March 30, 1965 H. N. SHAW 3,175,579

LIQUEFIED GAS FILLER AND EDUCTION DEVICE

Filed April 30, 1963 3 Sheets-Sheet 1

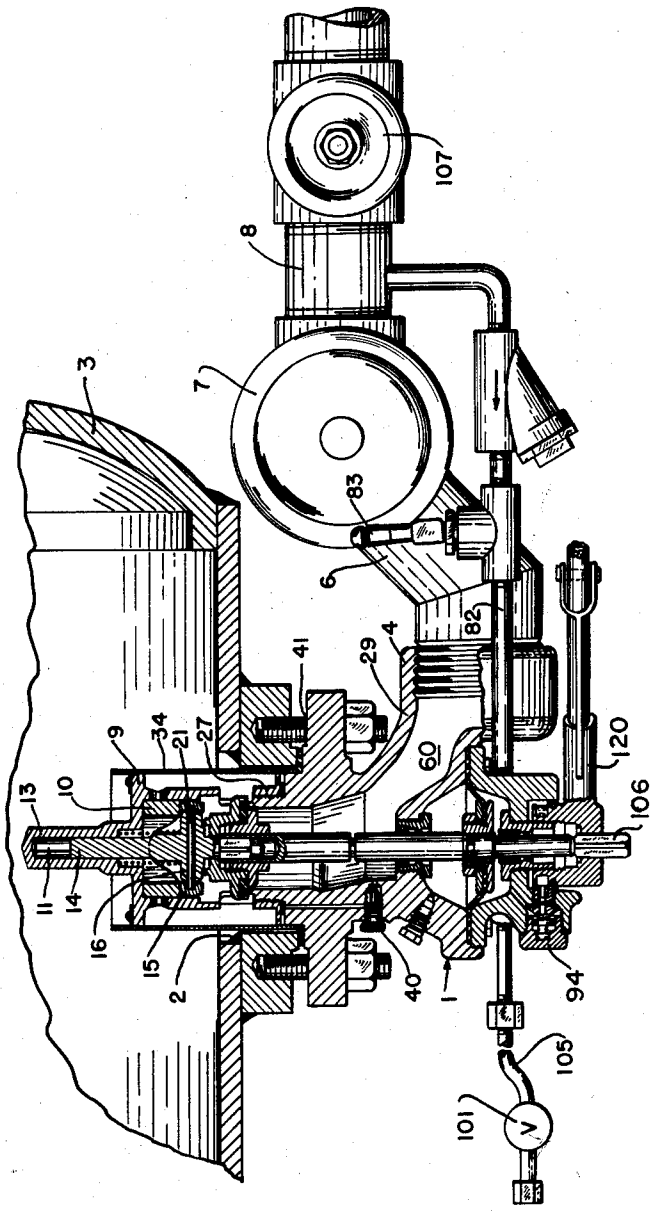


FIG. 1

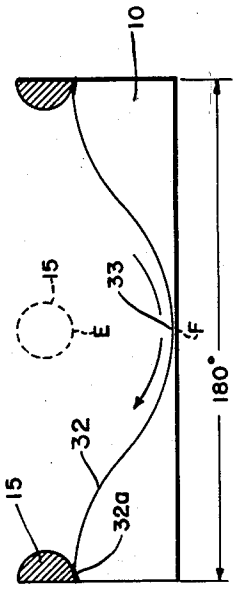


FIG. 4

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LIQUEFIED GAS FILLER AND EDUCTION DEVICE

