Jan. 19, 1926. 1,570,381

J. M. LEA

PUMP MECHANISM

Filed Jan. 27, 1923 2 Sheets-Sheet 1

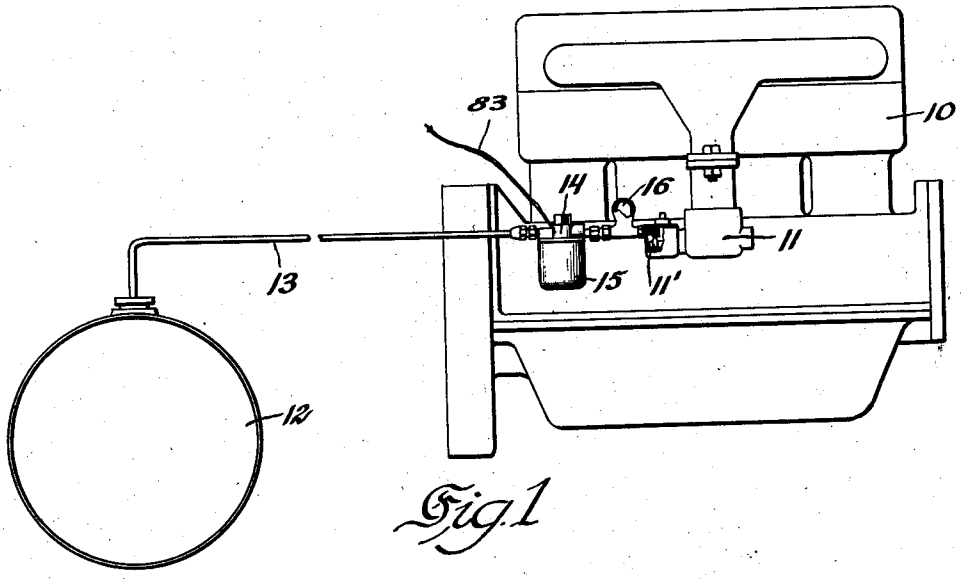


Fig. 1

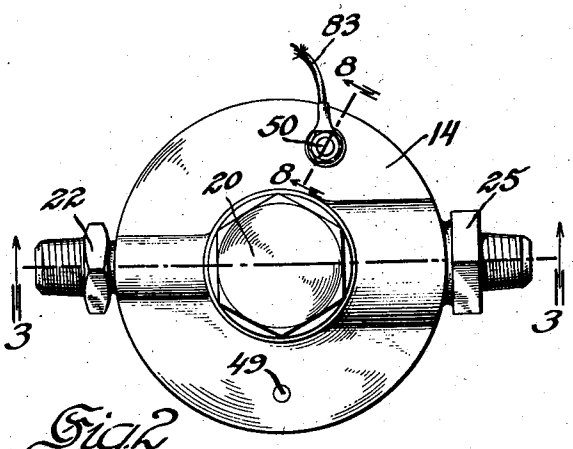


Fig. 2

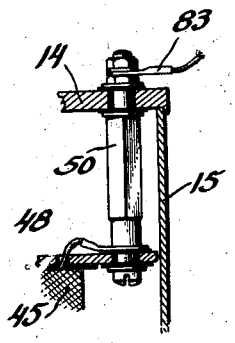


Fig. 8

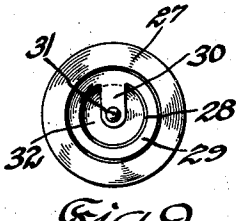


Fig. 9

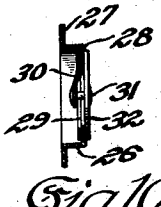


Fig. 10

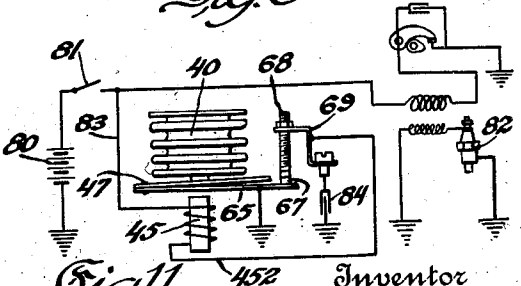


Fig. 11

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PUMP MECHANISM

