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E. HUSTINX

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LIQUID PUMP HAVING GAS-CUSHIONED BEARING MEANS

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FIG. 1.

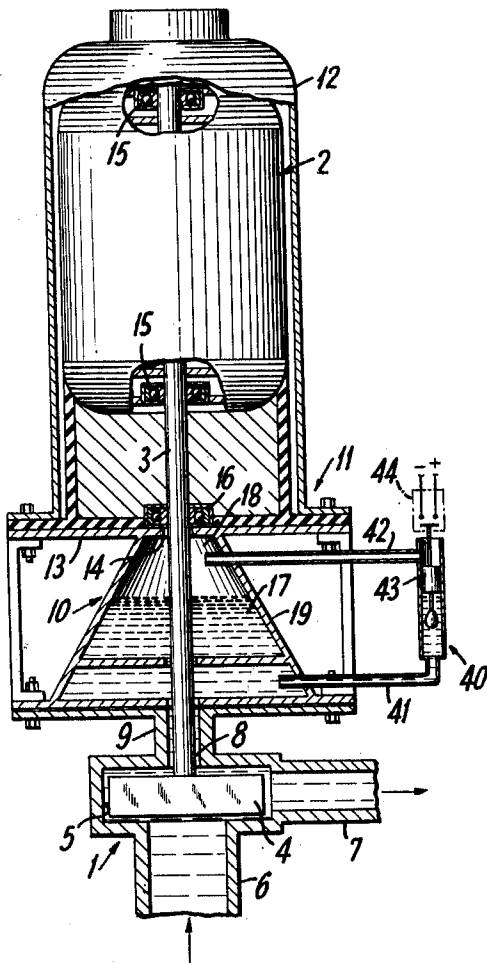
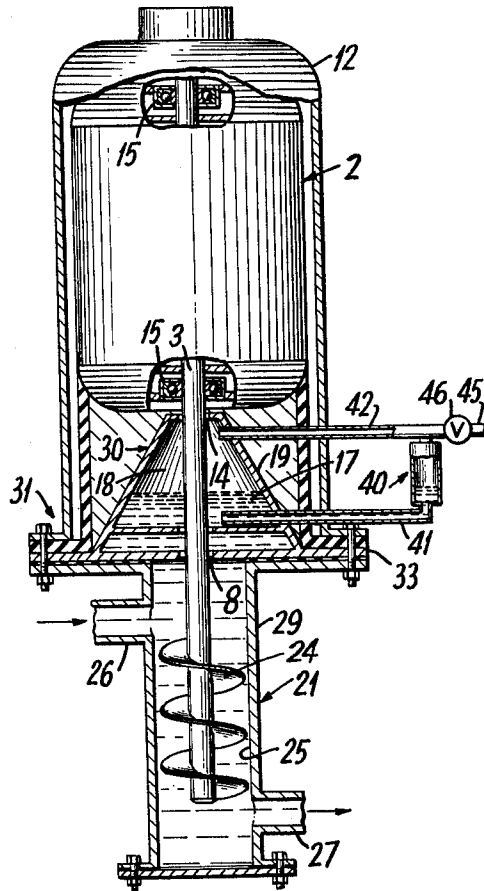


FIG. 2.



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Edmond Hustinx, Looiersgracht 4,
Maastricht, Netherlands

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The present invention relates to liquid pumps of the type in which a housed impeller is driven by an operating rod, such as a rotary shaft, extending through a wall of the housing, with means being provided to prevent leakage from the housing.

The propelling of liquids is usually effected by means of a pump. Conventional pumps have an impeller or piston which provides the pumping force, and an engine which drives the impeller or piston by means of a rotary shaft or by means of a connecting rod moving back and forth to reciprocate the pump piston, such shaft and connecting rod collectively being referred to herein as a "drive rod." The liquid circuit always has a differential pressure with respect to the surrounding atmosphere. The drive rod, therefore, must be protected against leakage of liquid at its entrance to the pump. The opening around the rod is, therefore, as narrow as possible. To prevent leakage of liquid, moreover, a packing is fitted between the opening and the rod by means of a stuffing-box. Friction and wear, however, require regular maintenance and renewal of the packing. This disadvantage increases when corrosive or sticky or viscous liquids have to be pumped. Changes in temperature and pressure contribute to wear and tear of the stuffing-box.

