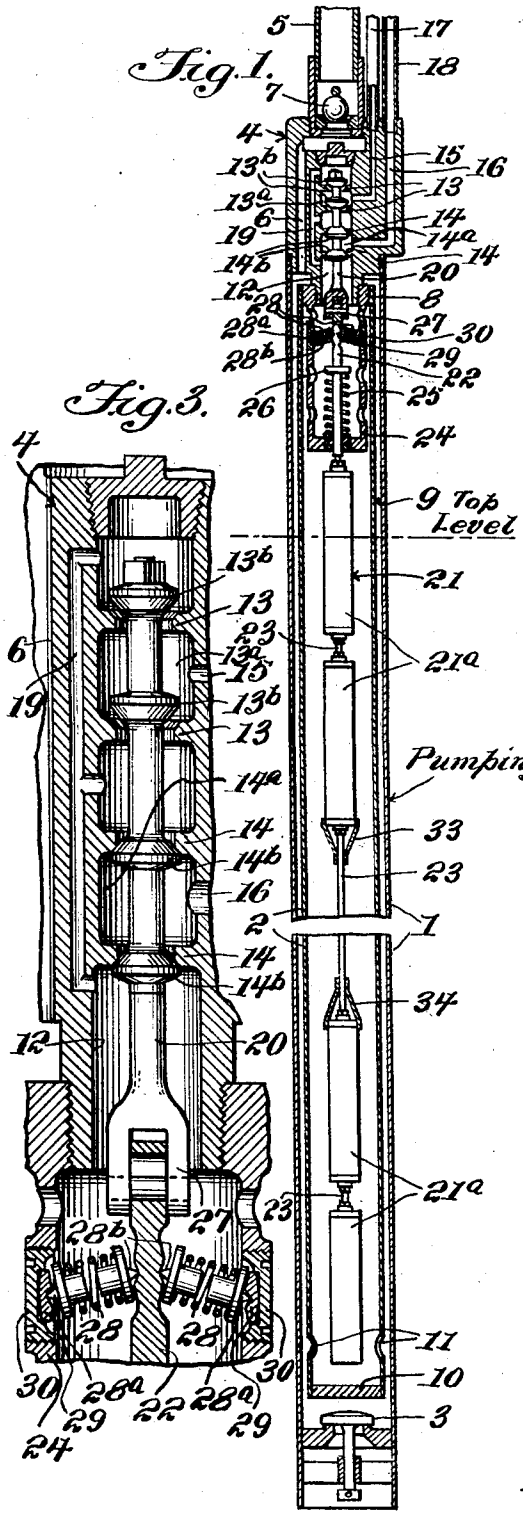
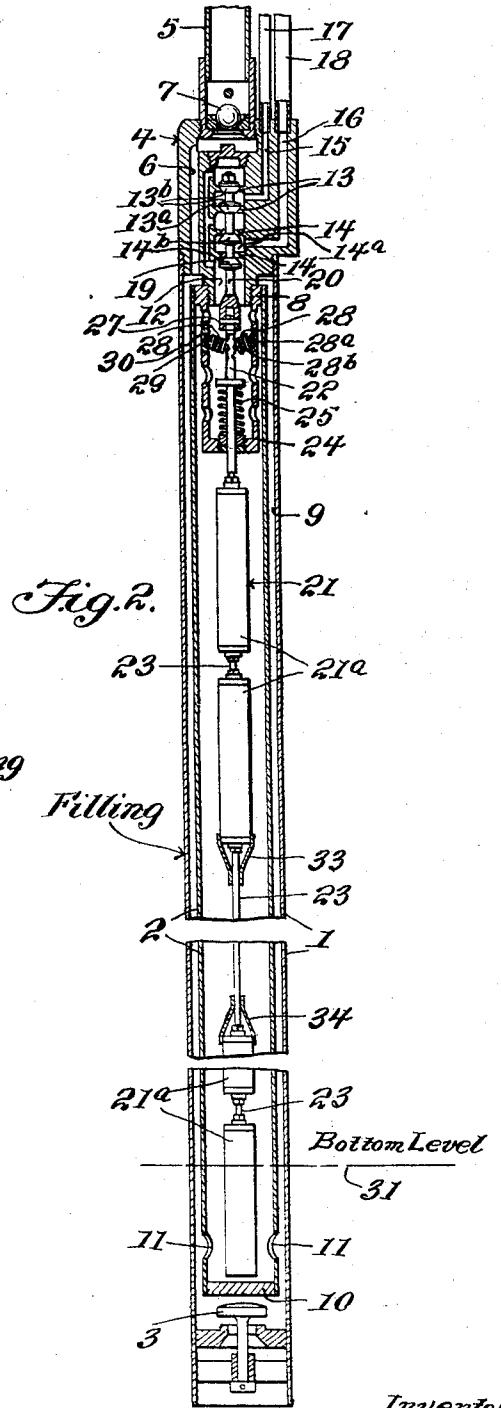
March 21, 1933. S. W. TRAYLOR, JR 1,902,386

