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Bryant et al.

[15] **3,696,975**

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[54] **SUBMERGED PUMP REMOVAL SYSTEM**

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Related U.S. Application Data

[63] Continuation of Ser. No. 776,946, Nov. 19, 1968, abandoned.

[52] **U.S. Cl.** **222/333**

[51] **Int. Cl.** **F04b 47/06**

[58] **Field of Search** 417/360, 448, 454; 222/333, 222/385, 377

[56] **References Cited**

UNITED STATES PATENTS

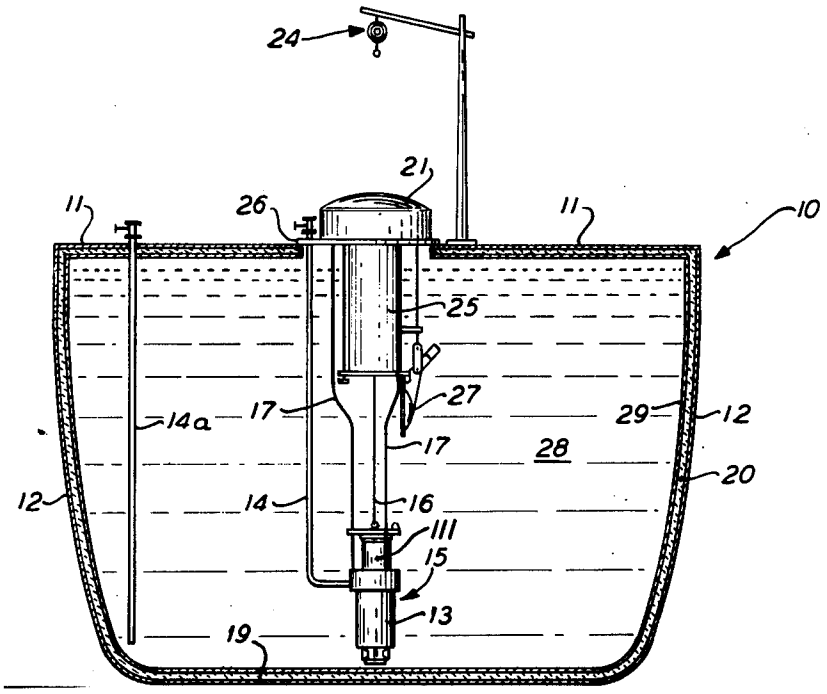
3,369,715 2/1968 Carter 222/333

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[57] **ABSTRACT**

This invention relates to a submerged pump system for a tank, comprising a discharge housing in the bottom of the tank, means to lower a pump into said housing and to raise said pump into a chamber in the top of the tank, valve means to seal said chamber from the tank after the pump has been lifted into the chamber, said valve means thereby sealing the tank from theatmosphere and allowing the pump to be safely removed from the chamber.