It is an object of the present invention to eliminate the stuffing-box, and frictional wear and corrosive damage thereof, by hermetically sealing the housing in an effective manner. In accordance with the present invention, guide bearing means of the drive rod, either in the form of a rotary shaft or piston-operating connecting rod, are isolated from contact by the liquid being pumped. This is accomplished by forming a cushion of gas, such as air, between the pump impeller and the bearing means. For this purpose, the power driving unit is mounted above the pump, and the drive rod extends vertically therebetween through an intervening closed chamber sealed at the bottom end to the pump housing and at the top end to a casing, enclosing in a fluid-tight manner the power driving unit. An opening in the top of the pump housing communicates the pump chamber with the bottom portion of this intervening chamber, and the drive rod passes up therethrough without contact therewith, so that the liquid being pumped will, under pressure, rise about the drive rod through the intervening space into this intervening chamber. An opening in the top of the intervening chamber communicates it with the interior of the casing for the power driving unit, and unisolated drive rod bearing means are mounted in the casing above this latter opening. The upper portion of the intervening chamber provides a gas head space in which gas or air is entrapped, due to the fact that the structure thereabove is hermetically sealed off by the power driving unit casing. The critical top level of the liquid which rises in the intervening chamber to a point below the drive rod bearing means is determined by the balance of the pressure of the liquid being pumped and that of the compressed gas trapped in the head space in the intervening chamber and the sealed casing of the driving unit.

It is advantageous to provide the intervening chamber with tapered side walls which converge upwardly, so that the pressure of the trapped gas will increase rapidly as the pressurized liquid rises in the bottom portion of the intervening chamber. For this purpose, the intervening

chamber may be of frusto-conical configuration, with its lower bottom end connected in a fluid-tight manner to the top of the pump housing about the opening in the latter, and with its smaller top end connected in a fluid-tight manner to the bottom of the driving unit casing about the opening in the latter.

If desired, a tube may be positioned between the bottom portion of the intervening chamber and the top of the pump housing, to provide a liquid passage from the hole in the top of the latter up to the bottom of the intervening chamber with the drive rod extending up through this tube without contact therewith. This connecting tube is hermetically sealed to the top of the pump housing and to the bottom of the intervening chamber.

By making the hermetic sealing of the encased units and the interconnecting parts thereof efficiently tight, it may be unnecessary to supply gas to the trapped gas head for such services wherein the gas, such as air, does not dissolve in the pumped liquids. In the event that the pumping is performed with atmospheric air surrounding the encased units, atmospheric air may be sucked in with the supply of liquid, and will then rise from the pump housing into the intervening chamber. This is particularly true when water is pumped by such a device.

Any gas leakage from the entrapped gas head which may occur may be offset by supply of supplemental quantities thereof through a valved conduit connected to any point of the encased system, for example, directly to the gas head space in the intervening chamber.

Such a gas supply valve may be operated and controlled by a conventional mechanism, the automatic operation of which is dictated by a float which rises and falls with the level of the liquid in the intervening chamber. For this purpose, a liquid column may be provided having its lower end connected to the bottom portion of the intervening chamber and its upper end connected to the chamber gas head space with the float being buoyed on the surface of the liquid in the column. The float is mechanically connected to any suitable control means, which may dictate the automatic operation of the valve, or which may stop and start the power driving unit in response to the rise and fall of the float with the level of the liquid in the column.

Conductivity of the liquid in the intervening chamber may be employed to dictate the operation of an electronic control circuit. For example, placement of contact means at an elevated critical liquid level point in the intervening chamber may allow the rising liquid to complete an electrical circuit of the electronic control means with rise of the latter to the critical point. Since the conductivity of the liquid will change with the length of an electrical path therethrough, the height of the head of liquid in the intervening chamber, may give a conductivity measurement which will dictate operation of an electronic control circuit.

Embodiments of the invention are illustrated in the accompanying drawing, in which:

FIG. 1 is an axial section of one embodiment of the present invention; and

FIG. 2 is an axial section of another embodiment thereof.

Referring to the drawing, in which like numerals identify similar parts throughout, it will be seen that embodiments of the invention may comprise a centrifugal pump 1 (FIG. 1) or a screw impeller pump 21 (FIG. 2), a power driving unit in the form of an electric motor 2, and a drive rod or shaft 3 connecting the motor to the pump impeller 4 (FIG. 1) or 24 (FIG. 2).

