

May 21, 1946.

H. L. NORWAY

2,400,570

LIQUEFIED PETROLEUM GAS DISPENSING SYSTEM

Filed Dec. 19, 1940

3 Sheets-Sheet 1

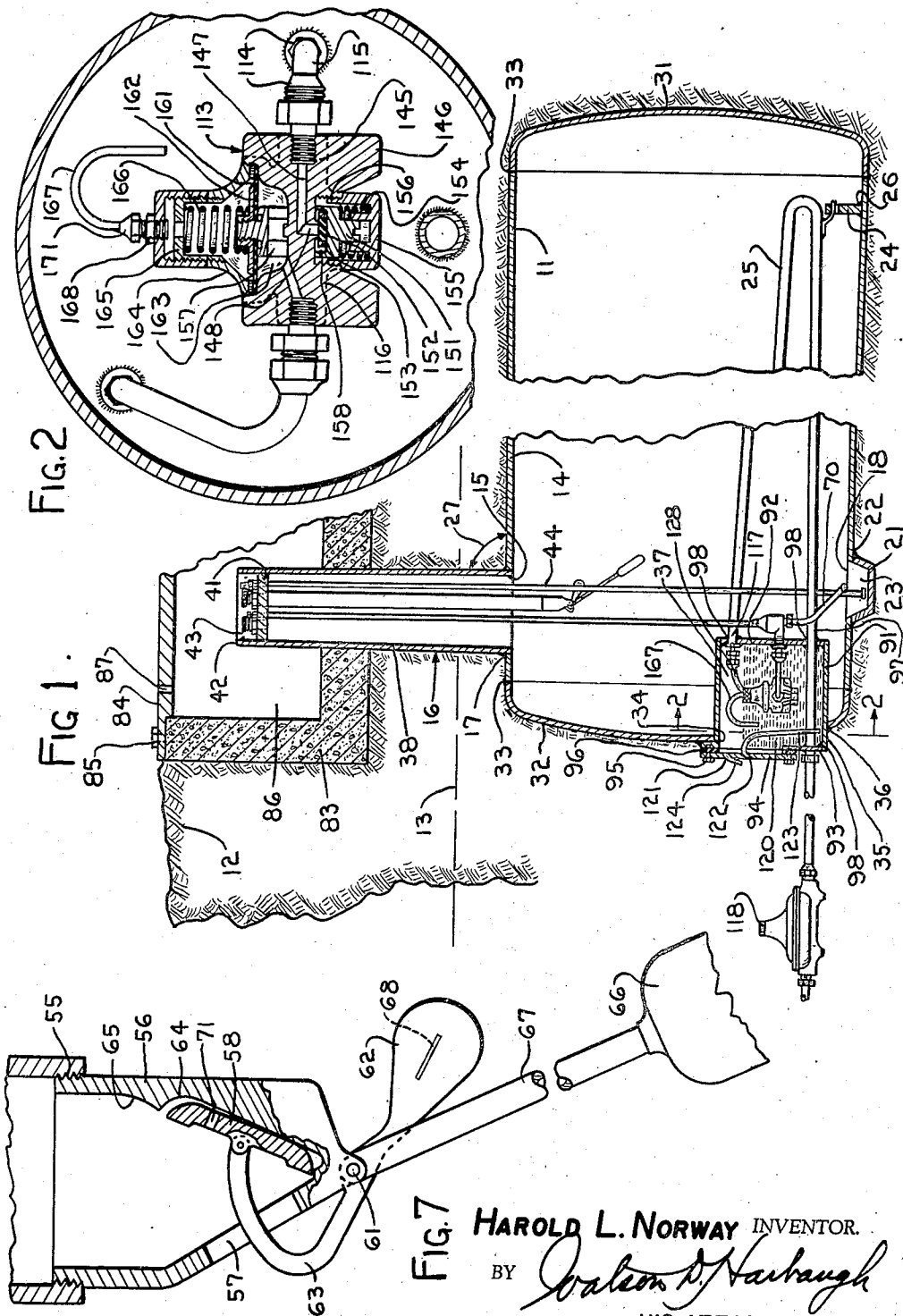


FIG. 7

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LIQUEFIED PETROLEUM GAS DISPENSING SYSTEM

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3 Sheets-Sheet 2

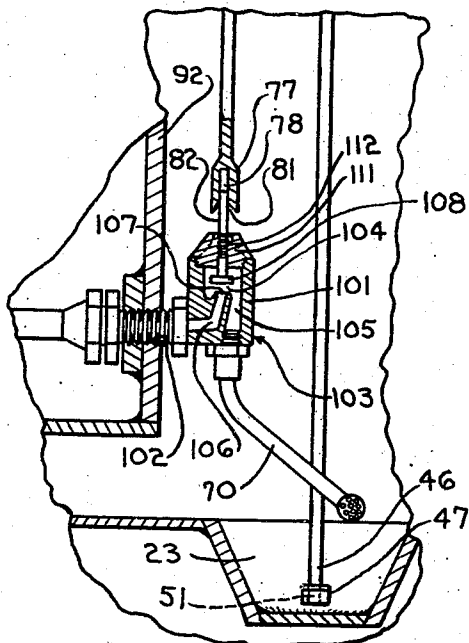
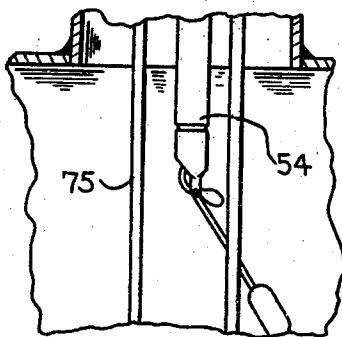
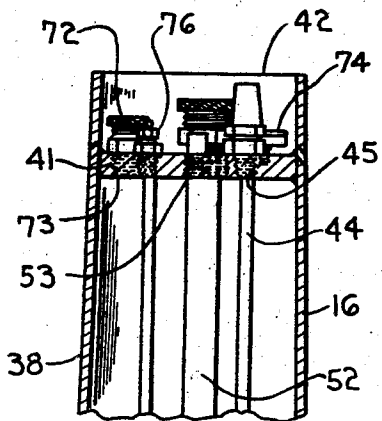


