United States Patent

Guinard

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[54] **IMMERSIBLE ELECTRIC PUMP ARRANGEMENTS**

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[63] Continuation-in-part of Ser. No. 10,258, Feb. 10, 1972.

[30] **Foreign Application Priority Data**

Feb. 21, 1969 France.....6904413

[52] **U.S. Cl.** **417/424,** 415/111, 308/9

[51] **Int. Cl.**.....**F04b 17/00,** F04b 35/04, F01d 11/00, F01d 25/16, F16c 7/00, F16c 35/00

[58] **Field of Search** 417/424, 423; 415/110, 111; 308/9

[56] **References Cited**

UNITED STATES PATENTS

2,888,878 6/1959 Cobb.....415/111

3,494,291 2/1970 Carter, Jr. 417/424

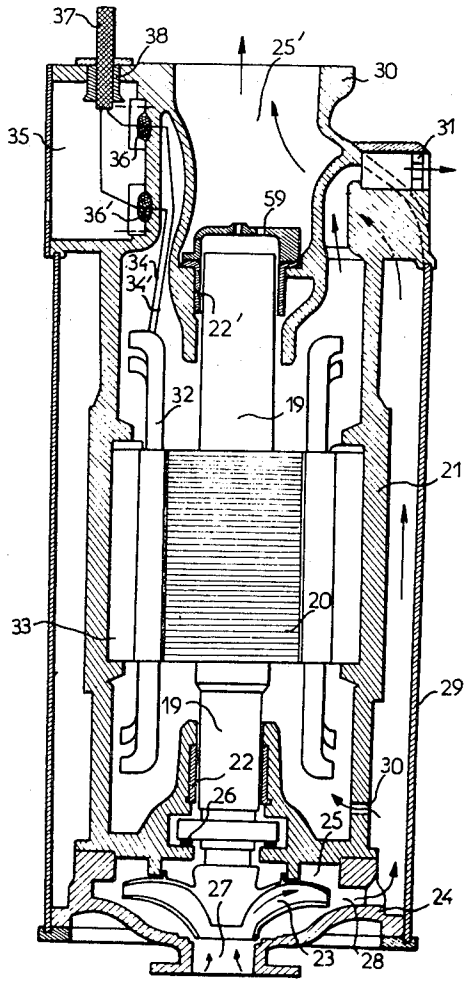
Primary Examiner—Robert M. Walker

Attorney—Robert E. Burns et al.

[57] **ABSTRACT**

This invention relates to an electric pump assembly for use in pumping explosives or dangerous liquids in containers, the assembly comprising a motor, which has a winding submerged in the pumped liquid, wherein the wires of the winding are completely insulated by a covering which resists this liquid, and are extended without a break, at their two ends and guided through sealing means to a junction box, outside the container, in which the electric pump arrangement is suspended in known manner and in a way in which a complete seal is obtained. The preceding characteristic enables the electric pump-motor to be perfectly sealed against the exterior, so that it is possible to circulate the liquid under pressure in the interior of this motor without difficulty, so as to ensure, on the one hand, cooling of the motor and, on the other, feeding of the hydrostatic bearings and a stop for the shaft of the rotor of the electric pump.

