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A. ARUTUNOFF
EXPLOSION PROOF SUBMERGIBLE ELECTRIC
MOTOR AND PUMP ASSEMBLY

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2 Sheets-Sheet 1

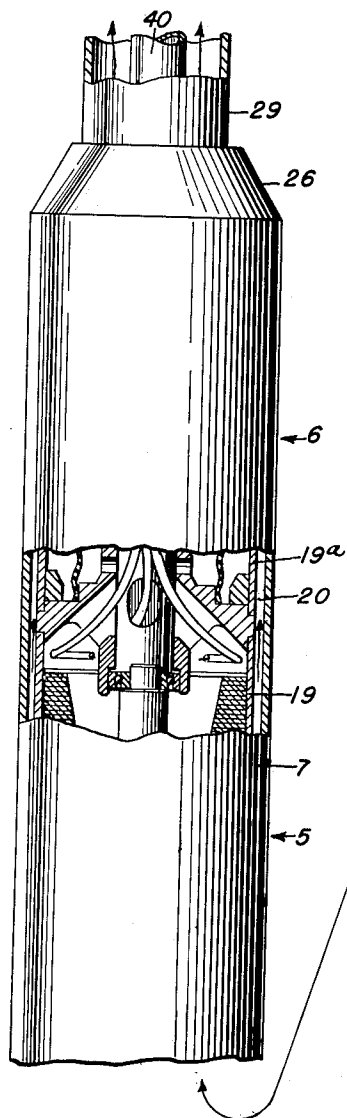


FIG. 1

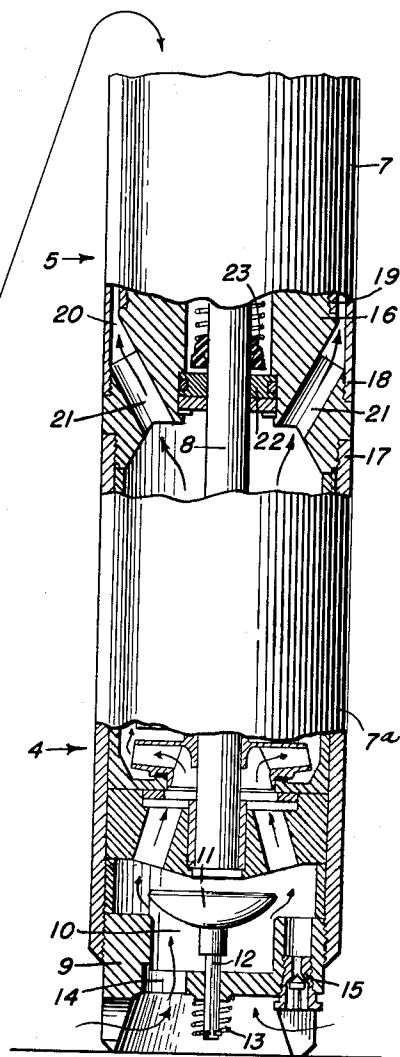


FIG. 1A

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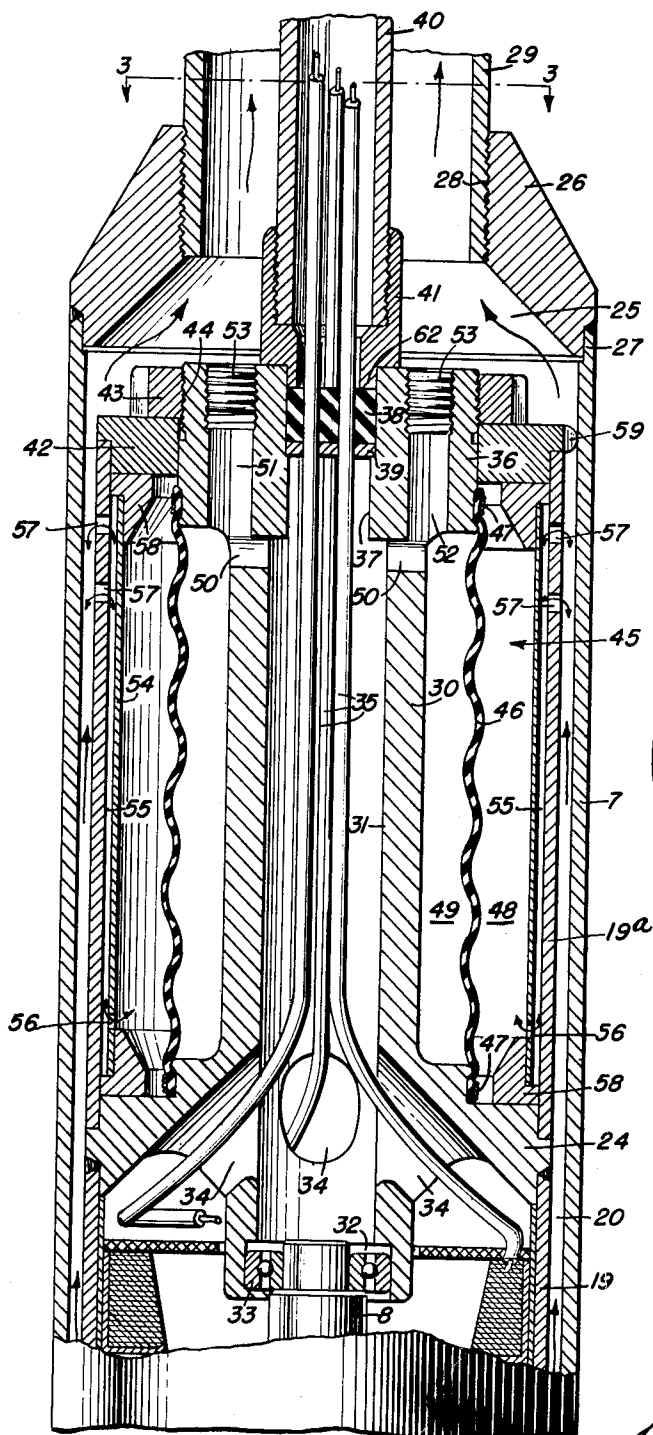


FIG. 2

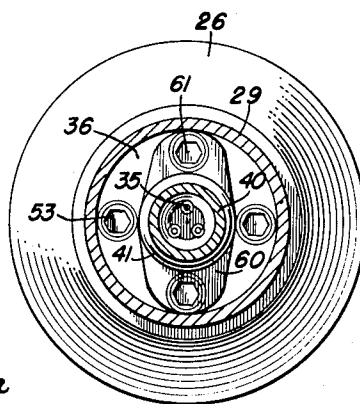


FIG. 3

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EXPLOSION-PROOF SUBMERSIBLE ELECTRIC MOTOR AND PUMP ASSEMBLY

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8 Claims. (Cl. 103—87)

This invention relates to electrically driven pumps of the type embodying a centrifugal pump unit and an oil filled submersible electric motor unit superimposed coaxially thereon. More particularly, the invention consists in new and useful improvements in a combined pressure equalizing and flame-propagation preventing unit for use in connection with an oil filled submersible electric motor and pump assembly.

Wherever multiple dispensers are required for delivery from a common supply source located below the ground, as for example in the case of a gasoline storage tank at gasoline dispensing stations, it is desirable to employ submersible motor-pump units to push the gasoline or other other volatile fluid of high vapor pressure up where ordinary suction type pumps are not efficient or dependable. With this type of unit, the motor being located with the pump below the liquid level in the tank, it is advantageous to pump the fluid through a passageway surrounding the electric motor and from thence to selected dispensing units. This arrangement facilitates the construction of a compact unit and affords a cooling medium for the electric motor augmenting the cooling effect of the protecting and lubricating fluid with which the motor unit is filled.