FIG. 8

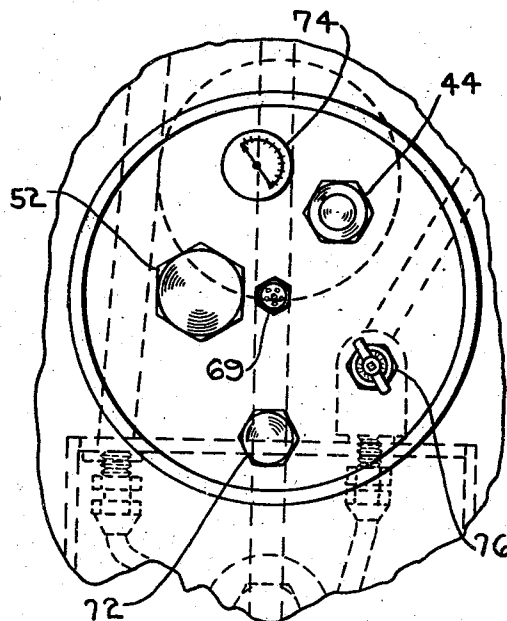


FIG. 3

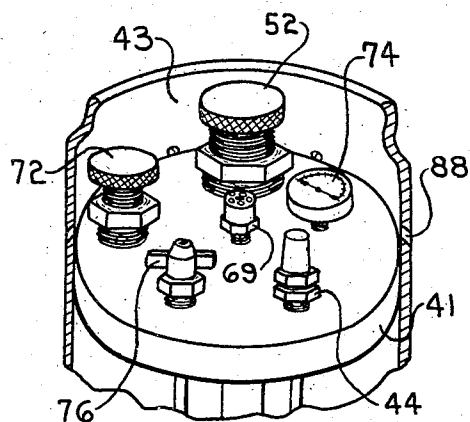


FIG. 10

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LIQUEFIED PETROLEUM GAS DISPENSING SYSTEM

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3 Sheets-Sheet 3

FIG. 6

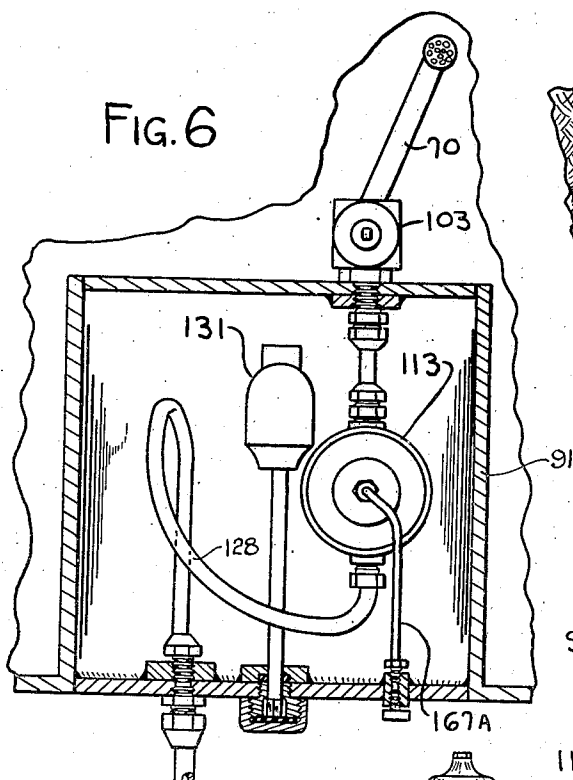
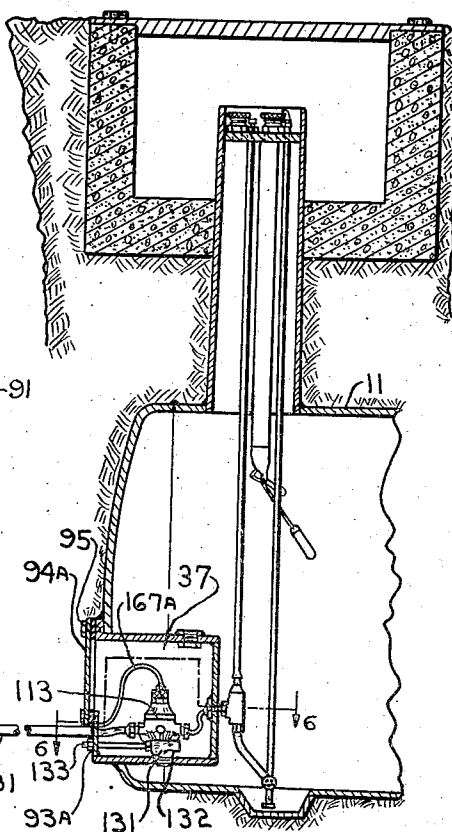