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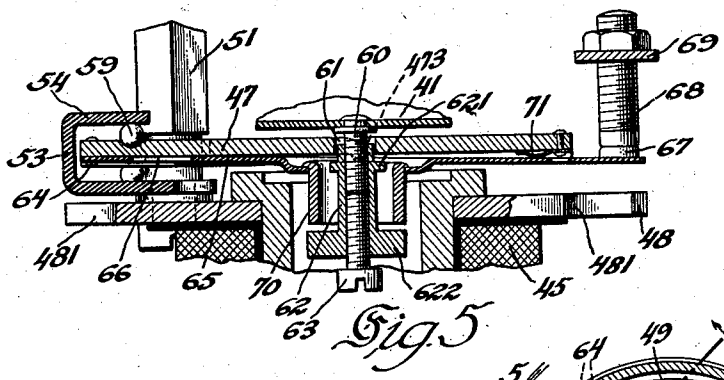


Fig. 5

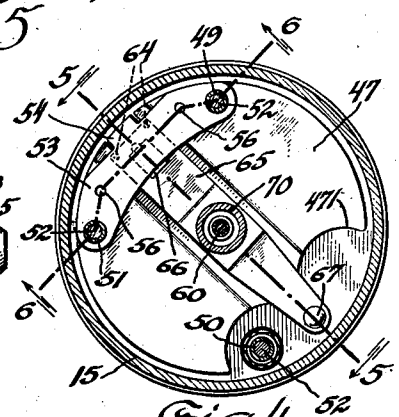


Fig. 4

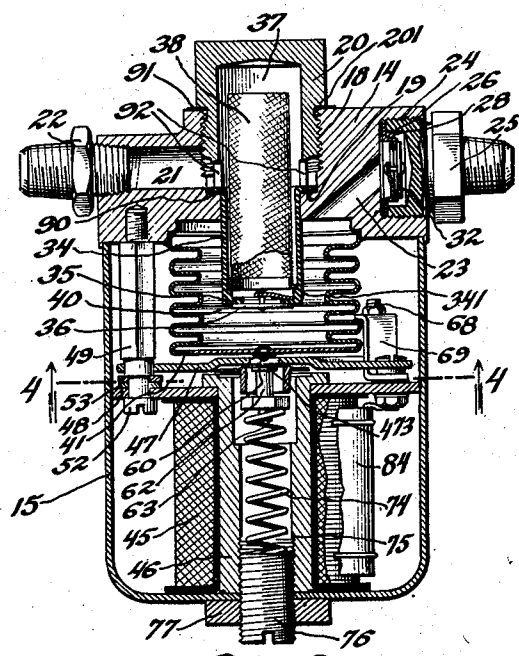


Fig. 3

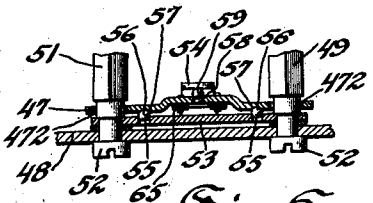


Fig. 6

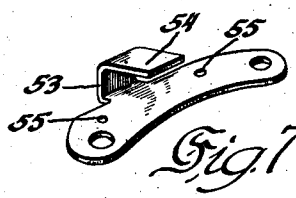


Fig. 7

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UNITED STATES PATENT OFFICE.

JOHN M. LEA, OF DETROIT, MICHIGAN.

PUMP MECHANISM.

Application filed January 27, 1923. Serial No. 615,411.

