June 11, 1963 E. S. MESSER 3,093,269

DISPENSING MEANS HAVING LIQUID STORAGE TANK AND LIQUID REMOVAL MEANS

Filed Jan. 23, 1961 2 Sheets-Sheet 1

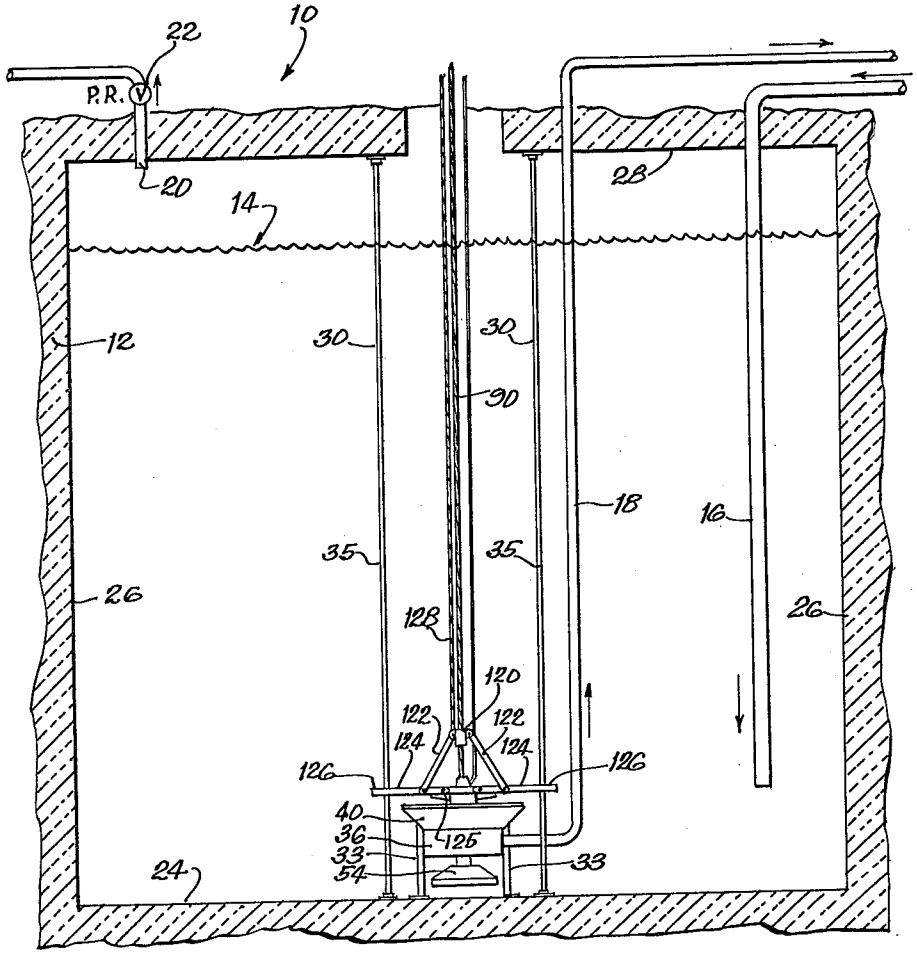


FIG. 1

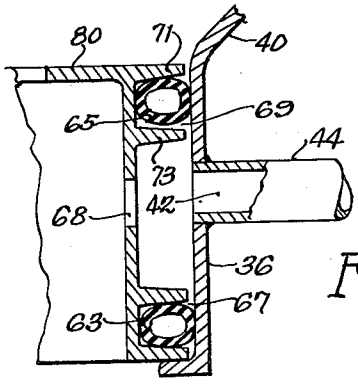


FIG. 4

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FIG. 2

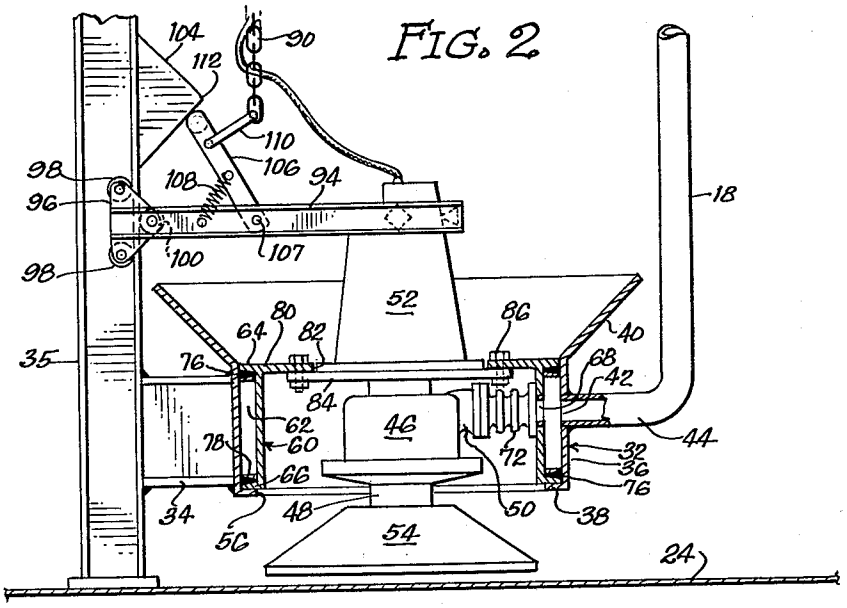
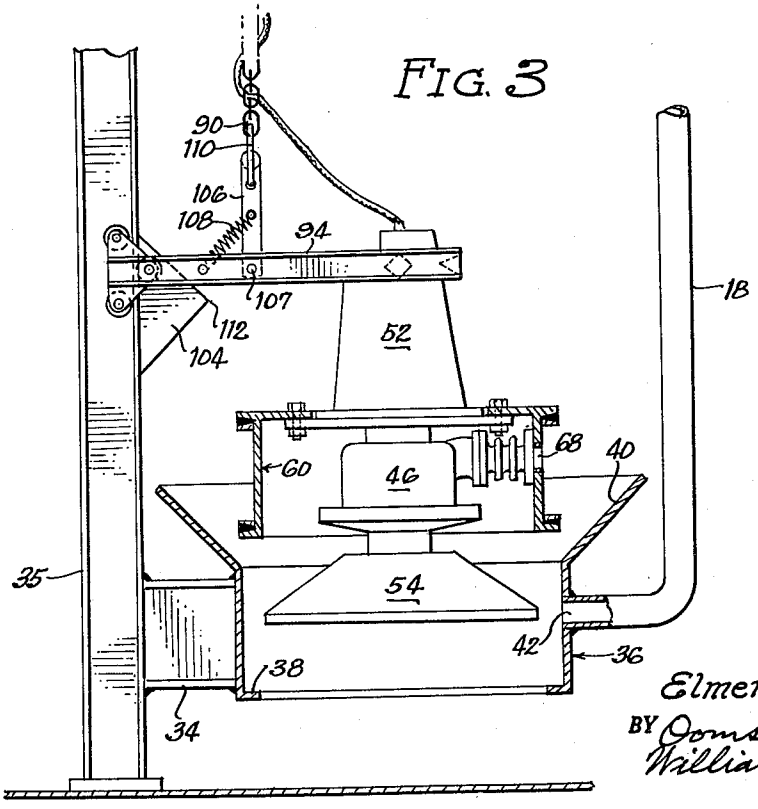


FIG. 3



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DISPENSING MEANS HAVING LIQUID STORAGE TANK AND LIQUID REMOVAL MEANS

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This invention relates to a method and means for the removal of liquids from a deep tank of large capacity and it relates more particularly to pumping means for the removal of liquid having a temperature differing widely from the ambient temperature.

The invention will be described with reference to the removal of a cryogenic liquid, such as liquefied natural gas, from storage containers of large capacity since the most diffcult of the problems are experienced in the removal of such extremely cold liquids. It will be understood, however, that the concepts described will have application to the removal of other liquids including extremely cold as well as extremely hot liquids or liquids at various temperatures therebetween.

