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LIQUEFIED PETROLEUM GAS EQUIPMENT
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Fig. 4

Fig. 5

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The present invention relates to liquefied petroleum gas equipment and more particularly to apparatus for handling liquefied petroleum gas.

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, preferably stored in an underground tank in the form of gas but not in the form of liquid. The storage tank is replenished by pressure of a gas foreign to liquefied petroleum gas in the tank. Such presence ultimately establishes a gauge pressure above the vapor pressure of the liquefied gas. The gauge pressure registered for any given storage tank is the vapor pressure plus the absolute pressure of the foreign gas present.

The most accurate method of measuring a quantity of liquid in the storage tank is by weight in view of the fact that, it is impossible to actually weigh a tank when it is buried, one of the objects of the present invention is to provide a liquefied petroleum gas system for the storage and dispensing of the gas in which the storage means is protected against overfilling in an improved manner, a means being provided that is related to a constant factor which can be relied upon in determining the volume of liquid present in relationship to its absolute weight.

The present invention positively prevents overfilling of the tank whether the operator is present and watching the operation or temporarily absent at the time the maximum level is reached in the storage tank and the present invention, furthermore, eliminates the need for making computations involving temperature when the tank is filled.

Another object of the invention is to provide an improved system for the filling of storage tanks whether they be filled by gravity or by a forced feed pump. Furthermore, the present invention provides an improved multiple function fitting or head which can be attached as a single unit to a tank whether the tank is provided with a riser pipe or not. Conventional fittings heretofore used have been formed of cast metal, whereas the present construction is so designed as to be constructed not only as a casting but as a forged body. This eliminates the waste present with cast bodies rejected because of porosity and provides a lighter unit.

A further object of the invention is to provide an improved head so constructed and arranged that a single fitting is utilized to provide for liquid elevation when the system is used as a flash system and also serves to agitate or stir the contents of the tank when the tank is filled and withdraw the liquid contained if upon occasion it becomes desirable to empty the tank.

A further object of the invention is to provide an improved flash dispensing system wherein the
first stage of pressure reduction is provided with an improved pressure regulator. 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 vertical sectional view taken longitudinally through a tank illustrating the structure and arrangements of the preferred embodiment of the invention when the storage tank is being filled and the system is in operation.

Fig. 2 is a perspective view of the body forging illustrated in Fig. 1 before machining.

Fig. 3 is a top view of the fitting as taken upon the line 2-2 in Fig. 1.

Fig. 4 is a section taken upon the line 4-4 in Fig. 3.

Fig. 5 is a section taken upon the line 5-5 in Fig. 3.

Fig. 6 is a view similar to Fig. 3 illustrating another embodiment of the invention.

Fig. 7 is a section taken upon the line 7-7 in Fig. 6.

Fig. 8 is a side elevation showing the full pipe and gauge control which can be used alternatively with the fittings shown in Fig. 3 and Fig. 6.

Fig. 9 is a lateral view of the device illustrated in Fig. 8 taken at a 90° angle.

Fig. 10 is an enlarged view of the float construction shown in Fig. 1, and

Fig. 11 is an enlarged vertical section through the first stage pressure regulator shown in Fig. 1.

Referring now to the drawings in further detail and particularly to Fig. 1, a pressure tested, corrosion treated tank 20 is buried in the ground below the frost line 22 thereof to absorb heat from the earth to warm the liquid (not shown) which is stored in the tank, such as a liquefied butane or propane or a mixture of both.

With this arrangement the heat of the earth is relied upon to establish a vapor pressure in the tank which may be utilized to force fuel either in its liquefied state or its vapor phase, out of the tank.

The tank is provided with a riser pipe 23 which is welded at the lower end thereof to the tank 20 as at 24 where it is disposed over an opening 25 in the top of the tank. At its top, the pipe 23 receives thereon a concrete curb box 26 having a cover 7 hinged thereto which when closed, may be locked (padlock not shown) and fastened to the tank 28.

The length of the pipe 23 is determined in relationship to the depth at which it is expected to bury the tank 20 so that the upper end of the pipe is disposed well down in the box 25 after the installation is made. The upper end of the pipe 23 is threaded as at 31 to receive a cap (not shown) which prevents foreign matter entering the tank during shipment and installation after which the cap is removed and a fitting or head 32 is threaded thereon.

The head 32 comprises a body carrying a pipe or duct 33 which extends to a point adjacent the bottom of the tank as shown in the particular embodiment illustrated in Fig. 1 where, through an opening 34, liquid from the body thereof within the tank may be withdrawn into the pipe 33 in a manner which will be described in further detail hereafter. The liquid then flows through pipe 34, through fitting or head 32 and passes outwardly and downwardly through tubing 35 which has an excess length thereof bent back and forth along the top of the tank as at 36 to absorb heat therefrom. The pipe 36 leads to a first stage pressure reduction regulator 37 which has an elongated back cap 38 disposed inside the tank and is supported upon a flange plate 41 welded to the tank over an opening 42 therein. Beyond the first stage regulator 37 a service pipe 43 leads to a second stage regulator 44 which may be located near the first stage regulator if desired but preferably is disposed inside the dwelling where the gas is to be used.

The tank is provided with an initial supply of liquefied gas and replenished from time to time through a hose connection 45 and valve 49 leading from a service truck 46, being supplied with liquefied gas under pressure by means of a reversible pump 47 whose intake 48 is connected to the bottom of the tank 46 and whose output is carried to the hose 49 by means of a conduit 51 which includes a meter 52 that is connected to the truck tank 46 by a by-pass including an elbow 53 and a pressure relief valve 54.