Filed April 30, 1963 3 Sheets-Sheet 2

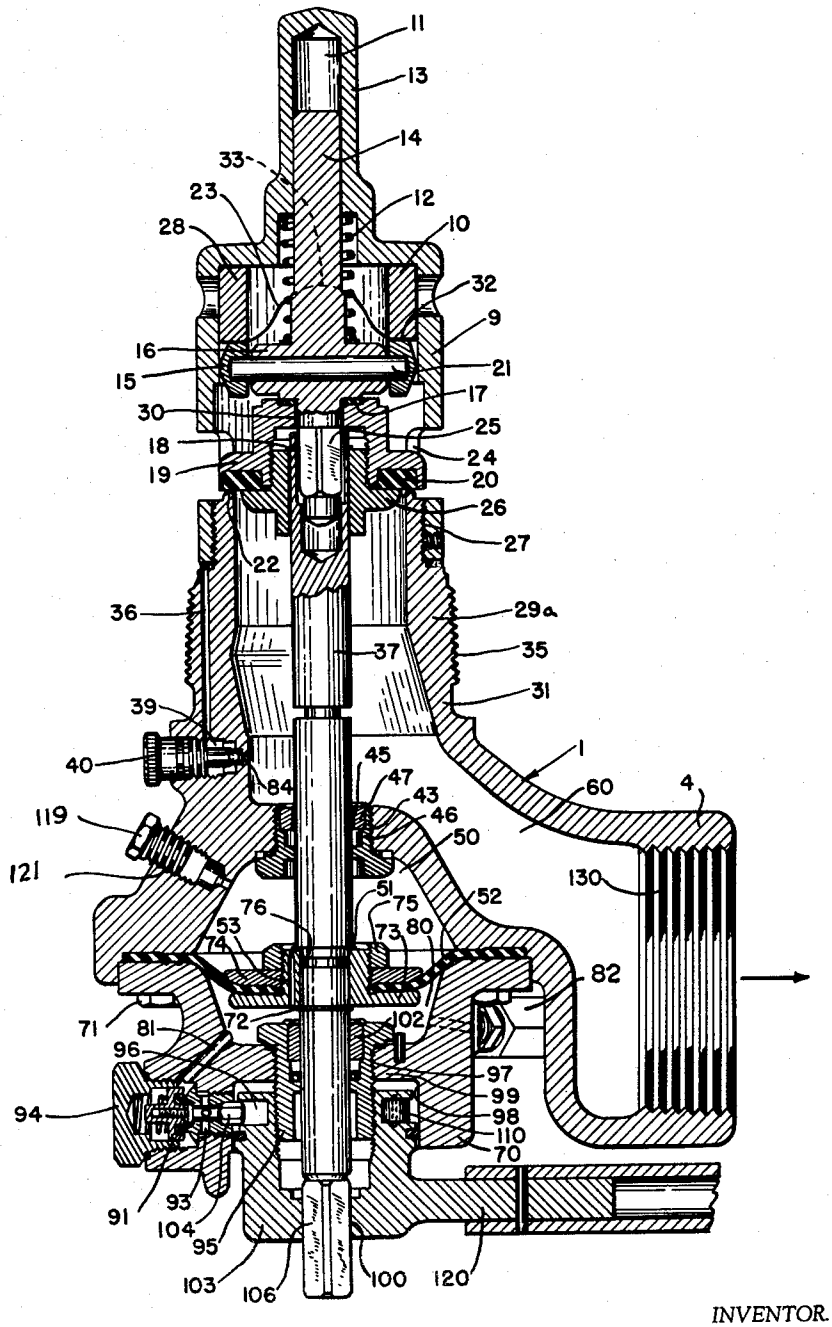


FIG. 2

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LIQUEFIED GAS FILLER AND EDUCTION DEVICE

Filed April 30, 1963 3 Sheets-Sheet 3

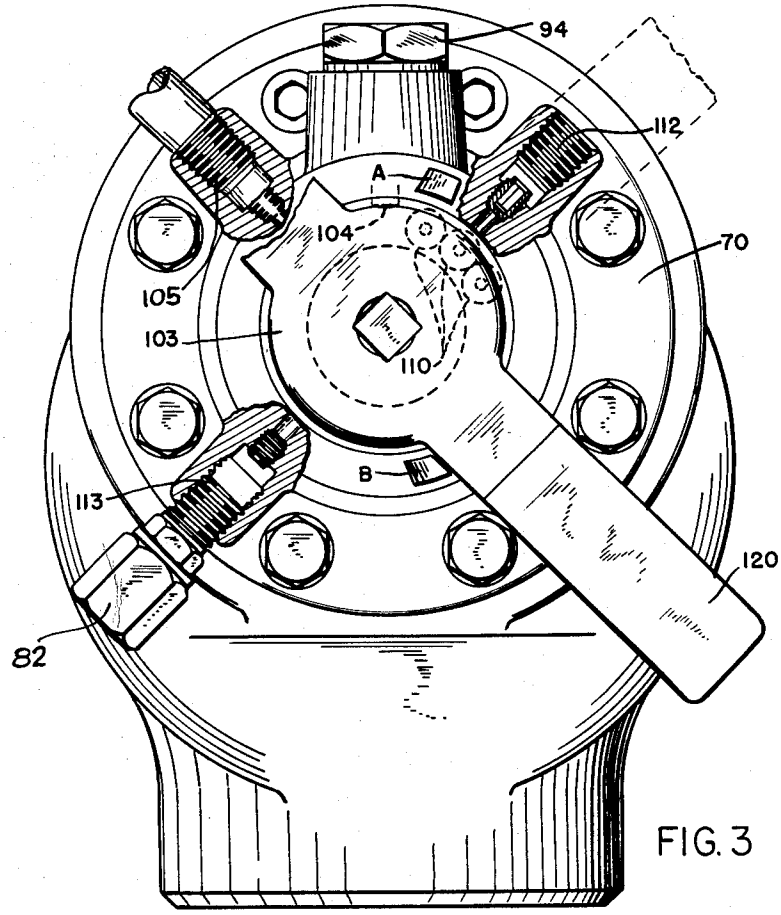


FIG. 3

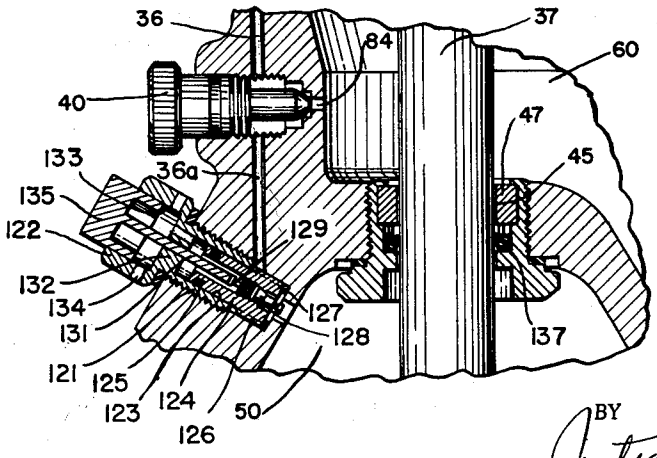


FIG. 5

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3,175,579

LIQUEFIED GAS FILLER AND EDUCTION DEVICE

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Filed Apr. 30, 1963, Ser. No. 276,903
14 Claims. (Cl. 137—565)

This invention relates in general to fluid filling and emptying systems for handling liquefied gas in bulk storage and transport containers which are generally of a cylindrical shape, and more particularly to a filler-eduction safety cut-off valve construction which provides all the safety advantages of excess flow valves without some of their disadvantages of normal openness and large pressure drops, and also includes the safety advantages of an overriding positive shut-off valve which is located protectively inside the container yet can be remotely controlled both manually and automatically to close or open automatically during the filling or dispensing of gas in its liquid phase as part of a closed system in which operating pressures are present or are developed with the liquefied gas being handled.