Referring to the FIG. 1 embodiment, it will be seen that the housing of the centrifugal pump 1 defines a pump chamber in which is rotatably supported impeller 4, driven

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by shaft 3 connected to the rotor of the electric motor 2. The housing of pump 1 has a liquid supply inlet passage 6 leading to the pump chamber and a pumped liquid outlet passage 7 leading from the pump chamber. The top of the housing of centrifugal pump 1 is provided with an opening 8, which is connected by a tube 9 to the bottom of intervening chamber 10 for communicating them together. The internal diameter of the connecting tube 9 is appreciably greater than the outer diameter of the drive shaft 3 so that liquid under elevated pressure in the pump chamber will rise therebetween into the intervening chamber 4.

In the FIG. 1 embodiment the driving motor 2 is encased in a casing 11, which includes an inverted shell 12 hermetically sealed to a transverse plate 13 that may be considered to be the bottom of this casing, and a portion of the latter also constitutes a top wall of the intervening chamber 10. An enlarged opening 14 in the transverse plate 13 communicates the top portion of the intervening chamber 10 to the driving motor casing 11 and the interior of the motor. The motor 2 conveniently may be provided with shaft bearings 15 at opposite ends of its rotor, and an additional guide bearing 16 for the shaft 3 may be mounted in the vicinity of the communicating opening 14. All three of these drive shaft bearings 15 and 16 constitute guide bearings, and they are located above the communicating opening 14 at the bottom of the motor casing.

In operation of the embodiment of FIG. 1, when liquid is pumped by the centrifugal pump 1 in through the inlet passage 6 and out through the outlet passage 7, by operation of the motor 2 and the attendant rotary drive of the connecting shaft 3, the pressurized liquid will rise through the opening 8 and tube 9 into the intervening chamber 10. Since a head of air has been trapped in the intervening chamber 10 and the interior of the motor casing 11, the pressurized liquid will rise in the intervening chamber such as to the level indicated in FIG. 1, to provide a pool 17 therein with the pressure of the compressed air in the head space 18 and the interior of the motor casing 11 balanced by the pressure of the liquid in the pool. It will also be seen from FIG. 1 that the air trapped in the head space 18 isolates the guide bearings 15 and 16 from contact with the pressurized liquid, and that liquid is prevented from leaking from the pump along the drive shaft by this means.

The side wall 19 of intervening chamber 10, in which rising liquid is pooled at 17 with the gas head 18 collected thereabove, preferably is tapered upwardly to be of progressively smaller cross-sectional area as its top portion approaches the opening 14 in the bottom of the driving unit casing 11. In embodiments of the invention, this tapering of the intervening chamber 10 is obtained by making the side walls thereof frusto-conical. As a result of this upward tapering of the side walls of the intervening chamber 10, the pressure of the gas head 18 increases rapidly as the level of the liquid pool 17 therein rises.

In the FIG. 2 embodiment, the impeller 24 is in the form of a rotary screw mounted to the bottom end of the drive rod or shaft 3 for rotation in tubular pump housing 11. The tubular pump housing 21 is provided with a liquid supply inlet passage 26 and a pumped liquid outlet passage 27. The bottom end of the tubular pump housing 31 is sealed off and the top section 29 thereof constitutes a connecting tube between the pump chamber and the bottom of the power driving unit casing 31, arranged about the opening 8 in the latter, up through which the drive shaft 3 extends.

In the FIG. 2 embodiment, the transverse plate 33, in which the opening 8 is formed and to which the bottom end of the casing shell 12 is sealed, has the upwardly tapered side walls 19 of the intervening chamber 30 mounted thereon and sealed thereto. Consequently, the intervening chamber 30 is nested within the bottom por-

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tion of the shell 12 below the motor 2, but it has opening 14 in its smaller top end located below the bearing units 15. Thus, a marginal zone of the transverse plate 33 and the tapered side walls of the intervening chamber 30 together constitute the bottom of the casing 31 in which the motor 2 is hermetically enclosed.

