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**Ludwig**

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[54] **PORTABLE PUMP**


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[51] **Int. Cl.** ..... **F04b 17/00,** F04b 35/04

[58] **Field of Search** ..... 417/411, 413, 422, 417/415



[56] **References Cited**

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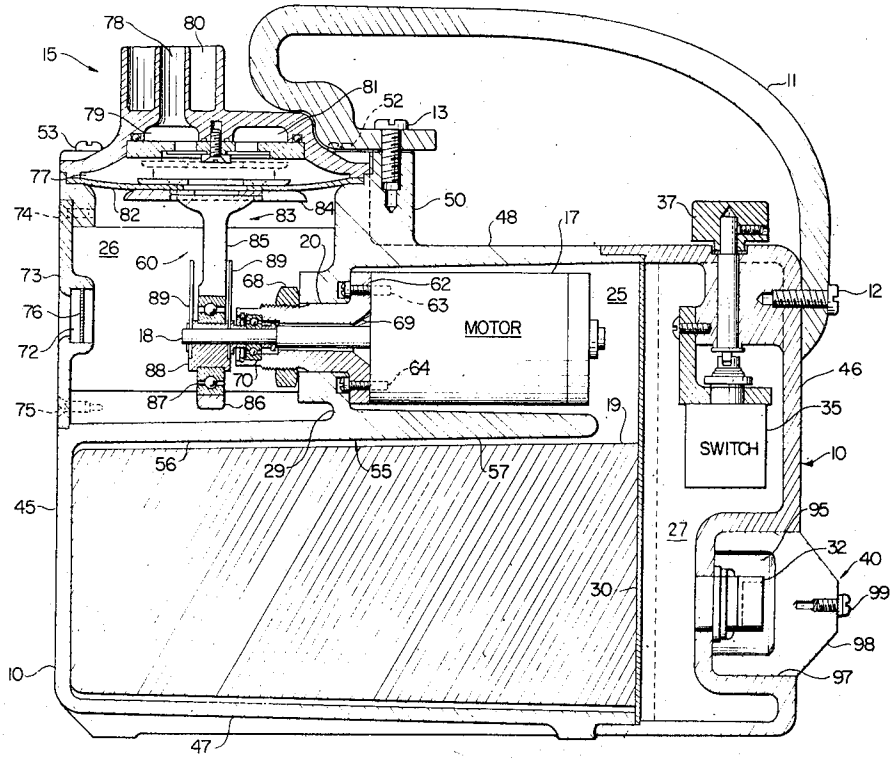
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[57] **ABSTRACT**

An explosion proof portable pumping unit instantaneously available for pumping flammable fluids. The pumping unit comprises a housing internally divided into three compartments, a diaphragm pump mounted within one compartment, an electric motor mounted within a second compartment and connected to the pump with a shaft extending through an aperture in the dividing wall, a battery electrically connected to the motor and mounted within the same compartment as the motor, a flame-propagation prevention sleeve concentric around the shaft for preventing a spark originating in the motor compartment from passing along the shaft into the pump compartment and causing an explosion therein, and a switch mounted within a third compartment which is segregated from the other two compartments for energizing the motor from the battery.