LIQUID PUMP

Filed May 19, 1932





Inventor
Samuel W. Traylor, Jr.
By Spear, Donaldson & Hall
Attorneys

Patented Mar. 21, 1933 1,902,386

UNITED STATES PATENT OFFICE

SAMUEL W. TRAYLOR, JR., OF ALLENTOWN, PENNSYLVANIA, ASSIGNOR TO TRAYLOR ENGINEERING & MANUFACTURING COMPANY, OF ALLENTOWN, PENNSYLVANIA, A CORPORATION OF DELAWARE

LIQUID PUMP

Application filed May 19, 1932. Serial No. 612,348.

This invention relates to liquid pumps of that type operated by high pressure gas or air, and has for one of its objects to provide a pump of this character adapted for single or multi-stage use and which will be comparatively simple in construction and operation and which will be adapted to be immersed to a comparatively great depth in the liquid to be pumped.

The invention has for a further object to provide a pump of the character stated wherein the valve, controlling the admission of the operating medium to and its discharge from the working chamber of the pump, will be operated by mechanism which cannot be damaged or rendered inoperative by the greatest pressure likely to be encountered in the working chamber.

To attain the foregoing and other objects, the nature of which will appear as the description proceeds, the invention comprehends a pump wherein the valve operating mechanism will include means constantly tending to move the valve into pumping position, and a weight acting to shift the valve into filling position when the liquid in the operating or working chamber is reduced to a predetermined level, the downward force of the weight being lessened sufficiently to permit said means to shift the valve to pumping position when the liquid in the chamber rises to a predetermined level, the weight at all times exerting a downward force on the rest of the valve operating mechanism.

The invention is hereinafter fully described, and claimed, and diagrammatically illustrated in the accompanying drawing, wherein:

Figure 1 is a diagrammatic vertical sectional view of a pump embodying my invention, the valve of the pump being shown in pumping position, and

Fig. 2 is a similar view of the pump with the valve in filling position.

Fig. 3 is an enlarged fragmentary view of the valve and toggle spring assembly in the position of Figure 1.

The amount of movement of the valve stem and of the opening and closing of the valves is actually quite small, the drawing being, for the purpose of clear illustration, somewhat exaggerated.

Referring in detail to the drawing, 1 designates an outer and 2 an inner casing of the pump. The casing 1 is provided with a foot valve 3, and secured to the upper end of this casing is a valve and coupling block 4. A pipe 5 extends from the block 4 to the top of the well when but one stage is used. If two or more stages are used, the pipe 5 is connected to the next highest stage. The block 4 is provided with passages 6 through which the liquid being pumped flows from the outer casing 1 into the pipe 5. Downflow through the pipe 5 is prevented by a ball check valve 7 located in the pipe immediately above the block 4.

The inner casing 2 has its upper end secured, as at 8, to the block 4, and is spaced from the outer casing to provide an annular flow passage 9 which extends from the foot valve 3 to the block. The inner casing 2, which is closed at its lower end, as at 10, constitutes a working chamber. This chamber communicates at its lower end with the flow passage 9 by way of radial ports 11, and communicates at its upper end with a passage 12 formed axially in the block 4 and through which the operating medium, such as high pressure gas or air, flows into and out of the working chamber.