The FIGS. 1 and 2 embodiments may be provided to advantage with a liquid column 40, in the form of a gauge glass, having its lower end connected by a duct 41 to the bottom portion of the intervening chamber 10 or 30 and its upper end connected by another duct 42 to the chamber gas head space 18, so that a column of liquid therein will rise and fall with the top level of the liquid pool 17. A float 43 is shown mounted in the liquid column 40 and is connected to an electrical control device 44 thereabove for operation of the latter as the float rises and falls with the liquid in the liquid column. It is to be understood that a similar float and electrical control device may be mounted in the liquid column 40 of the FIG. 2 embodiment. The electrical control device 44 has circuit wiring connected thereto which may operate a switch in the circuit of the driving motor 2, so that when the level of the liquid pool 17 rises above a critical limit operation of the motor may be discontinued and thereafter re-established with fall of the liquid level. When the top portion of the liquid column 40 is connected to a gas supply conduit 45 communicating with the duct 42, a valve 46 in the former may be operated by the electrical control device 44. For this purpose valve 46 may be a solenoid valve of conventional construction. Thus, should the level of the liquid pool 17 rise about a critical limit due to depletion of the gas head 18, such as by accidental leakage, more pressurized gas may be fed thereto to obtain a balance of the pressures of the gas and liquid at a lower level of the latter.

Having described my invention what I claim as new and desire to secure by Letters Patent is:

1. A liquid pump having gas-cushioned bearing means for the impeller drive rod thereof comprising
 - (a) a pump housing enclosing a liquid impeller and having a liquid supply inlet and pumped liquid outlet passages,
 - (b) said housing having an opening communicating with the pumped liquid outlet passage,
 - (c) a drive rod connected to said impeller for drive of the latter and extending upwardly through the opening substantially free of contact with edges of the opening, the intervening space permitting free flow of pumped liquid up through the opening about said drive rod,
 - (d) a fluid-tight casing above the opening enclosing a powered driving unit connected to an upper section of said drive rod,
 - (e) said casing having a bottom portion provided above said housing opening with another opening up through which an intermediate section of said drive rod extends substantially free of contact with edges of this casing opening and with intervening space permitting free flow of gas therethrough,
 - (f) means defining an upwardly tapered closed gas-containing chamber arranged between said openings in spaced relation about said drive rod intermediate section and of progressively smaller cross-sectional area in an upper portion towards said casing opening with a bottom portion of said chamber connected in a fluid-tight manner to said housing about said housing opening and the chamber upper portion connected in a fluid-tight manner to said casing about said casing opening,
 - (g) said housing opening permitting entry of pumped liquid up about said drive rod into said chamber to trap a body of the gas thereabove in a head space of the chamber adjacent said casing opening, and
 - (h) said gas cushioned bearing means being of unisolated form and arranged about said drive rod as a

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guide therefor in the vicinity of said casing opening above the critical top level to which the pumped liquid will rise.

2. The pump of claim 1 in which transverse baffle means is mounted across said chamber appreciably below said casing opening with said guide bearing means mounted immediately above the latter and with said baffle means having a medial opening through which said drive rod intermediate section extends substantially free of contact with edges of this baffle opening.

3. The pump of claim 1 in which said means defining said tapered chamber is an upwardly extending conical wall defining the bottom portion of said casing with said casing opening provided at the top end of said conical wall and with said guide bearing means mounted immediately above said casing opening within the space isolated in said casing.

4. The pump of claim 1 in which said means defining said tapered chamber is frusto-conical with said casing opening provided in the smaller top end thereof.

5. The pump of claim 1 in which a tube intervenes said chamber and housing, having its top and bottom ends respectively sealed thereto, and with the latter arranged about the opening in said housing, thereby providing a liquid passage up to the bottom of said chamber, with said drive rod extending up therethrough without contact therewith.

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6. The pump of claim 1 in which said chamber is provided with a liquid column having its lower end connected to the bottom portion of said chamber and its upper end connected to the chamber gas head space, said column having a float therein, and means to control the operation of said powered driving unit in response to the rise and fall of said float to stop said driving unit temporarily when the pumped liquid in said chamber rises above a critical level.

7. The pump of claim 1 in which said chamber is equipped with electrical contact means at an elevated critical liquid level point to complete an electrical circuit of electronic control means through the liquid with rise of the latter to said critical point.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,157,128

November 17, 1964

Edmond Hustinx

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 6, for "hermettically" read -- hermetically --; line 31, for "about" read -- above --.

Signed and sealed this 30th day of March 1965.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents