer where the liquid is gasified at once by heat contained in the vaporizer, and high pressure gas generated by self compression is filled into the pressure-proof bottle at atmospheric temperature. The thin-walled vessel arranged within the vaporizer is provided with a discharge valve at its bottom, which may be a hand-operated-valve, automatic float valve, or hinged tipping bucket or dipper, the outer surface of said vessel being kept in spaced relation to the internal wall of

the vaporizer, and after a definite quantity of liquid is filled in said vessel the discharge valve is opened by turning a handle. It may also be opened automatically by buoyancy of the float, thus exposing the liquid to the wall of the vaporizer which is of great mass, to cause a sudden vaporization. When a definite height of the float from the discharge valve is kept, or a definite volume of the tipping bucket is kept by adjusting a weight, a definite pressure gas may also be filled into the bottle. Provided that the bottle is of a definite capacity, high pressure gas up to 500 atmospheres may be filled therein by changing the height of the float or discharge volume of the bucket as above mentioned, that is, when the capacity of said vessel has a definite ratio with that of the bottle, then a required high pressure gas at atmospheric temperature may be generated by self-compression in a short time.

The insertion of the vessel in the vaporizer has for its object to minimize the quantity of gas which will evaporate while liquid is injected into the vessel, so that the quantity of said gas generated is small and there is no need to discharge it into the atmosphere in order to work the pump, at a low pressure, thus minimizing the loss due to evaporation.

Now, taking oxygen gas as an example, if the capacity of the bottle is 40 liters and the required pressure of oxygen gas filled in is 200 atmospheres, about 10 liters of liquid oxygen is to be injected at a low pressure of below about 10 atmospheres into the vessel by a hand pump without raising the pressure of the pump to stand against 200 atmospheres.

The annexed drawing exemplifies the present invention, in which a liquid pump 1, vaporizer 17 and pressure-proof container or bottle 33 are provided as shown in Fig. 1. The pump body 4 is hung from an insulating plate 12 in a container 2, filled with a low temperature liquid 3, said plate being secured to a frame 11 by means of rods or chains 5 so that the pump body 4 is always maintained at the same temperature with the liquid. By pulling up a handle 9 the liquid is drawn into the pump cylinder or body 4 through a suction valve 8 arranged in the piston head 7. Vapor is thus produced by surrounding heat during the suction stroke and discharged into the liquid through an opening 6 formed in the cylinder near the upper dead point of the stroke. The reason for providing the opening is that the vapor thus produced is not only discharged through it into the liquid, but the discharge quantity of the pump is kept ex-

actly constant. When the liquid only fills the cylinder, said handle 9 is pressed down and the liquid is discharged through the discharge valve 10 and is forced down at low pressure to the bottom of the vessel 18 situated within the vaporizer 17 through a nozzle 16 at the end of a pipe 13 containing a valve 15, both valve and pipe being covered with heat insulator 14.

When a definite quantity of the liquid has been filled into the vessel 18, a discharge valve 20 is opened, and, in the case of automatic type, the valve 20 is opened by buoyancy of a float 19 floating on the surface of the liquid, said float being maintained by a hook mechanism 22 arranged at the upper end of the spindle 21 which is fixed to the float. The liquid thereupon flows into the interior of the vaporizer 17 where pressure is raised due to a sudden vaporization of the liquid to close the valve 15 automatically, the rise of pressure being indicated by a pressure-gauge 29. The filling up of high pressure gas into the bottle 33 is effected through a pipe 30 and valves 31 and 32. Since the vessel 18 arranged within the vaporizer 17 is made of thin material and its circumference is out of contact with the inside wall of the vaporizer, it is soon cooled down with a little loss of liquid due to the vaporization, and though there occurs some pressure in the vessel on account of vapor generated at the beginning of the injection of liquid, the liquid can be forced by the liquid pump 1 against the pressure of the vapor. A minute pressure, produced while liquid is injected in the vessel will exist in the vaporizer, and exert a back pressure on the pump but this is out of the question, and the loss of the liquid due to vaporization is made to nil. When the liquid flows out of the vessel into the vaporizer and the valve 15 is closed automatically as aforesaid, a high pressure will be exerted on the hand pump, thus proving that a definite quantity of liquid has been filled into the vessel 18.

Fig. 2 shows another construction of the vessel in the vaporizer, in which an open bucket or dipper is used instead of an automatic float mechanism; and when a definite quantity of liquid has been filled in the bucket or dipper 34 through a pipe 16 as aforesaid, the bucket dips or turns around a fulcrum 35 against a weight 36 to drain the liquid into the inner surface of the vaporizer 17. In this case, the position of the weight is to be adjusted properly according to the required pressure of generated gas. The float and bucket types have respective advantages and disadvantages according to the place where they are arranged, i. e., in moving ships the former is to be used, but in other cases the latter may preferably be used.

As mentioned above, after all of the liquid in the vaporizer 17 is vaporized, required high pressure gas may be filled up into the bottle 33, but as the vaporizer is also full of high pressure gas identical to that in the bottle, it is convenient that, in case of next filling operation, the valve 31 is connected previously to several new bottles and is then opened to discharge high pressure gas remaining in the vaporizer into said other bottles, thus equalizing the pressure between the vaporizer and the new bottles. Thereupon said valve 31 is closed and an escape valve 25 is opened

to adjust the pressure down to an allowable discharge pressure of the pump.

Next, on turning the handle 23, the discharge valve 20 is closed through the intermediary of the spindle 21 actuated by a spring 24, thus recovering the original state, and in repeating the filling operation as above mentioned, an outer surface of radiating fins of the vaporizer as shown in Fig. 2 becomes covered with snow and ice in the course of time, disturbing the rate of heat transmission, in such a case, the vaporizer is arranged in a water tank 26, in which is circulated a current of sweet water or sea water, for the purpose of heating the vaporizer, thus keeping the temperatures of gas generated and the vaporizer constant. The circulating water enters through an entrance 27 and flows out of an outlet 28.

The above description only exemplifies the present invention which is not limited thereby, for example, liquid may be injected by gravity through the stop valve 15 into the thin-walled vessel 18 or the bucket 34 instead of using a liquid pump. Moreover, a definite quantity of liquid may be discharged into the vaporizer 17 by the handle 23 of the valve 20 without using the float, and in such a case, it is necessary that the number of the delivery strokes of the pump is so chosen as to correspond to the required pressure in the bottle 33. Thus the method and apparatus can be altered in various ways without departing from the spirit of the invention.

I claim:

1. An apparatus for filling high pressure gas into a bottle, comprising a container for a low temperature liquid, a pump permanently secured in the container so as to be completely submerged in said liquid, said pump having a cylindrical body, a hand-operated reciprocating piston therein, apertures being provided in the cylindrical body above the upper limit of the piston stroke, a discharge valve at the bottom of said body; a vaporizer having valved connection with said bottle, a thin-walled vessel within said vaporizer spaced from the side-walls of the vaporizer, a valved conduit from said discharge valve of the pump having a nozzle opening adjacent the bottom of said thin-walled vessel, a second discharge valve in the bottom of said vessel opening into said vaporizer and means for operating said second valve, whereby upon opening of said second discharge valve liquid proceeding from said vessel into said vaporizer becomes evaporated thus increasing the pressure therein and the bottle then filled by the thus generated gas by way of said valved connection.

2. An apparatus according to claim 1 in which said means for operating said second discharge valve consists of a float connected therewith in said thin-walled vessel.

3. An apparatus according to claim 1 in which said means for operating said second discharge valve consists of a tiltably mounted dipper adapted to receive the liquid from said nozzle, a device for regulating the amount of liquid to be received by the dipper.

4. An apparatus according to claim 1 in which a water-jacket is provided around said vaporizer for continuously running water.