Although provision has been shown for venting the storage tank 20 back to the supply tank 45 during filling operations, equalization of pressures between the two tanks is had with the hose 45 when connected. In fact, during the summer months the tank 46 because of the sun shining on it, will have a vapor pressure which is greater than the vapor pressure in the buried tank 20. This pressure assists the pump 47 in driving liquefied gas into the tank 20. Then, whenever flow through the pipe 45 is obstructed the meter 52 will stop registering and the by-pass relief valve 54 will come into operation.

The hose 45 supplies liquefied gas to the tank 20 through the pipe 33 which is supported upon the fitting 32 in communication with the hose 45.

Unit assembly

Referring now to Fig. 2 the body forging for the fitting 32 is illustrated as it appears before machining. The forging 55 is made with two dies whose line of separation follows the outline contour of the forging as seen in plan view. The lower die (not shown) provides a cylindrical shell 56 at the base having a cylindrical wall 57 and the upper die in cooperation with the lower die provides upwardly extending bosses 57, 55 and 59 and laterally extending bosses 60, 61 and 62, the space between the inclined bosses being provided with a bulk of metal 63.

The open space 64 in the shell 56 is separated from the metal 63 by a wall 65 which in the particular embodiment shown, is of sufficient thickness to permit the dies to function to their best advantage.

All contours of the forging taper from the line of separation, the shell 56 tapering downwardly and being provided with sufficient stock to receive threads 66 therein, Fig. 4, and the wall 65 being provided with sufficient stock and thicknesses where required, to receive the several units assembled therewith which will now be described.

In the particular embodiment with reference to Fig. 4, the boss 67 is provided as a liquid outlet and inlet connection having a double valve construction. The boss is drilled out to a depth indicated at 67 where it is in communication with an upwardly drilled and threaded opening 68 in a portion 11 of the wall 65. In this wall is formed a cylindrical well which serves as a guide 73. The guide is located beyond the end
of the plug 128 (Fig. 3) and receives the stem 74 of a valve member 75 which is spring pressed outwardly by a compression spring 76. The boss is threaded as at 77 to a depth providing an annular shoulder 78 beyond which the walls are undercut as at 81 to provide a valve chamber 80 for the valve 75 with sufficient clearance between the valve 75 and the walls 81 to permit free flow of liquid past the edges of the valve 75. The valve 75 is held in place by a retainer 82 screwed in place against the shoulder 78. The retainer 82 provides a valve seat 83 for the valve 75. The valve 75 is drilled out as at 84 to receive for mentioned and shaft 134 which valve is held in place by a compression spring 127 disposed inwardly of the place where a retainer 128 rests against a shoulder 131.

At its outer end the shaft 134 is cross sectionally contoured as at 135 in an irregular manner to receive a tool (not shown) thereon in only one relationship so that the relative position of the pet-cock valve 126 can be determined. A sealing cap 136 is provided as required. The pet-cock valve 126 is provided with an L-shaped passage 138 therein and in one position the passage 138 as shown in Fig. 4 connects the vapor education portion of passage 106 with the service passage 101 for batch vaporization as when the pet-cock valve is turned 90° counter clockwise from its position shown in Fig. 4, the passage 138 connects the service passage 101 with the liquid education compartment 80 for purpose of flash vaporization. It will be further seen also that the opening of one of the passages by the movement of the pet-cock will close the other.

In this way whenever the system is being operated with batch or flash vaporization, filling operations in which liquified gas is forced into the tank through the compartment 89 and pipe 33, do not in any way affect the service characteristics of the system. Furthermore, whenever it is desirable to empty the tank, as more particularly described in the Norway Patent No. 2,361-865, there is no opportunity for vapor to reach the compartment 89 through the vapor withdrawal passage 138 to break the suction, if set for batch vaporization. In the event the system is operating on flash vaporization as when the pet-cock is set for liquid education, the filling operation in no way affects the service conditions even if air is present in the hose line. Any air that might happen to be in the hose 45 at the time the connection was made, will be forced past the passage 108 and into the tank without entering the service line 101. Any air that might enter the passage 138 due to gas being used at the appliance will tend to bubble back into the incoming liquid since the inlet of passage 138 opens upwardly.

From the description thus far, it will be seen that a new and improved liquified gas dispensing method and apparatus is provided for batch or flash vaporization only on one end of tube being required for the purposes mentioned.

Boss 59 (Fig. 5) is drilled out to receive a safety pressure relief valve 141, many characteristics of which are more fully described in the Buttnen et al. Patent No. 2,364,208.

A cutler (not shown) provides a cylindrical cavity 142 in the boss 59 at the bottom of which is provided a raised valve seat 143 and at its outer end the wall 144 is internally threaded as at 145.

Mounted within the cavity 142 is a spring guide 146 having a hexagonal outer contour, the corners of which serve to guide the spring guide with respect to the wall 144. At its lower end the spring guide is threaded to receive a disc retainer 147 which holds a compression disc 148 in its proper position to cooperate with the seat 143. A compression spring 151 is disposed in the spring guide in a located by an adjustable spacer 153 threadedly received in the cavity by threads 145, where after adjustment, it is held in place by a drop of solder 154.

The safety valve 141 is continuously in open communication with the interior of the tank through a drilled passage 156 which forms the inner boundary and the port area of the valve.
seat 143. A weep-hole 157 is provided to prevent the collection of moisture around the valve seat.

Lest the capacity of the safety relief valve 141 is insufficient for any particular installation, the boss 62 is provided with enough body stock that a threaded opening can be provided there-through to receive a safety relief valve such as that shown in the Buttner et al. Patent No. 2,254,209, when, upon occasion, such is required.