**6 Claims, 2 Drawing Figures**



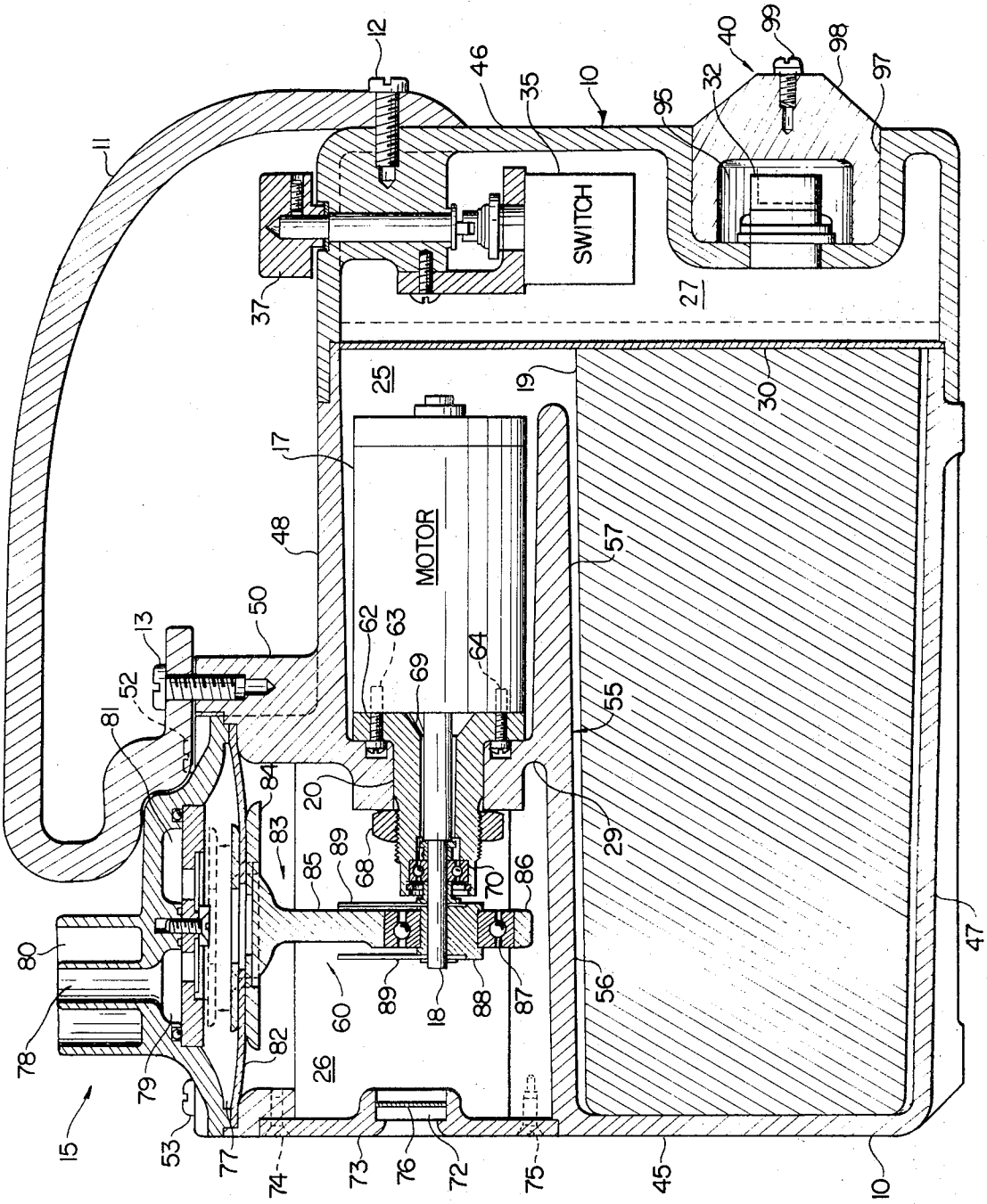



FIG. 1

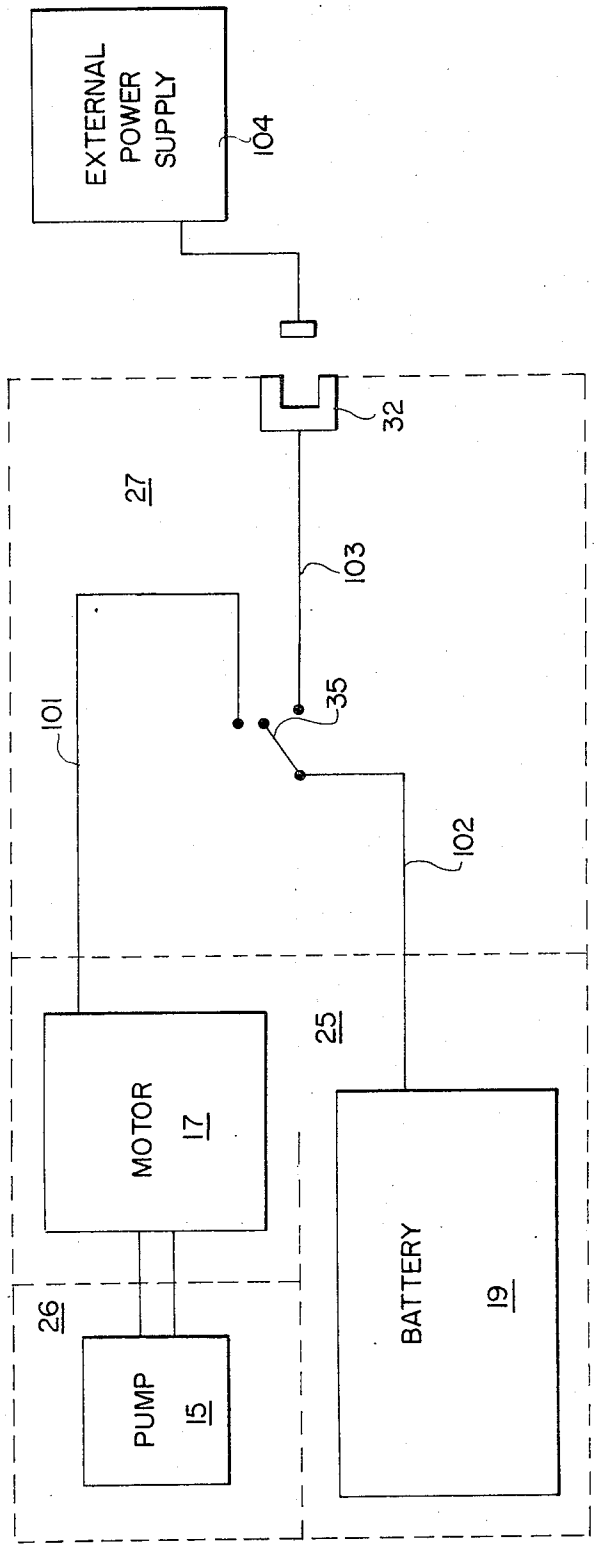

EXTERNAL POWER SUPPLY
104
32
27
103
101
35
102
25
MOTOR 17
BATTERY 19
26
PUMP 15

FIG. 2

# PORTABLE PUMP

## FIELD OF THE INVENTION

This invention relates to pumping units and more particularly to improvements thereto so as to provide a portable explosion proof and flame-propagation preventing pumping unit for pumping potentially explosive or flamable fluids.

## BACKGROUND OF THE INVENTION

There are numerous occasions where lightweight, readily portable, battery operated pumps are required for pumping explosive mixtures. One such occasion arises in the field of thoracic surgery when a vacuum must be maintained in the pleural cavity of a patient so as, for example, to permit reinflation of the lung contained therein. Inherent in the requirements for a pumping unit used in surgery are the necessities for a completely portable pumping unit that can be taken to the patient, a self contained integrated pumping unit that eliminates the collection of a plurality of disparate components, such as a separate pump, electric extension cord and power supply, thereby creating the unacceptable time delay necessary for assembling the components, and a pumping unit that is available for instantaneous operation.

An explosion proof requirement for a vacuum pumping unit used in thoracic surgery in connection with an underwater drainage apparatus is disclosed in the Bidwell et al U.S. Pat. Nos. 3,363,626 and 3,363,627. If a patient is under anesthesia, being administered ether or a related flammable anesthetic, and there is a puncture wound in the lung, it can be readily seen that the ether can leak into the