To all whom it may concern:

Be it known that I, JOHN M. LEA, a citizen of the United States of America, and a resident of Detroit, county of Wayne, and State of Michigan, have invented certain new and useful Improvements in Pump Mechanism, of which the following is a full, clear, concise, and exact description, such as will enable others skilled in the art to which the invention relates to make and use the same, reference being made therein to the accompanying drawings, which form a part of this specification.

The invention relates to pumping systems and more especially to those of the type embodying electromagnetic actuating means. While in many respects of more generic application, the invention is of particular utility in connection with, and will be herein described and illustrated as applied to, a fuel supply system for use with the internal combustion engine of a motor vehicle power plant.

The principal object of the invention is to improve the construction and operation of liquid supply mechanism and more especially of such mechanism as applied to the feeding of liquid fuel at approximately constant pressure from a tank or reservoir to a carbureter or like fuel utilizing device. To this end, the invention comprises electromagnetic actuating means, acting upon a liquid pumping device preferably of the bellows type, together with specific details of the circuit-controlling means, the bearings for the reciprocating parts, the suction and valve mechanism, and other features, all as hereinafter more fully described and particularly pointed out in the appended claims.

In the accompanying drawings illustrating one embodiment of the invention,

Fig. 1 is a side elevation of an engine and a fuel supply system in which the invention is utilized.

Fig. 2 is a top plan view of the pump casing and associated parts.

Fig. 3 is a vertical section on line 3—3 of Fig. 2.

Fig. 4 is a horizontal section on line 4—4 of Fig. 3.

Figs. 5 and 6 are detail horizontal sections on lines 5—5 and 6—6 respectively of Fig. 4, Fig. 5 being upon an enlarged scale.

Fig. 7 is a perspective view of a supporting yoke.

Fig. 8 is a detail vertical section on line 8—8 of Fig. 2.

Figs. 9 and 10 are views in plan and central section respectively showing the construction of a valve forming a part of the invention.

Fig. 11 is a diagram of the wiring system.

Referring to the drawings, 10 indicates an internal combustion engine, which may be of any suitable type, comprising a carbureter 11 to which liquid fuel is to be supplied from the tank 12 which is or which may, at times, located at a lower level than the carbureter. The carbureter comprises a fuel reservoir the inlet to which is controlled by a float valve 11′. These parts may be the usual parts of the power plant of an automobile in which case the tank is preferably mounted upon the chassis.

The pump, with which my invention is more especially concerned, may be mounted at any convenient point and is shown as supported by attachment to the casing of the carbureter itself and connected to the tank 12 by tubing 13. The pump mechanism may be enclosed within a casing formed by a base or head 14 and a cup 15, the base being provided with suitable means for attachment to pipe connections. If desired, a fitting 16 comprising an air cushion chamber may be connected to the pump on the delivery side in order to moderate the pulsations in pressure in the delivery passages.

The head 14 is provided with a central passage 18 counterbored to form the annular shoulder 19 and internally screw-threaded to receive the cap 20. An inlet passage 21 communicating with the central bore 18 extends laterally to the periphery of the head and receives at its outer end a pipe fitting 22 adapted for attachment to the supply pipe 13. An outlet passage 23 communicating with the lower side of the head extends to a recess 24 in the periphery which is screw threaded to receive the pipe fitting 25 adapted for connection to a device to receive the fluid delivered.

Within the recess 24 is mounted a valve device comprising a sleeve 26 having an outwardly directed annular flange 27 at one end

and an inwardly directed flange 28 at the other. The flange 27 is clamped by fitting 25 against the base of recess 24. Upon the inner face of flange 28 is seated a flat ring 29 of resilient material having a tongue 30 extending radially inward. To the free end of the tongue is secured, as by rivet 31, the disk 32 which seats against the outer face of flange 28 under the spring effect of ring 29 and tongue 30 and normally closes the aperture through the sleeve 26, the latter serving as a valve casing. Since both the ring 29 and tongue 30 are resilient, the flexing necessary to permit opening of the disk valve member 32 takes place not only in the tongue but also in the ring itself, thus distributing the strain and enhancing the life of the spring as well as permitting a wider opening of the valve without undue flexure of the tongue than would be possible were the tongue alone resilient.