When liquefied natural gas is stored in containers of large capacity, such as in metal tanks of 100 x 100 x 60 feet, it is impractical to construct the tanks to withhold high pressures. As a result, the liquefied natural gas is carried in such containers at about atmospheric pressure or at a temperature of about —240° F. to —258° F., depending upon the amount of heavier hydrocarbons present in combination with the methane which has a boiling point of —258° F. at atmospheric pressure. In the over-water transportation of liquefied natural gas from a source of plentiful supply, at which point the natural gas is liquefied, to an area where a deficiency exists, where the liquefied gas, reconverted to the gaseous state for use, as many as from 10 to 30 of such tanks of large capacity may be mounted within the insulated hold space of a ship for filling with liquefied natural gas.

Little, if any, difficulty is experienced in the introduction of the cold liquid into the tanks but removal of the liquid from the tanks presents a number of problems. One of the means presently employed in commercial practice makes use of an impeller which extends downwardly through an elongate housing to the bottom of the tank with the driving means for the impeller located outside of the tank on the top where access can be had to the driving means for replacement or repair. Such means have been found to be satisfactory when everything is operating in good condition but when failure occurs, it is most difficult to restore the pump to operating condition without removal of the liquid from the tank for the purpose of gaining access to the parts of the pump for replacement or repair. This raises a considerable problem because it becomes necessary to provide each tank not only with its individual pumping means but also with auxliary pumping means for purposes of effecting removal of the liquid in the event of failure of the main pump. Such combination of pumping means is not only costly but the auxiliary means is usually of very low capacity by comparison with the primary pumping means so that the ship or tank may be tied up for days before satisfactory removal of liquid can be effected.

The construction which makes use of an extremely long impeller shaft and housing extending from the top of the tank to about the bottom raises a number of other problems from the standpoint of distortion due to load or wide temperature change or from the standpoint of solidification of lubricant or other foreign matter, any one of which can cause binding to prevent operation of the pump.

Since pumping for the removal of liquid from the tank represents an essential operation, considerable effort has been expanded in the developement of a more effective and efficient means for liquid removal wherein failure is minimized and wherein, when failure occurs, the pumping means can be removed for repair or replacement in a simple and efficient manner without the necessity for first removing the liquid from the tank and it is, therefore, an object of this invention to provide a method and means for accomplishing same.

More specifically, it is an object of this invention to provide a method and means for removably mounting a pump essentially in the bottom portion of a tank wherein the pump and its driving means is submerged within the liquid to avoid the difficulties of transmission of power through an elongate shaft which is otherwise subjected to distortion under load or temperature differential; which can be properly located in the tank with or without liquid therein to enable said pumping assembly to be inserted into position of use for removal of liquid from a filled tank thereby to enable one pumping assembly to serve more than one tank or otherwise to enable a reserve pump to be substituted for another because of failure; which is removably locked in position for use within the tank for stabilizing the position of the pump in operation; which can be easily and quickly displaced from position of use within the tank for raising the pumping means from the tank for replacement or repair with or without the removal of liquid; which can be removed or replaced without interferences with the delivery line from the tank; which can be removed from the tank without excessive or expensive equipment, and which enables spare pumping means to be carried for immediate replacement of pumping means which has failed thereby to enhance the rapid delivery of liquid from the tank.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawings in which:

FIG. 1 is a schematic sectional elevational view of an insulated tank embodying the pumping assembly of this invention;

FIG. 2 is a sectional elevational view of a modification in the pumping means illustrated in FIG. 1 with the pumping means in position of use;

FIG. 3 is a sectional elevational view similar to that of FIG. 2 showing the arrangement of parts when the pumping means is being raised from the tank; and

FIG. 4 is a sectional view showing a modification in the sealing means between the inner and outer shells.

Referring now to the drawings, the numeral 10 represents a deep tank, one or more of which may be located on land or in the hold of a ship or other transportation means. It is shown as being lined with a relatively thick layer 12 of insulating material to minimize transfer of heat in the event that the tank is adapted to house a liquid 14 having a temperature differing widely from the ambient temperature. In the event that the tank is mounted within the hold space of a ship, the insulation may be applied as a lining about the inner wall of the hold to provide an insulated hold space in which the tank or tanks are mounted.