With submersible assemblies such as this, it is important to provide a pressure equalizer to compensate for contraction and expansion of the insulating and lubricating oil in the motor unit, resulting from variations in the pressure differential of the oil in the unit and the fluid surrounding the unit in the main tank. For this purpose it is known to provide a collapsible element disposed in the oil filled reservoir and defining therein separate pressure zones, respectively subjected to the pressure existing in the reservoir and the tank. The collapsible element is sealed between the respective zones and is responsive to variations in the pressure differentials above noted. In the interest of compactness and to avoid protruding electrical lines and connections, it is desirable to carry the electrical conduits from the motor to the source of electrical energy above ground, through a cable housing which extends axially through the reservoir and the collapsible pressure equalizing element located therein. It therefore becomes important to take maximum precautions against the propagation of flame in the event of a spark caused by a break in the insulation in this housing and a rupture of the diaphragm or pressure responsive element, so as to prevent any spark from reaching the gasoline delivery line.

It is the primary object of the present invention to meet this need and provide a combined equalizing and explosion preventing unit for use with a submersible assembly such as above referred to.

Another object of the invention is to provide a fire propagation preventing unit including a pair of minutely spaced concentric cylinders communicating at longitudinally spaced points with the area immediately surrounding the collapsible element and the annular fluid delivery passageway, respectively thereby providing an

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annular clearance of large surface area but minute cross section which will render it impossible for a spark or flame originating within the reservoir, to reach the gasoline delivery passageway.

A further object of the invention is to provide an extremely simple construction and one which may be readily assembled and disassembled with a minimum of effort.

With the above and other objects in view which will appear as the description proceeds, the invention consists in the novel features herein set forth, illustrated in the accompanying drawings and more particularly pointed out in the appended claims.

Referring to the drawings in which numerals of like character designate similar parts throughout the several views.

Figures 1 and 1A collectively illustrate the complete submersible assembly and show the relationship of the combined pressure equalizing and fire propagation preventing unit.

Figure 2 is an enlarged longitudinal sectional view of the upper end of the assembly illustrating the combined equalizing and fire propagation preventing unit, and

Figure 3 is a sectional view taken on line 3—3 of Figure 2.

In Figures 1 and 1A of the drawings I have shown the general assembly embodying the invention, including a centrifugal pump unit 4, a motor unit 5 and the combined equalizing and explosion-proof unit 6, respectively, arranged in superimposed relation within a continuous cylindrical casing 7. The pump unit 4 is of the conventional centrifugal type having a series of impeller stages (not shown) keyed to a central shaft 8. As the particular structure of the centrifugal pump forms no part of the present invention, they have not been illustrated but it will be clearly understood from Figure 1A that the lower section 7a of the main casing 7 is closed by a bottom member 9, the central portion of which is recessed as at 10 to provide an inlet valve body having a valve member 11, the stem 12 of which carries a coil spring 13 normally causing the valve to seat in the valve body 10. An inlet port 14 in the bottom 9 places the interior of the casing section 7a in communication with the interior of the tank (not shown) within which the assembly is submerged. A relief valve 15 may be provided in the bottom 9 to relieve undue pressures within the pump unit.

The upper end of the pump unit 4 is closed by a transverse head 16, reduced and threaded at its lower extremity as at 17 to receive the threaded upper end of the casing section 7a. The upper end of the head 16 is also reduced and threaded as at 18 to receive the threaded lower end of the main casing 7 which continues vertically and houses both the motor unit 5 and the equalizing and explosion-proof unit 6.

The details of the motor which may be conventional, are not shown, but as seen in the drawings, the motor is housed by a separate inner casing 19 mounted on a reduced extension of the head 16 and inwardly spaced from the main casing 7 to provide an annular fluid delivery passageway 20 which completely surrounds the motor and extends upwardly to the extremity of the casing 7, as will later appear. The discharge end of the pump unit 4 communicates with the annular passageway 20 through fluid ports 21 provided in the lower portion of the head 16 and a central opening in the head receives a bearing assembly 22 and shaft seal 23 for the combined pump and motor shaft 8.