pleural cavity, be drawn into the underwater drainage apparatus and eventually accumulated as an explosive mixture in the pumping unit. Should a spark subsequently be generated within the pumping unit, a flame could reach the ether in the pumping units disclosed in the prior art with a resultant explosion.

## SUMMARY OF THE INVENTION

The invention disclosed herein provides a completely portable explosion proof pumping unit in a relatively compact and lightweight housing that contains all the components required for instantaneous operation of the pump. This objective is obtained through the compartmentization of the housing, the segregation of the pumping unit components within the compartments and the provision of a flame-propagation preventing means for preventing a spark from passing from the motor compartment to the pump compartment.

In a preferred embodiment of the invention, the pumping unit comprises a pump, an electric motor for driving the pump, an electrical storage means, such as a battery, for energizing the motor, a housing for containing the pump, motor and battery wherein the housing comprises an internal dividing wall, having an aperture therein, for dividing the housing into a first internal compartment and a second internal compartment with the motor and the battery rigidly secured within one compartment and the pump rigidly secured within the other compartment in operable alignment with the motor. A shaft extends through the aperture in the dividing wall and is connected at one end to the motor and at the other end to the pump. Preventing propagation of a flame along the shaft between the two compartments is a flame-propagation prevention means that extends through the aperture in the dividing wall.



