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ELECTROMAGNETICALLY DRIVEN DIAPHRAGM PUMP FOR LIQUIDS

Fig. 1

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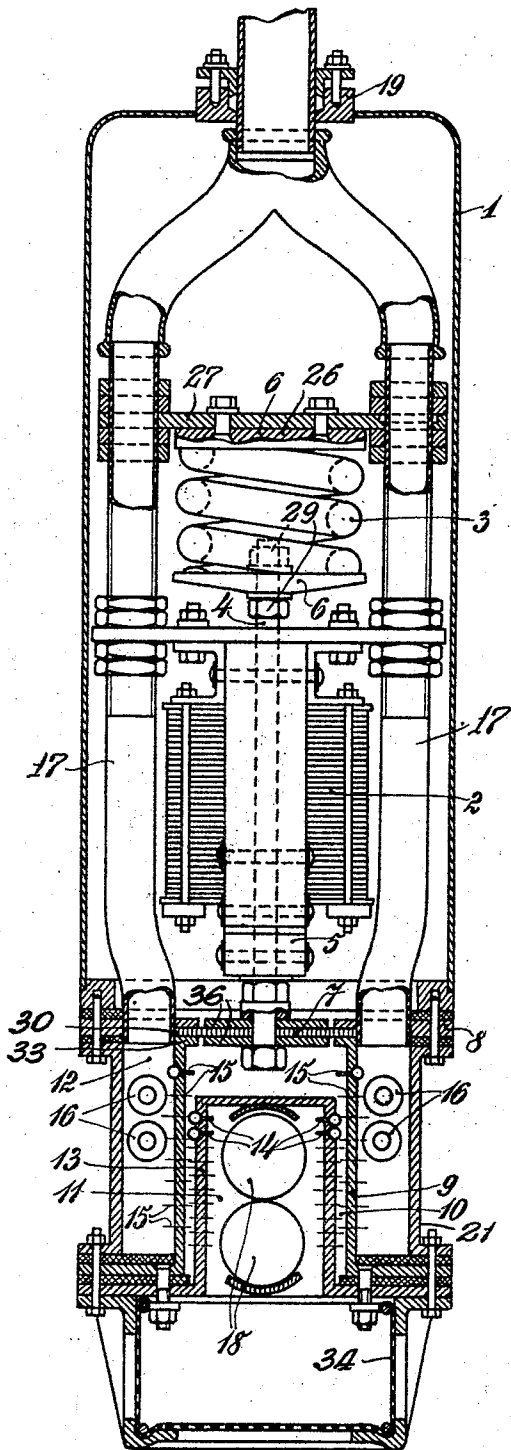
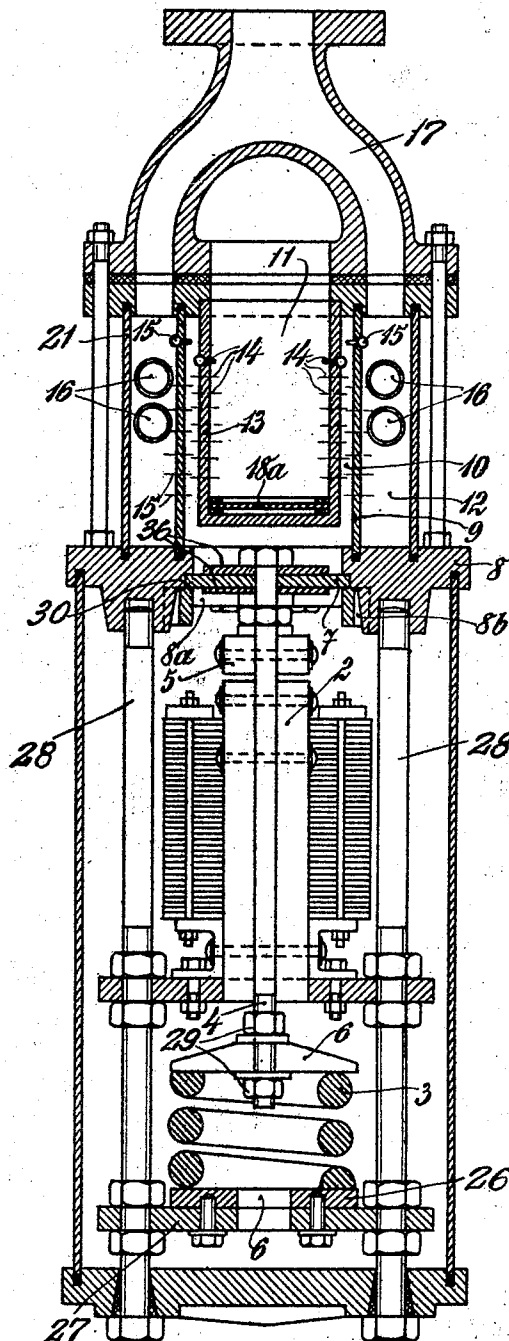