For many years the manufacturers and users of liquefied petroleum gas handling equipment have been concerned about the problem arising with starvation on the inlet side of their eduction pumps when high capacity pumping is desired for emptying a storage container with sufficient rapidity for such to be economical.

Where water remains liquid at the intake of a pump when cavitation condition might develop, liquefied gas presents an aggravated problem. Liquefied gas such as propane or butane have low boiling points and at normal atmospheric temperatures they have sufficient sensible heat available to furnish substantial amounts of latent heat of vaporization. Therefore, under liquid solid conditions liquefied gas is quite sensitive to vaporization with drops in pressure that may be induced in dispensing conduits ahead of pumps. A slight drop of pressure below the vapor pressure even before lower cavitation pressures are reached causes vaporization that forms gas pockets. Such pockets as well as cavitation at the pump blades is harmful to the pump.

Now, if a positive hydraulic head can be maintained upon liquefied gas at the pump inlet, i.e., a pressure above the vapor pressure in the tank, the pumping conditions can be greatly improved since the pump would not be required to draw liquefied gas from the container to which it is connected under conditions causing vaporization and cavitation. However, the excess flow valves now provided for safety purposes in eduction conduits leading to pump intakes depend upon a substantial pressure differential to operate. Such differentials have to be built into the design of excess flow valves notwithstanding the fact that the required differential drop across the excess flow valve is a liability at high pumping rates. Slow pumps have to be used because pumps fast enough to be economical often exceed the flow characteristics for which the excess flow valves are designed and the valve repeatedly snaps closed. This generally occurs irrespective of the head pressure above the valve.

However, since the downstream rate of flow is what influences the pressure drop differential occurring at the excess flow valve, it has been noted that if the downstream flow rate is kept constant and within the capacity of the valve the pressure drop differential increases as the tank approaches empty. The flow is gradually being starved at the valve as long as it is open because of a decreasing head pressure at the valve inlet. Thus, head pressure loses its helpfulness as soon as it becomes less

than the presure drop acros the valve. The greater that the pressure drop across the valve exceeds the hydraulic head, the greater will be the tendency for the pump intake to cause vaporization and cavitation.

For instance, assume two valves rated for identical intallation with one valve designed for a one pound pressure drop differential to close as an excess flow valve while the other valve designed for shut-off has a pressure drop of only one quarter pound for the same rate of flow of approximately 100 gallons per minute. It will be observed that approximately a four foot hydraulic head, or more, of liquefied gas is required to make up for the one pound pressure drop a maintain a liquid solid condition at the pump intake without vaporization dangers, whereas, with the other valve anything over a one foot head will maintain a liquid solid condition at the pump intake.

Thus, with most cylindrical tanks large enough to provide an initial head over four feet, the desired head pressure is lacking except for a very small amount of liquid dispensed before the hydraulic head falls below the four foot mark and thereafter vaporization becomes an increasing danger. The pressure between the valve and pump increasingly falls below the vapor pressure and there still would be a major portion of liquid left to be educted. The level of the liquid would drop quickly down to the four foot depth and after that very slowly even though progressively more rapidly as the bottom is approached below the half full level.

Although air pressure can be added to assist the diminishing hydraulic head, such pressure being additive, the effective tank pressure would be intolerably high when full in order to have there quarters of a pound remaining to be effective as a supplement to hydraulic head when only one foot of liquid remained in the tank. On the other hand, if only enough air is added to assist the last foot of liquid in the container where only a slight valve pressure drop of one quarter pound is present its additive pressure would be only two pounds above vapor pressure with a half full tank and approximately eight pounds when the tank is filled to the usual 10 percent outage. Thus, this mild assist pressure is quite tolerable. It is not too high for tank ratings and it is substantially unchanged by temperature, yet safely assists in providing an effective head much higher than the hydraulic head alone could provide with a full tank and a high rate of flow would not be confronted with a valve closure. However, for a remaining one foot hydraulic head with so little remaining volume in the tank yet to be educted the need for a hydraulic pressure assist is virtually eliminated by the present invention.

Moreover, comparatively speaking, where conventional filler-eduction excess flow check valves are designed to have as much pressure drop as can safely be possible yet interfere with pump capacity as little as possible, it is to be observed that the present invention is virtually open to full flow with comparatively no pressure drop that materially affects the pump. Additionally, it is controlled to close automatically instantly with greater sensitivity to pressure drops caused by fluid escaping through small breaks up to and even beyond the pump.

Accordingly, one of the objects of the present invention is to provide a safety cut-off valve for performing excess flow valve functions where the drop of pressure across the valve itself is very slight and therefore, only a slight hydraulic head is needed to maintain a positive head pressure to maintain a liquid solid prime at the pump intake.

Another object of the invention is to provide a filler-eduction valve with which a positive head pressure will be provided for the intake of eduction pump throughout

substantially all of the tank emptying pumping operation whereby operating factors without vaporization or cavitation are greatly improved for high volume pumps.