A double seat poppet operating valve controls the flow of the operating medium into and out of the working chamber 2. The upper seats 13 of the valve face upwardly, and the lower seats 14 of the valve face downwardly. An inlet passage 15 for the operating medium extends from the upper end of the block 4 to a chamber 13*a* located between the valve seats 13. A discharge passage 16 for the operating medium extends to the upper end of the block 4 from a chamber 14*a* located between the valve seats 14. A tube 17 conveys the operating medium to the passage 15, and a tube 18 conveys the exhaust operating medium from the passage 16 to the top of the well. A longitudinal passage 19, communicating with the chambers 13*a* and 14*a* above and below the

valve seats, serves in one position of the valve to convey the operating medium from the chamber 13*a* to the passage 12, and serves in another position of the valve to convey the operating medium from the passage 12 to the chamber 14*a*.

A stem 20, extending through the passage 12, and through the seats 13 and 14, is provided with heads 13*b* cooperating with the seats 13 and with heads 14*b* cooperating with the seats 14. The downward movement of the valve stem 20 seats the valve heads 13*b* and unseats the valve heads 14*b*. When the valve is in this position (Fig. 2), communication between the inlet passage 15 and the working chamber 2 is cut off, and communication between the working chamber and the exhaust passage 16 is established. As the operating medium is not flowing to the working chamber 2, and as the exhaust of the working chamber is open, the liquid in which the pump is immersed will flow into the working chamber. During the inflow of the liquid, the exhaust operating medium flows from the working chamber by way of the passages 12 and 19, chamber 14*a* and passage 18. The upward movement of the valve stem 20 unseats the valve heads 13*b* and seats the valve heads 14*b*. When the valve is in this position (Fig. 1), communication between the inlet passage 15 and the working chamber is established, and communication between the working chamber and the exhaust passage 16 is cut off. As the operating medium is now flowing to the working chamber 2, and as the exhaust of the working chamber is closed, the liquid in the working chamber is being forced therefrom by the high pressure gas or air, the liquid flowing from the working chamber into the passage 9 by way of the ports 11, and the liquid flowing from this passage through the passages 6 and pipe 5. The liquid passes through pipe 5 to the top of the well or to the next stage above directly into the casing 1 of such next stage beneath the closed bottom 10 of the casing 2 thereof. The operating medium flows from the tube 17 to the working chamber 2 by way of the passage 15, chamber 13*a* and passages 19 and 12.

In the particular embodiment of the valve shown, the pressure receiving face of the lower head of the exhaust pair 14*b* is sufficiently larger in area than the pressure receiving face of the upper head of this pair so that the pressure in the chamber 2 will, when these heads are seated, hold the valve in this position (Fig. 1). As when the valve is in this position the liquid is being forced or pumped from the working chamber 2, this position of the valve is hereinafter referred to as the pumping position. The pressure receiving area of the lower head of the inlet pair 13*b* is sufficiently larger than the pressure receiving area of the upper inlet head so that the incoming pressure will, when these heads are seated, hold the valve in this position (Fig. 2). As the valve when in this position permits the liquid in which the pump is immersed to flow into the working chamber, this position of the valve is hereinafter referred to as the filling position. This overbalancing is not great enough to interfere with breaking the seal by the operating mechanism for the valve, as hereinafter described.

The valve operating mechanism comprises a weight 21 which is located in the working chamber 2 and which is connected to the valve stem 20 by a rod 22. The weight 21 is of sectional formation, and the sections or parts 21*a* thereof are connected by rod connections 23. The rod connections between the weights are flexible enough to adapt themselves to crooked wells. These connections are spring steel rods that will bend a good deal before breaking, and they always come back to their original position. It must be remembered also that wells are never so crooked within a distance of the length of the filling chamber (which would ordinarily be within 80′) that the rods would not adapt themselves. These connecting rods provide resilient or flexible means that normally tend to hold the weights all in line. This means that the weights at all times have a tendency to have their axis parallel to the axis of the working chamber, thereby obtaining the most benefit from the fluid splitting ends of the weights. If the axis of the weights should be permitted to become non-parallel with the axis of the chamber, this would present an inclined broadside of the weight to the action of the liquid rushing up and down which would naturally interfere with operation.