FIG. 4



134

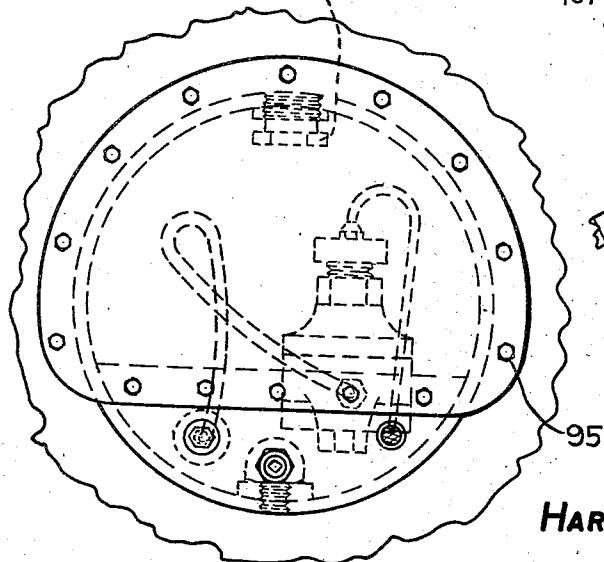


FIG. 5

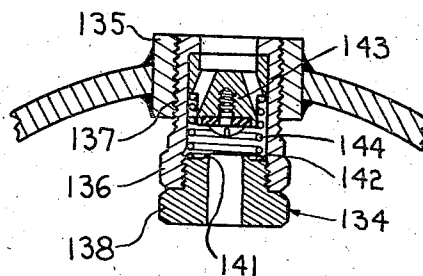


FIG. 9

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UNITED STATES PATENT OFFICE

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LIQUEFIED PETROLEUM GAS DISPENSING SYSTEM

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tion of Illinois

Application December 19, 1940, Serial No. 370,754

23 Claims. (Cl. 62-1)

The present invention relates to liquefied petroleum gas dispensing systems.

The petroleum product employed in the system with which the present invention is concerned, is preferably a hydrocarbon of the paraffin series, such as butane or propane, or a mixture of both, and the fuel is preferably stored in an underground tank in the form of a liquefied gas which, with the assistance of the heat of the earth and reduction in pressure is vaporized for use in a dwelling as a substitute for natural gas.

One way of vaporizing the liquefied gas is the so-called "batch" system in which the vaporization is carried on in the storage tank and vapor is withdrawn in the form of gas from the tank. The other way of vaporizing the liquefied gas is the so-called "flash" system in which the liquefied gas is withdrawn as a liquid from the tank and passed through a pressure reducing regulator which causes the liquid to flash into vapor.

Wherever the vaporization takes place, heat units are absorbed from surrounding parts, and, in the batch system, this refrigerating action is largely expended in the tank, whereas with the flash system, the heat absorption is concentrated in a comparatively small space, namely, around the pressure reducing device and adjacent parts.

Although the present invention will improve vaporization and operating conditions for both systems, it is primarily of interest with the flash systems and has for one of its objects the adaptation of the flash process to take advantage of the benefits derived with batch systems in that the latent heat required for vaporization is taken from the large body of liquid in the tank as in the case of batch vaporization.

A further object of the invention is to prevent frosting of the body of the regulator in which the flash vaporization takes place. In this connection, another object of the invention is to submerge in an anti-freeze solution, those parts of the regulator which are subject to the refrigerating effect of the vaporization phase accompanying pressure reduction.

Another object of the invention is to circulate an anti-freeze liquid convectively in heat exchange contact with the first stage regulator and a source of heat, in this instance the source of heat preferably being the heat of the earth.

A further purpose of the invention is to vent the regulator to the same anti-freeze liquid which conveys heat to the regulator.

Another object of the invention is to place a flash regulator in contact with a liquid exposed to

a source of heat such as the earth over an area greatly in excess of the area of the regulator.

Another object of the invention is to provide an improved means for determining the level of liquid in the tank and for evacuating from the tank such foreign fluids as water.

A further object of the invention is to provide an improved means for preventing the filling of the tank above a predetermined level.

A further object of the invention is to provide an improved shutoff control for the gas supply leading from the tank which is not exposed to atmospheric temperatures.

Another purpose of the invention is to provide a dispensing system of the class described where, under normally expected conditions of heavy withdrawal, a revaporizer is not needed, yet without changing the general organization of standardized parts a revaporizer may be used where extra heavy withdrawals of gas are anticipated and condensation is likely to be incurred.

A further purpose of the invention is to provide a rugged, unitary tank assembly which is simple in construction, easy to make, readily placed in operation and serviced.

These being among the objects of the invention, other and further objects will become apparent from the drawings, the description relating thereto and the appended claims.

Referring now to the drawings:

Fig. 1 is a fragmentary vertical section taken longitudinally through the tank, standpipe and eduction cavity illustrating one of the improved embodiments of the invention.