A further object of the invention is to provide a liquid eduction safety valve that is controlled manually to open and close and to close or be released to open either mechanically or hydraulically by application of pressures developed or present in the system with or without the pump running.

Another object of the invention is to provide a liquid filler-eduction valve that opens against the outflow of liquid from the tank by feed back of eduction pump output pressure to the valve actuating mechanism.

It is a further object of this invention to provide an improved, light, unitary, self-contained valve and pump apparatus secured to a transport tank which rapidly educts the fluid from the tank with full safety without reliance on external or excess flow control valves.

Another object of this invention is to provide an improved, fully automatic, internally mounted flow cut-off valve coupled with a high capacity pump which valve automatically assumes the closed position until the pump is started, thereby precluding over-the-road travel with an open valve yet can be opened manually if the pump fails to start.

A further object of this invention is to provide an improved valve internally mounted in a tank for fluid control having a visual indicator denoting whether the valve is in the open or close position.

Another object of this invention is to provide an improved, fully automatic, internally mounted flow control valve coupled with a high capacity pump and valve arrangement of minimized weight to be carried beneath a bulk tank whereby the tank may be filled or drained with minimum time and expense.

Another object of this invention is to provide an improved liquid emptying and filling apparatus that is simple in design, rugged in construction, economical to manufacture, adaptable for mounting on existing tanks or new construction, completely self-contained to complete a fluid filling or eduction operation and provides maximum safety and fail-safe operational characteristics.

Still another object of this invention is to provide an improved, automatically operated flow valve, having locking means whereby the valve can be secured against opening by back pressure from a manifold and a similar valve operating from another compartment or container.

Further objects and advantages of the invention will be readily apparent from the following detailed description of a specific embodiment of the invention with references made to the accompanying drawings in which:

FIG. 1 is a fragmentary partially sectioned schematic view showing the valve control and system incorporating a pump and valve for a typical utilization of the invention;

FIG. 2 is a fragmentary partially sectional side elevational view illustrating the draining and filling apparatus of this invention and the position of the component parts of the valve when in the closed position;

FIG. 3 is a partially sectioned bottom view of the draining and filling apparatus illustrating the relationship of certain components on the lower portion of the apparatus;

FIG. 4 is a linear view of the locking and unlocking means showing the particular components over 180° of rotation; and

FIG. 5 is a fragmentary view similar to FIG. 2 showing a modification of the device shown therein.

The invention is characterized by a liquid filler and eduction valve normally closed by a spring in the direction of outflow from a tank within which it is protectively mounted at the bottom thereof. The valve can be rotated with respect to its seat and the valve stem, and the valve stem is rotatably supported and extends outwardly through the wall of the tank to move the valve between two positions, one in which the valve is positively shut by a stationary cam rise and the other in which it is released to open over a cam relief. The stem is also rotatably received through a diaphragm which longitudinally displaces the valve stem for actuation of the valve in which a pressure on the lower side of the diaphragm is higher than that present on the upper side to open the valve, while a balance of pressures on opposite sides either of high or low pressures permits the spring to close the valve.

The upper diaphragm chamber may be supplied with pressure when present in the valve outlet through an orifice or supplied with tank pressure above the valve through a pilot valve control to close the valve or can be vented to atmosphere for opening the valve. The lower diaphragm chamber may be supplied with pump outlet superior to the valve outlet pressure or with tank pressure by pilot valve to open the valve when the upper chamber is vented to atmosphere and to close the valve when the lower chamber is vented to atmosphere or both chambers have equalized pressures.

Referring now to the drawings in further detail, a valve 1 is mounted at an opening 2 in the bottom of a tank 3 with its outlet 4 connected by conduit 5 to the inlet 6 of pump 7 which has an outlet 8. The valve 1 comprises a valve body 29 (FIGS. 1 and 2) which has a cylindrical inverted cup-like cap 9 marginally threaded at 27 to a male coupling thread on the body 29 bordering a valve seat 22. At the top of the cap 9 a boss 13 is provided with a central bore 11 which reciprocably receives rotatably therein a stub shaft 14 having a crosshead 16 therebelow supporting a shaft 21 that journals cam follower rollers 15 to follow an axial cam surface 23 on a cam ring 10 that bottoms on a shoulder 28 in the cap 9 and has a detent 32*a* at the top of the cam rise 32 (FIG. 4).

A compression spring 12 engages the crosshead 16 and urges it downwardly whereby a valve head 19 journalled on a stud 30 below the crosshead 16 is urged to close against the valve seat 22 through a bearing washer 17 made of a material having a low friction coefficient. The lower end of the stud 30 is machined to provide a wrenching surface 25.

Below the valve seat 22 a main shaft 37 is journalled in the body 29 as later described and has a wrenching socket 31 telescoping over the surface 25 as supported in engagement therewith by an external spring washer 18 resting on top a flanged collar 26 threaded to the valve head 19 to also hold the valve disc 20 in place. There is very little end play between the shafts 14 and 37, consequently movement of the main shaft 37 operates with the stub shaft 14 as a unitary valve stem for the valve 19. The valve in turn is rotatably mounted on the stem so that stem can open and close the valve without rotation of the valve with respect to the valve seat. The valve disc 20 is thick enough that resiliency thereof permit the rollers 15 to attain the detents 32*a* and hold them there.