The weight sections 21*a* are preferably of elongated cylindrical formation, and are considerably smaller diametrically than the working chamber 2. The weight sections 21*a*, in the embodiment illustrated, are arranged at opposite sides of the transverse center of the working chamber 2, two of the weight sections being located in the upper and two in the lower portion of the working chamber. Any number of weights or weight sections may be used, four weights as shown, being usually sufficient to operate a pump, and in order to get volume or capacity, the filling chamber should be of good size or length. By placing two weights toward the top of the filling chamber and two weights at the bottom of the filling chamber, the lower as well as the upper portion of the chamber is utilized in the operation of the pump.

The lower end of a casing 24 slidably receives and guides the rod 22. A coil spring

25 is sleeved on the rod 22 with its lower end bearing against the lower end of the casing 24 and with its upper end bearing against a shoulder 26 on the rod 22. The tension on spring 25 may be adjusted by screw means as indicated on the drawing. The casing 24 is carried by the coupling 8 and has its lateral wall perforated and spaced from the lateral wall of the working chamber 2 so that the operating medium may flow into and out of the working chamber.

The gravitational force of the weight 21 is greater than the force of the spring 25. Under conditions hereinafter set forth, the weight 21 acts to move the valve stem 20 downwardly to close the inlet passage 15 and open the exhaust passage 16, and thus move the valve from its pumping to its filling position. Under conditions hereinafter set forth, the spring 25 acts to move the valve stem upwardly to open the inlet passage 15 and close the exhaust passage 16, and thus move the valve from its filling to its pumping position.

The upper end of the rod 22 fits in the forked lower end of the valve stem 20. These ends have, as shown at 27, a pin and slot connection so that the rod 22 may move upwardly and downwardly for a limited distance without moving the valve stem 20. After the downward movement of the rod and weights 22 for this limited distance, toggle springs 28 act to effect the instantaneous movement of the valve from its pumping to its filling position, and after the upward movement of the rod and weights for this limited distance, these springs act to effect the instantaneous movement of the valve from its filling to its pumping position. These springs have knife edge ends 28*a* and 28*b* engaging corresponding grooves in opposite sides of the rod 22 and grooves in slightly cambered bearing members 29 recessed in adjustable screw plugs 30 in the casing 24. The springs 28 extend upwardly when the valve is in pumping position, as shown in Figure 1. The springs extend downwardly when the valve is in filling position, as shown in Figure 2. The springs 28 are moved past dead center from one of their inclined positions by the rod 22 during the limited movement of the rod with relation to the valve stem 20. The springs 28 are under initial tension and exert sufficient power to quickly move the slightly overbalanced valve stem 20 from one of its positions to the other after slight movement beyond dead center.

The weight 21 functions to effect the movement of the valve from one of its positions to the other on the principle that every body immersed in a liquid is submitted to the actions of two forces; namely, gravity, which tends to lower it, and the buoyancy of the liquid, which tends to raise it with a force equal to the weight of the liquid displaced. It therefore follows that the downward force of the weight 21 will decrease and increase as the liquid rises and falls in the working chamber 2. A decrease in the downward force of the weight effects the movement of the valve from its filling to its pumping position, and an increase in the downward force of the weight effects the movement of the valve from its pumping to its filling position. When the valve is in filling position, the inlet passage 15 is closed and the exhaust passage 16 is open, the spring 25, being subject to the gravitational force of the weight 21, is under compression, and the toggle springs 28 incline downwardly, as shown in Figure 2. When the liquid flowing into the passage 9 and into the working chamber 2 rises to a predetermined level, such as arbitrarily indicated in Figure 1, the downward force of the weight 21 will be reduced by the buoyancy of the liquid sufficiently to permit the spring 25 to react and move the weight and the rod 22 upwardly against the action of toggle springs 28. During the first phase of its upward movement, the rod 22 will, due to its pin and slot connection 27 with the valve stem 20, move with relation to the valve stem, and carry the toggle springs 28 past their dead center. Immediately after the springs 28 have been moved past their dead center they will, as all lost motion between the link 22 and valve stem 20 has been taken up, act in conjunction with the spring 25 to quickly shift the valve from filling to pumping position. When the valve is in pumping position the inlet passage 15 is open, the exhaust passage 16 is closed, and the toggle springs incline upwardly. The incoming operating medium—high pressure gas or air—forces the liquid in the working chamber 2 through the ports 11 into flow passage 9, the liquid flowing from this passage through the passage 6 to and through the pipe 5 to the top of the well, or to the next highest stage of the pump, depending upon whether one or more stages are used. When the level of the liquid in working chamber 2 is reduced to a predetermined level, such as arbitrarily indicated in Figure 2, the downward force of the weight 21 will be increased sufficiently to cause it to move downwardly against the tension of the springs 25 and 28 and move the rod 22 downwardly. During the first phase of its downward movement, the rod 22 will, due to its pin and slot connection 27 with the valve stem 20, move with relation to the valve stem and carry the toggle springs 28 past their dead center. Immediately after the springs 28 have been moved past their dead center they will, as all lost motion between the link 22 and valve stem 20 has been taken up, act in