22 Claims, 3 Drawing Figures



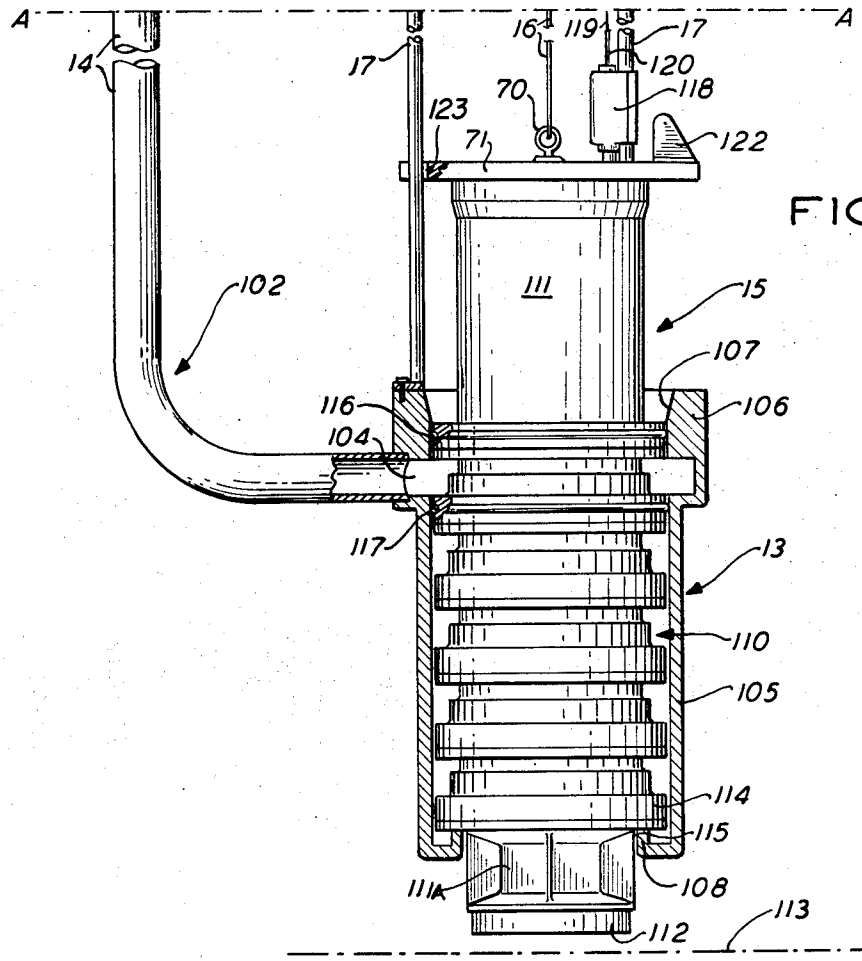


FIG. 2B

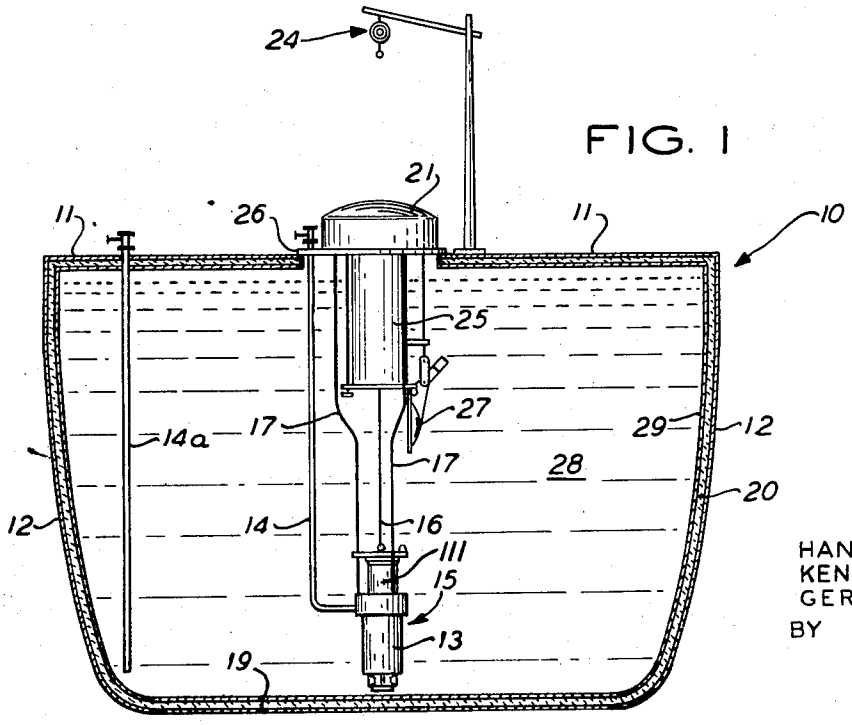
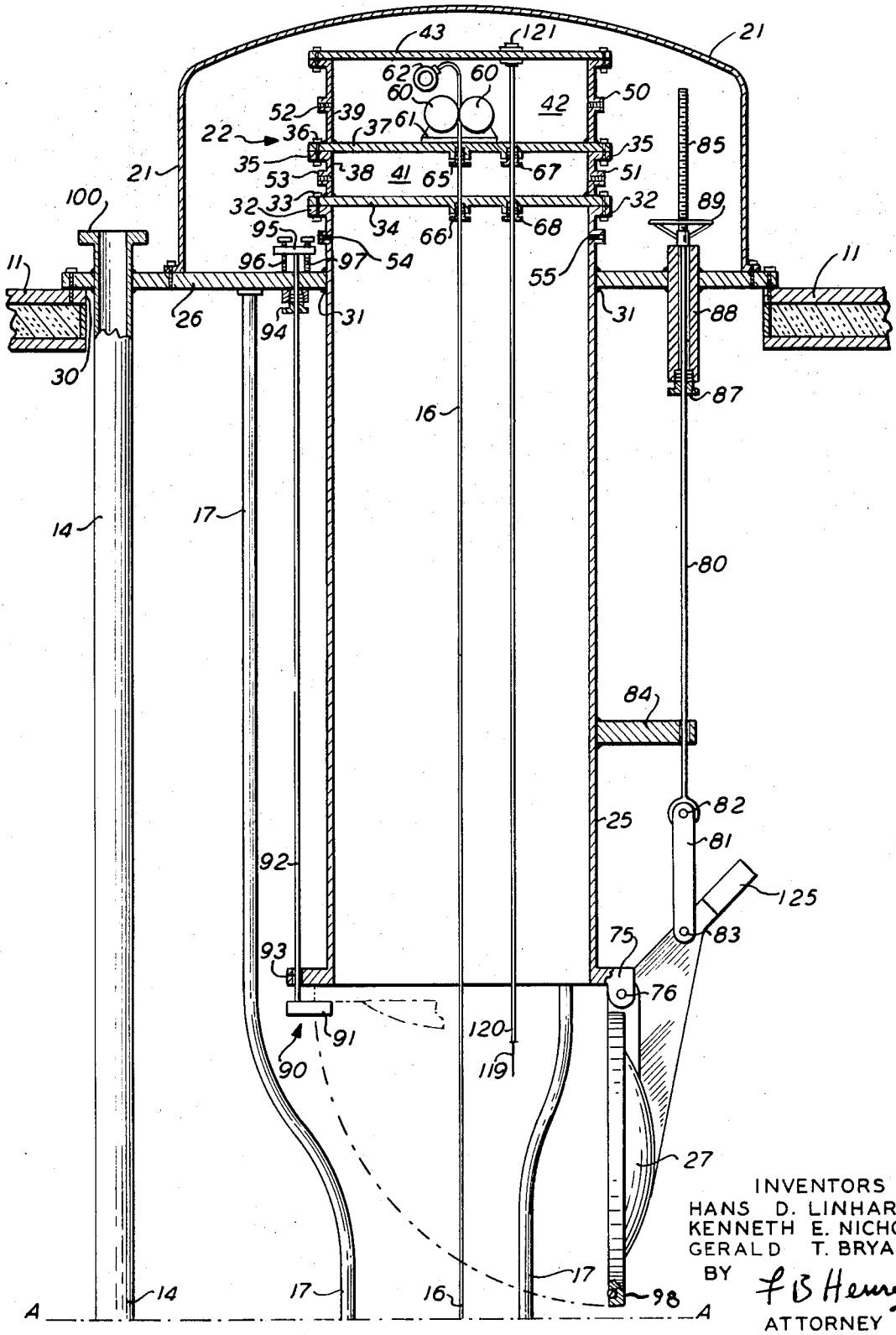