A transverse partition 24 is annularly recessed at its lower side to receive the upper extremity of the inner motor casing 19 and is similarly recessed on its opposite side to receive the lower end of a casing section 19a which forms a continuation of the casing 19 and, together

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with the adjacent portion of the outer casing 7, forms a continuation of the annular passageway 20 which ultimately discharges into a discharge chamber 25 formed at the upper end of the casing 7 by a closure 26 which is recessed as at 27 to fit within the casing 7 to which it is welded or otherwise secured.

The closure 26 is substantially frusto-conical in shape as shown in Figure 2, and its central portion is cut out and threaded as at 28 to receive complementary external threads on a discharge conduit 29 leading to the exterior of the main tank and from which the various supply lines direct the fluid being dispensed, to selected dispensing units not shown.

The partition 24 terminates at its upper extremity in a centrally disposed cylindrical neck 30, the bore 31 of which extends downwardly through the partition where it is recessed as at 32 at its lower end to accommodate a suitable bearing 33 for the upper extremity of the combined pump and motor shaft 8. A series of converging radial openings 34 in the partition 24 lead from the under side of the partition to the interior of the bore 31, to receive the motor cables or conductors 35 which extend from the motor unit 5 to a source of electrical energy above ground (not shown), as seen in Figure 2.

The upper end of the neck 30 terminates in a radially extended boss 36, the central portion of which is drilled as at 37 to form a restricted extension of the bore 31. The opening 37 receives a sealing block 38 of any suitable material and a washer 39, whereby the motor cables 35 are sealed with respect to the upper end of the sleeve bore 31 from which they extend vertically through a housing conduit 40 secured to the boss 36 by an adapter 41, later referred to more in detail.

The upper end of the inner casing section 19a is closed by an annular ring guide 42 which is recessed to fit within the upper end of the casing section and is held in place by a lock nut 43, internally threaded as at 44 to engage complementary threads on the projecting portion of the boss 36. Thus, there is formed within the casing section 19a, an annular reservoir or protecting chamber 45, surrounding the neck 30 and bounded at its upper and lower ends by the ring guide 42 and partition 24, respectively.

Within the chamber 45 and concentric with the neck 30, I provide a collapsible cylinder or breathing member 46 which is secured at its opposite ends to the boss 36 and a reduced shoulder on the partition 24. Any suitable means may be employed for connecting the ends of the cylinder 46 to the boss and partition, such for example, as liven thread or the like 47 which will afford a sealed connection. Inasmuch as the cylinder 46 is subjected to contact with the lubricating and protecting fluid of the motor as well as the gasoline being dispensed, as will later appear, it must be composed of a flexible material which is not vulnerable to chemical attack by either of these fluids. Various materials are adaptable for this purpose such as Buna-N and neoprene which have the desirable properties of flexibility and will withstand chemical attack.

Thus, within the chamber 45, the collapsible cylinder 46 provides an outer annular zone 48 and an inner annular zone 49, both surrounding the upstanding neck 30. The inner zone 49 communicates with the bore 31 in the neck 30 through radial ports 50 at the upper end of the neck adjacent the boss 36 and the boss is provided with filling openings 51 and 52 by means of which the inner zone or compartment 48 may be filled with lubricating and protecting fluid, said filling openings being closed by any suitable plugs 53. Thus, by removing both plugs 53 and using one opening as a filling opening and the other as a vent, lubricating and protecting fluid introduced into the compartment 49, fills the area surrounding the neck 31 and overflows into the bore 31 through ports 50 until the entire motor unit 5 is filled with fluid, whereupon the plugs 53 are replaced.