The materials of the valve parts will be dependent, of course, upon the nature of the liquid to be handled. In adapting the device for conveying hydrocarbon fluid, as gasoline, I prefer to make the spring ring and tongue of phosphor bronze and the disk valve of Monel metal.

The valve described is of particular advantage in mechanism such as that herein disclosed inasmuch as the moving parts may be made of extreme lightness for the capacity attained, thereby reducing the inertia and permiting very quick action. The structure is also of extraordinary simplicity and easy of manufacture and assembly. Accurate fitting is unnecessary since the spring ring merely lies loosely within the cylindrical wall of the valve casing, while the valve disk, seating against the flat outer face of the flange or casing, fits tightly without requiring accurate positioning or careful machining, each part locating and holding the other in proper position. The customary valve stem and guide, common to other spring-controlled valves, are eliminated and greater reliability against sticking is thereby attained.

Upon the shoulder 19 at the lower end of the central bore 18 is seated a valve casing or cup 34 having at its lower end an inwardly extending annular flange 35 corresponding to the flange 28 of the valve casing 26. Upon the flange 35 is mounted a downwardly opening inlet valve 36 which, except for the dimensions of the casing, may be identical with the valve already described and shown in Figs. 9 and 10. The casing 34 is made of considerable length in order to extend downwardly into the pump chamber sufficiently to submerge the valve 36 in liquid in the pump chamber and to provide, together with the space within the cap 20, a suction or supply chamber 37 the upper portion of which will normally contain air. A cylindrical screen 38 is mounted within the suction chamber through which liquid entering the chamber must pass to reach the inlet valve 36. The casing 34 may be provided with an annular ledge 341 upon which the lower end of the screen is seated. The screen may be open at both ends since the liquid in chamber 37 does not rise above the upper end of the screen.

Gaskets 90, 91, are located respectively at the lower end of cap 20 and under the shoulder 201 thereof and the dimensions of the parts are such that when the cap has been turned down to seat upon gasket 91 it will also compress gasket 90 and firmly secure and seal the upper end of valve casing 34. Openings 92 are formed in the lower edge of the cap to admit liquid from the supply passage 21.

In the embodiment of the invention described the pump chamber is constituted preferably by the interior of a bellows 40 of the type comprising a resilient metallic member with circumferentially corrugated side walls secured at the upper or fixed end to the head 14 and with a movable end wall 41. As is well known with this type of device the axial movement of the end wall permitted by the flexibility of the corrugated side walls causes relative expansion and contraction of the enclosed space. Therefore, by utilization of suitable means to produce reciprocation of the end wall, liquid may be drawn into the chamber through valve 36 during the expanding movement and expelled through valve 32 during the contracting movement. It will be understood that the bellows type of pump chamber is not required in all aspects of the invention and may be replaced in some cases by other usual or desired forms.

In accordance with the present invention I have provided electromagnetic means for effecting the expanding or suction stroke of the bellows 40, this means comprising a coil 45, surrounding a core 46, and an armature 47. The core is fixed to a plate 48 of non-magnetic material and the plate is rigidly supported upon the head 14, as by posts 49, 50, 51. The lower ends of the posts are reduced as shown to provide shoulders against which the plate is clamped as by screws 52. Between the plate 48 and the shoulders of posts 49, 51, is secured a yoke 53 which serves as a support for the armature 47. The lower arm of the yoke is approximately lune-shaped, as shown best in Figs. 4 and 7, and is provided adjacent to its extremities with apertures fitting over the reduced ends of posts 49, 51. The upper arm is constituted by a relatively narrow strip or tongue 54 bent over to lie in a plane parallel to the lower arm. In the simplest form of bearing the lower arm is provided with two recesses or apertures 55 in which

are seated balls 56. The armature 47 is formed with recesses 57 in its lower face, corresponding in position to the recesses 55 in the plate 48, and in which the balls 56 engage. Another recess 58 is formed in the upper face of the armature, midway of the recesses 55, in which is seated a third ball 59. In the assembly of the armature and its supports, the balls 56 may be positioned in the corresponding pairs of recesses 55, 57, in the lower or main plate 53 of the yoke and in the armature respectively, and the ball 59 positioned in recess 58, after which tongue 54 may be bent down to engage ball 59 and thus secure the parts in assembled relation. It will be seen that the armature is thus pivotally supported and adapted to oscillate about an axis passing through the balls 56, the ball 59 providing a third anti-friction bearing for the upper face of the armature. Any movement of the armature other than an oscillatory movement about the common axis of the balls 56 is prevented by the bearings.

The armature is of magnetic material and is shown as of disk form and circular except for a cut-away portion 471 on one side to accommodate the contacts and associated parts. The posts 49, 51, pass through apertures in the armature, as indicated at 472, but do not contact therewith. Spaces 481 in the edge of plate 48 permit circulation of air by movement of the armature

The periphery of the armature lies closley adjacent to the casing or cup 15 in order to reduce the air gap as much as practicable, since the casing provides the external magnetic circuit between the armature and the lower end of the core. The bearings described are therefore of especial advantage not only in providing a simple and inexpensive anti-friction support but also in insuring the maintenance of the armature properly positioned and spaced relatively to the casing, thus maintaining the air gap at the periphery notwithstanding the tendency to displacement of the armature that may result from unbalanced magnetic stresses.

The means for connecting the armature 47 to the bellows 40 comprises a stud 60 riveted as shown or otherwise suitably secured to the end wall 41, the outer end of the stud being screw-threaded and extending through an opening 61 in the armature. Mounted upon the stud 60 is an internally threaded sleeve 62 of non-magnetic material, as brass, the upper end of which extends within the opening 61 and is provided with an annular shoulder 621 engaging the lower face of the armature and serving as an abutment whereby downward motion of the armature is transmitted to the bellows. The armature fits somewhat loosely around sleeve 62 and between abutment 621 and the bellows so that rectilinear movement of the bellows and connected parts may be permitted notwithstanding the pivotal actuating movement of the armature. Raised bearings 473 may be formed on the armature to permit rocking movement.

The lower end of sleeve nut 62 is enlarged to form a head 622 serving as a stop for the ring 70 as hereafter described and the sleeve is locked in adjusted position on stud 60 by screw 63.

Upon a suitable support below the armature or upon the lower face of the armature itself, as shown, is secured, as by rivets 64, a contactor spring 65. A portion of the spring is cut away at 66 to increase its flexibility near the fixed end. Upon the free end of the spring is mounted the contact 67 in position to engage a second contact 68 upon a post 69 supported by but insulated from the plate 48. The post 69 is also connected electrically to one terminal of coil 45.

To the central portion of the spring, which is itself of non-magnetic material, such as phosphor bronze, is secured a body 70 of magnetic material. This body may be of annular form to surround the sleeve nut 62 above the stop collar or head 622, the latter serving to limit the downward movement of the ring 70 and the spring. The central portion of the spring may be spaced slightly from the armature to eliminate the sticking effect of residual magnetism when the electromagnet is de-energized, and a small cushion spring 71 for the sole purpose of noise reduction may be interposed between the armature and the spring 65 adjacent to the free end of the latter. The ring 70 may be arranged to telescope within the upper end of core 46, as shown, or by some equivalent construction may be so mounted that axial movement of the magnetic body will not materially vary the length of the air gap between the ring and the core. The position of the ring relatively to the armature, however, is such that the air gap between the ring and armature may vary. As a result of this arrangement of parts the ring is attracted to the armature upon the passage of current through the coil, thereby tending to flex the spring 65 upwardly and maintaining the electrical contact under pressure during a great portion of the stroke.