The tank 10, which is representative of the one or more tanks which may be employed, is provided with the conventional attachments, such for example, as an inlet pipe 16 through which the liquid is advanced for filling the tank, an outlet pipe 18 through which the liquid is displaced for removal from the tank, and a vent pipe 20 fitted with a pressure relief valve 22 for the release of vapor from within the tank in the event that the pressure rises beyond a predetermined maximum.

For the sake of completing the description of a representative tank, the latter is shown as being formed with a bottom wall **24**, side walls **26** and a top wall **28**, all of which are formed of a fluid and vapor impervious material which, when used for the storage of a liquefied gas or other extremely cold liquid, is formed of a temperature-insensitive material which does not lose much of its strength or ductility at low temperature, such for example, as aluminum or alloys of aluminum, stainless or the like high nickel or austenitic steels. Usually the top wall of the tank will be tied down to the bottom by means of a plurality of spaced apart tie-down bars **30** which extend vertically through the tank between the top and bottom walls.

Having described a representative tank, reference will now be made to the means incorporated therein for the removal of liquid from the tank in accordance with the concepts of this invention. First, each of the tanks are constructed with a rigid outer shell **32** which is supported on legs **33** or otherwise tied into the tank in a fixed position in the lower end portion thereof by means of struts **34** on support bars which extend laterally from the shell either to the side walls of the tank or to the structural columns **35** for support. The shell, formed of a structurally strong material, comprises a cylindrical section **36** which is open at the top and open at the bottom. In the preferred construction, the shell is provided with a flange **38** extending inwardly for a short distance from the lower edge thereof to provide a rest for the inner shell which will hereinafter be described and the shell is also provided with a truncated section **40** extending upwardly and outwardly from the upper edge as a means for guiding the inner shell into position of use within the outer shell. The shell is formed with an outlet opening **42** in the cylindrical section **36** for direct communication with the outlet pipe **18** through a connecting pipe section **44**. It will be apparent from the foregoing that the truncated section **40** and the flanged section **38** are not essential when other conventional means are employed as a stop to position the inner shell within the outer shell and for means in guiding the inner shell into the outer shell.

The outer shell **32** is adapted to receive the pumping means to form a part thereof when the pumping means is in position of use. In the illustrated modification, the pumping means comprises a centrifugal or cylindrical pump having a pump housing **46** in which a rotor is mounted for rotational movement about a vertical axis for withdrawing liquid from the tank into the inlet **48** at the bottom and for expelling the liquid centrifugally through an outlet **50** in the side wall of the housing. The rotor is driven by an electrical motor **52** mounted above the housing **46** and, though not essential, a bell **54** is secured to the lower end portion of the housing **46** with the skirt of the bell flared outwardly to a base dimensioned to be less than the opening **56** between the flanged portions **38** extending inwardly from the lower edge of the outer shell **32** to enable the parallel portion to be displaced therethrough during movements of the pumping means into and out of position of use. The bell merely serves to guide the liquid from the lower portion of the tank into the inlet opening for the pump for displacement of liquid from the tank.

Rigid with the pump to form a part of the pumping means is an inner shell **60** adapted to correspond in shape with the outer shell to be telescoped therein when in position of use. Said inner shell comprises a cylindrical section shaped to correspond with the cylindrical section **36** of the outer shell but dimensioned to be slightly less in the cross-wise dimension to provide an opening **62** which may be in the form of an annular space therebetween when such sections constitute cylindrical members. The inner shell is provided with means to establish a sealing relationship with the outer shell across the opening with such sealing means being spaced above and below the opening **42** in the outer shell thereby to define a sealed opening **62** therebetween. In the illustrated modification, such sealing means comprises flanged portions **64** and **66** extending outwardly continuously from the upper and lower edges of the cylindrical section **60** for a distance to correspond with the spaced relationship between the shells to engage vertically spaced apart portions of the outer shell in sealing relationship. In another modification, illustrated in FIG. 4, the sealing means comprises O-rings **63** and **65** which are retained within annular recesses **67** and **69** formed by vertically spaced apart ribs **71** and **73** extending outwardly from the outer wall of the inner shell for a distance less than the spaced relation between the shells. Thus, the periphery of the O-rings will protrude from the inner shell resiliently to engage the inner wall of the outer shell in sealing relation. The flanged section **66** extending outwardly from the lower edge of the inner shell comes to rest on the flange **38** extending inwardly from the lower edge of the outer shell further to enhance the sealed relationship and properly to locate the inner shell within the outer shell in position of use, with the inlet to the pump free of said cooperating shell sections.

The inner shell **60** is formed with an opening **68** in the side wall **70** which is connected to the outlet **50** of the pump by means of a bellows **72** whereby fluid displaced under pressure by the pump flows into the annular space between the shells and then through the opening **42** in the outer shell, whether or not it is aligned with the opening **68** through the inner shell, whereby liquid flows through the outlet pipe **18** from the tank. Since the liquid filling the annular space **62** will be under pressure, it is desirable to seal off the annular space to minimize the flow of liquid back into the tank. For this purpose, the outer edges of the flanges **64** and **66** and the correspondingly aligned inner surfaces of the outer shell **32** are preferably machined to a relatively smooth finish for more effective sealing engagement therebetween. Still further, it is desirable, though not essential, to provide sealing means such as gaskets **76** of a compressible material, preferably of V-shape in cross-section, with metal rings **78** on the sides thereof opposite the flanges for displacement of the rings in the direction towards the flanges responsive to the presence of liquid under pressure in the annular space **62** whereby the rings **78** operate to compress the sealing gasket **76** therebetween with corresponding displacement of sealing material outwardly into more substantial sealing engagement with the inner wall of the outer shell to seal off the space **62** therebetween. When the pump is inactivated and pressure is released, the rings **78** and gasket **76** are able to return to normal position for release of the inner shell to enable the latter to be moved relative to the outer shell into and out of position of use.

For interconnecting the pump and motor with the inner shell, the top wall **80** of the inner shell is formed with an opening **82** of substantial dimension and the pump housing **46** is provided with a plate **84** dimensioned to be larger than the opening so as to extend beyond the under side thereof whereby the plate **84** and the top wall **80** can be interconnected as by bolt and nut members **86** or other conventional fastening or metal joining means.

In practice, the support bars **34** are arranged to space the outer shell **32** from the bottom wall **24** of the tank by an amount slightly greater than the amount that the bell **54** of the pump extends downwardly beyond the shell, when in position of use, so that the bell will extend to a level spaced only a short distance from the bottom wall of the tank for liquid removal. The liquid that is drawn into the bell and through the throat **48** of the pump and into the pump housing is forced out of the housing through the coupling **72** into the opening **62** between the shells. From there, the liquid under pressure finds its way into the outlet pipe **18** for removal from the tank.

The inner shell and attached pumping means are shiftable together into and out of position of use, as by means of a hoist such as a flexible chain or cable **90** having one end directly or indirectly connected to the inner shell or pumping means while the other end extends upwardly through the tank to a point which is accessible from the

top of the tank for connection either to a hoist, lift or the like for raising or lowering the pump and its attached inner shell into and out of the tank. Instead of making use of power operated means, the assembly can be raised or lowered by manual means if desirable.

When the motor drive **52** is an electrical motor, the electrical cable **92** can be wrapped about the chain or otherwise attached so that the load will be carried by the chain as distinguished from the cable. When a hydraulic motor is employed, the lines for carrying the driving fluid to and from the motor may be in the form of flexible lines suspended within the tank or otherwise attached to the chain or cable for displacement therewith.

The funnel-shaped section **40** on the upper end portion of the outer housing is not essential since it functions primarily as a guiding means to direct the movement of the inner shell **60** into the cylindrical section **36** of the outer housing when the inner shell is lowered into the tank into position of use. Though not essential, it is desirable to guide the inner shell during movement vertically into and out of the tank and to lock the inner shell into position of use within the tank. For this purpose, as illustrated in FIGS. 2 and 3, the inner shell is provided with a horizontally disposed support bracket **94** shown as being fixed to the upper portion of the motor housing to extend laterally therefrom. Fixed to the outer end portion of the bracket is a vertically disposed plate **96** having rollers **98** and **100** journalled thereon for rolling engagement with vertically disposed tie-down bars **30** or other guide means rigid with the tank for guiding the inner shell during relative movement vertically in the tank.