Fig. 2 is an enlarged transverse section taken upon the line 2-2 in Fig. 1, also showing the pressure reduction regulator in section.

Fig. 3 is a plan view of the standpipe illustrated in Fig. 1 showing the arrangement of the various elements thereon as projected upon the associated parts in the tank which are indicated in broken lines.

Fig. 4 is a view similar to Fig. 1 illustrating another improved embodiment of the invention.

Fig. 5 is an end view of the eduction cavity shown in Fig. 4.

Fig. 6 is an enlarged section taken upon lines 6-6 in Fig. 4.

Fig. 7 is an elevational view partly in section of an improved form of a means for preventing the filling of a tank above a predetermined level.

Fig. 8 is an enlarged vertical section showing the relative locations of the elements associated with the standpipe.

Fig. 9 is a section showing an improved excess

flow check valve mounted from inside the education cavity.

Fig. 10 is a perspective view of the top of the standpipe.

As already mentioned, the invention is illustrated in connection with a flash system of vaporization where a liquefied gas is forced from a storage tank by the vapor pressure of the stored gas and is passed through a first stage regulator which reduces the pressure whereby the liquefied gas is vaporized and the resulting vapor is then conducted through and to a second regulator where it is reduced to a service pressure of 6 ounces per square inch. In the drawings, a storage tank is indicated at 11 as buried in the earth 12, below the frost line 13 normally expected to exist in the region where the installation is made.

Tank construction

The tank comprises a cylindrical central shell 14 apertured on the top at 15 to receive the standpipe 22 which is welded therein as by a weld line 17. On its bottom, the shell 14 is provided with an opening 18 that partially overlaps a vertical projection of the opening 15, and the opening 18 is closed by a cup 21 welded thereto as at 22 to provide a sump 23. A support 24 for the revaporization coil 25 is welded upon the inside of the shell 14 as at 26 and for purposes of installing the tank properly in place so that the sump 23 works most effectively, the standpipe 16 is so positioned as to provide an angle at 27 which is slightly in excess of a right angle. When the tank is buried, the plumbing of the standpipe 16 will assure that any water collecting in the tank will lie to the right of the sump 23 until such time as the amount of water will exceed a depth of 1" or 1½" after which it will flow into the sump 23, the excess collecting there over and above that expected to be present after the tank has been tested hydraulically in its pressure test.

Both ends of the cylindrical shell are closed by caps 31 and 32 secured by welds, 33. The cap is apertured as at 34 to receive the well member 35 welded therein as at 36 to provide a cavity 37 in the tank, and the tank is preferably constructed and assembled in this order.

Standpipe construction

The standpipe 16 comprises a cylindrical casing 38 closed at the top by a wall 41 spaced from the top 42 a sufficient distance to provide a recess 43 therein.

Referring to Figs. 3, 8 and 10, a slip tube gauge 44 is threaded into an opening 45 in the wall 41 where the lower end 46 of the gauge thereof enters the sump 23. The lower end 46 is provided with a stop 47 which prevents complete removal of the slip tube gauge and in addition to the slip tube gauge functioning in the conventional manner to determine the level of the liquid in the tank, the stop 47 has an opening 51 therein with the mouth of the opening close to the bottom of the sump 23 so that water present in the sump will be evacuated through the slip tube gauge whenever the slip tube gauge is all the way down and the top is vented in the same manner in which the slip tube is employed as a gauge. The slip tube gauge would be left open as long as it was discharging water and could be closed again whenever liquefied gas began to flow.

The tank is filled through a fill pipe indicated

at 52 as secured in the threaded opening 53. The fill pipe is so constructed and arranged that it can be completely assembled outside the tank and inserted into place in the standpipe 16 through the opening 53. The top of the fill pipe 52 is provided with a back pressure check valve which is opened by the pressure forcing liquid into the tank and the bottom 54 thereof is threaded at 55, as more particularly shown in Fig. 7, to receive a fitting 56 having a discharge opening 57 from the side thereof and a flap shutoff valve 58 pivoted as at 61 on the bottom and outside thereof where it is easily assembled.

The flap valve 58 is held normally opened by a weight 62 upon the other end of a curved arm 63 which extends through the opening 57 to control the movement of the valve 58. A recess 64 protected by a shielding lip 65 receives the flap valve 58 in one side of the fitting 56 where it is protected against a closing action of the flow of liquid passing down the pipe, through the opening 57. The valve 58 and the weight 62 are so balanced as supported by the pivot 61 that an appreciable upward pressure upon the weight 62 will cause the flap valve 58 to leave the recess 64 and enter the path of the incoming fluid. The flowing fluid then causes the valve to close and when closed the valve positively stops the flow of liquid into the tank in a manner preventing the filling of the tank above a predetermined level. A valve actuating means that is responsive to the level of the liquid in the tank, such as a float 66 is employed to actuate the valve and supply the required upward pressure at the proper time in the filling operation.

In order to actuate the valve 58 the float 66 is mounted upon an arm 67 which is pivotally mounted upon the same axis 61 as the valve and in the preferred embodiment of the invention the float arm 67 engages a stop 68 upon the weight 62 as the liquid and float 66 approach the predetermined safe filling level.

Although in less expensive installations, the float 66 might serve as a weight, it is preferred that the weight 62 be provided and be movable separately from the float away from the arm 67 as the flap valve 58 is closed. In this way there is no straining of parts when the valve 58 is closed quickly by the incoming liquid and once the liquid supply line is turned off at the service tank, a vent-hole 71 will permit the liquid to drain through the flap valve and permit the weight 62 to reopen the valve 58.

It is preferred that the opening 57 be directed towards the left end of the tank as shown in Fig. 1 whereby the eddy current developed by the incoming liquid will tend to keep any water condensation in the tank away from the liquid education tube 70.

In this way a positive shutoff is provided to prevent an overfilling of the tank, thereby avoiding the deficiencies of conventional practice in which vapor return gauges are inadequate due to the peculiar nature of the liquefied petroleum gas. With certain conventional devices the continuance of filling pressures in the tank cause a liquefaction of the gases already there and the level continues to rise regardless of a dip tube vent.

Although a vapor return connection is not entirely necessary, one is shown at 72 as threaded into an opening 73 in the wall 41. A safety check valve (not shown) is provided in the vapor return 72 which is opened when the nozzle of the vapor return hose is connected thereto.

A pressure gauge 74 and a safety relief valve 69 are mounted upon the wall 41 and also a shaft 75 which can be manually turned by the winged handle 76 to control the passage of liquid through the eduction pipe 70, more specifically described hereinafter.

The lower end of the shaft 75 is provided with a wrench socket 78 having a flared mouth 81 which serves as a guide to engage with the valve shaft 82 which controls the operation of the eduction tube 70.

When the tank is buried in the ground, the upper part of the standpipe 16 is located in a concrete box or vault 83 having a cover plate 84 secured thereto by bolts 85. The cover 84 seals the space 86 and a vent 87 is provided for free venting of the vault to atmosphere in the event the safety relief valve is called upon to function. In order to prevent water from collecting in the recess 43 at the top of the standpipe the walls of the standpipe are drilled as at 88 just above the wall 41 to drain water collecting in the recess 43.

Eduction cavity—General construction

Referring now to the eduction cavity 37 the well member 35 is a fabricated construction comprising a cylindrical tank or shell 91 which is about 6" to 8" in diameter and the same in length. The shell 91 is closed at its inner end by a plate 92 welded marginally thereto and the outer end has a wall 93 which is 2" or 3" high. The opening above the wall 93 is sealed by a head 94 and gasket 96 held in place by bolts 95.

A. Eduction cavity shown in Figure #1

Referring to Figs. 1 and 2, the plate 92 is perforated to receive the two ends of a revaporation coil 25 at preferably vertical spaced points in which the outlet end 97 of the coil is low enough to pass through the wall 93. In this construction when the coil is welded in place as by welds 98 the coil is rigidly supported and held in place at three spaced points.

Referring to Fig. 8 a shutoff valve fitting 101 is threaded into the plate 92 through the opening 102 and comprises a main body portion 103 having a valve compartment 104 therein to which liquefied gas is conducted by the liquid eduction pipe 70 through an inlet passageway 105 and from which an outlet passage 106 leads from the valve opening 107 controlled by a valve member 108.

It is preferred that the valve be a negative type valve, i. e. one, opening against the flow of the liquid, so that the valve compartment 104 can be located upon the pressure side of the valve. Then there is no need for packing where the valve stem 82 is threaded through the valve cap 111 as at 112.

Thus, as already mentioned, the flow of liquefied gas from the tank into the eduction cavity is controlled by the handle 76 at the top of the standpipe 16.

The outlet passage 106 of the valve body 103 is connected to a first stage regulator 113 by means of couplings 114 and a short elbow 115, one of the couplings comprising a union so that the regulator may be removed and attached at will. The outlet side 116 of the regulator is connected to the upper end 117 of the coil 25 by a pig-tail 128 so that liquid withdrawn through the eduction tube 70 passes through the valve 101, the regulator 113, the coil 25 and out to a second stage regulator 118 which reduces the ultimate gas pressure to 11" of water column for use in a dwelling.

The head 94 as shown in Fig. 1 has a vent or 75

opening 121 therein to maintain an equalization of pressures between the atmosphere and the eduction cavity 37. The head 94 is also provided with a liquid level drain or opening 122 which prevents the cavity 37 from being filled with liquid above a predetermined point.

The cavity 37 is filled preferably by an anti-freeze 120 non-miscible with water and in order to prevent any water seeping into the cavity 37 and forcing the anti-freeze out, the drain opening 122 is connected to a sump pipe 123 extending to the bottom of the cavity 37 so that any liquid head developed in the cavity 37 will force the water collecting at the bottom thereof, out through the opening 122. Otherwise the vent opening 121 is provided with a tube 124 to trap air above the liquid level and prevent a flooding of the cavity 37 in event an excessive amount of water is present at any one time around the tank.

B. Eduction cavity shown in Fig. 4

To the extent that the parts are alike in the two modifications, identical numbers have been used, and to the extent that the parts are substantially identical, the suffix "A" is used.

In Fig. 4 the embodiment is shown by which the liquid stored in the tank is employed as the anti-freeze solution in the cavity 37. Although the coil 25 may be employed or not employed in either or both of the embodiments illustrated, depending upon extreme gas withdrawal conditions expected to be experienced in any particular installation, the embodiment shown in Fig. 4 is illustrated without the coil.