A vent connection 161 is preferably provided to remove any accumulation of air which might be present at the top of the riser pipe. This vent connection is received in the boss 58 where it is drilled sufficient to receive a slug check 162 that is held normally open by a spring 163 i.e. away from a retainer 155 whose lower face comprises a valve seat. The spring extends through a guide opening 164 in the slug check retainer 165, the outer end of the spring abutting against a spacer 166 which is also a guide for the stem 167 of the safety check 168 mounted within a body 171 which body has a machined valve seat 172 thereon cooperating with a disc 173 upon the valve 168. The safety check valve 168 is kept normally closed by a compression spring 175 positively operated by a pin 176 support ed on the valve, whenever the body cap 176 is removed and an attachment is connected to the body 171 that has a projection thereon engaging the pin 175. This attachment may be a valve outlet bleeding into the atmosphere or may be a hose connection returning to a tank, such as the tank 46 shown in Fig. 1, if it is desirable to prevent any escape of gas to the atmosphere as a fire precaution under exceptional conditions.

A passageway 177 places the valve 168 in direct and continuously open communication with the top of the riser pipe 23, and a weep-hole 182 is provided in the slug check 162 to equalize pressures on opposite sides thereof to open it again when normal conditions are resumed after it has been brought into operation.

Gauge

The stock 63 is machined to proper dimension to receive a liquid level gauge 161 preferably with an opening or hole 162 as large as possible cut through the wall 61 to accommodate the shaft 183 of the gauge and to provide room for visual investigation of the interior of the tank, if upon occasion desired, and the fitting 22 threaded with a luting compound such as litharge to the riser pipe 23 against ready removal. This machining serves also to remove as much metal stock as possible for salvage from the forging, the salvage being an item of economy and saving. However, the hole may be merely drilled to provide a journal for the shaft 183 at the top thereof in which case very slight leakage would be experienced if it became desirable to open up the gauge to replace either the dial or the hand there in if the gauge is not a scaled magnetic gauge. Around the upper part of the machined opening 182, a recess 180 is provided to receive a gasket 184 which is disposed below the flange 185 upon the gauge housing 186. The gasket 184 is compressed to provide a seal by means of four bolts 187 secured in the metal 63. The disk 189 and hand 192 for the gauge are shown in Fig. 3.

The gauge shaft 183 is operated by a float 193 (Fig. 1) which is pivoted as at 194 to a collar 195 which forms either a coupling between two sections of pipe 33 or a sleeve held in place on the pipe 33 by any suitable means such as a lock screw (not shown). The float 193 is counterbalanced by a weight 196, and, at a predetermined point 190 spaced from the pivot pin 194, a thrust shaft 197 is pivotally fastened to be operated by the float arm 198 to move a lead nut element 201 (Fig. 8) up and down along a bracket 202, a part of said element being guided in a slot 203 (Fig. 9). The lead nut engages a helical cut 204 on the lower end of the gauge shaft 183.

The lead nut is mounted for rectilinear movement with respect to the bracket 202 and the discrepancy of alignment existing between the accurately moving float arm and the rectilinear movement of the lead nut 201, is accommodated by a pivotal connection 205 between the thrust arm 197 and the lead nut 201. In this way movement of the float 193 translated to the pivotal point 194, moves the lead nut 201 along the bottom end of the shaft 183 to rotate it.

Depending upon different types of installations and different lengths of pipe 33 the brackets 202 are secured in place by sleeves or clamps 206 fastened in place at any convenient height upon the pipe 33. The construction illustrated and described herein provides a compactness for this purpose with the sectional diameter is small enough to permit same to be lowered through the riser pipe 23 quite easily.

At the lower end of the dip pipe 33, a fitting 207 is threaded thereto which has the opening 34 therein, the fitting being provided with a valve seat 208 and a spigot 211 pivotally mounted within the fitting as at 212 upon a shaft which extends laterally beyond the fitting to receive a crank arm 213 carrying a thrust shaft 214 thereon. The arm 213 is weighted to hold the valve 211 normally away from the seat 208 but when the thrust shaft 214 is actuated, the flapper valve 211 is moved away from its resting position. When so moved, and with liquid being forced into the tank, the stream of liquid will cause the flapper valve to close thereby obstructing further flow of liquid through the opening 34. This provides a positive means for preventing the flow of liquid into the tank when a predetermined level is reached.

The operation of the valve 211 is controlled by the float 193 through means of a swivel eye 215 slideable on shaft 214 engaging an adjustable stop upon the thrust shaft 214. The stop 216 is capable of being so set that the swivel eye 215 engages it slightly prior to the time that the liquid in the tank carries the float 193 to the maximum safe filling limit. The leverages of the crank arm 213 and the point at which the swivel eye 215 is located upon the float arm 198 are so selected that slight movement of the float at the fill limit will move the flapper valve 211 enough to cause the incoming liquid to close it and thereby positively prevent overfilling of the tank.

In order to have the float 193 fully responsive to the liquid level through the expected range in the tank, the float arm 198 is made long enough to engage the bottom of the tank well to one side of the pipe 33, the float 193 in its fully lowered position being indicated in phantom at 217. With this construction and arrangement, the float 193, gauge 161, and fitting 207 can be lowered as a unit through the riser pipe and the float is urged slightly from vertical to start it on its lateral movement in the tank.

However, it will be noted that the head 52 is screwed into place upon the riser pipe 23 and this requires rotation of the pipe 33. In order to have
the float arm 193 long enough to have the float 193 function as described the length thereof is greater than the radius of the tank and therefore the arm would be bent if it otherwise were rigid throughout its length when the fitting 22 was screwed into place.