3 Claims, 4 Drawing Figures



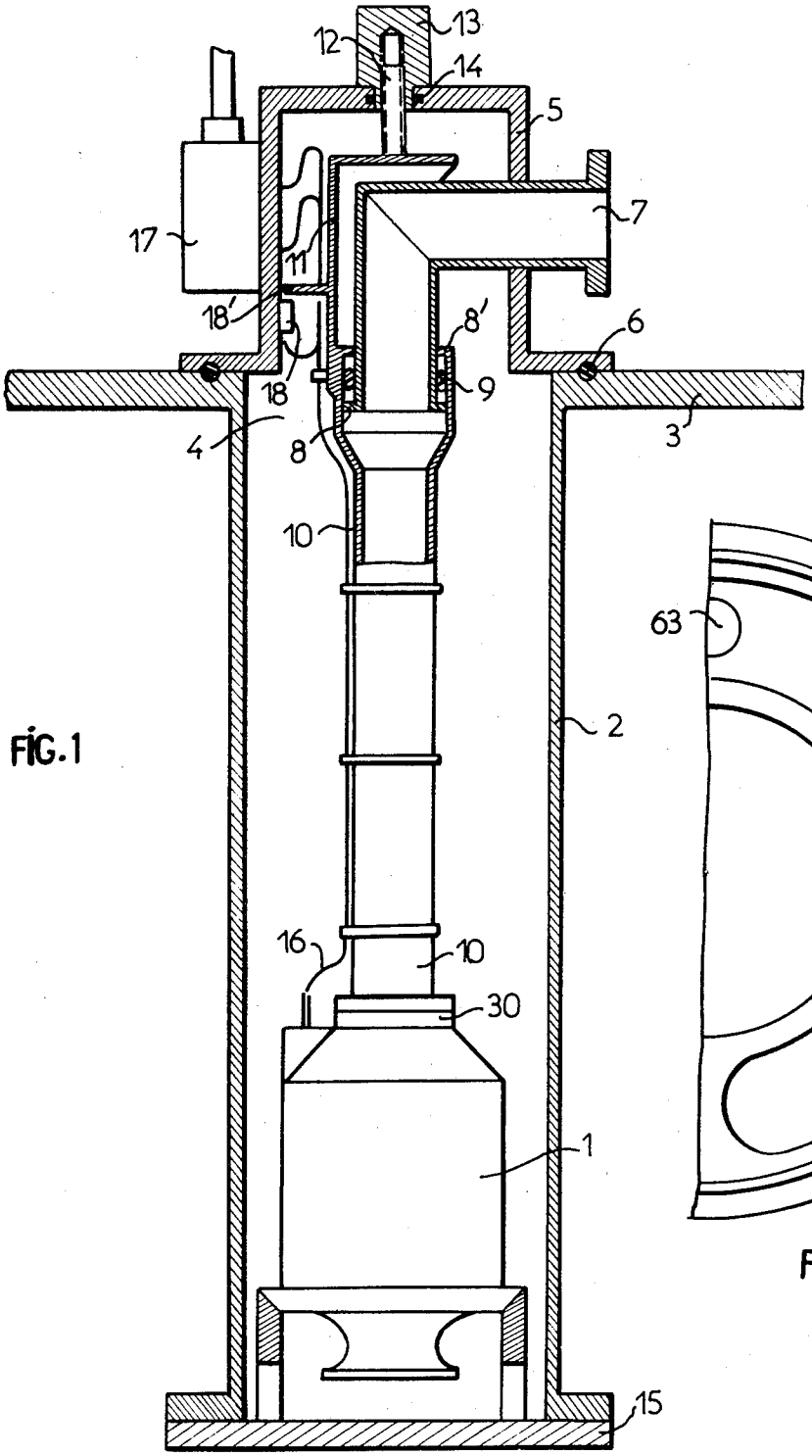


FIG. 1

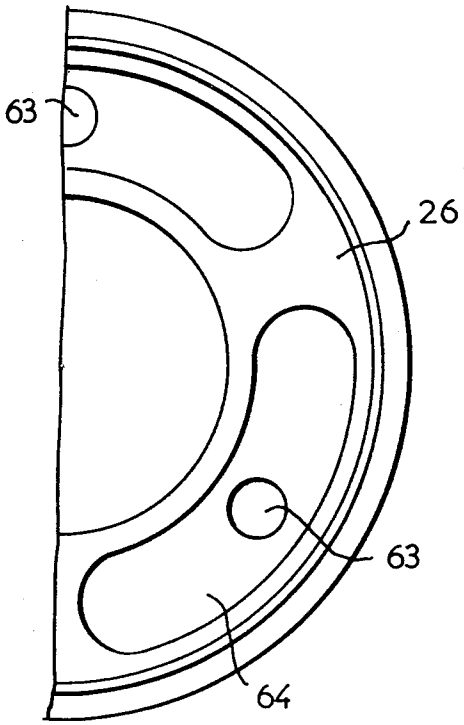


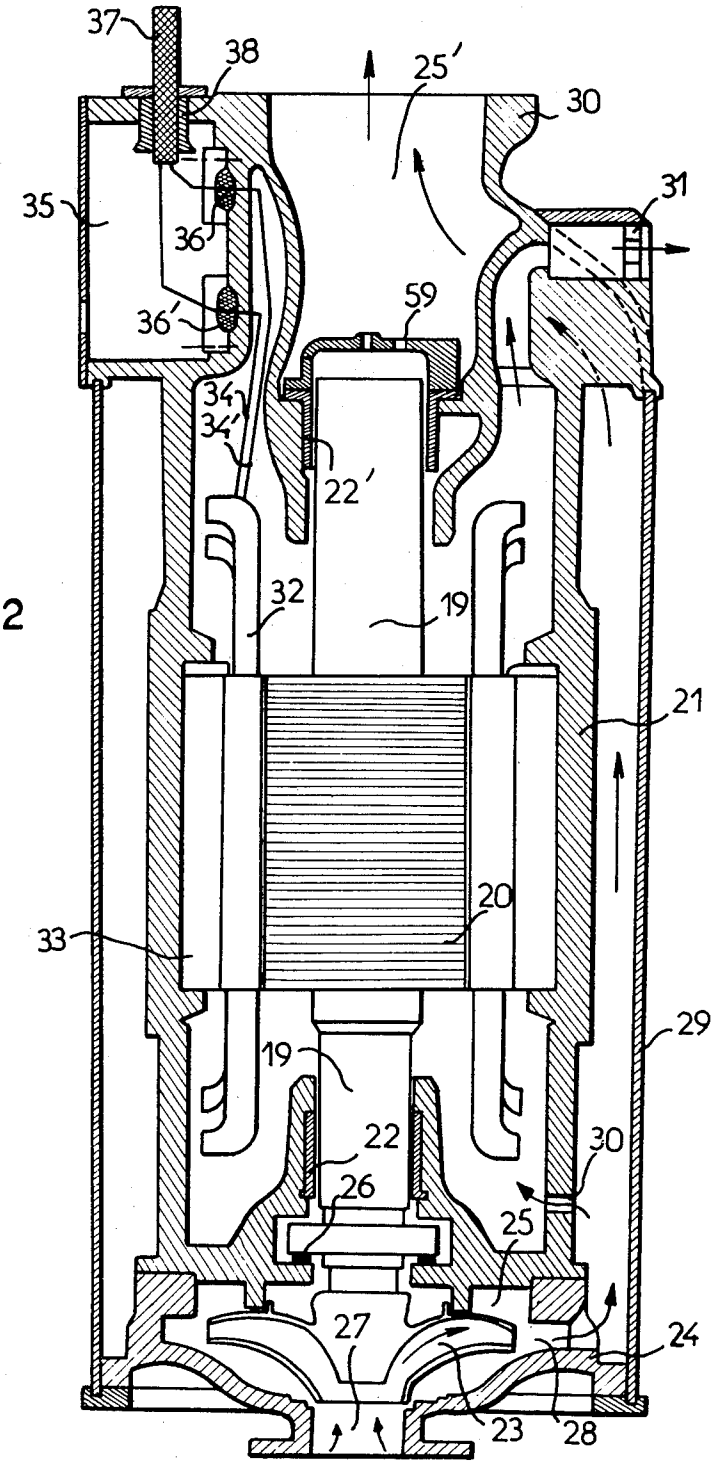
FIG. 4

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FIG.2