conjunction with the weight 21 to quickly shift the valve from pumping to filling position.

The downward force of the weight 21 will not become greater than the power of the spring 25 and springs 28 until the liquid in the working chamber 2 falls to a predetermined low level, and the downward force of the weight, combined with the downward force exerted by springs 28, will not become less than the upward force of the spring 25 until the liquid reaches a predetermined high level in the working chamber.

For example, assuming that the weight at a particular rising level of liquid while the pump is filling, exerts a downward gravitational force of 10 lbs. Assume that this is balanced by a net upward force of 10 lbs., being the difference between the upward force of the operating spring 25 of 50 lbs. and the downward force of the toggle springs of 40 lbs. With this balanced condition, a further rise of liquid level will reduce the downward force of the weight slightly, which will permit the operating spring to move the rod 22 and the weights up until the dead center of the toggle springs is passed when they quickly actuate the valve by exerting their force upwardly.

By way of further illustration, assuming that the weight at a particular decreasing level of liquid while the pump is pumping, exerts a downward force of 50 lbs., and that this is balanced by 40 lbs. exerted upwardly by the toggle springs and 10 lbs. exerted upwardly by the extended operating spring. With this balanced condition, a further decrease of liquid level will increase the downward force of the weight slightly, which will move the rod 22 downwardly until the dead center of the toggle springs is passed when they quickly actuate the valve by exerting their force downwardly. The figures given are purely illustrative and the invention is in no wise to be limited thereto.

The levels as illustrated in the drawing, are merely arbitrary and for illustration only, and are not to be construed as limiting the levels to any particular points in the length of the working chamber.

In order to prevent the rushing motion of liquid flowing into and out of the working chamber 2 from imparting any axial motion to the weight 21, and thus insure the shifting of the valve solely as the result of variations in the buoyancy of the weight, (i. e. as the result of variations in the effective downward force of the weight on the valve control assembly including the spring 25) the lowermost of the upper weight sections 21*a* is provided at its lower end with a cone or taper 33, and the uppermost of the lower weight sections is provided at its upper end with a cone 34. The cones or tapered ends split the inflowing and outflowing streams of liquid and thus prevent their imparting axial movement to the weight and prevent premature shifting of the valves. As shown, the cones 33 and 34 are in the form of attached shields, but it will be apparent that they may be formed integral with the weight sections. That the cones or tapered ends may be employed, if desired, in connection with all of the ends of the weights, will be apparent. The plate 10 which closes the lower end of the working chamber 2 answers the same purpose for the incoming oil. This plate splits the inrushing oil and makes it enter the inner chamber through slots 11, thereby preventing the weights from being washed up and shifting the valve prematurely.

The weight 21 is made from non-magnetic metal to the end that it may function efficiently in wells having high residual magnetism, it being an object of the invention to provide non-magnetic buoyant means for the operation of pumps. Some oil wells have a high residual magnetism, and the use of ferrous or other magnetic floats or weights as the buoyant actuating means for the valves is impractical in magnetic wells, as this magnetism will hinder the successful operation of the buoyant means. Aluminum weights have been found by experiment to operate successfully in magnetic wells such as are encountered in California.