Thus, when the cam rollers 15 are on the cam rise 32 in the detent 32*a*, the stem cannot be moved axially to open the valve, but when the rollers 15 are over the cam reliefs 33 the stem is free to open and close the valve, yet the cam rollers can be turned any time to mechanically force closure of the valve even from its open position. Openings 24 through the wall of the cap 9 permit liquid to flow from the tank 3 to the valve seat 22 and preferably a screen filter 34 is installed over the openings a spaced distance therefrom to prevent solid particles from damaging the valve disc.

Just below the valve seat 22 the body 29 can be mounted in sealed relation in the opening 2 in the tank 3 either by a threaded joint 35 arrangement (FIG. 2) or as shown in FIG. 1 by a flange and bolt mounting 41. Flange mounting is preferred for ready orientation of the valve.

Below the tank mounting 41 the body is shaped generally as an elbow fitting with a right angle passage 60 therethrough and with the outside wall 42 thereof con-

toured and recessed to provide a diaphargm compartment 50 having a threaded opening 43 through the crown thereof disposed coaxial with the seat 22 and in communication with the passage 60. The shaft 37 is received through this opening as journalled in guided relation by a threaded collar 46 supporting a bearing member 47 which has small longitudinal interior grooves 45 facing the shaft to permit restricted communication between the passage 60 and compartment 50.

Closinng the mouth of the compartment 50 is a diaphragm 52 clamped in place by a bonnet 70 held by bolts 71 and having an area exposed on the lower side appreciably greater than the area defined by the valve seat 22. The diaphragm 52 is apertured to receive the shaft 37 therethrough and is provided with a diaphragm collar 73 having an O-ring seal 76 engaging the shaft 37. The diaphragm is secured in sealed relation to the collar 73 by a washer 74 and nut 75 secured to the collar. The collar has a bleed orifice 53 (FIG. 2) through it and the shaft has a shoulder 51 and a spring washer 72 which couples together the vertical movement of the diaphragm and shaft 37 to dispose the diaphragm in its lower position when the valve is closed.

The bonnet 70 defines a chamber 80 below the diaphragm 52 and has a central opening 97 receiving a collar 95 threadedly therein for journalling the shaft 37 in a relationship sealed by a gasket 102. The collar extends beyond the bottom of the bonnet and into a circular cavity 98 provided in the bottom wall 99 where it loosely supports in threaded relationship a socket wrench member 103 having a handle 120 on it for actuation and a socket 100 slidably receiving the squared lower end 106 of the shaft 37 for rotating the shaft thereby.

The periphery of the socket member 103 is journalled in the circular cavity 98 and has a groove 96 therein provided with camming rollers 110 which displace outwardly a pilot valve stem 104 that radially intersects the groove. The stem when displaced opens a normally closed valve 91 that is threaded into the side wall of the bonnet to vent the bonnet chamber 80 to atmosphere through passages 81 and 93 drilled in the wall and the stem 104, respectively. The valve 91 can be assembled and serviced by removal of a back cap 94. Whenever the valve 19 opens, the lower end of the stem 37 disappears within the socket member 103 to serve as an indicator that the valve 19 is open.

Lugs shown at A and B (FIG. 3) limit the movement of the handle 120 to an angle of 90° and as shown in broken lines, the cam rollers 110 engage the relief valve piston 104 when the handle is passing from its "open" to its "closed" position against lug A. This engagement frees the relief valve to close at both limits of its movement. Thus, when the valve 19 is being closed, the vent valve 91 is momentarily opened to vent chamber 80 so that no hydraulic perssure can be built up in the chamber 80 that would oppose the diaphragm movement when the valve 19 is moved to its closed position, and then closed again so that no liquefied gas is lost to the atmosphere.

When the handle 120 is in open position, pressure can be supplied to the chamber 80 through any one of a number of nipple connections.

The outlet end of the body 29 is threaded as at 130 to receive the conduit 5 leading to the intake 6 of a pump 7 having an output connection 8. It will be observed that the pump is connected and is designed to pump liquid. Accordingly, it is desirable that the intake of the pump be primed with liquid before it is started. The invention provides for several ways to do this through a conduit 36 drilled in the body 29 down to a threaded opening 39 to take liquid from the tank.

The preferred way is to bottom drill the opening 39 into the passage 60 to provide a conduit 84 by passing the valve 19 and threading a needle valve plug 40 into the opening to adjust for a continuous bleed of liquid from the tank to the passage 60 to keep the passage 60 and pump 7 primed.

A connection 82 leads from the output side 8 of the pump 7 so that once the pump is started, the output pressure of the pump is effective in chamber 80 and opens the valve 19. However, in event there is a break in the pump output hose, the output pressure drops. Then the compartment is no longer supplied at an output pressure above the pump intake pressure to which the upper compartment 50 is subjected and the diaphragm is quickly balanced on opposite sides through the bleed passage 53. Thereupon the spring 12 assisted with the outflow of liquid through the valve closes the valve 19 in seconds. Thus, a very slight drop in pump output pressure operates to close the valve, thereby providing a very sensitive but full flow safety shut-off valve arrangement.

It is desirable to provide a manual shut-off valve 83 in the connection 82 which is normally left open but when an emergency arises can be closed to actuate the closing of the valve 19 with the same as though a break had occurred in the pump outlet 8.

In addition to the vent valve 91 a safety line 105 can be extendea to run to an operator's station or to other critical points around the tank where hand operated vent valves 101 may be located whereby the pressure in compartment 80 can be vented at any one of a number of stations to close the valve 19.