Other features and advantages of the present invention will be discussed in or are apparent from the description of the preferred embodiment of the invention found hereinbelow.

## BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a front sectional view of a pumping unit of one embodiment of the invention.

FIG. 2 is an electrical schematic drawing of the electrical wiring in the pumping unit.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawing there is depicted an explosion proof vacuum pumping unit in accordance with the invention. The pumping unit is comprised of a housing **10** having a handle **11** mounted thereon by mounting means such as screws **12** and **13**, a diaphragm pump **15**, an electric motor **17** operably connected to pump **15** by a shaft **18**, an electrical storage means or battery **19** for energizing motor **17** and means for preventing the propagation of a flame along shaft **18** such as elongated sleeve **20**. Housing **10** is divided into three internal compartments, a first or electrical compartment **25**, a second or pump compartment **26** and a third or auxiliary compartment **27**, by a vertical first or forward internal dividing wall **29** and a vertical second external charging connection **32** mounted on housing **10** and a switch **35** having an externally assesible operating member **37** for controlling the energizing of motor **17** from battery **19** or the recharging of battery **19** through charging connection **32**. Protecting charging connection **32** is an explosion proof cover **40**.

The essential advantages of having a small compact pumping unit that is easily transportable, yet still affords the critical protection against the propagation of a fire or explosion within the pumping unit is realized through the housing compartmentation and the location and arrangement of the elements of the pumping unit within the various compartments of housing **10**. Housing **10** can be made of, for example, a rigid plastic and has a substantially rectangular cross section enclosed by a front wall **45**, a rear wall **46**, a bottom **47**, a top **48** and two side panels not shown. Located along the front of top **48** of housing **10** is a raised section **50** for receiving pump **15** mounted thereon with mounting means such as screws **52** and **53**.

As mentioned hereinbefore, dividing walls **29** and **30** divide the internal space of housing **10** into three compartments. Rearward dividing wall **30** extends vertically between bottom **47** and top **48** of housing **10** and between the sides of housing **10** thereby forming the forward wall of auxiliary compartment **27** and providing an air tight seal between auxiliary compartment **27** and the other two internal compartments. Forward dividing wall **29** separates electrical compartment **25** from pump compartment **26** and has an aperture therein through which shaft **18** extends. Forming the back wall of raised section **50**, forward dividing wall **29** extends downwardly and is integrally formed with a horizontal platform **55** into a front section **56** and a rear section **57**. The forward end of front section **56** is connected to front wall **45** at a point approximately halfway between bottom **47** and pump **15** and rear section **57** extends beyond the abutment with forward di-

viding wall 29 in a rearward direction substantially to, but spaced from, rearward dividing wall 30. The lengths of forward dividing wall 29 and front section 56 of platform 55 are approximately equal thereby giving pump compartment 26 a substantially square cross section which is defined by forward dividing wall 29, the upper portion of front wall 45 portion 56 of platform 55 and pump 15. The electrical compartment 25 has a substantially "L" shaped cross section which is defined by rearward dividing wall 30, the lower portion of front wall 45, the forward portion of bottom 47, forward dividing wall 29 and a portion of top 48.

The location of the elements of the pumping unit in the various compartments further increases the explosion proof characteristic of the pumping unit. As mentioned above, pump 15 is mounted on and forms the top of raised section 50. Extending downwardly into pump compartment 26 is a pump operating mechanism 60, described below. Arranged perpendicularly to pump operating mechanism 60 and longitudinally spaced in a rearward direction therefrom is motor 17, located between top 48 and rear section 57 of platform 55 within electrical compartment 25. Motor 17 is mounted at its forward end onto a circular flange 62 of sleeve 20 with mounting means such as screws 63 and 64. Battery 19 is located along the bottom of electrical compartment 25 beneath pump 15 and motor 17 and is separated therefrom by platform 55, battery 19 occupying most of the area between platform 55 and bottom 47. Thus, battery 19 provides ballast for the pumping unit by lowering the center of gravity thereby increasing the stability of housing 10. In addition, the location of battery 19 maximizes protection against a fire or explosion, originating within electrical compartment 25, spreading to compartment 26 because of the cooling effect resulting from the long tortuous path the flame must follow, which is described in greater detail below. Further protection against fire is achieved by locating switch 35 in isolated auxiliary compartment 27 and charging connection 32 in a cylindrical well 95 extending inwardly of the outer surface of housing 10. Hence, any arcing in switch 35 or charging connection 32 is retained within auxiliary compartment 27 or well 95, respectively.