A cylindrical baffle sleeve 54 of relatively thin metal

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is arranged in minutely spaced relation with respect to the inner periphery of the inner casing section 19a to provide an annular space 55 of large surface area but restricted cross section which completely surrounds the outer compartment or zone 48. In Fig. 2 the lateral spacing of the sleeve 54 with respect to the casing section 19a is exaggerated for purposes of illustration.

The lower portion of the outer compartment 48 communicates with the minute space 55 through radial ports 56 and the upper portion of the space 55 in turn, communicates with the gasoline delivery passageway 20 surrounding the casing section 19a, by means of radial ports 57. Thus, the outer compartment 48 is subjected to the pressure conditions prevailing in the gasoline tank and delivery line 20 through the communicating ports 56 and 57 while the inner compartment 48, separated from the outer compartment 48 by the collapsible cylinder 46, is subjected to the pressure conditions prevailing within the motor, through the bore 31 in neck 30 and the communicating ports 50.

Spacer rings 58 support the opposite ends of the thin sleeve 54 and maintain the desired spacing to define the proper cross-sectional dimension of the annular space 55.

The proper spacing of the upper end of the casing section 19a with respect to the main outer casing 7, is maintained by radially projecting lugs 59 extending from the ring guide 42. Preferably, the adapter 41 is provided with flanges 60 projecting in opposite directions and drilled to receive retaining screws 61 by means of which the adapter is rigidly secured to the boss 36 as shown in Fig. 3. A reduced extension 62 on the lower end of the adapter 41 fits within the opening 37 in the boss and serves to retain the cable seal 38 in sealing engagement within its opening.

The entire assembly is submerged in a gasoline or other fluid supply tank below ground, the motor unit first having been filled with lubricating and protecting fluid as previously described. Upon operation of the electric motor the lubricating and protecting fluid naturally expands to some extent due to the heat of the motor and as the volume of liquid in the motor and the inner compartment 49 increases, the flexible cylinder 46 expands to the necessary extent, correspondingly reducing the volume of the gasoline or other dispensed fluid in the outer compartment 48 by forcing the latter outwardly through ports 56 and 57 with the intervening annular space 55. When the motor is stopped the liquid contracts and reduces in volume, whereupon the flexible cylinder 46 is collapsed upon the entrance of gasoline from the delivery passageway 20 into the outer compartment 48. When the motor starts again the expansion of the protecting liquid simply expands the cylinder 46 and forces the gasoline which has entered the outer compartment 48, back through the ports 56 and 57 and the passageway 55.

Should a spark occur as a result of a break in the insulation of the cable 35 for example, and the diaphragm or collapsible cylinder 46 be ruptured, it would be impossible for any spark or flame to reach the gasoline delivery passageway 20 or delivery conduit 29 as such flame would be extinguished in the outer compartment 48 due to the small annular clearance between the sleeve 54 and the casing section 19a and the distance of travel necessary between the ports 56 in the sleeve 54 and the ports 57 at the outer end of the casing section 19a.

It will thus be seen that with this improved assembly the motor is completely isolated from the gasoline being dispensed and variations in pressure caused by expansion and contraction of the motor protecting fluid, is prevented from diluting the protecting fluid by the entrance of gasoline into the motor unit. Furthermore, the assembly is rendered completely explosion proof by the arrangement of the sleeve 54 in minutely spaced relation from the casing section 19a, forming therebetween a restricted space of great length and great cooling capacity.

Compactness and ease of assembly is another feature

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of importance. For example, it will be noted that a single nut 43 on the boss 36 at the upper end of the neck 30, retains the entire protecting and explosion proof unit in assembled relation.

From the foregoing it is believed that the invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be made in the details of construction without departing from the spirit of the invention as set forth in the following claims.