Referring to Fig. 10, a buckle joint is provided in the arm 198 which permits the turning of the pipe 33 at the time of installation or removal without injury to the float. This joint is made by fashioning the arm 198 in two sections 189a and 189b with their adjacent ends flattened in a manner capable of being super-imposed one upon the other and pivotally mounted by a rivet 218 so that the float can move from the position indicated at 221 to the position indicated in phantom at 222. The rivet 218 is disposed in a vertical plane so that when the float portions 220 are super-imposed one upon the other, the shaft 199 transmits a vertical force as though it were a rigid construction. A light tension-spring 223 is cycled to engage the free end 224 of the shaft portion 198b to pull the shaft portion 198b into axial alignment with the shaft portion 198a whenever the float 193 is free for that purpose, the other end of the spring 223 being pinned to the shaft portion 198a by a hook 225 disposed longitudinally in the same general direction sufficient to impose upon the spring 223, the force which is necessary for it to accomplish its purpose.

Thus, whenever the head or fitting is rotated, the float arm 198 buckles each time required by the closeness of the side walls of the tank and ultimately straightens to place the float in its expected path of operation.

The arm 198b is preferably made of a bi-metal strip which flexes in a vertical plane with temperature changes. This is provided to compensate for thermal expansion and contraction of the body of liquefied gas present in the tank so that, due to the cooperation of the float determining the volume and the bi-metal strip determining the temperature, there is an automatic adjustment for temperature changes in determining the absolute weight of liquid present in the tank. The arrangement of the bi-metal is such that the arm flexes upward to delay the action of the flapper valve 211 so that there will be a measured overfilling of the tank in relation to outage required for liquid contracting after it has been cooled by earth temperature. The filling operation will be stopped before a fixed theoretical level is reached if the liquid happens to be colder than the ultimate temperature which it will assume in the tank, thereby permitting sufficient room for the liquid to expand safely when it warms.

Referring now to the embodiment illustrated in Figs. 6 and 7, like numbers of reference are used to indicate parts like those already described. A unitary head or fitting 231 is shown which does not have any vent return valve thereon, and uses a gauge connection wherein the shaft 189 is journaled in the body 231 and is connected with the gauge by means of a sleeve 232 receiving the splitted shaft 233 of the gauge 184a in drive relationship.

Furthermore, in this particular embodiment the head 231 is adapted for batch vaporization only and the fill pipe 33c does not extend to the bottom of the tank but constitutes the embodiment illustrated in Figs. 8 and 9.

In view of the fact that liquid withdrawal for emptying the tank is not contemplated in this particular embodiment which is more or less adapted for aboveground installations where the tank used is small enough to be shipped back and forth between the fuel dealer and his customers in the ordinary course of business, if necessary, the fill opening is machined to receive a safety check valve 234 spring pressed outwardly by a spring 235 which forces the valve 234 to close against a seat 236 on the bottom of a retainer 237. In this embodiment the retainer 237 is preferably separated from the filler body 238 which of itself, carries a spider 241 that serves as a guide for the stem 242 of a valve 243. The valve 243 is spring pressed outwardly by a spring 244 to engage a seat 245 machined in the filler body 238. In this construction the check valves open simultaneously only upon the application of a pressure outside of the tank.

A modification of the safety valve 141 is shown in this construction wherein the valve seat 143c comprises an insert. As a general rule, the forgings illustrated herein are made of bronze or brass. In this embodiment the valve seat 143c is made of aluminum or similar metal or material which oxidizes very rapidly to form a thin layer of aluminum oxide which has glass-like characteristics very favorable to the prevention of coalescence between the seat and disc 140, this being one of the features of the present invention. The insert 143c is threaded into the forged body as at 246 with the opening 247 therethrough provided with a geometrical contour suitable to receive a wrench that can be used to tighten or loosen, the seat 143c for installation or removal.

A further safety relief valve in the form of a fuse plug 248 is illustrated in this embodiment in the form which can be used with the first described embodiment if desired.

In mounting the fitting 231 upon a riser pipe 23a, a pipe which may be much smaller than the riser pipe 23, a screw flange 251 is threaded on to the riser pipe 23a and is grooved at 252 to receive a gasket 253 compressed between the machined face 254 upon the bottom of the fitting 231 and the screw flange 251 which are held in bolted sealed relationship by means of the bolts.

With this particular embodiment the bosses are disposed at such angles to each other that four bolts 255 may be employed to secure the head in position. The outlet boss 256 receives an excess flow check valve 257 therein, which is held in place by a retainer 258 inserted inside of the conical seat 261 which receives a P. O. L. connection such as that shown in Fig. 4 at 111. The P. O. L. connection shown in Fig. 4 comprises a male member carried by the head whereas in Fig. 6 the opening is a female member. The needle valve which controls the flow of gas to the outlet opening is in this particular embodiment, disposed in a separate boss 262 as shown in Fig. 7. In this particular construction, the valve seat 263 is formed in the body of the fitting 231 and the threaded shaft is threadedly received also directly in the body, a cross drilled passageway 264 being provided between the two bosses 252 and 262.

The fill pipe 33a as illustrated in Fig. 9 is so constructed and arranged that it can be completely assembled outside of the tank and inserted into place through the riser pipe 23a. At its bottom, the fill pipe 33c is threadered to receive a fitting 265 somewhat similar to the fitting 201. The fitting 265 has a discharge opening 266 upon one side thereof and a flapper cut-off valve 267 pivoted as at 268 on the bottom and outside thereof where it is easily assembled. A counter weight
sealed contact with an adapter 312 by a swivel nut 313. The male member 311 is constructed as an integral spider to serve as a guide for the valve element 266 as supported by a backcap spring 314 which rests at one end upon the spider and steadies the operation of the valve. The adapter at the bottom thereof is internally threaded as at 315 to receive an elongated bushing 316 which serves as a wall in heat exchange contact with a liquid in the tank 20. The backcap 316 is received in the tank through an opening 317. The first stage regulator 37 thus described is assembled as a unit outside of the tank and is mounted upon the tank by means of an internally threaded flange plate 318 welded to the tank as at 321 and external threads 322 upon the adapter 312 are received in the flange and sealed against leakage by lockwash or some other suitable pipe joint gasket 323.