In Fig. 4 the plate 94a is one without any openings therein so that pressures inside the tank 11 and inside the cavity 37 may be equalized without any leakage through the head 94a.

Equalization is had by means of a manual shutoff valve 131 threaded into the bottom wall of the cavity as at 132. The valve 131 is controlled by a shaft 133 extended through the wall 93a and sealed by a suitable packing (not shown) and when opened said valve permits free flow of liquid between the tank 11 and the cavity 37.

In order to provide for convective circulation of liquid through the cavity 37 an excess flow check valve 134 as more particularly shown in Fig. 9 is threaded into the boss 135 to seal the cavity 37 from the tank when there is an excess flow from the tank into the cavity 37.

The excess flow valve 134 is of the slug type mountable and removable from the inside of the cavity 37 either as a complete unit or part by part. The valve casing 136 which carries the rest of the parts is threaded into the welded boss 135 as at 137 and when withdrawn, serves to remove the valve as a unit. The valve casing 136 receives a threaded plug 138 therein which is provided with a valve seat 141 and a shoulder 142 which co-operates with the slug check 143 and a spring 144 by which the slug check 143 is normally urged away from the seat 141. In event it is desirable to remove only the valve parts, the plug 138 may be loosened while the casing 136 is held tightly in place thereby permitting repair and replacement of the valve in whole or in part.

In the event it becomes desirable to service the regulator 113 in Fig. 4, the valve 131 is closed and the bolts 95 loosened. This will permit the sudden escape of pressure from the cavity 37 and the excess flow check valve will close automatically. The cavity 37 will then evacuate

itself and the head 94a may be completely withdrawn to service the regulator.

First stage regulator

The regulator comprises a unitary body 145 provided with radially disposed fins 146 cast integrally therewith to absorb heat from the liquid in which the regulator is disposed, to supply that heat to the liquefied gas as it is vaporized.

In the construction shown, the inlet passageway 147 leads to a downwardly opening valve port 148 which is closed by a vertically movable centerpiece 151 carrying a seat 152 and a seat retainer 153.

The centerpiece is forced upwardly by a back cap spring 154 held in place by a backcap 155 threaded into the body 145 as at 156. A yoke 157 spans the port 148 to support the seat. At its top, the yoke 157 is threaded to receive the diaphragm 161 which is held in place by a threaded diaphragm plate 162. Marginally, the diaphragm 161 seals the expansion compartment 163 and is held in place by a bonnet 164 which carries an adjusting screw 165. The adjusting screw serves to regulate the pressure exerted by a spring 166 supported thereby so that the spring 166 opposes the action of the back cap spring 154 to hold the seat 152 away from the port 148 thereby permitting free flow of liquefied gas through the port 148 until the pressure differential is built up against the lower face of the diaphragm sufficient to close the valve 152.

The space in the bonnet above the diaphragm is vented to atmospheric pressure through a vent pipe 167 secured thereto by a union 168 having a flare nut 171.

In the particular embodiment shown in Fig. 1 the tube 167 opens into the interior of the cavity 37 and into the anti-freeze liquid 120 to prevent water condensation therein, while in the embodiment illustrated in Fig. 4 the tube 167a opens outside of the cavity through the wall 93a. In this last instance, there is little danger of a freezing of any moisture that might get into the tube 167a, because it is completely submerged in the earth warmed liquid circulating through the cavity 37.

Second stage reduction

The outlet of the regulator 113 is connected to the second stage regulator by a service conduit 181 which may be made of any suitable length to locate the regulator 118 inside or outside the dwelling or in the basement or upon the first floor of a dwelling wherever it is found desirable to locate the regulator.

The regulator 118 receives the gas under 5# to 20# pressure from the first stage regulator 113, and reduces it to a working pressure of 11" of water column, the pressure conventionally used with gas burning appliances.

Assembly

In assembling the eduction cavity all the parts are assembled thereto and the unit is then inserted into the opening 34 and welded in place by the weld line 36 after which the valve control shaft 75 is inserted and lowered to engage the socket 78 over the handle 82 as guided by the flared mouth 81. The mechanic can see to do this by looking through the relatively large opening 53. Thereafter the fill pipe 52 is mounted in the opening 53, the slip tube gauge is inserted and the fittings mounted upon the plate 41. The tank is then ready for shipment and in its as-

sembled form it is evident that all the important parts are protected from damage in transit.

Installation

As already mentioned the tank is buried below the frost line. Before the earth is filled into the trench around the tank the cavity 37 is attended to. In event the embodiment shown in Fig. 1 is employed the fill plug at 121 is removed and the cavity 37 filled with the non-miscible liquid to a level at which it begins to run out of the drain vent 122.

In event the embodiment is installed which is illustrated in Fig. 4, the shaft 133 is turned to open the valve 131 before the earth is filled in the trench.

After the tank is covered with earth, the standpipe 18 being free of side obstructions, the concrete box 83 may be received and lowered in place with a snug fit around the standpipe. Thereafter the filling of the trench in which the tank is placed is completed.

The cover 84 for the box 83 may be removed at any time during the operation and the fill pipe connected with the source of liquefied petroleum gas under pressure. In event a vapor return connection is provided, this also is connected with a supply tank to equalize the pressures between the supply tank and the storage tank. The weight of the float 66 or weight 62 will maintain the check valve open to permit the liquefied gas to enter the tank, the level of which gradually rises until it comes in contact with the float 66. Thereafter the float moves from a position inclined to the vertical to a position inclined to the horizontal and thereby increases its effective leverage during the lost motion between the float arm and the valve arm. Thereafter the float moves the valve outwardly gradually into the path of the incoming liquid far enough for the liquid to pick up the valve and close it; thereby obstructing the further flow of liquid gas to the tank and assuring that the tank will not be filled above a predetermined level.

During or after the filling operation the valve 101 may be opened to place the tank in operation. Thereafter liquefied gas will flow to the first stage regulator and be there reduced in pressure and simultaneously supplied with heat from the liquid body in which the regulator body is submerged.

The heat absorbed from the liquid body is replaced convectively through the walls of the cavity 37 (Fig. 1) or by convective circulation of the liquid in the tank through the openings in the wall 37. As heat is absorbed in this relationship the body of liquid in the tank replaces it with heat absorbed from the earth.

Thus, it will be seen with the present construction that heat units are supplied directly in a new and improved manner to that part of the system, namely, the first stage regulator, where the greatest refrigerating effect is experienced.

Consequently, although several preferred embodiments of the invention have been discussed and described herein, it will be apparent to those skilled in the art that various changes, modifications and alterations may be made without departing from the spirit of the invention, the scope of which is commensurate with the claims.

What is claimed is:

1. In a liquefied petroleum gas system, a tank comprising a cylindrical central shell having an aperture and a side opening therein, a standpipe secured in said aperture, a cup covering the opening and providing a water sump, end members for

the shell, one of said members having an opening therein, a well in said opening, an eduction member mounted upon the standpipe and terminating in said cup, a liquid eduction tube mounted upon the well, a pressure reducing regulator connected to said eduction tube, a closure for the well, anti-freeze means in said well in contact with said regulator, a valve between the eduction tube and regulator and means mounted upon the standpipe for operating said valve.

2. In a liquefied petroleum gas system, a tank having an opening in the top thereof and an aperture in the end, a standpipe mounted in the opening, a well mounted in the aperture, a liquid eduction tube including a pressure reduction means mounted in the well, a vaporization coil mounted upon the well, an anti-freeze material in the well in contact with the wall of the well and the regulator, and means for controlling the flow of liquid through the tube operable from the standpipe.

3. In a liquefied petroleum gas system a tank construction comprising a shell including means for filling the tank, a cavity in one end of the tank, a closure for the cavity, a pressure regulator disposed in the cavity, a gas eduction conduit comprising one section leading from the interior of the tank to the regulator and a service line leading from the regulator to a place of consumption, and liquid means in the cavity in contact with the regulator body and the wall of the cavity.

4. A liquefied gas dispensing system comprising a tank, a standpipe, means carried thereby for filling the tank, a pressure reduction regulator having a bonnet and located below the level of the filling limit of the tank and in heat exchange contact with the convectively circulating contents of the tank, and a vent for venting the bonnet of the regulator to pressures lower than tank pressure.

5. A liquefied gas dispensing system comprising a tank buried in the ground and having a body of liquid therein absorbing heat from the surrounding earth, a gas conduit including a pressure reducing regulator in heat exchange contact with said body of liquid, means ahead of the pressure regulator for controlling the flow of gas through the conduit, and means accessible from above the ground to control said last means.

6. A liquefied petroleum gas dispensing system comprising a tank buried in the ground below the frost level, a pressure reducing regulator disposed below the fill limit of the tank, and a body of liquid supplied with heat from the tank in convectively circulating contact with the regulator.

7. A liquefied petroleum gas dispensing system comprising a tank buried in the ground and having a liquid therein absorbing heat from the surrounding earth, and a pressure reducing regulator disposed in said liquid and receiving heat therefrom.

8. A liquefied petroleum gas dispensing flash system comprising a tank buried in the ground and having a body of liquid therein supplied with heat from the ground, a first stage pressure reducing regulator disposed in contact with said body of liquid and receiving heat therefrom, and means connecting the regulator with a source of liquefied gas under pressure, and a service line leading from said regulator to a place of consumption including a second stage regulator.

9. In combination with a storage tank, a liquid eduction conduit, a housing in contact with liquid in the tank, a diaphragm in the housing, one side thereof being exposed to atmospheric pressure, the other side of which is exposed to discharge pressure, a valve upon said other side and con-

trolled by said diaphragm, an outlet from the housing upon said other side, and means for conducting liquid to the valve from said liquid eduction conduit.

10. The process of vaporizing a liquefied petroleum gas comprising dividing a body of liquefied petroleum gas in several parts, passing one part through a metal body in heat exchange relationship with the other part confined to circulate convectively and reducing to a predetermined pressure the pressure of said one part while in contact with the body, withdrawing from the body the pressure reduced part to a point of use and continuously supplying heat to said other part from a source including the earth.

11. The process of vaporizing a liquefied petroleum gas below the frost line in the ground comprising passing the liquefied gas through a metal body, supplying the body with heat from a liquid circulating in direct contact with the body and simultaneously reducing the pressure of the liquefied gas in the body to a regulated pressure and supplying the liquefied gas with large quantities of heat from the body.

12. A liquefied gas dispensing system comprising a tank buried underground to receive heat therefrom below the frost line, means for filling the tank from above ground, a cavity in the wall of the tank, a regulator mounted in the cavity, a closure for the cavity, means for educting the contents of the tank to a point of use through the regulator, and means for conveying heat from the contents of the tank to the regulator comprising an element in heat exchange relationship with the regulator.

13. The process of dispensing liquefied petroleum gas in its vapor phase at its point of use comprising bringing a flowing stream of liquefied petroleum gas into heat exchange relationship with a body of liquid, disposed in heat exchange relationship with the earth below the frost line, reducing the pressure upon said flowing stream to a regulated pressure below the vapor pressure of said flowing stream while said flowing stream is in heat exchange relationship with said body of liquid to vaporize said flowing stream, and conducting the vaporized gas to the place of use.

14. A liquefied petroleum gas vaporizing apparatus including, a tank adapted to be buried underground to receive earth heat, conduit means in the tank having an inlet and an outlet and including a pressure regulating valve connected in the conduit means between the inlet and outlet of the conduit means, part of the conduit means constituting means for connecting the pressure regulating valve with a source of liquid petroleum gas, and a body of heat transfer liquid in the tank surrounding the regulating valve and said conduit means to conduct earth heat from the tank to the regulating valve and said conduit means.

15. A liquefied petroleum gas vaporizing apparatus including, a tank adapted to be buried underground to receive earth heat, an expansion and gas storage element having a portion disposed in the tank, a pressure regulating valve in the tank and connected with the expansion and gas storage element, a liquefied petroleum gas supply pipe for connecting the pressure regulating valve with a liquefied petroleum gas supply, a body of heat transfer liquid in the tank surrounding the regulating valve and said portion of the expansion and gas storage element to conduct earth heat from the tank to the regulating valve and said portion of the expansion and gas storage element, a dis-

charge pipe connected with the expansion and gas storage element, and a low pressure regulating valve interposed between the storage element and said discharge pipe.

16. A liquefied petroleum gas vaporizing apparatus including, a tank adapted to be buried underground to receive earth heat and having a body of heat transfer liquid therein, an expansion and vaporizing coil having a low portion thereof in the tank in heat exchange relationship with the liquid therein, a pressure reducing valve within the confines of the tank in position to receive heat from said liquid, said valve being connected with the expansion and vaporizing coil, means for conducting liquefied petroleum gas to the valve under pressure, a service conduit means connected to the expansion and vaporizing coil, and a low pressure regulating valve in said conduit means.

17. A storage tank for liquefied petroleum gas, a liquid eduction tube and regulator mounted within the contour of the tank, and means for sealing off the regulator from the pressure existing in the interior of the tank at will whenever it is desirable to service the regulator including a housing for the regulator, and a removable wall secured to the tank for providing access to the regulator.

18. In a liquefied petroleum gas dispensing system, a pressure reducer for flash vaporizing liquefied petroleum gas comprising a body defining a valve compartment, said body having a passageway therethrough terminating in a valve port opening into the compartment, a valve member cooperating with said port, means responsive to the pressure in the compartment for controlling the action of the valve, and means upon the body for absorbing heat from the environment of the body to supply the latent heat of vaporization to the liquefied petroleum gas present in said compartment in its liquid phase.

19. A liquefied petroleum gas vaporizing apparatus including a tank adapted to be buried underground to receive earth heat, an expansion and gas storage element having an inlet and an outlet and a portion thereof disposed in the tank, a pressure regulating valve connected with the

inlet of the expansion and gas storage element, means connecting the pressure regulating valve with a source of liquefied petroleum gas, and a body of heat transfer liquid in the tank surrounding the regulating valve and said portion of said expansion and gas storage element to conduct earth heat from the tank to the regulating valve and said portion.

20. The process of vaporizing a liquefied petroleum gas comprising passing liquefied gas in its liquid phase into a metal body, supplying the body with heat from a convectively circulating body of liquid outside of the metal body, simultaneously reducing the pressure of the liquefied gas present in the metal body to a predetermined pressure, and supplying said body of liquid with heat from the ground.

21. In a liquefied petroleum gas dispensing system the combination of a tank constructed to be buried in the ground below the frost line, an expansion regulator for vaporizing liquefied petroleum gas disposed below the fill limit of the tank in position to be supplied with latent heat of vaporization from the contents of the tank by convective circulation of liquid in the tank when liquid is present in the tank.

22. A liquefied petroleum gas dispensing system comprising a tank constructed to be charged with a body of liquid and to confine the liquid to convective circulation, a pressure reducing expansion valve for vaporizing liquefied gas disposed to be bathed with liquid in the tank in heat exchange relationship therewith when the tank is charged with liquid whereby latent heat of vaporization required to vaporize liquefied gas handled by the valve is supplied from said body of liquid.

23. The process of substantially completely vaporizing a liquefied petroleum gas comprising simultaneously reducing to a predetermined pressure the pressure upon the liquefied petroleum gas present in a metal body in its liquid phase and supplying the metal body with heat units from a warm body of liquid circulating in direct contact with the body and in heat exchange with the earth.

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