What I claim is:

1. A submergible electric motor and pump assembly comprising a pump unit, an oil filled electric motor unit superimposed concentrically thereon, a lubricating and protecting fluid reservoir above said motor unit, an outer casing enclosing said units and reservoir, a fluid delivery conduit connected concentrically to the upper end of said outer casing, an inner casing housing said motor unit and extending upwardly therefrom to form the annular boundary wall of said reservoir, said inner casing being spaced from said outer casing to form therewith an annular fluid delivery passageway encircling said motor unit and reservoir, with its upper end communicating with said fluid delivery conduit, discharge ports in said pump unit leading to said passageway, a transverse partition above said motor unit, defining the bottom of said reservoir, a head closing the upper end of said reservoir, a cylindrical membrane of flexible material dividing said reservoir into concentric inner and outer compartments, the inner compartment communicating with said oil filled motor unit, ports at the upper end of said extended inner casing, placing said outer compartment in communication with said fluid delivery passageway, whereby said membrane is responsive to the differential pressures of the motor unit and delivery passageway, fire propagation preventing means comprising a thin metal baffle sleeve in said outer compartment in closely spaced relation to said inner casing, forming therewith an intervening passageway of large surface area and minute cross-section, and ports at the lower end of said sleeve placing the outer compartment in communication with said intervening passageway and through the ports in said extended inner casing, with said delivery passageway.

2. A submergible electric motor and pump assembly comprising a pump unit, an oil filled electric motor unit superimposed concentrically thereon, a lubricating and protecting fluid reservoir above said motor unit, an outer casing enclosing said units and reservoir, a fluid delivery conduit connected concentrically to the upper end of said outer casing, an inner casing housing said motor unit and extending upwardly therefrom to form the annular boundary wall of said reservoir, said inner casing being spaced from said outer casing to form therewith an annular fluid delivery passageway encircling said motor unit and reservoir, with its upper end communicating with said fluid delivery conduit, discharge ports in said pump unit leading to said passageway, a transverse partition above said motor unit, defining the bottom of said reservoir, a head closing the upper end of said reservoir, a tubular neck extending concentrically between said partition and bottom to form the inner wall of said reservoir, said head and bottom having openings to the bore of said neck to accommodate the lead wires from said motor unit, a gland sealing said bore around said lead wires, a cylindrical membrane of flexible material dividing said reservoir into concentric inner and outer compartments, ports in said neck placing the inner compartment in communication with said oil filled motor unit, ports at the upper end of said extended inner casing, placing said outer compartment communicating with said fluid delivery passageway, whereby said membrane is responsive to the differential pressures of the motor unit and delivery passageway, fire propagation preventing means comprising a thin metal baffle sleeve in said outer compartment in closely spaced relation to the inner casing, forming

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therewith an intervening passageway of large surface area and minute cross section, and ports at the lower end of said sleeve placing the outer compartment in communication with said intervening passageway and through the ports in said extended inner casing, with said delivery passageway.

3. A fire propagation preventing device for oil filled submergible electric motor and pump assemblies of the type wherein the motor unit is concentrically superimposed on the pump unit and surmounted by a fluid reservoir, with a continuous outer casing housing said units and reservoir, and including an inner casing enclosing said motor unit and reservoir and spaced from the outer casing to form an annular fluid delivery passageway surrounding said motor unit and reservoir within said outer casing; said device comprising a thin metal baffle sleeve in said reservoir in closely spaced relation to said inner casing, forming therewith an intervening passageway of large surface area and minute cross section, whereby any communication between said reservoir and fluid delivery passageway is prevented, except through said restricted annular passageway.

4. Apparatus as claimed in claim 3, including a flexible cylindrical membrane dividing said reservoir into inner and outer compartments, means placing the inner compartment in communication with said oil filled electric motor, and staggered ports in said baffle sleeve and inner casing, respectively, placing said outer compartment in communication with said fluid delivery passageway through said restricted passageway.