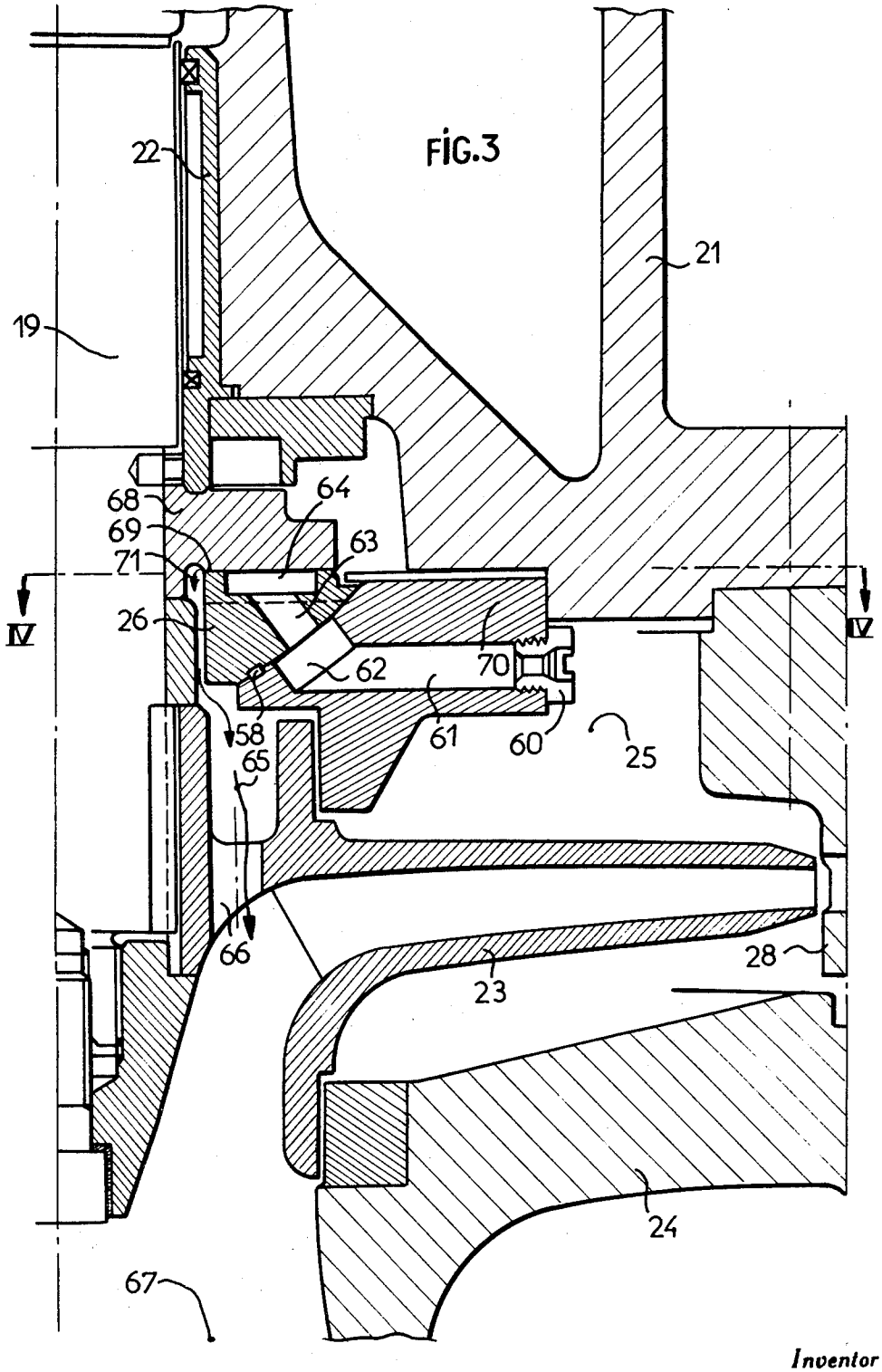


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FIG.3



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IMMERSIBLE ELECTRIC PUMP ARRANGEMENTS

FIELD OF THE INVENTION

This application is a continuation-in-part of my application Ser. No. 10,258, filed Feb. 10, 1970, wherein the invention relates to an immersible electric pump arrangement.