Fig. 2



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ELECTROMAGNETICALLY DRIVEN DIAPHRAGM PUMP FOR LIQUIDS

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10 Claims. (Cl. 103—53)

The invention relates to electromagnetically driven diaphragm pumps for liquids of the type in which an alternating current electromagnet and a spring cooperate in oscillating the pump diaphragm in resonance with the frequency of the alternating current.

When determining for a pump the conditions for resonance, in addition to the mass of the liquid in the pump chamber, also the masses of liquid in the intake and outlet chambers and in the intake and outlet or delivery pipe-lines must be considered as far as these masses take part in the oscillation lest the actual conditions for resonance and those for a satisfactory supply of the liquid become incompatible with each other.

It is therefore a primary object of this invention to associate with one another constructively the oscillating elements of the diaphragm pump so as to restrict as far as possible, on the one hand, the field of oscillations and, on the other hand, to reduce the mass of liquid within the three chambers of the pump, intake chamber, pump chamber, and outlet chamber.

More specifically, it is one of the objects of the invention to make the volume of the pump chamber as small as possible by a new arrangement of its constructive elements. It is another object of the invention to reduce the liquid filled space or spaces of the intake chamber or of the outlet chamber or of both chambers by placing, into said chamber or chambers, liquid displacing air filled bodies with elastically yielding surfaces or walls which displace the liquid in said chamber or chambers besides taking up part of the oscillating energy thus preventing it from reaching the pipe-lines.

For accomplishing these and other objects of the invention, which will become clear when the following description proceeds, the pump chamber is given a special shape which reduces to the minimum required for the stroke of the valves, the length of the path which the liquid travels from the inlet valves to the outlet valves, and which, simultaneously, brings the diaphragm into close proximity to the valves.

The pump chamber of this invention is arranged as the intermediate space between a pair of cylindrical vessels, one within, and concentrically with, the other. The bottom of one of the vessels, preferably of the outer vessel, constitutes the diaphragm, whereas the cylindrical walls of both vessels are provided with the inlet valves and the outlet valves, respectively. This pair of vessels is contained in an outer vessel, preferably also concentric with the aforesaid pair

of cylindrical vessels and forming with the wall of the outer of said pair of vessels an annular chamber. These three vessels thus confine, and separate one from another, a liquid intake chamber, a pump chamber, and a liquid outlet chamber; preferably in the sequence: hollow of the inmost vessel, intermediate space between the pair of cylindrical vessels, and intermediate space between the outer of the pair of cylindrical vessels and the outmost vessel. Obviously, by this means, the space of the pump chamber can be ultimately reduced in size.

In order to reduce the liquid filled space or spaces within the intake chamber or within the outlet chamber or within both, the invention provides within this space, or within these spaces, one or more air filled bodies with elastically yielding walls, such as hoses, spherical bags, or the like. One or more hoses of annular shape, for instance, may be disposed within the space intervening between the outmost vessel and the outer vessel of the pair of cylindrical vessels and also in the hollow of the inmost vessel, or bags may be provided in this last-named space or in both spaces, or vice versa.

Oscillating pumps energized by alternating current are particularly suitable for use as submerged pumps. They have no rotating or reciprocating parts and, consequently, the difficult task of lubricating and packing such parts, does not arise. The pump of this invention is the more useful for this purpose, as it may be constructed with a relatively small diameter and a sufficiently large passageway through the valves may be obtained by choosing sufficiently high cylinder walls within which a sufficiently large number of valves may be provided. The invention thus facilitates greatly the construction of hydraulic pumps for use in wells, bore-holes, or the like.

Of particular advantage in this regard, as the lateral or radial dimensions may be still further reduced, is the arrangement wherein the vessels, the electromagnet, its armature and rod, and the spring are all disposed about a common longitudinal axis. In a preferred embodiment of this arrangement, the rod traverses freely the frame of the electromagnet and, at its one end, is secured to the diaphragm, whereas at its other end, it is operatively connected to the spring. Owing to the symmetry of this arrangement, especially if the spring is of ample dimensions and strength, any lateral deviations of the oscillating system may be avoided during its work. Any guiding means which otherwise would impede the de-

velopment of the oscillations, above all the setting up of resonant higher harmonics, become needless.

Two embodiments of a hydraulic pump in accordance with the invention are shown, by way of example, on the accompanying drawing, in which

Fig. 1 is a longitudinal section of a pump in which the diaphragm is arranged above the valves, the suction or intake taking place from below;

Fig. 2 is a longitudinal section of a modification in which the diaphragm is arranged below the valves, the suction or intake taking place from above.

In the embodiment shown in Fig. 1, there are arranged within a casing 1, 21, the pump, consisting of various parts which will be described immediately, the electromagnet 2 and the spring 3. The electromagnet is energized by alternating current from any conventional source, the supply lines not being shown on the drawing for the sake of clearness. The frame of the electromagnet is provided with a bore through which a rod 4 passes freely without any guiding means. This rod carries the armature 5 of the electromagnet. The spring 3, of ample dimensions and strength bears with either end against a disc, 6 and 26, respectively. Disc 6 is secured to one end of rod 4, whereas the other disc 26 is secured to a cross-plate 27 mounted, in the case of Fig. 1, at the delivery tubes 17 of the pump, and, in the case of Fig. 2, at the ties 28. The diaphragm 7, of any material suitable for its purpose e. g. of buna rubber, is secured at its center to the other end of rod 4. The rod, whose one end is thus secured to the diaphragm and whose other end is operatively associated with the spring, is, by means of screws 29, adjustable with regard to its length and thus holds the diaphragm and the spring under tension. The diaphragm forms the bottom of the outer vessel 9 of a pair of cylindrical vessels, 9 and 13, and at its edge 30 is clamped between annular bottom plate 8 and flange 33 of cylinder 9 (Fig. 1) or press ring 8a (Fig. 2), respectively. Recesses 8b are cut into this ring 8a against which the extension pieces of bottom plate 8 bear.

The three walls 21, 13, and 9 confine, and separate from one another, the three chambers of the pump viz. the intake chamber 11, within vessel 11; the pump chamber 10, between walls 13 and 9; and the outlet chamber 12, between walls 9 and 21. These three chambers are concentric with one another thus offering to the liquid only a very short path through the pump.

The inlet valves are arranged within wall 13, the outlet valves within wall 9. It will be readily seen that the pump chamber may be constructed extremely narrow and ultimately only as wide as to prevent the valves on their stroke from touching the opposite wall. A pump chamber of small volume will thus result from this construction. The numerous, small valve openings are arranged around the cylinder walls on circles spaced apart from one another. The valves on each circle are controlled by a rubber ring as valve body.

When the diaphragm is oscillated, as will be described later on, the liquid will flow from the inlet valves 14 in a radial direction, on a short path, through the narrow pump chamber 10 to the delivery or outlet valves 15. In this way, only a small quantity of liquid, as compared with the total quantity of liquid supplied, will partici-

pate in the oscillation of the diaphragm. From the outlet valves 15 the liquid passes into the outlet or delivery chamber 12.

In order to reduce further the liquid filled space and, correspondingly, the mass of liquid which might participate in the oscillation, closed bodies such as hoses 16 with walls of resilient or yielding material and filled with air are disposed within the outlet chamber 12. These hoses contract and expand in the rhythm of the oscillations and thus prevent the oscillations from reaching the delivery or outlet pipe-lines. For the same purpose, air filled bodies, such as spherical air bags or balloons may be arranged within the intake chamber 11. Instead of the hoses, spherical bags may be used, and, vice versa, hoses instead of the bags. By means of these elements, the supply of liquid is also rendered uniform. This effect is also enhanced by the arrangement of valves 14 and 15 on concentric or coaxial cylinder surfaces, respectively. A pipe-line may be connected to the intake or suction chamber, or the liquid may reach the intake chamber 11 directly from the bore-hole, well, or the like, through sieves, such as the intake sieve 34, Fig. 1.

The oscillating system of the pump is tuned to resonance with the frequency of the current which passes through the electromagnet. When considering this oscillating system, of course, the mass of liquid which oscillates together with the diaphragm must be taken into account. Owing to the described particular shape of the pump chamber, the short path between the valves, and the air filled bodies 16 and 18, this mass of liquid is small and thus unable to exert any undue influence.

Electromagnet 2 and spring 3 will cooperate, in resonance and rhythm with the frequency of the current supplied to the system, and will set armature 5 together with rod 4 and diaphragm 7 into strong oscillations. The oscillating diaphragm will convey the liquid through the pump from the intake chamber 11 to the outlet chamber 12. As the rod is freely suspended between oscillating spring 3 and diaphragm 7, the diaphragm is subjected to no lateral coercive forces and any tendency of lateral movement will be absorbed within, and rendered harmless by, spring 3. To this end, spring 3 should be constructed of ample dimensions and great strength.

When the pump is for use in submerged condition, for which use, owing to its narrow shape, it is particularly suited, the casing 1 will be constructed liquid tight.

The rubber rings which control the valves 14 and 15 may be constructed as air filled hoses and thus exercise the function of the air filled bodies above described.

The embodiment of Fig. 2 shows the inverse arrangement of parts of that of Fig. 1. The liquid is supplied from the top of the pump and is also delivered upwardly, the lengths of the travel of the liquid and of the pipe-lines through the pump thus being small and, correspondingly, the losses through internal resistance of the pump.

The output of pumps of this kind depends upon the diameter of the diaphragm, upon the size of its clamping plates (36), and upon the amplitude of the oscillations. In the embodiment shown in Fig. 2, the output may be varied to a certain extent by varying the size of bottom plate 8, the diameter of ring 8a, and the size of clamping plates 36 being varied correspondingly.

For taking up oscillation energy, a membrane 18a may be provided at the bottom of cylindrical vessel 11 which separates from the hollow of chamber 11 a fully closed air filled space, as shown in Fig. 2.

What I claim is:

1. In an electromagnetically driven diaphragm pump for liquids, in combination, an outer vessel, a pair of cylindrical vessels disposed within said outer vessel, one of the bottoms of said pair of cylindrical vessels being formed as a diaphragm; said outer vessel and said pair of cylindrical vessels confining, and separating from one another, a liquid intake chamber, a pump chamber, and a liquid outlet chamber, respectively; inlet valves and outlet valves respectively disposed in the cylindrical walls of said pair of vessels; an electromagnet, an armature actuated by said electromagnet, a rod connected to said armature and to said diaphragm; a spring operatively associated with said rod for causing said diaphragm to oscillate under the influence of said electromagnet.

2. In an electromagnetically driven diaphragm pump for liquids, in combination, an outer vessel, a pair of cylindrical vessels disposed within said outer vessel, concentrically with one another; the outer vessel and the wall of the outer of said pair of cylindrical vessels forming an annular chamber; the bottom of said outer of said pair of cylindrical vessels being formed as a diaphragm; said three vessels confining, and separating from one another, in the sequence from the inmost vessel to the outmost vessel, a liquid intake chamber, a pump chamber, and a liquid outlet chamber, respectively; inlet valves disposed in the wall of the inmost vessel, outlet valves disposed in the wall of the outer of said pair of cylindrical vessels; said combination further including an electromagnet, an armature actuated by said electromagnet, a rod connected to said armature and to said diaphragm; a spring operatively associated with said rod for causing said diaphragm to oscillate under the influence of said electromagnet.

3. An electromagnetically driven diaphragm pump for liquids as set forth in claim 1 wherein said pair of cylindrical vessels, said electromagnet, said armature, said spring, and said rod are disposed about a common longitudinal axis.

4. An electromagnetically driven diaphragm pump for liquids as set forth in claim 1 wherein said pair of cylindrical vessels, said electromagnet, said armature, said spring, and said rod are disposed about a common longitudinal axis; and wherein said electromagnet has a central bore, said rod traversing freely said bore and being secured at its one end to said diaphragm and at its other end operatively connected to said spring.

5. In an electromagnetically driven diaphragm pump for liquids, in combination, an outer vessel, a pair of cylindrical vessels disposed within said outer vessel, concentrically with one another; the outer vessel and the wall of the outer of said pair of cylindrical vessels forming an annular chamber; the bottom of said outer of said pair of cylindrical vessels being formed as a dia-

phragm; said three vessels confining, and separating from one another, a liquid intake chamber, a pump chamber, and a liquid outlet chamber, respectively; inlet valves and outlet valves respectively disposed in the cylindric walls of said pair of vessels; an electromagnet, an armature actuated by said electromagnet, a rod connected to said armature and to said diaphragm; a spring operatively associated with said rod for causing said diaphragm to oscillate under the influence of said electromagnet; said combination further including at least one air filled closed body with elastically yielding walls disposed within at least one of said intake and outlet chambers for the purpose of reducing the liquid filled space of said chamber.

6. An electromagnetically driven diaphragm pump for liquids as set forth in claim 5 wherein said air filled closed body is in the form of a hose.

7. An electromagnetically driven diaphragm pump for liquids as set forth in claim 5 wherein said air filled closed body is in the form of a spherical bag.

8. In an electromagnetically driven diaphragm pump for liquids, in combination, an outer vessel, a pair of cylindrical vessels disposed within said outer vessel, concentrically with one another, the bottom of the outer of said pair of cylindrical vessels being formed as a diaphragm; said three vessels confining, and separating from one another, a liquid intake chamber, a pump chamber, and a liquid outlet chamber, respectively; inlet valves and outlet valves respectively disposed in the cylindric walls of said pair of vessels; an electromagnet, an armature actuated by said electromagnet, a rod connected to said armature and to said diaphragm; a spring operatively associated with said rod for causing said diaphragm to oscillate under the influence of said electromagnet; said valves being in the form of rubber rings.

9. In an electromagnetically driven diaphragm pump for liquids, in combination, an outer vessel, a pair of cylindrical vessels disposed within said outer vessel, concentrically with one another, the bottom of the outer of said pair of cylindrical vessels being formed as a diaphragm; said three vessels confining, and separating from one another, a liquid intake chamber, a pump chamber, and a liquid outlet chamber, respectively; inlet valves and outlet valves respectively disposed in the cylindric walls of said pair of vessels; an electromagnet, an armature actuated by said electromagnet, a rod connected to said armature and to said diaphragm; a spring operatively associated with said rod for causing said diaphragm to oscillate under the influence of said electromagnet; said valves being in the form of air filled annular hoses.

10. In an electromagnetically driven diaphragm pump for liquids as set forth in claim 2, said inmost vessel having a membrane spaced a short distance apart from its bottom, said membrane separating a closed air filled space from the liquid space of said vessel.

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