FIG. 1

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FIG. 2A



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SUBMERGED PUMP REMOVAL SYSTEM

This is a continuation of application Ser. No. 776,946, filed Nov. 19, 1968 and now abandoned.

This invention relates to pumping systems especially suited for handling liquefied cryogenic gases, although other types of fluids may be handled with the systems. The pumping systems may be utilized with either mobile (ship, etc.) or fixed storage tank systems (frozen hole, etc.).

The most commonly used commercial system at the present time is described in J. C. Carter, U.S. Pat. No. 3,369,715, issued on Feb. 20, 1968. This patent discloses a pumping system which utilizes an elongated large diameter pipe section which extends from the top of the tank to the bottom of the tank. This large diameter pipe serves as the discharge pipe and also as the guiding and supporting structure for the pump and motor. This system has proven to be expensive to build, costly to maintain and presents safety problems which will be discussed below. The elongated large diameter pipe, which may be described as an elongated casing, sometimes reaches 30—50 ft. in length. The elongated casing is made up of sections which must be welded together and which must be gas tight. Due to the stresses and strains caused by the ship's movement , these elongated casings have a tendency to rupture.

The prior art also utilizes a foot valve which is positioned at the bottom of the elongated casing. The foot valve is located at the very bottom of the tank and is spring loaded to close and seal the lower end of the casing when the pump mechanism is raised. Thus, the casing must be purged throughout its length before the pump mechanism can be removed through the upper end of the casing. In practice this foot valve often becomes jammed with sediment and residue lying at the bottom of the tank. Since the foot valve is in an inaccessible location, the tank must be completely evacuated and maintenance men dropped down into the bottom of the tank to repair the foot valve when it has become inoperative. A foot valve is required in the prior art construction in view of the fact that when the pump is removed, some means must be employed to seal the casing to prevent combustible gases (LNG, etc.) from escaping from the tank into the atmosphere surrounding the tank. The prior art system also utilizes a slidable gland sealing arrangement at the upper portion of the elongated casing. This gland sealing arrangement prevents the leakage of fluid from the tank as the pump is discharging fluid. This gland sealing arrangement is quite costly to manufacture and due to the corrosive atmosphere at sea, it is difficult to maintain its gas-tight integrity.

It is therefore an object of this invention to provide a pumping system for the removal of cryogenic liquids from tanks by utilizing a pumping system which is extremely simple in construction and which requires little maintenance. A further object of this invention is to provide a sealing system for the pumping system which is located at the top of the tank being evacuated, so as to allow easy access to the sealing system in the event of its failure. A further object of the invention is to provide a plurality of thin elongated guide rails to guide the pump and motor assembly to the bottom of the tank. A further object of the invention is to provide a discharge conduit of small diameter which can be easily sealed at the top of the tank. A further object of the invention is

to provide a chamber at the top of the tank into which the pump and motor may be lifted. A further object of the invention is to provide a sealing system which is positively actuated to close the chamber into which the pump and motor are lifted. A further object of the invention is to provide a locking system which positively locks the sealing system in a closed position. Other objects and advantages of this invention will become evident in connection with the following description.

FIG. 1 is a schematic cross-sectional view of a storage tank which forms part of the hold of a ship.

FIGS. 2A and 2B, when taken together, comprise an enlarged elevational view, partly in section, partly broken away, of the pumping system embodying the features of this invention.

Referring to FIG. 1, reference number 10 indicates the ship's hold which is especially designed to transport cryogenic liquids. Both the deck 11, bottom 19, and the sides 12 are constructed of steel plate and are suitably insulated with cork, balsa wood or other material 20 so that the cryogenic liquid in the tank 28 will be retained at liquid temperatures. The interior surfaces of the tank 28 are formed with corrosive resistant metals 29 of low permeability which are especially suited for the transportation of cryogenic liquids. The internal supporting structure between sides 12, deck 11 and the bottom 19 is not shown and forms no part of the present invention. The illustration in FIG. 1 is a cross-sectional view of a single hold in a ship, it being understood that many such holds are located throughout the length of the ship. The holds are separated by fluid tight bulkheads which extend athwart-ship.