For latching, a triangular plate **104** is fixed to the tie-down bar or other vertical member adjacent the support plate **94** and spaced a short distance upwardly therefrom. A latching arm **106** is pivoted at its lower end onto a pivot **107** rigid with an intermediate portion of the support bracket **94** for rocking movement between an upright position, shown in FIG. 3, and latching position, shown in FIG. 2. The latching arm is constantly urged to rock about its pivot towards latching position by a resilient means, such as a coil spring **108** anchored at one end onto an intermediate portion of the latching arm while the other end is secured to an outwardly extending portion of the support bracket. The cable **90** by which the inner shell is displaced into and out of the tank is secured to a yoke **110** pivoted to the outer end portion of the latching arm. The latching arm has a length dimensioned to clear the apex **112** of the triangular bar **104** when the inner shell is properly seated within the outer shell in position of use so that the latching arm **106** can be rocked by the resilient means **108** to its latching position in engagement with the underside of the upwardly inclined portion of the triangular bar **104** thereby to latch the inner housing in position of use, as shown in FIG. 2. When it is desired to raise the pumping means, the upward pull on the chain **90** will operate first to rock the latching arm in the clockwise direction about its pivot **108** to clear the triangular bar **104** thereby to free the pumping means and the inner shell for separation from the outer shell for relative movement in the vertical direction.

It will be apparent that the inner and outer shells need not be limited to cylindrical sections since shells of other shape such as rectangular, square or other polygonal shapes may be employed with corresponding change in the shape of the sealed space **62** defined therebetween. It will be understood that other means for guiding and for latching the inner shell within the outer shell in position of use may also be employed.

It will be apparent from the foregoing that the construction described offers many advantages over assemblies heretofore employed for the removal of cold liquid from one or more tanks:

(1) Pumping means can be employed to service a number of tanks thereby materially to save on the cost of equipment and tank construction, especially where separate pumping means have heretofore formed an essential part of each tank.

(2) In the event of failure of any one of the pumping means within a tank, the pumping means can be removed easily and quickly for replacement by another pump for the continued removal of liquid.

(3) In the event of failure of any one of the pumping means, the pumping means can be removed for replacement or for repair without the necessity for first emptying the liquid from the tank.

(4) Because of the ability to substitute one pumping means for another, it becomes necessary to carry a minimum number of pumping means for use in a multiple tank assembly, in the event of failures.

(5) Pumping means of the type described and claimed in this invention can be provided at minimum expense from the standpoint of cost and installation.

(6) Movement of the pumping means into and out of the tank can be easily and quickly achieved either manually or by a simple winch or hoist means, without requiring the assistance of the ship's boom or other complicated boom means.

FIG. 1 illustrates a modification in the means for guiding the inner shell during vertical movement. In the modification shown in FIG. 1, the cable **90** is connected to the center of the inner housing whereby the forces raising and lowering the pump assembly will be balanced. A sleeve section **120** is slidably mounted about the lower end portion of the cable with spokes **122** extending outwardly therefrom. The inner ends of the spokes are pivoted to the periphery of the sleeve while the outer ends are pivoted to intermediate portions of stabilizing arms **124**, each of which has a yoke **126** in the outer end portion. The inner end portions of the stabilizing arms are pivoted at **125** to a bracket on the upper end of the inner shell or motor housing. The sleeve **120** is provided with a cable **128** for positive displacement of the sleeve in raised or lowered positions.

In operation, the yoke is raised to collapse the stabilizing arms to enable the inner shell to be displaced through the opening in the top wall of the tank. Once in the tank, the yoke is lowered to rock the stabilizing arms outwardly to horizontal position of use, whereby the yoke ends embrace the adjacent columns **35** to guide the inner housing during vertical displacement in the tank.

It will be understood that changes may be made in the details of construction, arrangement and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. A dispensing means for removal of liquid from a deep well tank comprising the combination of a tank having top, bottom and side walls formed of a fluid and vapor impervious material, an outer shell which is open at the top and bottom formed with vertically disposed side walls having an outlet port therein, means fixing the outer shell within the tank adjacent the bottom side thereof, an inner shell shaped to correspond to the outer shell and defined by continuous vertically disposed side walls spaced inwardly a short distance from the vertically disposed side walls of the outer shell to define a continuous enclosed space therebetween and having an outlet port in the side wall of the inner shell, means above and below said ports sealing the space between the inner and outer shells to define a sealed space therebetween in communication with said ports, a pump means independent of said shells having an inlet and an outlet, a driving motor operatively connected to said pump means for operation thereof, means mounting the pump means and motor on the inner shell with the inlet in communication with the interior of the tank and the outlet in communication with the outlet port of the inner shell, a delivery pipe communicating the outlet port of the outer shell with the exterior of the tank and means for raising and lowering the inner shell with

the pump means and motor into and out of the outer shell.

2. A dispensing means as claimed in claim 1 which includes a flange extending inwardly from the lower edge of the outer shell for a distance greater than the space between the inner and outer shells whereby the lower edge of the inner shell comes to rest upon said flange in position of use.

3. A dispensing means as claimed in claim 1 in which the sealing means comprises flanges extending from one of the surfaces including the outer face of the inner shell and the inner face of the outer shell for a distance corresponding to the spaced relationship between the shells to engage the opposite surface in sealing engagement when the inner shell is telescoped within the outer shell in position of use.

4. A dispensing means as claimed in claim 3 which includes a sealing gasket of resilient material extending continuously about the space between the shells adjacent the interior surfaces of said flanges and rings movably mounted on the side of said resilient sealing gasket opposite said flanges to compress the resilent gasket therebetween responsive to the presence of fluid under pressure within the sealed space between the shells.

5. A dispensing means as claimed in claim 1 which includes a bell in communication with the inlet to said pump and extending downwardly therefrom to about the bottom side of the tank when said inner shell is in position of use within the outer shell.

6. A dispensing means as claimed in claim 1 which includes a funnel-shaped section forming a part of the outer shell at the upper edge thereof for guiding the inner shell into the outer shell when lowered into position of use.

7. A dispensing means as claimed in claim 1 which includes means for guiding the inner shell within the tank continuously during movement vertically through the tank.

8. A dispensing means as claimed in claim 1 which includes means releasably latching the inner shell within the outer shell in position of use.

9. A dispensing means for the removal of liquid from a deep well tank comprising the combination of a tank having top, bottom and side walls formed of a fluid and

vapor impervious material, an outer shell of cylindrical shape having an outlet port in the side wall thereof, means fixing the outer shell within the tank adjacent the bottom side thereof, an inner cylindrical shell having a diameter slightly less than the diameter of the outer shell to provide an annular space therebetween and having an outlet port in the side wall thereof in communication with said annular space, means sealing the space between the inner and outer shells, a pumping means independent of said shells having an inlet and an outlet, means mounting the pumping means within the inner shell with the inlet free of said shell and with the outlet in communication with the outlet port through the side wall of said shell, a delivery pipe communicating the outlet port through the outer shell with the exterior of the tank and means for raising and lowering the inner shell with the pump means and the motor relative to the outer shell.

10. A dispensing means as claimed in claim 9 which includes an annular flange extending inwardly from the lower edge of the outer cylindrical shell for a distance greater than the difference in the diameter between the inner and outer shells to provide a rest on which the inner shell is received when in position of use.

11. A dispensing means as claimed in claim 9 in which the means sealing the space between the inner and outer shells comprises annular flanges extending outwardly from the upper and lower portions of the inner shell into engagement with the adjacent surface of the outer shell when in position of use.

12. A dispensing means as claimed in claim 9 which includes a bell member attached to the pump means and in communication with the inlet thereof and dimensioned to extend downwardly beyond the inner and outer shells when in position of use.

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