BACKGROUND OF THE INVENTION

There is a requirement for pumps particularly adapted for use in emptying large basins and containers accommodating explosive or dangerous liquids, in particular combustible liquefied gases, liquid ammonia or certain chemical products the handling of which calls for certain precautions. More particularly, powered pump arrangements are required which offer great safety in operation, both as regards mechanical and electrical components, thus excluding, in particular, all risk of heating up likely to cause fires; furthermore, such pump arrangements should be extremely well sealed against the exterior, thus enabling any inward leakage of dangerous liquid from the container to be prevented.

SUMMARY OF THE INVENTION

The electric pump arrangement forming the subject-matter of the invention and meeting the above-stated conditions is characterized in that it comprises a motor, which had a winding submerged in the pumped liquid, and the wires of the winding, completely insulated by a covering which resists this liquid, are extended, without a break, at their two ends and guided through sealing means to a junction box, outside the container, in which the electric pump arrangement is suspended in known manner and in a way in which a complete seal is obtained. The preceding characteristic enables the electric pump-motor to be perfectly sealed against the exterior, so that it is possible to circulate the liquid under pressure in the interior of this motor without difficulty, so as to ensure, on the one hand, cooling of the motor and, on the other, feeding of the hydrostatic bearings and a stop for the shaft of the rotor of the electric pump.

BRIEF DESCRIPTION OF THE DRAWINGS.

For a better understanding of the invention, reference will now be made to the accompanying drawings, by way of example. In the drawings:

FIG. 1 is an elevation, partly in axial section, of an installed electric pump arrangement,

FIG. 2 shows an axial section through the electric pump arrangement,

FIG. 3 is a partial sectional view, on an enlarged scale, of a lower hydrostatic bearing and hydrostatic stop assembly, and

FIG. 4 is a cross-section.

DESCRIPTION OF SPECIFIC EMBODIMENTS

As shown in FIG. 1, a vertical electric pump arrangement 1 is disposed in a well 2, let into a container of which there is shown only part of the upper wall 3 which contains an opening 4 for fixing the tube forming the well 2.

The opening 4 is blocked in a liquid-tight manner by a member 5 in the form of a bell or cap secured to the top of the container by means not illustrated, with the interposition of toroidal sealing means 6. Welded into the cylindrical wall of the part 5 is a tubular elbow 7, the vertical portion of which is connected, by a sliding joint comprising flanges 8 and 8' and a toroidal sealing member 9, to the vertical delivery pipe 10. The latter is extended at its upper end by a stirrup-shaped part 11, fixed to the bell cap 5 by means of a screw-threaded rod 12 extending through an opening in the top of this bell cap and on which is screwed a nut constituting a plug 13. Plug 13, by means of sealing ring 14, seals this opening in a liquid-tight manner.

The lower end of the well 2 is closed by a plate 15 which constitutes a flap valve which is opened when the electric pump 1 is moved down, this downward movement being brought about by rotating the plug 13.

The insulated wire constituting the winding of the stator of the pump motor is extended and passes out of the motor casing at 16. It is run to an exterior terminal box 17 secured to the bell cap in a sheath which provides insulation and complete protection against the liquid in the container. Connected to the wire 16 is a micro-switch 18, secured to the interior of the bell cap 5 and actuated by a part 18' integral with the delivery piping 10-11 and arranged to prevent start-up of the motor if the electric pump 1 is not lowered sufficiently to be submerged in the liquid in the container after the base valve 15 of the well 2 has been opened.

As shown in FIG. 2, the electric pump arrangement is constituted by an electric motor the interior of which is flooded by the liquid from the container. The motor shaft 19 carrying the rotor 20 is mounted in the casing 21 on two bearings 22 and 22' of the hydrostatic type, lubricated by the pumped liquid. The impeller 23 of centrifugal type is mounted outside casing 21 on the lower end of the shaft 19; the impeller casing 24 is secured to the lower end of the motor casing 21, the shaft 19 having a flange resting on a stop 26, which supports the weight of the rotor and the hydraulic thrust, and which will be described by reference to FIG. 4.

The impeller casing has an axial intake opening 27 and a diffuser 28, the liquid being delivered under pressure into an annular passage between the motor casing 21 and a tubular part 29, the upper end of which is connected at 30 to the axial delivery pipe 10 of the pump.