While the pumping system which will now be described is especially suited for use on board ship, it may also be used in stationary vessels located on the land or on the bottom of the sea. The pumping system also can be used in underground storage facilities such as for example the frozen hole tanks.

The topside portion of the pumping system extends above the deck 11. A heat shield 21 surrounds and completely encloses the upper portion of the pumping system. The heat shield is bolted down or otherwise connected to the deck with quick release couplings. The heat shield is provided in order to protect the pumping system from the sun, sea water, ice, snow and other adverse elements which may damage or otherwise affect the operation of the pumping system. The heat shield is painted with reflective paint in order to reflect as much heat as possible. The portion of the pumping system which lies under the heat shield 21 is indicated by the reference number 22 and will be more specifically described below in connection with FIG. 2A. This portion comprises a series of sections which are bolted together and which support the lifting cable 16 and conduit 120 for the electrical cable which transmits power to the lower end of the pumping system. Positioned at the bottom of the pumping system is a fixed discharge housing 13 FIGS. 1 and 2B. The housing is positioned as close as possible to the bottom of the tank and is located and held in this position by means of a plurality of support and guide rails 17. The guide rails serve to guide the ascent and descent of the pump motor assembly 15. A discharge pipe 14 extends from the discharge housing up to the deck 11. When not in use the discharge pipe 14 is sealed by means of a

valve which is connected to the upper portion of the discharge pipe. When discharging fluid the pipe is connected by a coupling to a discharge conduit which is led off the ship in the conventional manner. Since this forms no part of the invention it is not illustrated. Either a single discharge pipe **14** or a plurality of such pipes may be utilized depending upon the output of the pump and motor system **15**. The conventional inlet pipe **14***a* is used to fill the tank **28**. A valve in the upper portion of pipe **14***a* is closed when the tank has been filled.

The supporting guide rails **17** are rigidly connected to a base plate **26** which is in turn bolted to the deck plate **11** of the ship. The connection between the base plate **26** and the deck plate must be gas tight and capable of withstanding a relatively high pressure. The support and guide rails may be bolted or welded to the base plate **26**. Extending through the base plate **26** is an elongated cylindrical chamber **25**. The chamber may be welded to the base plate or otherwise affixed thereto to prevent the escape of gas. A valve which is indicated by the reference numeral **27** is pivotally mounted on the lower end of the chamber so as to close completely the lower open end of the chamber. This valve is provided so that when the pump and motor assembly **15** is raised into the chamber the valve **27** may be closed to seal the chamber from the tank. With the valve **27** closed and the enclosed assembly completely isolated, the upper portion of the chamber may be opened and the pump and motor assembly removed for repair or replacement or for periodic preventive maintenance. Accordingly, the chamber **25** has the function of an isolating fluid lock between the tank and exterior. The pump and motor assembly may be raised from its lowered position into the chamber by any suitable winch means indicated generally by the reference number **24**. Only a single transportable winch means is needed for lifting all the pump and motor assemblies throughout the whole ship.

In FIGS. 2A & 2B there is illustrated in detail the preferred embodiment of the present invention. An annular opening **30** is provided in the deck plate **11**. Base plate **26** is bolted over the annular opening **30** to the deck plate **11**. This connection must be gas tight in order that the gaseous contents of the tank cannot escape into the surrounding atmosphere.

As mentioned above, chamber **25** extends through base plate **26** that in turn constitutes a portion of the top wall of the tank, FIG. 2A. Suitable gas tight welds are used to connect the chamber **25** to the base plate **26**. The upper end of the chamber **25** is flanged at **32**. The flange is bolted by means of bolts **33** to a plate **34** which forms the lower portion of a gas seal chamber indicated by the reference numeral **41**. The cylindrical side wall **38** of the chamber **41** is flanged at **35** at the upper portion thereof. The flange **35** is in turn bolted to plate **37** by means of bolts **36**. The plate **37**, side wall **39** and the top plate **43** form an upper gas seal chamber **42**. Each of the chambers **25**, **41** and **42** are provided with purge connections **50** through **55** which are utilized to purge undesired gases from the various chambers. The particular sequence of events that takes place in the purging process will be described in detail below.

Positioned within the upper chamber **42** is a cable sheave assembly, comprising a pair of cable sheaves **60** mounted upon a support assembly **61**. The support assembly is rigidly mounted on plate **37** by any suitable means. Trained through the cable sheaves is a flexible lifting cable **16** which terminates in the upper chamber **42** with coupling eye **62**. The cable extends downwardly through an aperture in plate **37** and passes through packing gland **65** into chamber **41**. The cable passes through an aperture in plate **34** and then through packing gland **66** into lower chamber **25**. The cable extends downwardly into the tank and is coupled at its lower end to an eye **70** which is attached to plate **71** which forms the upper part of the pump and motor assembly **15**.

An annular flange **75** is fixed to the lower end of chamber **25**. The valve **27** is pivotally mounted to plate **75** by means of pivot **76**. The valve swings from an essentially vertical position to a horizontal position partly shown in dotted lines and is directly actuated in the present instance by an elongated connecting rod **80** which passes down through the plate **26** and which connects with link **81** through pivotal connection **82**. The link **81** is in turn connected to an arm on the valve means **27** by means of pivotal connection **83**. The connecting rod **80** is guided and supported in its vertical movement by supporting member **84** which is rigidly attached to the exterior portion of chamber **25**. The upper portion of the connecting rod **80** passes through packing gland **87** and then through a supporting column **88** which is fixed to plate **26**. The topmost portion of connecting rod **80** is threaded **85**. An actuating wheel **89** is screwed onto the threaded portion of the connecting rod and by turning the actuating wheel **89** the valve means **27** may be opened and closed as desired. The wheel is rotatably fixed to the upper part of column **88**.

In order to insure that the valve means **27** remains in a closed position a swing door lock device **90** is provided. The lock comprises a lug **91** which is rigidly mounted to the lower end of rod **92**. The rod is supported for pivotal and axial movement in an opening **93** in the flange **75**. The rod **92** passes up through packing gland **94** and through an opening in plate **26**. The rod terminates in a horizontally extending flange **95**. The flange has a plurality of threaded openings through which are screwed bolts **96**, **97**. When the valve means **27** has been closed by means of actuating wheel **89** the lug **91** may be rotated so that it contacts the lip portion **98** of the valve means **27**. Bolts **96** and **97** may be then screwed toward the deck plate **26** so that rod **92** may be put under tension, thereby locking the valve means **27** in a closed position. The angular position of lug **91** may be indicated on the top surface of flange **95** so that it may be rotated to an out of the way position or rotated so as to contact the lip of the valve means **27**. If desired, a plurality of locking devices may be provided to assist in the sealing and locking of the swing valve means **27**. The swing valve is provided with an annular Teflon seal which contacts the surface of flange **75**.

The discharge pipe **14** extends upwardly through an opening in plate **26**. The pipe may be either welded to plate **26** or bolted thereto as desired. The connection between the pipe and plate should be gas tight in order to insure that none of the contents of the tank escapes to the surrounding atmosphere. The upper portion of the pipe **14** terminates in flange **100**, which may be

coupled to a valve which in turn may be connected to conduit means which leads to the shore side storage tankage. The discharge pipe extends downwardly to the bottom portion of the tank where it connects to discharge housing **13**. The bottom portion of the pipe is suitably curved at **102** so that it presents the least restriction in passing fluid from the discharge housing to the deck area. The lower portion of the discharge pipe **102** communicates with discharge chamber **104** which is an annular chamber located in the upper portion of the discharge housing **13**.

The discharge housing **13** comprises a cylindrical side wall portion **105** and an upper annular portion **106** having an internal frusto-conical surface **107**. The discharge housing is positioned in the tank by a plurality of support guide rails **17**. The top of the guide rails **17** are either bolted or welded to plate **26** and the bottom portions of the guide rails are either bolted or welded to the upper portion of the discharge housing at **106**. In the preferred embodiment of the invention three equally spaced support guide rails are used. The guide rails may be made of either tubular or solid stock with high strength and corrosion resistant properties. As will be discussed below, the guide rails are used to guide the movement of the pump and motor assembly **15** which is raised and lowered by means of lifting cable **16**.

The pump and motor assembly generally indicated by the reference number **15** is made up of an upper electrical motor assembly **111** and a lower pumping assembly **110**. In the embodiment shown in FIG. **2B** the pumping assembly is made up of a number of stages in the conventional manner. Mounted on the lower portion of the pump assembly is an inducer **111A** and an inlet **112**. The details of the pump assembly, including the inducer and the inlet are not described in detail in this application in view of the fact that these details form no part of the invention. The discharge housing **13** is positioned so that the inlet **112** is positioned close to the tank bottom **113**. A small space is provided between the inlet opening and the tank bottom in order to allow for suction and to prevent the pump from sucking into the inlet opening solid residues which may have settled out on the bottom of the tank. If desired, an inlet screen may be mounted on the lower portion of the discharge housing **13** to prevent the entrance of solid material into the pumping system. The inlet screen normally takes the form of a wire mesh which is connected between the lower portion of the discharge housing and which rests on the bottom of the tank **113**. The inlet screen is not shown in FIG. **2** and in that it forms no part of the present invention.

In its lowermost position the first stage **114** of the pump assembly rests on an inturned flange **108** of the discharge housing. The inturned flange **108** defines an opening **115** through which the inducer passes. As can be seen from FIG. **2B** the external diameter of the pumping stages closely approximates the internal diameter of the discharge housing **13**. If desired, seal rings may be placed around each stage of the pumping assemblies in order to prevent the communication between stages around the pumping assemblies. The details of the pumping stages are not illustrated in view of the fact that they form no part of the present invention.

The upper pumping assembly which may be described as the high pressure pumping stage, discharges into discharge opening **104**. The high pressure in this opening is prevented from leaking into the tank or to a lower stage of the pumping assembly by means of sealing rings **116** and **117**. The sealing rings are annular in form and may be made of Teflon. Of course other suitable sealing material may be used as desired. The annular sealing rings mate with cylindrical portions of the discharge housing.

The motor assembly **111** drives the pump assembly **110** through an extension of the motor shaft (not shown). The motor assembly is supplied with electrical current through an electrical cable **119** which is connected to an explosion-proof conduit box **118**. The electrical cable **119** passes through a conduit **120** which prevents the contents of the tank from contacting the electrical cable. The conduit **120** passes up through packing glands **67**, **68**. The conduit box **118** and the eye **70** are mounted on a flange **71** fixed to the upper portion of the motor assembly **111**. The flange **71** has peripheral portions **123** cut away to create bifurcated portions which at least partially encompass the support and guard rails **17**. Thus the support and guide rails guide the pump and motor assembly during its ascent and descent and locate the pump and motor assembly in the center of the discharge housing opening. The frusto-conical surface **107** further serves to center the pump assembly as it is being lowered into the discharge housing. When the pump and motor assembly is in its lowest position the entire weight of the pump and motor assembly is accepted by the discharge housing which is in turn supported by the guide rails **17** and the topmost plate **26**.

The support and guide rails **17** need not be completely rigid but are constructed of a material which will allow a small degree of movement which may be caused by the pitching and rolling of the ship or by collisions with piers, pilings or other vessels. Similarly, the discharge pipe **14** should be made of a material which is comparably resilient.

In normal operation. The pump and motor assembly remains in the bottom of the tank as illustrated in FIGS. **2A** and **2B**. When energized the pump and motor assembly will discharge the contents of the tank into discharge pipe **14** and will continue to do so until it can no longer pull suction on the bottom of the tank. The ship then takes on other liquid cargo through pipe **14***a* from the port of discharge or returns unloaded to its home port for picking up a new cargo of cryogenic liquid. Although this pumping system is especially suited for the discharge of cryogenic liquid it can also be used for the discharge of any liquid which is stored and transported at ambient or other temperatures. The types of sealing materials used in this pumping system would have to be altered to compensate for the type of fluid being pumped.

In the event that the pump and motor assembly has to be removed from the tank while it contains product for servicing or repair the following steps are taken. The heat shield **21** is unbolted from the plate **26**, the electrical connection between the electrical source on the ship and the electrical cable **119** is disconnected at coupling **121**. The electrical connection from the ship's power source may pass through an opening of heat

shield 21 and then connect to the cable 119 at coupling 121. The heat shield need not be vaportight since it only serves to protect the upper portion of the pumping system from physical injury and from becoming excessively hot due to the sun, etc.

An inspection of the positions of the flange 95 and actuating wheel 89 should then be made in order to insure that the lug or lugs 91 and the valve means 27 are positioned in locations which will not interfere with the raising of the pump and motor assembly.

In order to insure that the upper chamber 42 does not contain any vapors of the gas which is being transported and which may have passed up through packing glands 65 through 68, the chamber 42 is purged. This may be done by connecting a source of suitable purge gas such as nitrogen or other comparable inert gas to purge connection 50. The upper chamber 42 is then purged with this inert gas and the contents of chamber 42 are allowed to escape through opening 52. Purge connections 50 and 52 are of course normally closed but are opened for the purposes of purging the upper chamber 42. When the upper chamber 42 has been completely purged, the upper plate 43 is unbolted from the side wall 39 of the upper chamber. At the same time electrical cable 119 and its tubular conduit are disconnected from the plate 43. With the plate 43 removed, a hoisting mechanism 24 may be located above the lifting cable 16 and connected thereto by means of eye 62. As mentioned above, a single hoist which may be electrically, pneumatically, or hydraulically operated may be utilized to remove all the different pumping assemblies on the ship.

The electrical cable, and its flexible conduit, is then connected to an external reel mounted on the deck which may be equipped with a constant tension clutch so that as the lifting cable 16 is withdrawn the electrical cable is also withdrawn from the tank and stored on the reel.

At the time that upper chamber 42 is being purged, chamber 41 is also being purged in the same manner by the introduction of a purge gas through purge connection 51 and its exhaust through connection 53. The purge gas in chamber 41 is at a greater pressure than the product gas pressure in chamber 25. The ensuing result is that no product gas can escape during the removal operation as a small amount of purge gas will pass through the packing glands 66 and 68 into chamber 25.

While the hoist lifts the lifting cable 16 nitrogen gas continues to be introduced into purging connection 51.

This unique purging arrangement which floods intermediate chamber 41 with nitrogen gas prevents the escape of any product gas through the packing glands 66 and 68 as the electrical and lifting cables are being drawn through these glands.

The lifting and electrical cables continue to be withdrawn from the tank until the pump and motor assembly is completely housed in the chamber 25. A plurality of cams 122 may be mounted on the plate 71 to assist in the centering of the pump and motor assembly in the chamber 25. The cam members have an angle surface which contacts the lower portion of the chamber 25 and which serves to center the motor assembly in the bottom of the chamber 25. The pump and motor assembly continues to be lifted into the chamber 25 until they are completely enclosed therein. This may be indicated by a mark on the lifting cable or by the bottoming of the motor assembly on the top of the chamber 25.

Actuating wheel 89 may then be turned until the valve means 27 closes the bottom of the chamber 25. The Teflon seal is positioned to contact the flange 75 and thereby form a gas tight seal to prevent the escape of product gas into the chamber 25. In the interest of safety and ease of operation, the valve means 27 may be provided with a counterweight 125 which will facilitate the operation of the valve actuating means. Furthermore, if the link 81 becomes disconnected from the connecting rod 80, the counterweight 125 will cause the valve means 27 to remain closed or to swing shut. When the valve means has been closed, the locking device 90 is rotated into position and brought to bear on the external lip of the valve means. If more than one locking means is provided, they are sequentially operated to insure that the valve means remains closed.

To insure that the chamber 25 becomes free of the product gas during the actuation of the valve means, the purge gas is admitted to purge connection 54 during this process. When the valve means has been closed and locked in place, the purging is continued to be admitted to purge connection 54 and is exhausted out connection 55 until all dangerous vapors are removed. Plates 37 and 34 may then be disconnected from the upper portion of the chamber 25 and the pump and motor assembly removed from said chamber.

When the repairs have been completed or the maintanence performed on the pump and motor assembly, essentially a reversal of the procedure described above is carried out to return the pump and motor assembly to the bottom of the tank. The pump and motor assembly is lowered into the chamber 25 and the plates 34 and 37 are again bolted into position. Purge gas may again be connected to connection 51 to insure that none of the product gas escapes to the surrounding atmosphere during the lowering process. When the plates 34 and 37 have been securely fastened in place in a gas tight manner, the locking mechanism 90 is disengaged and the valve means 27 is opened by means of the actuating wheel 89. The pump and motor assembly is then lowered by means of cable 16 into the depths of the tank. The pump and motor assembly is guided in its downward movement by means of the support and guiderails 17. The surface 107 guides and centers the pump assembly into the center of the discharge housing. Lowering is continued until the pump and motor assembly bottoms in the discharge housing on internal flange 108. When this occurs, the introduction of purge gas into chamber 41 may be discontinued and purge connections closed. Eye 62 is disconnected from the hoist and the electrical conduit is disconnected from its storage reel. Flange 43 is then bolted in place and the electrical connection between the cable 119 and coupling 121 is made. Connection is then made between the source of power on the ship and the coupling 121.

Heat shield 21 is then positioned over the upper portion of the chamber 25 and is bolted in place.

The contents of the tank may then be discharged by energizing the pump and motor assembly and by discharging the contents of the tank through pipe 14.

Although the discharge system which forms an essential part of this invention is designed to be simple in structure and reliable in operation, provsion has been made to remove the entire discharge system from the ship's tank if desired. By unbolting plate **26** from the deck **11**, the entire discharge assembly may be raised from the tank.

As mentioned above, various types of winches or lifting devices may be utilized to lift the pump and motor assembly from the tank. Similarly, the actuating mechanism for the valve means **27** may be either manually, pneumatically, mechanically, electrically, or hydraulicly controlled. If desired, the valve means may be operated from a station remote from the tank by a suitable control means. Another advantage of the present invention lies in the fact that a single operator can control and observe the entire operation to insure that the pump removal proceeds without difficulty. The invention furthermore avoids use of a remotely positioned foot valve, i.e. at the lower end of an elongated large diameter casing which extends from the top of the tank all the way down to the bottom of the tank. By contrast, the foot valve of this invention can be independent of the pump-motor assembly for accessible location near the deck. In addition, the valve has an auxiliary locking and tight sealing arrangement which insures that the product pressurized gas cannot escape into the surrounding atmosphere. The illustrations shown in FIGS. **1** and **2A, 2B** are not to scale in order to facilitate the instant disclosure.

The particular details of the apparatus described in relation to FIGS. **1** and **2A, 2B** above are not meant to limit the scope of this invention. Rather, it is intended that the scope of this invention be limited only by the following claims.

We claim:

1. A submerged pump system for a closed storage tank, comprising a housing forming a pump receptacle at the bottom of the tank, a second housing forming a sealing chamber in the top of the tank, means to lower a pump into said receptacle for pumping operation and to raise said pump into the sealing chamber in the top of the tank, and valve means to seal said chamber from the tank interior after transfer of the pump from said receptacle to said chamber.

2. A pump system according to claim **1** wherein sale valve means is pivotally mounted at the lower end of the chamber and is actuated by means located outside of said tank.

3. A pump system according to claim **1** having auxiliary locking means for locking said valve means in a tight sealing position, said locking means being actuated by means located outside of said tank.

4. A pump system according to claim **3**, in which said locking means comprises a member actuated through the top of said tank, a camming lug connected to said member for biasing said valve means into a tight sealing position.

5. A pumping system for a gas tight storage tank adapted to contain a volatile liquid comprising pumping means normally located in said tank, discharge means connected to said pumping means to direct the pumped fluid out of the tank, a sealing chamber connected to the tank and communicating with the interior thereof through a valve-controlled opening, said sealing chamber being located in the top of the tank, means to raise the pumping means from its normal location in the bottom reaches of the tank through the valve-controlled opening and into the sealing chamber, valve means to seal said opening and isolate the pumping means in the chamber and prevent escape of the tank contents into the chamber, and means to open the upper part of said sealing chamber to the atmosphere whereby the pumping means may be removed without the escape of the tank contents into the atmosphere.

6. A pumping system defined in claim **5** further comprising means to purge the sealing chamber of tank contents prior to the opening of the sealing chamber.

7. A submerged pump system for a storage tank, comprising a discharge housing in the bottom of the tank, means to lower a pump into said housing and to raise said pump into a chamber in the top of the tank, valve means to seal said chamber from the tank, said discharge housing being connected to the upper portion of said tank by means of a plurality of elongated support and guide rails, guide means on said pump adapted to engage said support and guide rails, and said lowering means comprising a cable connected to said pump and passing through the upper portion of said chamber.

8. A submerged pump system for a storage tank, comprising a discharge housing in the bottom of the tank, means to lower a pump into said housing and to raise said pump into a first chamber in the top of the tank, valve means to seal said first chamber from the tank and means to admit purging gas to the upper portion of said first chamber, a second chamber positioned above said first chamber, said lowering means passing through said chambers and connected to said pump, and means to introduce purging gas into said second chamber to prevent the escape of the fluid in said tank.

9. A method of removing a submersible pump from a closed tank containing a pressurized fluid, comprising the steps of raising the pump from the tank bottom, through the tank interior and into an upper chamber defining a fluid lock in the tank top, sealing said pump in the upper chamber to prevent communication between said chamber and tank, opening chamber at the exterior side of the tank top and removing said pump from said chamber.

10. The method defined in claim **9** characterized by purging the sealed upper chamber with inert gas prior to removing said pump.

11. A submerged pump system for a tank adapted to contain liquefied gas, comprising a discharge housing having an inlet opening in close proximity to the bottom of the tank, a discharge means connected to said housing and extending from said housing to a location outside of the tank, means to raise and lower a pumping assembly from and to said discharge housing, chamber means connected to the upper portion of the tank and adapted to receive said pumping assembly when said assembly is raised into said chamber means by said raising and lowering means, and means to seal said chamber means from the tank after said pumping assembly has been raised into said chamber means so as to prevent the escape of the contents of said tank.

12. A pump system as defined in claim **11** in which said seal means comprises valve means, and means to actuate said valve means from outside said tank.

13. A pump system as defined in claim 11 in which the discharge means comprises at least one conduit extending upwardly from said housing to the top of the tank.

14. A pump system as defined in claim 11 further comprising closure means normally sealing the chamber means to prevent the escape of the contents of the chamber means, said closure means adapted to be opened to allow the removal of the pumping assembly from the chamber means.

15. A pump system as defined in claim 14 in which the means to raise and lower the pumping assembly passes through the closure means.

16. A pump system as defined in claim 11 further comprising means to purge, said chamber means.

17. A submerged pump removal system for a closed tank having a submerged pump assembly, comprising a chamber adapted to form a gas lock connected in the upper portion of said tank, said chamber being of limited volume for essentially receiving only said submerged pump assembly, means to move the submerged assembly from the tank bottom into the chamber, means to seal the chamber from the tank after the pump has been moved into the chamber to seal off the contents of the tank, said chamber having closure means at its top normally sealing the chamber form the atmosphere, said closure means adapted to be opened to allow the removal of the pump from the chamber to the tank exterior, and means to purge said chamber prior to the removal of the pump therefrom.

18. A submerged pumping system for a closed tank comprising a pumping assembly, means to support said assembly in a normal operating position in the lower portion of said tank for discharging fluid therefrom, a gas tight chamber positioned remote from the normal operating position of said assembly and connected to the upper portion of said tank, said chamber having a first opening into said tank and a second opening into the surrounding atmosphere, means to move the pumping assembly from its normal operating position into said chamber, said gas tight chamber having sealing means for said first opening to seal the chamber from the tank after said pumping assembly has been moved into said chamber, closure means for said second opening for sealing the chamber from the surrounding atmosphere, said closure means adapted to be opened to allow the removal of the pumping assembly for the chamber.

19. A pumping system as defined in claim 18 further comprising means to purge said chamber prior to the removal of the pumping assembly therefrom.

20. A submerged pump system for a storage tank containing a fluid, comprising a pump assembly unit normally located at the bottom of the tank for pumping therefrom pressurized fluid, housing means at the top of the tank forming a sealing chamber, the upper end of the chamber being normally sealed from atmosphere by removable wall structure, means for raising the pump unit from the bottom of the tank into the chamber through the lower end thereof, and valve means operable to seal the lower end of the chamber after the pump unit has been moved into the chamber whereby the pump unit is isolated and can be subsequently removed from the upper end of the chamber without venting the tank.

21. A submerged pump system as specified in claim 20 wherein the valve means is mounted on the lower end of the chamber and has actuating means for opening the chamber to receive the pump unit and for sealing the chamber to isolate it from the tank interior.

22. A submerged pump system as specified in claim 20 wherein the linear dimensions of the chamber are limited so as substantially to minimize the volume of pressurized fluid sealed therein with the pump unit.

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