In operation, after the tank has been installed, the service truck is backed into position and the hose 45 connected to the fill connection.

The fuel pump 47 is started and with the check valve 32 held in its normally open position, liquefied gas will flow into the tail of the adapter therein a gauge pressure and the incoming liquid will force the air to the top of the riser pipe where it may be progressively vented to the atmosphere or to the truck tank in the manner described.

As the liquid level rises in the tank it covers the opening 34; thereafter agitation of the vapor in the tank is reduced to a minimum so that any air therein may be maintained in a more or less stratified condition to be vented as suggested.

The float 183 begins to rise and operate the liquid level gauge to indicate the level present in the tank at any given moment during filling operations.

As a general rule, the temperature of the liquid in the truck tank 46 is higher than the ultimate temperature of the liquid in the buried tank 20, particularly if the tank is being serviced in mild or summer weather. It is a common practice to estimate the quantity of liquid supplied to a tank in relationship to the temperature of the liquid. If this temperature is taken at the truck tank and the truck tank is warm as compared with the liquid in the tank, there will be a discrepancy between the meter reading 52 and the volume indicated upon the liquid level gauge 181.

In view of the fact that the maximum safe level of any given liquefied gas varies with the temperature of that gas for any particular tank there is a possibility of the tank being overfilled under certain circumstances or underfilled under other circumstances, if the level limit is arbitrarily fixed for the tank regardless of temperature.

In the particular embodiment illustrated, the float 193 is pivoted as at 194 preferably below the upper fill limit so that as the level rises, the arm of the float is submerged and is brought in contact with the liquid. Thereby, the arm is influenced immediately and directly by the temperature thereof, this temperature being maintained quite uniform throughout the body of liquid by the turbulence created by the liquid being introduced directly into the body thereof.

Once the liquid comes in contact with the arm 198, the bi-metal portion thereof begins to flex in response to the temperature of the liquid and vary the position of the float 193 with respect to the swivel eyelet 213 sliding in the shaft 14 so that the valve 211 may be actuated at different levels depending upon temperatures. This relates the filling operation and the maximum level.
to the absolute quantity of liquid in the tank. This arrangement is of particular advantage where the tank is buried, where the temperature is substantially uniform and a safe volume of liquid can be more closely determined, yet takes care of the contingency of liquid being supplied to the tank at a temperature above or below the temperature which will ultimately exist for the liquid as buried into the ground. Furthermore, the bi-metal strip in the arm 1880 will eliminate the need of computation from the reading of the gauge since, in combination with the metal strip, will determine the absolute volume of liquid gas present in the tank, by a weight criterion, said gauge being graduated in pounds if need be and computed in relationship to vapor volume also present in the tank.

Once the float 15 makes the point where the filling operation is to be stopped, the swivel eyelet 215 engages the stop 216, moves the valve 211 out into the path of full liquid, the inward movement of which carries the valve 211 to its closed position. This immediately creates a back pressure upon the hose 46, the meter 52 stops its operation and the output of the pump 41 is by-passed back to the tank through the by-pass relief valve 54.

After the tank 20 has been filled and vented the manual cut-off needle valve 112 may be opened and the pet cock valve set for either batch or flash vaporization. In the event it is set for flash vaporization, liquid will then be conducted to the first stage regulator 37 where it will pass through the opening 282 to be vaporized by a reduction of pressure to the extent that heat present in the regulator body is sufficient to support vaporization. Under normal operations with the regulator buried in the protective shell as shown below the frost line, the heat therein will provide adequate vaporization for an average draw of fuel in the service line. In the event, however, an excessive draw is made upon the system, liquefied gas which does not acquire sufficient heat to vaporize at the regulator norm will fall to the bottom of the backcap 316 where it will come in contact with the metal thereof, which has been warmed by the liquid in the tank from heat absorbed from the earth. There, under the low pressure existing in the backcap, the liquefied gas will vaporize and return to the top of the regulator to go into the service line and be carried to the second stage reduction, where vaporization at 11 inches of water column is further assured. As mentioned, the inlet pressure to the second stage regulator is had at a pressure of 5 to 10.

Consequently, from the description had of the present invention, it will be seen that in addition to the stated and apparent objects of the invention, a method and apparatus for storing and dispensing liquefied petroleum gas is hereby provided which is simple in construction, easy to manufacture, install and service, and simple to operate, being within the safety factors prescribed by various authorities for the liquefied petroleum gas industry. Furthermore, having shown and described certain preferred embodiments of the present invention, it will be apparent to those skilled in the art that various and further uses, modifications and changes may be made without departing from the spirit and substance of the invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. In a liquefied gas dispensing system of the class described, a pressure storage tank receiving heat from an outside source, means for withdrawing liquid from the tank, a pressure regulator connected to said means to receive liquid and having a portion thereof disposed in heat exchange contact with the liquefied gas in the tank.

2. In a liquefied gas dispensing system of the class described, a pressure storage tank receiving heat from an outside source, means for withdrawing gas from the tank, a pressure regulator including a valve connected to said means and having a chamber on the low pressure side of the valve disposed in heat exchange contact with the liquefied gas in the tank.

3. In a liquefied gas dispensing system of the class described, a storage tank, a service pipe connected to the tank, a pressure regulator having a bridge therein with the inlet port below the outlet port, a section of said regulator being disposed in said tank to receive heat therefrom, said bridge being arranged in position to be warmed by vapor passing from said section out through said outlet port of the regulator.

4. In a liquefied gas storage and dispensing device of the class described, a storage tank means selectively withdrawing liquid or vapor from the tank, a service pipe connected to said means, a pressure regulator connected in said service pipe, a section of said regulator receiving heat from said tank for assuring vaporization of the fluid withdrawn in the pipe.

5. In a liquefied gas storage and dispensing device of the class described, a storage tank, a fitting for filling and selectively withdrawing liquefied or vaporized gas from the tank, a service pipe connected to the fitting including a pressure regulator supported upon the tank and having a portion thereof warmed by the contents of said tank.

6. A combined pressure reducer and vaporizer for liquefied petroleum gas comprising a body having a valve chamber, a valve in the chamber, means responsive to the pressure in the valve chamber for operating said valve, and an elongated heat exchange member mounted upon the body for expanding fluid admitted to the valve chamber through the valve.

7. In a liquefied gas dispensing system having a storage tank, means for filling the tank including a conduit extending to the bottom of the tank, a valve closing in the direction of inflow of liquid in the conduit, a double valve obstructing the outflow of liquid in said conduit, a service conduit, and means connecting the service conduit with the first conduit below said double valve.

8. In a liquefied gas dispensing system having a storage tank, means for filling the tank including a conduit extending to the bottom of the tank, a valve closing in the direction of inflow of liquid in the conduit, a double valve obstructing the outflow of liquid in said conduit, a service conduit and means connecting the service conduit with the first conduit below said double valve, a vaporizing expansion valve means connected to the conduit including a heat exchange element, and a pressure regulator for reducing the pressure of the gas to a service pressure and to withstand the surge of filling liquid in the service conduit when the first valve closes.

9. In combination, a plurality of tanks, a reversible pump on one tank including a by-pass controlled by a valve opening in the direction of flow of liquid through the by-pass from the outlet side of the pump; a head upon the other tank including a filler opening and a conduit connected
thereto and extending to the bottom of said other tank, a valve in said conduit closing in the direction of flow of liquid through said conduit into said other tank, a flexible conduit for interconnecting the filler opening and the outlet side of the pump including a manual cut-off valve, a liquid level responsive device in said other tank for actuating said conduit valve at a predetermined level, said conduit valve when actuated closing the flow of liquid through the conduit and creating a back pressure in the hose to open said by-pass valve until said manual valve is closed.

10. A filling device for liquefied petroleum gas storage tank comprising a die formed head secured to the tank and having an opening therein, a safety check valve in said opening, a conduit extending to a point adjacent the bottom of the tank in communication with said opening, a valve in said conduit, means responsive to the level of liquid in the tank, and means interconnecting the responsive means and the second valve including a lost motion device.

11. A filling device for liquefied petroleum gas systems comprising an inlet conduit, means for introducing liquefied gas into the conduit, a valve closing in the direction of flow of said introduced gas disposed in said conduit, means responsive to the quantity of liquid introduced through the conduit for operating said valve, and means controlled by said responsive means for indicating variations in said quantity.

12. In a liquefied fuel gas dispensing system of the class described having a pressure storage tank buried in heat exchange relationship with the earth to absorb heat therefrom, unitary means secured to said tank including a conduit for performing the functions of filling the tank with liquefied gas to a predetermined level and evacuating the tank of liquid fuel and educting gas from the tank for consumption through said conduit.

13. In a liquefied fuel gas dispensing system of the class described having a pressure storage tank buried in heat exchange relationship with the earth to absorb heat therefrom, a unitary fitting secured in sealed relation to the tank and having a bifurcated passage theethrough, a conduit element carried by the fitting and interconnecting said passage and a point adjacent the bottom of the tank, means for controlling the flow of fuel through one of said bifurcations including a manually controlled valve and a check valve, and means for controlling the flow of fuel through the other bifurcation including a check valve and a valve closing outwardly, means interconnecting the last two valves for holding the outwardly closing valve open when said last check valve is moved positively to its open position.

14. For use in combination with a liquefied petroleum gas dispensing tank, a head constructed to be secured in sealed relation to the tank including a fill conduit, a valve controlling the inflow of liquefied gas through the conduit, and means constructed to respond to the level and temperature of liquid in the tank for operating the valve.

15. For use in combination with a liquefied petroleum gas dispensing tank, a head receivable on the tank including a fill conduit, a normally open valve for controlling the inflow of liquefied gas through the conduit, and means constructed to respond to the level of liquid in the tank for actuating the valve, said means including means for responding to the temperature of the liquid in the tank for varying the point at which said level responsive means operates to actuate said valve.

16. For use in combination with a liquefied petroleum gas dispensing tank, a head constructed to be secured to the tank including a body portion, a fill conduit, and connecting means, the fill conduit being connected to the tank at a point above the liquid level of the tank, a valve closing in the direction of flow of liquefied gas through the conduit towards the opening and free to open with flow of liquid in the opposite direction, and means constructed to respond to the level of liquid in the tank for operating the valve, said means including an element for responding to the temperature of the liquid in the tank for governing the operation of said level responsive means.

17. For use in combination with a liquefied petroleum gas dispensing tank having an opening therein; a head adapted to close said opening including a body member, a conduit carried by the body member to extend to the bottom of the tank when the head is in place, a valve closing in the direction of flow of liquid through the conduit from the body member and opening with the flow of liquid through the conduit in the opposite direction, means for responding to the level of liquid in the tank for actuating the closing of said valve, a filling conduit in the head in communication with the first conduit ahead of said valve and including a back flow check valve, and an outlet conduit in the head in communication with the first conduit between said valves.

18. For use with a liquefied petroleum gas dispensing tank, a head including a body receivable on the tank, a conduit carried by the body and opening at one end into the tank when the head is in place, a valve closing in the direction of flow of liquid through the conduit and out of said opening, means constructed to respond to the level of liquid in the tank for operating the valve, filling and dispensing conduit in the body in communication with the conduit head of the valve, and automatic valve means controlling the outflow of gas through the dispensing conduit.

19. In a liquefied gas dispensing system of the class described, a pressure storage tank buried in the ground to receive heat from the ground, means including a conduit for filling the tank to a predetermined level with liquefied gas to provide a body of liquid in the tank and for withdrawing the gas from the tank, said means including an inlet for receiving filling liquid into the conduit and an outlet for dispensing liquid from the conduit, a closed bottom tube extending into the space within the tank in heat exchange relationship with the body of liquid, and a pressure reducer connected to said outlet and mounted upon said tube with the valve compartment of the pressure reducer draining into the tube.

20. In a liquefied gas dispensing system of the class described, the combination of a pressure storage tank buried in the ground to store in heat exchange relationship with the ground a liquefied petroleum gas in both its liquid and vapor phases, means for educting gas from the tank in its liquid phase, a tube in the tank in heat exchange relationship with the liquid in the tank, a pressure reducer connected to said educting means and mounted upon said tube with the valve compartment of the pressure reducer draining into the tube.

21. In a liquefied gas dispensing system of the class described, the combination of a pressure...
storage tank buried in the ground below the frost line to store in heat exchange relationship with the ground a liquefied petroleum gas in both its liquid and vapor phases, a riser pipe upon said tank extending to a point above the frost line, a fitting carried by the riser pipe including a conduit extending from the fitting into the tank for eutectic gas from the tank in its liquid phase, a pressure reducer for lowering the pressure upon the eutectic liquid from the pressure thereon in the tank to a pressure below said pressure to expand the eutectic liquid, and means connecting said conduit through the fitting and pressure reducer and arranged for warming said eutectic liquid with heat from the contents of said tank.

22. In a liquefied gas dispensing system of the class described, a pressure storage tank buried in the ground to receive heat from the ground, receiving means secured to the tank for filling the tank with liquefied gas to a predetermined level, said heat vaporizing said gas to maintain a gauge pressure in the tank, means for eutectic liquefied gas from the tank in its liquid phase, a unitary pressure regulator connected to said means to receive the eutectic liquid and having an elongated backcap thereon, means for mounting the regulator upon the tank with the backcap disposed inside the tank, and means for insulating the regulator from heat exchange contact with outside temperature.

23. In a liquefied fuel gas dispensing system of the class described, a pressure tank buried in the ground for storing liquid gas and to receive heat from the ground, said heat vaporizing said gas to maintain a gauge pressure in the tank, means for eutectic liquefied gas from the tank in its liquid phase, a unitary pressure regulator connected to said means to receive the eutectic liquid fuel and having an elongated backcap thereon, means for mounting the regulator upon the tank with the backcap disposed inside the tank, and means for insulating the regulator from heat exchange contact with outside temperature.

24. In a liquefied gas dispensing system of the class described, a pressure tank buried in the ground to receive heat from the ground and having therein a liquefied gas, said heat vaporizing said gas to maintain a gauge pressure in the tank, means for eutectic liquefied gas from the tank in its liquid phase, a unitary pressure regulator connected to said means to receive the eutectic liquid and having an elongated backcap thereon, means for mounting the regulator upon the tank with the backcap disposed inside the tank, and means for insulating the regulator from heat exchange contact with outside temperature.

25. In a liquefied gas storage and dispensing device of the class described, a storage tank, a service pipe connected to the tank to eutectic liquid therefrom and including a first stage pressure regulator and a section of the pipe ahead of the first stage regulator receiving latent heat of vaporization from the contents of said tank said regulator being arranged to accomplish the first stage of pressure reduction upon the eutectic liquid.

26. A pressure reducer for vaporizing liquefied gas comprising a body portion, an inlet and outlet for the reducer, a valve between the inlet and outlet, a diaphragm forming one wall of a valve chamber surrounding said valve for operating the valve, and an elongated backcap upon the body providing an expansion chamber therebeyond of substantial volume on the outlet side of the valve into which chilled unvaporized gas gravitates to absorb heat.

27. For use in a liquefied petroleum gas dispensing system having a pressure storage tank; a head receiving upon the tank, said head comprising a unitary body having a plurality of bosses thereon, means for filling and emptying the tank associated with one boss and including a passage through the body and a conduit element carried by the body in communication with said passage, a service connection and control in another boss including a service passage through the body having a section for communication with the top of the tank, means interconnecting said service passage and conduit element including a valve for closing said section, means for obstructing the inflow of liquid through said conduit element but readily permitting outflow through the conduit element at all times, and means carried by said body for operating said obstructing means at a predetermined level of liquid in the tank.

28. For use in a liquefied petroleum gas dispensing system having a buried storage tank and including a riser pipe; a head adapted to be removable connected to the riser pipe comprising a unitary body having a plurality of bosses thereon, one machined to provide space for receiving a filling valve and another machined to provide space for a service line cutoff valve, a dip tube carried by the body to extend to the bottom of the tank when the head is installed and disposed in communication with the filling valve space and said service valve space.

29. For use in a liquefied petroleum gas dispensing system having a buried storage tank including a riser pipe; said head adapted to be removable connected to the riser pipe comprising a unitary body having a plurality of bosses thereon, one machined to provide space for receiving a filling valve and another machined to provide space for a service line cutoff valve, and means for connecting the head to the riser pipe.

30. For use in a liquefied petroleum gas dispensing system having a buried tank and a riser pipe; said head adapted to be removable connected to the riser pipe comprising a die formed body having a plurality of machined bosses thereon, means for mounting the die formed body to the riser pipe, and means for connecting the head to the riser pipe and means for connecting the head to the filling valve.

31. For use in a liquefied petroleum gas dispensing system having a buried tank including a riser pipe; said head adapted to be removable connected to the riser pipe comprising an integral body having a plurality of machined bosses thereon, a filling valve in one boss, an eduction control in another boss for connection with a service line, a passageway between said filling means and eduction control, a passageway interconnecting the eduction control and the top of the tank when the head is installed, means for closing the first passageway and opening the other passageway to the riser pipe, and means for connecting the head to the riser pipe and said service means.
including a valve in said dip tube for preventing the filling of the tank above a predetermined level.

32. In a liquefied gas dispensing system having a storage tank provided with a threaded opening, a head, means for mounting the head with respect to said opening in sealed relation, said head comprising a unitary body, a gauge mounted thereon, a filling device, normally open control means connected to said filling device, and float means for operating said gauge and closing said normally open means to prevent overfilling of the tank.

33. In a liquefied gas dispensing system having a storage tank provided with a threaded opening in connection therewith, a head, means for mounting the head with respect to said opening in sealed relationship, said head comprising an integral body, a gauge mounted thereon, a filling device including a conduit carried by the body, normally open control means in said filling device, and means for operating said gauge and closing said normally open means for preventing overfilling of the tank.

34. For use in a liquefied petroleum gas dispensing system having a pressure storage tank: a head adapted to be secured in sealed relation to the tank and comprising a die formed body with a plurality of bosses thereon, a service outlet in one boss for communicating with the tank, a filling device disposed in another boss, and means carried by the body connected to the filling device to place in communication with the tank and including a conduit receivable in the tank and a trap valve to prevent overfilling of the tank, the outlet of said means being below the inlet of the service outlet so that filling liquid will not enter the service outlet.

35. A unitary head of the described comprising a forged body having upwardly extending bosses thereon, one of said bosses having a machined opening therein with a safety check valve mounted therein, a drilled conduit leading from the opening to the bottom of the body, means at the opening for mounting a tube upon the body in communication with said conduit, an eductor passage communicating with said conduit having therein a shut-off valve, a second conduit opening on the bottom of the body and leading to said passage, and a valve placing the passage in communication with one of said conduits.

36. A unitary assembly for connection with respect to a tank for storing and dispensing liquefied petroleum gas, comprising a body having a passage therethrough, a filling conduit carried by the body in communication with the passage and extending to the bottom of the tank when the assembly is installed, a branch conduit leading to a service connection, a conduit arranged to lead from the top of the tank into the branch and a selector valve disposed at the junction of said conduits.

37. In combination, a delivery tank means, a dispensing tank means, means for detachably connecting the tank means to convey liquid from one tank means to another, including a pump connected to one tank means; a head connected to the other tank means and a flexible conduit interconnecting the pump and head, said pump including a pressure relief by-pass connected to the outlet of the pump, a conduit carried by said head, a valve in the conduit, and a device responsive to the level of liquid in the dispensing tank means for actuating the last mentioned valve.

38. A head for a liquefied petroleum gas storage tank comprising a forged body constructed and arranged to be fastened to said tank, a filling passage therethrough and a back pressure check valve disposed therein, a service conduit in said body including means upon the body for securing a service pipe thereto, a liquid eduction tube assembled on the body in communication with the passage to extend to a point adjacent the bottom of the tank, a vapor eduction passageway in said body, means for selectively connecting the service conduit in communication with the eduction tube or the eduction passageway and including means for closing off one while the other is in operation.

39. In a liquefied petroleum gas dispensing system having an underground storage tank; a head, a fill conduit carried by the head and extending to the bottom of the tank, valve means controlling the inflow of liquefied gas through the conduit, means responsive to the level of liquid in the tank for operating the valve and including means responsive to the temperature of the liquid in the tank for governing the operation of said level responsive means.

40. In a liquefied petroleum gas dispensing system, a tank, a head, a fill conduit carried thereby, said head comprising valve means controlling the inflow of liquefied gas through the conduit, mechanism responsive to the level of liquid in the tank for operating the valve including heat sensitive means arranged to be submersed in head exchange contact with the liquid and responsive to the temperature of the liquid in the tank for modifying the action of the balance of the rest of said mechanism.

41. For use in a liquefied petroleum fuel dispensing system having a pressure storage tank; a head receivable upon the tank comprising a unitary body having a plurality of bosses; filling means extending through one of the bosses including a conduit element carried by the body and adapted to extend to the bottom of the tank when the head is in place; dispensing means extending through another boss and including a passage in communication with said conduit element and a passage in communication with the top of the tank when the head is in place, a valve for obstructing at will the flow of fuel through one of the passages; and means associated with said filling means for obstructing the flow of filling liquid through the conduit element including a device arranged to be actuated when a predetermined level of liquid in the tank is reached.

42. For use in a liquefied petroleum fuel dispensing system having a pressure storage tank; a head receivable upon the tank comprising a unitary body having a plurality of bosses; filling means extending through one of the bosses including a conduit element carried by the body and adapted to extend to the bottom of the tank when the head is in place; dispensing means extending through another boss and including a passage in communication with said conduit element and a passage in communication with the top of the tank when the head is in place, a valve for obstructing at will the flow of fuel through one of the passages; and means associated with said filling means for obstructing the flow of filling liquid through the conduit element including a device arranged to be actuated when a predetermined level of liquid in the tank is reached.