In the case where the pumped liquid is a liquefied gas, it is necessary to prevent it from vaporizing inside the motor under the effect of heat generated by the latter. For this purpose, adequate circulation of liquid is achieved inside the motor with the help of an inlet bore 30, whereby the annular compression passage between the parts 21 and 29 communicates, near its lower end, with the interior of the casing 21, while a leakage bore 31 establishes communication between the upper part of the casing 21 and the interior of the container or of the well 2. The liquid compressed in this manner inside the motor casing may be utilized to feed the hydrostatic bearings 22 and 22' and the stop 26, but it appears more advantageous to feed them directly by the pressure built up at 25 and 25', as will be explained with reference to FIG. 3.

The winding 32 of the stator 33 of the motor is constituted by wire insulated by a liquid-tight coating which resists any chemical action of the pumped liquid. The ends 34 and 34' of the wire comprising the winding

are passed out of the casing **21** into a lateral compartment **35** through transverse orifices fitted with elastomeric seals **36** and **36'**, and are then inserted in a sleeve **37**, resistant to mechanical damage and fixed at **38** in the wall of the compartment **35** and run to the top of the container where the wires are introduced into the outer terminal box **17** (FIGS. **1** and **3**).

As indicated above, it is very important to avoid, in the interior of the container of the pumping arrangement, any source of heat likely to cause vaporization of the pumped liquefied gas. For this purpose the rotating portion of the electric pump arrangement is supported by a hydrostatic stop and its shaft is mounted in bearings, likewise hydrostatic, these hydrostatic bearings and stops, in contrast to corresponding hydrodynamic systems, always providing a substantial gap between the rotating portions and the fixed portions, this making it possible to avoid any friction or any dangerous heating likely to cause local boiling of the liquefied gas.

This is the more important since the moving portion of the electric pump arrangement may be subjected to very considerable and variable axial thrust resulting on the one hand from its weight and on the other from the intake forces which vary with the delivery of the pump, particularly in the case of electric pumps used for unloading from the holds of vessels carrying liquefied gases and where, on the one hand, the delivery of the pumps varies considerably and, on the other, they are subjected to cavitational stress. The hydrostatic stop of the invention comprises a plate fixed on the shaft of the system between the motor and the pump, and, below this plate, an annular part mounted to swivel on the case so that it is not able to rotate about the shaft, the upper face of this part containing a number of cavities supplied with pumped liquid through perforations in this part and terminating in a chamber communicating with the delivery side of the pump, said cavities also communicating with the intake side of the pump for the purpose of discharging the liquid.

The swivel mounting of the hydrostatic stop enables the bearing plane of the plate integral with the rotating shaft to be kept perpendicular to the axis, whereas the hydrostatic bearings ensure that the shaft is perfectly centered, so that the combination of the hydrostatic stop and bearings makes it possible to obtain the required operating conditions of the pumping arrangement.

As illustrated in FIGS. **3** and **4**, the hydrostatic stop is constituted by a part **68**, solidly connected to and rotating with the shaft of the electric pump arrangement, the lower face of this part forming a planar annular disc **69** perpendicular to the axis of the shaft **19**. In the at rest position, that is to say in the absence of pressurized pumped liquid, the part **68** bears by its lower planar face **68** on a part **26** which is held against rotation and forms a stop, this latter part having a spherical lower surface and being mounted on a spherical bearing portion **58** of a part **70** solidly connected to the body **21**. The part forming a stop **26** contains in its upper planar face a number of recesses or cavities **64** (FIG. **4**) which are uniformly spaced from each other and are each bounded by two concentric arcs of a circle, whereas the spherical bearing portion contains a chamber **62** in the form of an annular throat with which the recesses or cavities **64** communicate through perforations **62**. The annular chamber **62** communicates, through a radial passage **62** in which is fitted a removable replaceable nozzle **60**, with the chamber **25** communicating with the delivery side of the pump, the impeller **23** of which is overhung at the lower end of the shaft **19**.