The bellows member 40 may be initially so set as to oppose the expanding force and thereby tend to expel the liquid or it may be so set as to be initially under compression thus assisting in overcoming the inertia effect in the bellows member. In the latter case it is necessary, and in the first case preferable, to use an additional spring such as coil spring 74 which may be housed within a central bore 75 in the core 46. The upper end of the spring may engage the head 622 on the sleeve nut 62 while the

lower end is supported upon the screw plug 76 adjustably mounted in the internally threaded lower end of the bore 75. This spring may have sufficient relative strength to cause the bellows to be normally under compression or it may reinforce the spring action of the bellows. It serves also the important purpose of enabling the strength of the liquid-expelling movement to be regulated as desired. A nut 77 on the lower end of plug 76 may operate both to lock the plug in adjusted position and to retain the cup or casing member 15.

Energy required for actuation of the electromagnet may be supplied from any suitable source. When employed, as illustrated, in connection with a motor vehicle power plant, the usual storage battery 80 may be utilized, the wiring being preferably such that current will be supplied to the pump upon closing the ignition switch 81 controlling supply of energy to the spark plugs 82. From the ignition circuit a wire 83 is connected by post 50, insulated from head 14 and plate 48, to one terminal of coil 45, the other terminal 452 of which is connected through post 69, contacts 68, 67, spring 65 and armature 47 to ground. A condenser 84, the purpose of which is well known, is inserted between post 69 and ground in parallel with the contacts.

The operation of the pump is as follows:—

The combined effect of the bellows and resilient bellows-contracting means employed, as spring 74, is such as to maintain normally the contacts 67, 68, in engagement when the electromagnet is not energized. When, however, current is caused to flow through the coil 45, as by closing the ignition switch 81, a magnetic field is established, the lines of force of which pass through armature 47 and magnetic body or ring 70. The ring 70, as above explained, is attracted initially to the armature thus tending to bend the intermediate or thick portion of the contact spring 65 upwardly and retaining the contact 67 in engagement with contact 68 during a predetermined movement of the armature toward the magnet. As the armature is attracted to the core it will move toward the latter carrying with it the movable wall 41 of the bellows and producing thus the suction stroke of the pump, at the same time compressing the spring 74. The relative positions of the parts at this time are as shown in Fig. 5. This movement continues until it is sufficient to counteract the flexing effect upon the spring caused by the magnetization of ring 70 whereupon the armature will cause positive separation of the contacts.

The resulting interruption of magnetic attraction permits spring 65 to travel with a snap action to its lower position into engagement with the stop collar 622 the strength of which action is controlled by the thin or cut-away portion of the spring 65. During the time that spring 65 is under heavy stress by the action of the bellows and spring 74, this weak portion of the spring 65 is out of action and protected by the fact that it lies along the under side of the armature to which it is attached, the heavy stress being in the heavy portion only. The spring 65 has sufficient rigidity to maintain the air gap as required between the member 70 and the core 46.

Assuming that the pump chamber was already filled with liquid at the beginning of the suction stroke, the expansion of the chamber will be accompanied by the discharge into the chamber through valve 36 of a portion of the column of liquid contained in the inlet passage or in the suction or supply chamber 37. When the pump is in operation the chamber 37 will contain in its upper portion a quantity of air under sub-atmospheric pressure. This permits the closure of the valve after the discharge into the pump chamber of a portion of the liquid accumulated in the valve casing or cup 34 without sudden stopping of the entire column of liquid flowing from the tank and also, by suction after the closure of the valve 36, causes the continuance of flow of liquid, thus refilling the valve casing or cup. The suction chamber therefore enables a very quick suction stroke to be effected with great economy in electrical energy. The large area of opening of valve 36 and its lightness as well as its submergence in the liquid in the pump chamber also contribute to quick and efficient charging stroke.

