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AUTOMATIC CONTROL MECHANISM FOR GAS STORAGE TANKS

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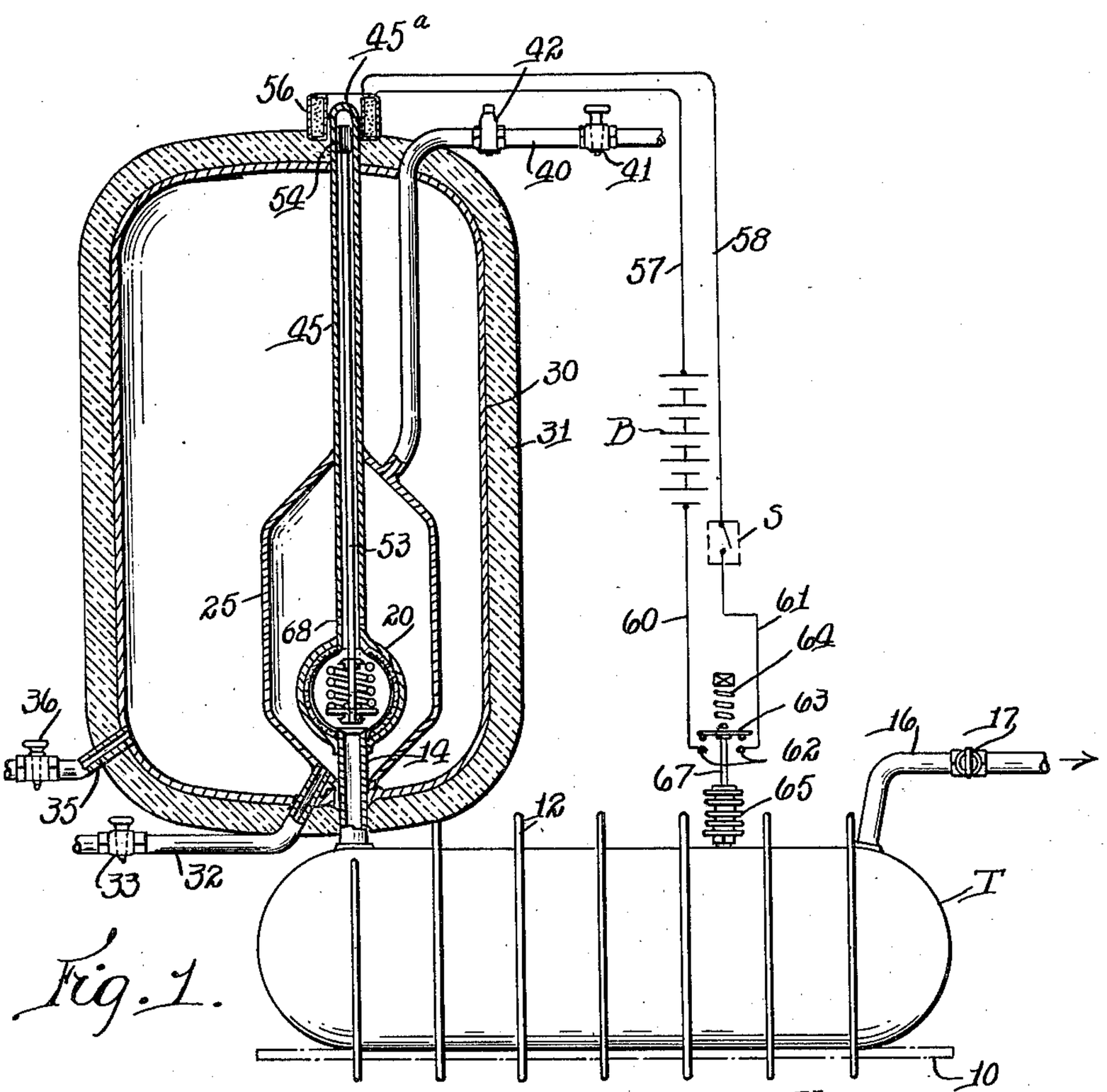

Fig. 1.

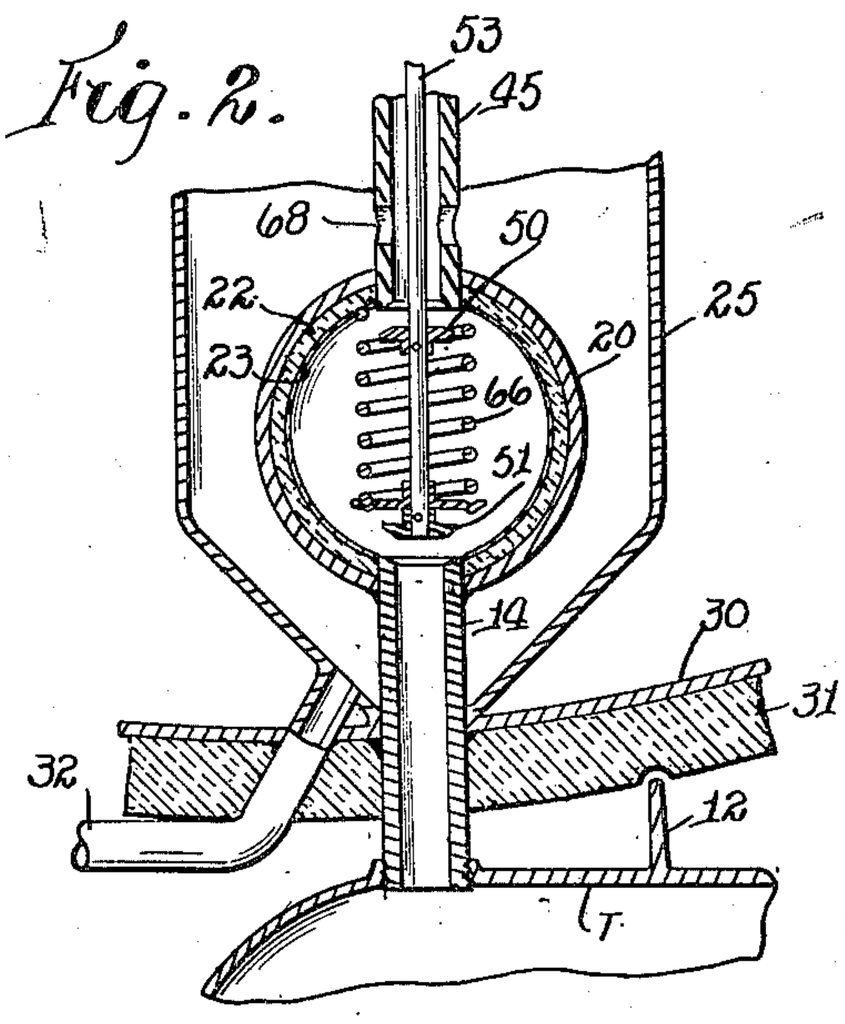

Fig. 2.

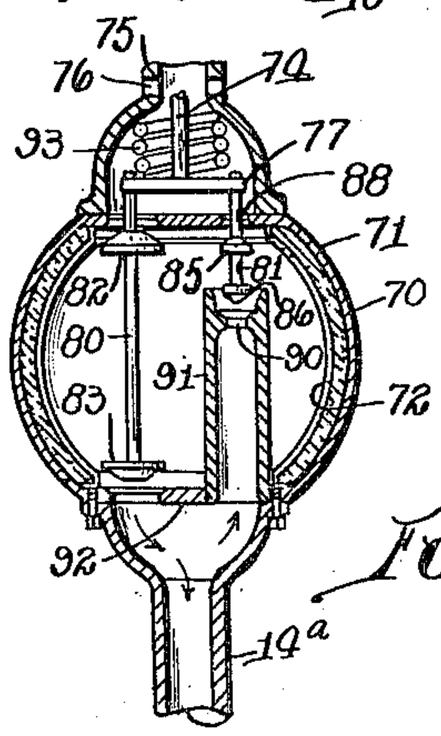

Fig. 3.

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AUTOMATIC CONTROL MECHANISM FOR GAS STORAGE TANKS

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4 Claims. (Cl. 62—1)

1

This invention relates to the maintenance of an adequate gas supply in a storage tank from which gas is withdrawn intermittently or irregularly. The invention relates more particularly to storage tanks in which the gas is produced by evaporation of a very cold liquid, such as liquid nitrogen.

It is the general object of the invention to provide automatic means for supplying such cold liquid to the tank on the lowering of the normal gas pressure therein, and for maintaining substantially normal gas pressure as gas is withdrawn from said tank.

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

Preferred forms of the invention are shown in the drawings, in which

Fig. 1 is a side elevation, partly in section, of mechanism embodying the invention;

Fig. 2 is an enlarged sectional elevation of certain parts shown in Fig. 1; and

Fig. 3 is a view similar to Fig. 2 but showing a modified construction.

Referring to Figs. 1 and 2, a gas tank T is mounted on a support 10 and may be provided with heat-absorbing fins or discs 12. Gas is provided in the tank T by evaporation of a cold liquid, such as liquid nitrogen, which is supplied to the tank through a feed pipe 14. Such evaporation produces gas under pressure and is facilitated by heat absorbed from the support 10 or from the fins 12. The gas may be discharged from the tank T through a pipe 16 which is under the control of a valve 17.

The upper end of the feed pipe 14 connects into a relatively small inner or feed tank 20, normally filled with a cold liquid such as liquid nitrogen. The inner tank 20 is preferably lined with heat-insulating material 22 and has a thin inner metallic lining 23.

The tank 20 is enclosed in a somewhat larger storage tank 25, also adapted to contain liquid nitrogen. The storage tank 25 is enclosed in a still larger outer tank 30 which is normally filled with liquid oxygen. This tank may be covered with a thick layer of insulation 31.

The storage tank 25 may be filled with liquid nitrogen through a feed pipe 32 having a shut-off valve 33. The outer tank 30 may be similarly filled with liquid oxygen through a feed pipe 35 provided with a shut-off valve 36.

The storage tank 25 may be vented on occasion through a pipe 40 having a shut-off valve 41.

2

The pipe 40 may also be provided with a safety valve 42 for a purpose to be described.

A pipe 45 extends upward from the inner or feed tank 20 through the upper ends of the tanks 25 and 30 and is closed at its upper end, as shown at 45a in Fig. 1. Valves 50 and 51 (Fig. 2) are mounted in spaced relation on a valve rod 53 which extends upward inside of the pipe 45 and which has a cylindrical iron armature 54 mounted on its upper end and loosely slidable in the tube 45.

The upper end of the tube 45 extends into a solenoid coil 56 connected by wires 57 and 58 to a battery B and switch S. Wires 60 and 61 connect the battery B and switch S to terminals 62 which may be connected by a cross bar 63 on a plunger 67. The lower end of this plunger is connected to a bellows operator 65 mounted on and connected into the tank T.

When the tank T is under pressure, the bellows operator lifts the bar 63 against the pressure of a spring 64 and thus breaks the solenoid circuit. When the pressure in the tank T is lowered, the bar 63 drops to complete the solenoid circuit.

The valve rod 53 is normally pressed downward by a spring 66 to seat the lower valve 51 and to thus close the upper end of the feed pipe 14. The tube 45 is provided with ports 68 (Fig. 2) through which nitrogen may flow from the storage tank 25 to the inner or feed tank 20 when the valve 51 is thus seated by the spring 66 and the valve 50 is open. The spring 66 (Fig. 2) is strong enough to seat the valve 51 against the normal gas pressure in the tank T.

If any substantial amount of gas is drawn out from the tank T through the pipe 16 and valve 17, the gas pressure in the tank T will drop, thus allowing the bar 63 to close the circuit through the solenoid 56. This will energize the solenoid to raise the rod 53, closing the upper valve 50 and opening the lower valve 51.

The liquid nitrogen contained in the inner or feed tank 20 will then flow down through the pipe 14 into the gas tank T, where evaporation will promptly take place.

The gas pressure in the tank T will then rise until the bellows operator 65 breaks the solenoid circuit and allows the valve rod 53 to drop. This seats the lower valve 51 to stop the feed of liquid nitrogen to the gas tank 10, and opens the upper valve 50 to admit more liquid nitrogen to the feed tank 20 from the storage tank 25.

The entire operation is automatic and will be repeated as often as gas is withdrawn from the tank T in any substantial amount.

The discharge of the liquid from the inner or feed tank **20** to the gas tank T on substantial lowering of the gas pressure in the tank T will be accelerated if the valve construction shown in Fig. 3 is substituted for the valve construction shown in Fig. 2.

In Fig. 3, an inner or feed tank **70** is mounted at the upper end of the feed pipe **14***a* and is provided with heat-insulating material **71** and with an inner lining **72**. A valve rod **74** extends up through a pipe **75** provided with ports **76**, all as previously described. A cross bar **77** is secured to the lower end of the rod **74** and supports two plungers **80** and **81**. The plunger **80** has upper and lower valves **82** and **83** which function the same as the valves **50** and **51** in Fig. 2.

The plunger **81** also has upper and lower valves **85** and **86**. The upper valve **85** closes a port **88** in the upper end of the tank **70** when the valve **85** is raised, and the lower valve **86**, when lowered, closes a port **90** at the upper end of a pipe **91** which extends upward from the lower end of the tank **70** and which is open at its lower end through a plate **92**.

A coil spring **93** seats the valves **83** and **86** when there is normal pressure in the gas tank, as in the previous construction. The rod **74** is solenoid-operated and pressure-controlled as previously described. When the pressure in the gas tank drops, the solenoid circuit will be closed, the rod **74** and associated valve parts will be raised, and the liquid in the tank **70** will flow downward through the pipe **14***a*. At the same time, air or gas may flow upward through the pipe **91** and through the port **90** to relieve any gas-bind in the tank **70** and to thus facilitate discharge therefrom.

With both forms of the invention as herein shown, a gas storage tank will be automatically and promptly replenished with an evaporative liquid on any substantial drop in pressure in the gas storage tank.

Any momentary rise in pressure in the storage tank **25**, due to the opening of the upper valve **50** or **82**, will be relieved by the safety valve **42**.

Having thus 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 claims, but what is claimed is:

1. In a gas storage apparatus, a gas storage tank, an inner liquid supply tank connected thereto, a liquid storage tank surrounding said inner liquid supply tank, means to fill said liquid storage tank, means to feed an evaporative liquid from said liquid storage tank to said inner liquid supply tank, means to feed liquid from said inner liquid supply tank to said gas storage tank, said

first and second feeding means operating alternately, and control devices for said two feeding means which are responsive to pressure changes in said gas storage tank.

2. In a gas storage apparatus, a storage tank, a liquid supply tank of relatively small capacity and which is connected to said storage tank and which is normally full, feed and discharge valves for said supply tank, an operating rod connected to both of said valves and effective to open and close said valves simultaneously but alternately, actuating means to move said operating rod, and a device effective to activate said actuating means in response to changes in pressure in said gas storage tank.

3. In a gas storage apparatus, a gas storage tank, a liquid supply tank of relatively small capacity and which is connected to said storage tank and which is normally full, feed and discharge valves for said supply tank, a device to open and close said valves simultaneously but alternately, control means for said latter device which is responsive to changes in pressure in said gas storage tank, a pair of vent valves both positioned in the upper part of said supply tank, and means to open and close said vent valves alternately and substantially simultaneously with the alternate opening and closing of said feed and discharge valves, said vent valves being effective to prevent gas bind.

4. In a gas storage apparatus, a gas storage tank, a liquid supply tank of relatively small capacity and which is connected to said storage tank and which is normally full, feed and discharge valves for said supply tank, a solenoid operative to open and close said valves simultaneously and alternately, an electric circuit to supply current to said solenoid, and means to open and close said electric circuit in response to changes in pressure in said gas storage tank.

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

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