Pump 15 is a standard diaphragm vacuum pump that develops a cubic foot per minute flow rate and 28 centimeters of water vacuum. Pump 15 is well known in the art and comprises a pumping chamber 77, an inlet port 78 communicating with pumping chamber 77, an inlet check valve 79 located in inlet port 78, an outlet port 80 communicating with pumping chamber 77, an outlet check valve 81 located in outlet port 80, a flexible diaphragm 82 completely sealing off pumping chamber 77 from pump compartment 26 and pump operating mechanism 60 which is rigidly attached to diaphragm 82. Pump operating mechanism 60, shown in the drawing at the bottom in the intake stroke of pump 15 in solid lines and at the top in the exhaust stroke of pump 15 in broken lines is comprised of a piston 83 having a base section 84 which is attached to diaphragm 82 and a rod section 85 integral with base section 84 and extending downwardly and terminating in a circular member 86. Circular member 86 has an aperture therein for concentrically receiving a bearing 87 and an eccentric plate 88. Eccentric plate 88 has an aperture therein through which it is mounted on shaft 18 and rotated thereby. Mounted on either side of eccentric plate 88 is a semi-circular balancing disc 89, which is provided to ensure a smooth reciprocal motion of pump operating mechanism 60 imparted thereto by the rotation of eccentric plate 88 and shaft 18.

The electrical assembly of the pumping unit comprises motor 17, battery 19, switch 35, charging connection 32 and a plurality of conductors, which have not been shown and do not form any part of the invention. Motor 17 is a standard 6 volt D.C. motor that is well known in the art. Battery 19 in one embodiment of the invention comprises 10 nickle-cadmium batteries, each battery producing a 1.25 volt potential when fully charged, connected in a series parallel circuit so as to develop 6.25 volts D.C. when fully charged. Switch 35 is a standard multi-position rotary switch that is well known in the art. Switch 35 is electrically connected with appropriate conductors such as conductors 101 and 102, FIG. 2, respectively to motor 17 and battery 19 for operably controlling the energization of motor 17 from battery 19 when placed in the proper position. Switch 35 has a further position for providing an electrical path through conductor 103 for charging battery 19 from an external electrical power supply 104 electrically connectable at charging connection 32. Although not shown in the present embodiment, the pumping unit can also include rectifier means electrically connected to charging connection 32 and to switch 35, thereby providing means for operating motor 17 from an external A.C. power supply so as to conserve the power stored in battery 19.

External charging connection 32, located in well 95 as described above is protected by a removable explosion-proof connector cover 40. Cover 40 forms an air tight seal with well 95 thereby providing a totally enclosed volume surrounding charging connection 32 and has, in cross-section a substantially arch shape comprising a cylindrical base section 97 and a truncated conical section 98 integral with base section 97. Base section 97 has a carved out area for receiving charging connection 32 and has threads on the outside surface for screwing into corresponding matching threads on the outside well 95. Conical portion 98 has a screw 99 threaded therein to which can be attached a cover retaining chain (not shown), the other end of which can be attached to housing 10.

Motor 17 and pump operating mechanism 60 is cooled by the circulation of air admitted into pump chamber 26 through an aperture 72 in a removable face plate 73 located over a larger aperture in front wall 45 and attached thereto with mounting means such as screws 74 and 75. A screen 76, located across aperture 72, prevents passage of foreign objects into pump compartment 26 and any resultant damage therefrom.

As mentioned above sleeve 20 is concentrically spaced around shaft 18 and is elongated and extends therewith into both electrical compartment 25 and pump compartment 26. Sleeve 20 is retained in its longitudinal position between electrical compartment 25 and pump compartment 26 by means of a retaining ring 68. Sleeve 20 has a bore completely therethrough which has a diameter such that sleeve 20, concentrically spaced around shaft 18, provides an annular cylindrical chamber 69 between sleeve 20 and shaft 18. Chamber 69 has a length which is at least 20 times the radial distance between sleeve 20 and shaft 18. Located within the forward end of sleeve 20 is a bearing

70 for maintaining shaft 18 in alignment between motor 17 and pump operating mechanism 60.