Upon the separation of contacts 67, 68, the pump chamber becomes simply a spring actuated reservoir tending to discharge its contents within predetermined limits of pressure through outlet valve 32. The frequency of the suction strokes will depend, of course, upon the rate of utilization of the liquid and, when the pump is employed to supply liquid to a reservoir, as for example to a carbureter, constant level reservoir or float chamber, the repetition of the suction strokes will be under the control of the valve permitting entrance of liquid to such reservoir.

If the fluctuation of pressure upon the delivery system is objectionable, any usual form of air cushion or like equivalent means may be employed in the delivery line, but the strokes can be delivered with such rapidity that the capacity of each stroke can be made so small that it is usually unnecessary to use such means in feeding fuel to the float bowl of an ordinary type of carbureter. The capacity of delivery may be somewhat

increased, however, particularly when delivering through a small orifice, by its use.

It will be understood that the structural features herein described may be varied and modified in many respects without departing from the spirit and scope of the invention and therefore I do not desire to be restricted by reason of the illustrative embodiment above set forth except as required by the language of the appended claims in view of the prior art.

I claim:

1. In liquid pumping mechanism, the combination of an expansible chamber having a movable member, a valve controlling flow into said chamber, a supply chamber positioned to discharge liquid through said valve into said expansible chamber, and a supply conduit communicating with said supply chamber, said supply chamber arranged to contain a body of gas under sub-atmospheric pressure whereby suction is exerted upon said supply conduit during and after the closure of said valve.

2. A bellows pump comprising a base, a bellows member mounted thereon, means for expanding and contracting said member, inlet and outlet passages in said base, a supply chamber above said inlet passage and extending into said bellows member, an inlet valve at the lower end of said chamber and normally submerged in the liquid in said bellows, said supply chamber constructed and arranged to contain air in the upper portion thereof and a column of liquid between said air and said valve, and a supply conduit communicating with said chamber.

3. In a liquid pumping system, a reciprocating pumping means, a supply conduit connecting said means to a reservoir, a chamber positioned above said means and adapted to contain air in the upper portion thereof, said supply conduit communicating with said chamber, an intake valve adapted to discharge liquid from said chamber to said pumping means, said parts constructed and arranged to maintain a column of liquid between said valve and the air in said chamber whereby approximately continuous flow of liquid may be maintained through said conduit due to sub-atmospheric pressure in said chamber while intermittent discharge of liquid from said column takes place through said valve during the operation of said pumping means without sudden stoppage of flow through said conduit upon closure of the valve.

4. In a device for pumping fluids, a pumping means, a reciprocating member arranged to actuate said means, a second reciprocating member carrying electrical contact means adapted to control the action of said first member, and means for producing a magnetic field, both of said members arranged to be actuated magnetically in said field.

5. In a device for pumping fluids, a pumping means, a reciprocating member arranged to actuate said means, electrical contact means arranged to control the actuation of said member, a second reciprocating member adapted to actuate said contact means, and means for producing a magnetic field, both of said members arranged to be actuated magnetically in said field.

6. In a device for pumping fluids, an expansible chamber having a movable wall, an electromagnet, an armature therefor arranged to actuate said movable wall, electric contacts adapted to control the action of said magnet, and magnetically actuated means for retaining said contacts in engagement during a predetermined portion of the travel of said armature toward said magnet, said armature being arranged to cause separation of said contacts.

7. In a device for pumping fluids, a pumping means, an electromagnet, an armature therefor arranged to actuate said pumping means, contacts for supplying current to said electromagnet, a reciprocating member arranged to cause movement of one of said contacts, said member being subjected to magnetic influence to hold the contacts closed during a predetermined travel of said armature.

8. In a device for pumping fluids, a pumping means, an electromagnet, an armature therefor arranged to actuate said pumping means, contacts for supplying current to said electromagnet, and a reciprocating member arranged to cause movement of one of said contacts, said member being arranged to be influenced by the magnetic field of said electromagnet so as to hold the contacts closed during a predetermined travel of the said armature.

9. Structure as set forth in claim 8, the reciprocating member comprising a magnetic body and a spring upon which one of said contacts is supported.

10. In a device for pumping fluids, a pumping means, an electromagnet, an armature therefor arranged to actuate said pumping means, contacts for supplying current to said electromagnet, a reciprocating member arranged to cause movement of one of said contacts relatively to the other, said member being positioned in part within the core of the electromagnet and adapted to be moved toward the armature by the influence of the magnetic field of said electromagnet.

11. A pump comprising an expansible chamber having a movable wall, an electromagnet having a hollow core, an armature for said magnet arranged to actuate said wall in one direction, a spring positioned in said hollow core arranged to actuate the armature and wall in the other direction,

contacts for applying current to actuate said electromagnet, and another armature resiliently related to the first and having a magnetic portion projecting into the hollow core and into an air gap between the armature and core, one of said contacts being acted upon by said spring and magnets in controlling and actuating the pump.

12. In a device for pumping fluids, a pumping means, an electromagnet, an armature therefor arranged to actuate said pumping means, contacts for applying current to said magnet, a reciprocating member, subject to magnetic influence and associated with one of said contacts, arranged in resilient relation to said armature in such manner that the resilient element is increasingly stressed by the normal action of said armature and said reciprocating member under the influence of the magnetic field of said magnet.

13. A pump comprising an expansible chamber having a movable wall, an electromagnet, an armature therefor connected to said movable wall to actuate the same, contacts for controlling supply of current to said magnet, spring means for supporting one of said contacts, a reciprocating body associated with said spring means and magnetically influenced to stress said spring means in a direction to hold said contacts closed, the parts being so arranged that the spring means is stressed by movement of the armature in a direction to separate the contacts and thereby effect a quick break.

14. A pump comprising a bellows member, an electromagnet, an armature pivotally supported in position to be actuated by said magnet, means connecting said armature to one wall of said bellows member whereby the pivotal movement of said armature causes reciprocating movement of said bellows, and means for supplying fluid to said bellows member and delivering it therefrom.

15. A pump comprising an expansible chamber having a movable wall, an electromagnet having a hollow core, an armature therefor connected to said movable wall, and a spring within said core adapted to move said armature and wall away from said magnet.

16. In a pump mechanism, an expansible chamber having a movable wall, an electromagnet, an armature therefor connected to said movable wall, an electric circuit arranged to supply energy to said electromagnet, and contacts in said circuit, one of said contacts being movably supported upon said armature.

17. A pump comprising an expansible chamber, an electromagnet, an armature for said magnet connected to said chamber and operative to expand the same under the influence of the magnet, spring means operative to cause contraction of the chamber, contacts for controlling supply of current to said magnet, one of said contacts being resiliently supported, and a magnetic body arranged to move toward said armature under the influence of the magnet and operative to stress said resilient support to hold said contacts in engagement during the expansion stroke of said chamber.

18. A pump comprising an expansible chamber, an electromagnet, an armature for said magnet connected to said chamber and operative to expand the same under the influence of the magnet, spring means operative to cause contraction of the chamber, contacts for controlling supply of current to said magnet, and a magnetic body adapted to move one of said contacts relatively to the other, said body positioned to be moved away from the electromagnet and toward the armature and in a direction to hold the contacts in engagement under the influence of said magnet, the armature being arranged to actuate the said body and thereby separate the contacts after a predetermined expansion of said chamber.

19. A pump comprising an expansible chamber having a movable wall, an electromagnet having a hollow core, an armature for said magnet arranged to actuate said wall in one direction, a spring positioned in said hollow core arranged to actuate the armature and wall in the other direction, a casing enclosing said magnet and chamber, and means for retaining said casing in position adapted to act as an abutment for said spring.

20. In a liquid pumping mechanism, the combination of a chamber and a passage communicating therewith, an annular flange surrounding said passage, a resilient ring seated on said flange and having a tongue extending radially inward, and a disk connected to said tongue and seated against the flange on the side thereof opposite said ring.

In testimony whereof I affix my signature.

JOHN M. LEA.