Referring to FIG. 5, a modification is shown in which the bleeder passage 53 (FIG. 2) can be eliminated and whereby the chamber 50 can be vented to atmosphere so that the valve 19 can be opened independently of a pump 7 by the pressure present in the lower chamber 80. This will provide two results. It will liquid prime the passage 60 by freeing vapor present below the valve 19 to bubble up into the tank 3, and with the valve 107 (FIG. 1) open liquid can be educted under continuous manual attention by gravity without the pump running.

Either the plug 119 (FIG. 2) can be removed if continuous venting is desired or preferably, the passage 36 can be extended as at 36*a* to the threaded opening 121 provided through the wall of chamber 50 if pressures are to be applied on both sides of the diaphragm 52. In which case, a dual acting valve arrangement (FIG. 5) is threaded therein and comprises a plug 122 having a cylindrical cavity 123 in the inner end thereof slidably receiving a piston sleeve valve element 124*a* therein sealed by an O-ring 125. The valve element 124 has a hex-shaped external contour 126 at its inner end shouldered to stop against the end of the plug in open position and faced off on its end face to close against a valve seat at 127. This controls the flow of replenishing or equalizing fluid through conduit 36*a* to the chamber 50.

A Dill valve 128 is threaded into the valve end of the valve element 126 with its stem 129 exposed to contact with a removable pin 131 extending through a spider 132 in the plug at the bottom of a cavity 133 in its outer end and vented to atmosphere through lateral holes 134 in the sides thereof. Insertion and finger pressure on the head 135 of the pin 131 initially moves the piston sleeve valve 124 to its closed position to seal off conduit 36*a* and further movement of the pin opens the Dill valve 128 to vent chamber 50 to atmosphere through the spider 132 and vent holes 134. Thereupon the pressure in the chamber 80 below the diaphragm 52 opens the valve 19 for as long as the head 135 is manually depressed. When the pin 131 (and head) is released, the Dill valve closes, and pressure bleeding through the passage 36*a* causes the piston sleeve valve 124 to open for quick application of tank pressure to the chamber 50 to close the valve 19 again if the pump is not running.

Whenever the chamber 50 is vented to atmosphere in FIG. 5, the use of the vent valve 101 (FIG. 1) or the handle 120 operates to vent chamber 80 to equalize pressures on opposite sides of the diaphragm whereby the spring 12 closes the valve 19.

In this connection it is to be noted that a V-seal **137** is provided below the bearing **47** which permits outflow of fluid from compartment **50** when the valve is open and prevents any inflow from the passage **60** when the compartment is vented to atmosphere.

In operation it will be observed that a hydraulic head is imposed upon the pump intake to maintain a pressure preventing vaporization or cavitation at the pump intake to assure a liquid solid condition throughout all conduits connected to the pump including the outlet up to a manual shut-off valve **107**. Then when the pump is started, the output pressure is forced up much higher than the intake pressure and this is instantly effective in the compartment **80** whereupon with the handle **120** located at "open" position, the diaphragm, stem, and valve **19** are raised to their open position. Thereupon the manual shut-off valve **107** is opened for pumping operations to proceed. The valve **19** has little pressure drop and the pump intake continues its liquid solid prime. Thereafter the valve **19** is closed by venting pump output pressure in compartment **80** or by equalizing pressures on opposite sides of the diaphragm to an extent whereby the spring **12** is capable of closing the valve **19**.

Consequently, it will be understood by those skilled in the art how the objects of the invention are attained and how various and further changes may be made in the valve system described without departing from the spirit of the invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. A liquid eduction device comprising a tank for storing liquefied gas in both its liquid and vapor phases, outlet means for said tank including a valve housing having a valve seat facing the tank in communication with said tank at the bottom thereof and subjected to the hydraulic head of the liquid in said tank in addition to the pressure in the tank of the vapor thereon, a valve member closing against said valve seat and including a rotatable stem, means for closing the valve including an element resiliently closing the valve member and a cam member operated by rotation of said stem for positively closing the valve member, a liquid pump connected at its inlet to the valve seat and having an outlet with a shut-off valve therein, a bleed passage bypassing said valve head and seat for liquid priming of the pump inlet, pressure responsive means for reciprocating said valve stem including a diaphragm, means for applying to one side of the diaphragm liquid pressure from the output side of the pump to open said valve and including a shut-off valve, means for venting said liquid pressure, and means for applying to the other side of the diaphragm liquid pressure from the inlet of said pump to urge closure of the valve.

2. A liquid eduction device comprising a tank for storing liquefied gas in both its liquid and vapor phases, outlet means for said tank including a valve housing having a passage therethrough including a valve seat of the same size as the passage facing the tank in communication with said tank at the bottom thereof and subjected to the hydraulic head of the liquid in said tank in addition to the pressure of the vapor thereabove, a cap supported on said housing having valve inlet openings at the level of said valve seat, a valve head closing against said valve seat including a stem rotatably and reciprocably supported by said cap, means for closing the valve including a resilient member resiliently closing and a cam member operated by rotation of said stem for positively closing the valve head, said members being supported within said cap above said valve head, a liquid pump connected at its inlet to the passage and having an outlet, a bleed passage bypassing said valve head and valve seat for liquid priming the pump inlet, pressure responsive means for reciprocating said valve stem including a diaphragm, means for applying to one side of the diaphragm liquid pressure from the output side of the pump to open said valve, means for venting said liquid pressure including a valve actuated by rotation of the stem to close the valve head for reducing the pressure to below the tank pressure at said inlet openings, and means for applying to the other side of the diaphragm liquid pressure from the inlet of said pump to urge closure of the valve.