Between the swivel stop **26** and the shaft **19** is an annular gap **71** for the return of the pumped fluid which then flows, as indicated by the arrow **65**, through the hole **66** in the pump impeller **23** towards the intake side **67** of the pump.

When the system is operating, the pressurized liquid injected through the nozzle **60** and the passage **61** into the chamber **62** and into the cavities **64** in the stop **26**, exerts upon the plate **69 – 68** an upward axial thrust and lifts the rotating unit of the pump and motor. As the gap between the stop **26** and the planar lower face **69** of the plate **68** increases, the liquid flows through the passages **71** and the hole **66**, and the pressure of the liquid diminishes in this gap as the latter increases, until the pressure of the liquid is balanced by the weight of the rotating unit and the increasing intake force exerted by the liquid on the impeller of the pump. When this balance is established, the stop becomes stabilized at a predetermined amount of play between the upper face of the stop **32** and the lower face **69** of the plate **68**. In the case where the delivery of the pump varies, the intake force also varies and the play of the stop also tends to vary, but a variation in pressure then occurs in this gap and this tends to re-establish the initial extent of the gap.

The hydrostatic bearings **22** and **22'** are preferably likewise fed from the chamber **25** with pressurized pumped liquid through similar means, not illustrated. The upper bearing **22'** may in particular be fed with pressurized liquid from the delivery chamber **25'** through a hole **59**, the liquid being returned to the container by the nozzle **31**.

The employment of hydrostatic bearings and stops enables use to be made of clearances 10 to 100 times greater than that in conventional bearings, so that excellent cooling of these bearings is achieved, as well as lubrication, by circulation of the pumped liquid. It will be seen that in the case of a container of liquefied gas, in the installation that has been described the sealing elements are fitted in the low-pressure part, at the top of the container, where there is a gas volume the level of the liquefied gas, whereas in the high-pressure part, that is, on the delivery side of the pump, the interior of the well contains only permanent welded joints. The low-pressure seals are easily achieved with the help of pressure joints of appropriate material.

The pump arrangement described thus contributes to the provision of an installation for stocking and pumping dangerous liquids by means of a submerged electric pump, which installation is particularly safe.

I claim:

1. An immersible electric pump arrangement intended particularly for use in containers accommodating explosive or dangerous liquids, especially liquefied gas fuels, ammonia or the like, comprising a casing; a vertical shaft; an electric motor in the casing having its winding submerged in the pumped liquid and having a rotor mounted on the upper part of this shaft and a pump having its impeller secured to the lower part of

this shaft; a hydrostatic stop disposed between the motor and the pump to support said shaft carrying the rotor of the motor and the impeller of the pump, said stop comprising a plate fixed on said shaft and having a planar annular lower face perpendicular to this shaft; a chamber formed in the casing and communicating with the delivery side of the pump; a part rigidly connected to the casing and disposed in the said chamber, said part having its upper portion formed as a concave spherical bearing; a further part constituting a swivel, held against rotation around the shaft and having a spherical lower portion resting on said bearing portion and a planar annular face presented to the plate rigidly connected to the shaft; a series of recesses uniformly distributed over the planar upper face of the swivel; perforations in the swivel and in the part which supports it for enabling said recesses to communicate with said chamber communicating with the delivery side of the pump to inject the pumped fluid between the upper face of the swivel and the lower face of the plate rigidly connected to the shaft; and an annular gap formed between the swivel and the shaft for the return of the liquid to the intake side of the pump.

2. An electric pump arrangement according to claim 1, in which said part rigidly connected to the casing and comprising said concave spherical bearing portion has at said bearing portion an annular throat, a radial passage being formed to enable this annular throat to communicate with the chamber communicating with the delivery side of the pump, a removable replaceable nozzle fitting at the inlet to this passage, and perforations formed through the part constituting the swivel at the centers of the recesses in its upper face to enable these recesses to communicate with the annular throat formed in the spherical bearing portion.

3. An electric pump arrangement according to claim 2, comprising two hydrostatic bearings disposed in the casing, the one above and the other below the rotor of the motor, and means for injecting into these bearings liquid pumped from said chamber communicating with the delivery side of the pump.

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