When pump 15 is operating, the pumped fluid is drawn into pumping chamber 77. Should a leak develop in diaphragm 82 when and the pumping unit was pumping a combustible fluid, the fluid would pass into pump compartment 26 during the exhaust intake and it is possible that an explosive mixture can accumulate in pump compartment 26. If a spark should occur in the electrical compartment it is not possible for this spark to reach the pump compartment because the flame would be extinguished in chamber 69 due to the small annular clearance between sleeve 20 and shaft 18 and the distance of the path along shaft 18.

In operation, a hose (not shown) is connected between the space in which a vacuum is to be drawn and inlet port 78. Assuming that battery 19 is charged, operating member 37 of switch 35 is merely positioned to the appropriate position to energize motor 17. Motor 17 rotates shaft 18 which, in turn, because of eccentric plate 88, causes reciprocal motion of pump operating mechanism 60. Should recharging of battery 19 become necessary, cover 40 is removed and an external charging power supply is connected at charging connection 32. Operating member 37 of switch 35 is then appropriately positioned and battery 19 will commence receiving a charge.

From the above description it can be seem that there is provided a readily transportable, lightweight, and explosion proof vacuum pump that can be used to draw its vacuum in areas containing potentially explosive fluids. Although the invention has been described in detail with respect to an exemplary embodiment thereof, it will be understood by those of ordinary skill in the art that variations and modifications may be effected within the scope and spirit of the invention.

I claim:

1. A portable explosion proof pumping unit for pumping a flammable fluid comprising:

*a.* a pump;

*b.* an electric motor for driving said pump;

*c.* electrical storage means for energizing said motor;

*d.* a housing comprising an external wall and at least one internal dividing wall having an aperture therein for dividing said housing into a first totally enclosed internal compartment and a second totally enclosed internal compartment, said motor and said storage means rigidly mounted within said first compartment and said pump rigidly mounted within said second compartment in operable alignment with said motor, said pump including inlet and outlet passageways for pjmping the flammable fluid therethrough, said inlet and outlet passageways being disposed entirely external of said first compartment whereby the pumped fluid passing through said passageways if free of contact with said motor and said electrical storage means;

*e.* shaft means connected at a first end to said motor and, extending through said aperture in said wall, connected at the other end to said pump;

*f.* means for preventing the propagation of a flame between said first compartment and said second compartment along said shaft means, said prevention means extending through the aperture in said dividing wall and comprising a sleeve concentric with said shaft and in closely spaced relation therewith so as to provide an annular cylindrical chamber between said sleeve and said shaft, said chamber being in communication with said first compartment and having a large volume and thin radial thickness; wherein said aperture provided the only opening into an otherwise completely sealed said first internal compartment, and wherein said sleeve of said prevention means has an enlarged bore at the end distal to said motor;

and bearing means mounted within said enlarged bore of said prevention means.

2. A pumping unit in accordance with claim 1 wherein said housing further includes a second internal dividing wall for forming a third totally enclosed internal compartment, said second wall providing an air tight seal between said third compartment and said first and second compartment, and said pumping unit further comprising a switch electrically connected between said motor and said storage means for operably controlling the energization of said motor from said storage means, said switch being rigidly mounted within said third chamber and having a member operably connected thereto and extending through the external wall of said housing for providing means for operating said switch.

3. A pumping unit in accordance with claim 2 wherein said storage means is electrically rechargeable from an external electrical power supply and said switch has a position for permitting charging of said storage means; said pumping unit further comprising an external charging connection mounted externally onto said housing and electrically coupled to said storage means through the charging position of said switch thereby providing an electrical path for charging said storage means from the external electrical power supply.

4. A pumping unit in accordance with claim 3 wherein said housing has a cylindrical well extending inwardly of the outer surface of said housing and said charging connection is mounted within said wall; said pumping unit further comprising a removable explosion-proof connector cover for forming an air tight seal with said well thereby providing a totally enclosed volume surrounding said charging connection.

5. A pumping unit in accordance with claim 1 wherein said housing has an opening into said second chamber and further includes a ventilation cover for covering said opening, said ventilation cover having an aperture therein and a screen coverng said aperture.

6. A pumping unit in accordance with claim 1 wherein said pump is a diaphragm pump including a reciprocable piston eccentrically mounted at one end to said other end of said shaft such that rotation of said shaft causes reciprocal motion of said piston.

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