3. A liquid eduction device for a tank storing liquefied gas in both its liquid and vapor phases comprising outlet means attachable to said tank including a valve housing having a valve seat facing the tank in communication with said tank at the bottom thereof and subjected to the hydraulic head of the liquid in said tank in addition to the pressure of the vapor thereon, a cap on said housing having openings at the level of said valve seat, a valve head closing against said valve seat including a rotatable stem reciprocably supported in said cap, means carried by said cap for closing the valve including a resilient element resiliently closing and a cam member operated by rotation of said stem for positively closing the valve head, a liquid pump connected at its inlet to the valve seat and having an outlet with a shut-off valve therein, a bleed passage bypassing said valve head and seat for liquid priming of the pump inlet, pressure responsive means for reciprocating said valve stem including a reciprocating member, means for applying to one side of the reciprocating member liquid pressure from the output side of the pump to open said valve, means for venting said liquid pressure, means for applying to the other side of the reciprocating member liquid pressure from the inlet of said pump to urge closure of the valve, and bleed means bypassing said reciprocating member tending to equalize liquid pressures or opposite sides of the reciprocating member.

4. A quick acting cut-off filler-eduction valve for liquefied gas stored in both its liquid and vapor phases comprising a valve body defining a passageway having a valve seat therein in communication with liquid phase gas, a valve head closing against said seat and having a stem extending through the valve seat, resilient means urging said valve head to closed position, a bleed conduit bypassing said valve and valve seat to maintain gas in its liquid phase in said passageway, pressure differential responsive means including a reciprocating member connected to the valve stem, means for applying a pressure higher than that present in the passageway to one side of said pressure responsive means to urge it to open the valve, means assisting said resilient means for applying pressure in said passageway against the other side of said pressure responsive means to urge it to close the valve when said higher pressure drops below a predetermined differential between the two pressures, manual means for closing said valve, and means controlled by said manual means for venting said one side of said pressure responsive means before the manual means closes said valve.

5. A quick acting cut-off filler-eduction valve comprising a valve body defining a passageway having a valve seat therein, a valve head closing against said seat and having a stem extending through the seat, resilient means urging said valve head to closed position, a bleed conduit bypassing said valve and valve seat for equalizing pressures on opposite sides thereof in their closed position, pressure differential responsive means including a reciprocating member connected to the valve stem, means for applying a pressure higher than that present in the passageway to one side of said pressure responsive means to urge it to open the valve, means for applying pressure in said passageway against the other side of said pressure responsive means to urge it to close the valve when said higher pressure applying means ceases, bleed means interconnecting opposite sides of said pressure responsive means tending to equalize pressures on opposite sides thereof, manual means for locking said valve head in closed position closing said valve, and means controlled by said manual means for venting said one side of said pressure responsive means before the manual means closes said valve.

6. A quick acting cut-off filler-eduction valve comprising a valve body defining a passageway having a valve seat therein and inlet openings around said valve seat, a valve head closing against said seat and rotatably receiving a stem extending through the seat, resilient means above said valve head urging said valve head to closed position, cam means actuated by rotation of said stem for locking said valve head in closed position, a bleed conduit bypassing said valve and valve seat to maintain said passageway liquid solid, pressure differential responsive means including a reciprocating member connected to the valve stem, means for applying a high pressure present in the passageway to one side of said member to move the valve head to open position, means for applying a lower pressure against the other side of said member to urge it to close the valve when said higher pressure drops to a pressure equal to and less than said lower pressure, manual means for rotating said stem to actuate said cam means during opening and closing said valve, and means controlled by said manual means for venting said one side of said pressure responsive means before the manual means is moved to hold said valve closed.

7. A liquid eduction device comprising a tank for storing liquefied gas in both its liquid and vapor phases, outlet means for said tank including a valve housing having a valve seat facing the tank in communication with said tank at the bottom thereof and subjected to the hydraulic head of the liquid in said tank in addition to the pressure of the vapor thereon, a valve head closing against said valve seat including a stem, means for closing the valve including a resilient element resiliently closing and a rotatable cam member for positively closing the valve head, a liquid pump connected at its inlet to the valve seat and having an outlet with a shut-off valve therein, a bleed passage bypassing said valve head and seat for liquid priming of the pump inlet, pressure responsive means for reciprocating said valve stem including a diaphragm, means for applying to one side of the diaphragm liquid pressure from the output side of the pump to open said valve including a pilot shut-off valve, means for venting said liquid pressure including venting valves located on the tank remote from said valve housing, means for applying to the other side of the diaphragm liquid pressure from the inlet of said pump to urge closure of the valve.

8. A quick acting cut-off filler-eduction valve comprising a valve housing defining a passageway having a valve seat therein and an inlet opening at the level of said valve seat, a valve head closing against said seat, a valve stem journalled in said valve head against relative axial movement therewith to extend through the seat and reciprocally supported in the housing above and below the valve head, means supported by said housing above the valve head for closing the valve including a cam rise having a detent at its top, a follower driven by said stem to occupy said detent and lock the valve head in closed position and a resilient element urging said valve head to its closed position, a bleed conduit bypassing said valve and valve seat, pressure differential responsive means including a reciprocating member supported in the housing at one side of said passageway and connected to the valve stem, means for applying a pressure higher than that present in the passageway to one side of said reciprocating member to urge the stem to open the valve, means for applying pressure in said passageway against the other side of said reciprocating member to assist said resilient element to move the stem to close the valve when said higher applied pressure drops to the pressure present in said passageway, manual means for closing said valve including a rotatable supported wrenching member reciprocably receiving the end of the stem in visually exposed relationship when said follower is disposed in said detent, and valve means controlled by said wrenching member for venting said one side of said pressure responsive means during the time said follower engages the incline of said cam rise.