5. A combined equalizing and fire propagation preventing unit for oil filled submergible electric motor and pump assemblies, housed in a continuous cylindrical outer casing, including an inner casing concentric with said outer casing and spaced inwardly therefrom to form an annular fluid delivery passageway leading from the discharge of said pump, a transverse partition in said inner casing forming the bottom of a fluid reservoir located above said motor and in communication therewith, a flexible cylindrical membrane dividing said reservoir into inner and outer compartments, said inner compartment communicating with said motor unit, ports in the upper end of said inner casing placing said outer compartment in communication with said annular fluid delivery passageway, a thin metal baffle sleeve in said outer compartment in closely spaced relation to said inner casing, forming therewith an intervening passageway of large surface area and minute cross section, and ports at the lower end of said sleeve placing the outer compartment in communication with said intervening passageway and through the ports in said inner casing, with said delivery passageway.

6. A combined pressure equalizing and fire propagation preventing device for submergible electrically driven motor and pump assemblies of the type including an outer casing having a pump unit at the lower end, a superimposed motor unit concentric with said pump unit, an inner casing housing said motor and spaced from said outer casing to form therewith an annular fluid delivery passageway leading from said pump around said motor, said device comprising a lubricating and protecting fluid reservoir formed by said inner casing, in said motor unit above said motor, a transverse partition defining the bottom of said reservoir, an upstanding tubular sleeve formed concentrically on said partition, defining the inner wall of said reservoir, the bore of said sleeve being open to said motor to receive the lead wires from the latter, a port in said neck to permit the passage of fluid from the reservoir to the motor, a gland sealing said lead wires in said bore, the upper end of said neck having a radially enlarged boss threaded at its extremity, a closure for the top of said reservoir, having a central opening to receive the projecting threaded end of said boss, a closure retaining nut for said threaded boss, a flexible cylindrical membrane secured between said boss and partition,

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dividing said reservoir into concentric inner and outer compartments, the inner compartment communicating with said motor through said neck, ports in the upper end of said inner casing, placing the outer compartment in communication with said delivery passageway, a fire propagation preventing sleeve of thin metal in said outer compartment, in closely spaced relation to said inner casing, forming therewith an intervening passageway of large surface area and minute cross section, and ports at the lower end of said sleeve placing the outer compartment in communication with said intervening passageway and through the ports in said inner casing, with said delivery passageway.

7. A device as claimed in claim 6, including a spacing ring at opposite extremities of said sleeve, said closure adapted to abut the uppermost ring, whereby when said retaining nut is tightened, said sleeve and rings are maintained in fixed position.

8. An oil filled submergible electric motor and pump assembly comprising a pump unit, a motor unit arranged concentrically above said pump unit and having a motor shaft operatively connected to said pump, lead wires for said motor unit, a combined pressure equalizing and flame propagation preventing unit arranged concentrically above said motor unit, a continuous cylindrical shell housing said units, an inwardly spaced concentric casing housing said motor unit and protecting unit and forming with said shell, an annular fluid delivery passageway, a transverse partition at the lower end of said casing, separating the motor unit from the pump unit, ports connecting the discharge end of said pump unit to said fluid delivery passageway, a second transverse partition in said casing de-

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fining therein a protecting fluid reservoir above said motor unit, means providing fluid communication between said motor unit and said reservoir, said second partition having a concentric upstanding tubular neck for receiving the lead wires from said motor unit, a concentric fluid discharge conduit connected to the upper end of said shell and leading from said annular passageway, a tube within said conduit, concentric with said neck for housing said lead wires, a gland sealing said lead wires in said neck, an annular head closing the upper end of said reservoir, a collapsible cylindrical membrane extending between said head and second partition in spaced relation to said neck, to form in said reservoir inner and outer concentric fluid compartments, ports in said neck, the inner compartment encircling said neck and communicating with said motor unit through the ports in said neck, a thin metal baffle sleeve interposed in said outer compartment between said cylindrical membrane and said casing, in closely spaced relation to the latter, forming therewith an intervening annular passageway of large surface area and minute cross section, ports at the lower end of said sleeve placing said outer compartment in communication with said intervening passageway, and ports at the upper end of said casing, placing said lastnamed passageway in communication with said fluid delivery passageway.

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