9. A liquid eduction device comprising a tank for storing liquefied gas in both its liquid and vapor phases, outlet cut-off valve means for said tank having a pressure drop of less than one quarter pound per square inch at full open flow including a valve housing having a passage with a valve seat of the same size as said passage and facing the tank in communication with said tank at the bottom thereof and subjected to the hydraulic head of the liquid in said tank in addition to the pressure in the tank, a valve head closing against said valve seat including a rotatable stem, means for closing the valve including a resilient element resiliently closing the valve head and a cam member operated by rotation of said stem for positively closing the valve head, a liquid pump connected at its inlet to the valve seat and having an outlet with a shut-off valve therein, a bleed passage bypassing said valve head and seat for liquid priming of the pump inlet, pressure responsive means for reciprocating said valve stem including a diaphragm disposed to one side of the passage, means for applying to one side of the diaphragm liquid pressure from the output side of the pump to open said valve including a pilot shut-off valve, means for venting said liquid pressure, means for applying to the other side of the diaphragm liquid pressure from the inlet of said pump to assist said resilient element to urge closure of the valve.

10. A liquid eduction device comprising a tank for storing liquefied gas in both its liquid and vapor phases, outlet means for said tank including a valve housing having a passage therethrough and a valve seat at the top of the passage facing the tank in communication with said tank at the bottom thereof and subjected to the hydraulic head of the liquid in said tank in addition to the pressure of the vapor thereon, a valve head closing against said valve seat including a stem, means for closing the valve including a resilient element resiliently closing the valve head, a liquid pump connected at its inlet to the passage and having an outlet with a shut-off valve therein, pressure responsive means for reciprocating said valve stem, means for applying to one side of the pressure responsive means a liquid pressure from the output side of the pump to open said valve, a small passage interconnecting the interior of the tank with the other side of the pressure responsive means to oppose opening of the valve, valve means in said small passage for closing said passage and venting said other side of the pressure responsive means to permit opening of the valve.

11. The combination called for in claim 10 in which said valve means includes a manually opened valve closing with fluid flow from said other side of the pressure responsive means and a valve element carrying said manually opened valve urged by pressure on said other side to open communication with said small passage.

12. A liquid eduction device comprising a tank for storing liquefied gas in both its liquid and vapor phases, outlet means for said tank including a valve housing having a passage therethrough and a valve seat of a predetermined area facing and in communication with said tank at the bottom thereof and subjected to the hydraulic head of the liquid in said tank in addition to the pressure of the vapor thereon, a valve head closing against said valve seat including a stem, means for closing the valve including a resilient element urging closure of the valve head, pressure differential responsive means including a reciprocating member connected to the valve stem and having a pressure responsive area greater than said predetermined area, means for applying pressure present in the passage to one side of said pressure responsive means to urge it to open the valve, means for venting to atmosphere the other side of said pressure responsive means to permit opening of the valve by said pressure responsive means under the pressure applied to said one side thereof, and manually controlled means for venting said one side of said pressure responsive means to release said resilient element for closing said valve.

13. A liquid eduction device for a tank storing liquefied

gas in both its liquid and vapor phases, outlet means adapted to be secured to the bottom of the tank including a valve housing having a passage therethrough and a valve seat of a predetermined area in communication with said tank at the bottom thereof, a valve head receivable within said tank and closing against said valve seat including a stem having a lower portion extending through said valve seat, means for closing the valve including a resilient element urging closure of the valve head, pressure differential responsive means including a diaphragm member supported in said housing and connected to the lower portion of said stem, said diaphragm having a pressure responsive area greater than said predetermined area, means for applying pressure present in the passage to the lower side of said diaphragm to urge it to open the valve, means for venting to atmosphere the upper side of said diaphragm to permit opening of the valve by said diaphragm under the pressure applied to said lower side thereof, and manually controlled means for venting said lower side of said diaphragm to permit said resilient element to close said valve.

14. A liquid eduction device comprising a tank for storing liquefied gas in both its liquid and vapor phases, outlet means for said tank including a valve housing having a passage therethrough and a valve seat of a predetermined area facing and in communication with said tank at the bottom thereof and subjected to the hydraulic head of the liquid in said tank in addition to the pressure of the vapor thereon, a valve head closing against said valve seat including a stem, means for closing the valve including a resilient element urging closure of the valve head, pressure differential responsive means including a reciprocating member connected to the valve stem and having a pressure responsive area greater than said predetermined area, means for applying pressure present in the passage to one side of said pressure responsive means to urge it to open the valve, means for venting to atmosphere the other side of said pressure responsive means to permit opening of the valve by said pressure responsive means under the pressure applied to said one side thereof, and manually controlled means for venting said one side of said pressure responsive means to release said resilient element for closing said valve, said stem being slidably received in sealed relationship through a wall of the housing in visually exposed relationship when said valve head is closed against said valve seat.

No references cited.

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