The weight 21 is of sectional formation in order to prevent the "column effect" encountered in high pressures bending or otherwise damaging it, and to provide for lateral flexibility when operating in crooked wells. The weight 21 is long and slender to adapt it to be used in small diameter wells and to function efficiently in crooked wells.

A buoyant member used as an operating means in an oil well must of necessity be long and slender. It must have length in order to give it volume, and it must be slender to adapt it for use in oil wells, the casings of which are sometimes as small as 4″ in diameter.

A buoyant member in a well pump, to operate high pressure valves and overcome friction of the moving parts, as well as the friction between the buoyant member and its housing (particularly in crooked wells) must have considerable volume, as the volume of liquid displaced by the buoyant means is a measure of the buoyant effort available for the operation of the pump. A buoyant member having sufficient volume for the operation of a pump becomes too long for practical use when high pressures are encountered unless it is sectionalized; i. e., in several parts. The reason for this is that a long, slender buoyant member has the high pressure acting on its ends, and this end pressure produces a "column effect" in the buoyant member and causes it to bend

or break intermediate its ends and this renders it useless. Bending causes the buoyant member to bind in its working housing and thereby renders it useless for the operation of the pump. If, as in the present invention, the buoyant member is made in several pieces and the pieces short enough to withstand the "column effect" of the pressure under which they work, these difficulties are overcome.

The weight 21 functions more efficiently than a float, especially in high pressures, for the reason that a float made strong enough to withstand high pressures would be so heavy that its useful buoyancy is insufficient for satisfactory operation of the valves.

The invention provides a valve structure in a well pump that has no sliding contacts, thereby eliminating friction, and also eliminating the need for lubrication. This is very important as when natural gas is used for the operation of a pump, the gas renders any bearings or sliding contacts extremely dry, and, therefore, increases the friction in the valve structure to such an extent that successful operation is questionable and in some cases impossible.

A feature of the present invention is that a downward force is at all times exerted on the valve operating or control mechanism by the buoyantly controlled member or weight, also referred to herein and in the claims as a buoyant member or members.

Floats cannot be used when their buoyant force alone must operate a valve, because under high pressure floats must be made so heavy to withstand pressure that the buoyant effect available is very small, whereas with a weight the buoyant effect can be very much greater, inasmuch as the excess weight of a weight over that of a float is counterbalanced, this excess weight being counterbalanced by a spring, as shown, or by another weight, or by any other means. The weights must always exert a downward force against the counterbalancing force. This construction tends toward improved stability and accuracy of operation as distinguished from floats.

I claim:

1. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, operating means constantly tending to move said valve means into inlet position, and a buoyant member located in said chamber and constantly exerting a downward force tending to move the valve means into exhaust position, said buoyant member being adapted when the liquid in said chamber is reduced to a predetermined low level to positively move said valve means into exhaust position against the force of said operating means, said buoyant member having its downward force reduced by the buoyancy of the liquid when it rises to a predetermined high level in said chamber to permit said valve means to be moved by said operating means into inlet position, said operating means including the buoyant member being in substantial longitudinal alignment for a substantially frictionless line motion directly from the buoyant force of the liquid on the said member to the valve means.

2. Apparatus according to claim 1 in which said operating means comprises a spring constantly tending to move said valve means upwardly against the gravitational force of said weight.

3. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, and means for operating said valve means, said operating means including a weight located in said chamber and having its downward force varied by the rise and fall of the liquid in said chamber to effect the operation of said valve means, said operating means including the weight being in substantial longitudinal alignment for a substantially frictionless line motion directly from the buoyant force of the liquid on the weight to the valve means, said parts being free from rotary motion.

4. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, and means for operating said valve means, said operating means including a weight located in said chamber and exerting at all times a downward force on the rest of the valve operating means, said weight having its downward force varied by the rise and fall of the liquid in said chamber to effect the operation of said valve means, said valve operating means also including a rod connecting the said weight with the valve stem, a spring constantly tending to move the rod upwardly, and toggle spring means to actuate said rod in conjunction with said weight and spring.

5. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, and means for operating said valve means, said operating means including a weight located in said chamber and exerting at all times a downward force on the rest of the valve operating means, said weight having its downward force varied by the rise and fall of the liquid in said chamber to effect the operation of said valve means, said valve operating means also including a rod connecting the said weight with the valve stem, a spring constantly tending to move the rod upwardly, toggle spring means to actuate said rod in conjunction with said weight and spring, and a lost motion connection between the end of the rod and the valve stem to provide for positive and instantaneous action of the

toggle springs upon the valve stem when their dead center is passed.

6. Apparatus according to claim 1 in which said means comprises a spring constantly tending to move said valve means upwardly against the downward force of said buoyant member, said valve and operating means including the buoyant member and spring being in longitudinal alignment for a substantially frictionless line motion directly from the buoyant force of the liquid on the buoyant member to the valve means, said parts being free from rotary motion.

7. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, and means for operating said valve means, said means including a weight located in said chamber and having its downward force varied by the rise and fall of the liquid in said chamber to effect the operation of said valve means, said weight comprising upper and lower weight sections with laterally flexible connections therebetween, normally tending to hold the weight sections all in line and axially parallel or coincident with the axis of the working chamber.

8. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, and means for operating said valve means, said operating means including a weight located in said chamber and having its downward force varied by the rise and fall of the liquid in said chamber to effect the operation of said valve means, said weight comprising an upper pair of adjacent weight sections and a lower pair of adjacent weight sections and longitudinally rigid connections between said weight sections, the connection between said pairs being laterally flexible and resilient, said connections normally tending to hold the weight sections all in line and axially parallel or coincident with the axis of the working chamber.

9. Apparatus according to claim 7 in which said upper and lower weight sections are disposed on opposite sides of the transverse center of the length of the weight, and tapered ends provided on the weight sections to provide a streamline effect preventing premature movement of the weight by the rush of liquid into and out of the working chamber.

10. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, and means for operating said valve means, said operating means including a weight located in said chamber and exerting at all times a downward force on the rest of the valve operating means, said weight having its downward force varied by the rise and fall of the liquid in said chamber to effect the operation of said valve means, said weight comprising upper and lower weight sections with connections therebetween, and fluid splitting means provided on the ends of the weight sections to prevent premature movement of the weight by the rush of liquid.

11. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, operating means constantly tending to move said valve means into inlet position, and a weight located in said chamber and adapted when the liquid in said chamber is reduced to a predetermined low level to move said valve means into exhaust position against the force of said operating means, said weight having its downward force reduced by the liquid when it rises to a predetermined high level in said chamber to permit said valve means to be moved by said operating means into inlet position, said valve means comprising a pair of valves controlling admission of motive fluid and a pair of valves controlling vent or exhaust of motive fluid, said valves all being mounted in line on a common stem.

12. Apparatus according to claim 11 in which the valves of each pair have differential pressure receiving areas to maintain them normally seated.

13. In a liquid pump, a working chamber, valve means controlling motive fluid inlet and exhaust for said chamber, and means for operating said valve means, said operating means including a weight located in said chamber and exerting at all times a downward force on the rest of the valve operating means, said weight having its downward force varied by the rise and fall of the liquid in said chamber to effect the operation of said valve means, said valve operating means also including a rod connecting the said weight with the valve stem, a spring constantly tending to move the rod upwardly, toggle spring means to actuate said rod in conjunction with said weight and spring, and a lost motion connection between the end of the rod and the valve stem to provide for positive and instantaneous action of the toggle springs upon the valve stem when their dead center is passed, said valve means comprising a pair of valves controlling admission of motive fluid and a pair of valves controlling vent or exhaust of motive fluid, said valves all being mounted in line on a common operating stem, and the valves of each pair having differential pressure receiving areas to maintain them seated normally.

14. In a liquid pump, a valve block, valves in said block controlling motive fluid inlet and exhaust, an outer casing, an inner casing forming with the outer casing a discharge conduit for liquid being pumped from the casing through the valve block, a weight within said inner casing, a third casing depending from said valve block, a rod

extending upwardly from said weight and guided in the lower end of said third casing, ports in said casings to provide for entrance and egress of motive fluid and of liquid being pumped and a connection between said rod and valves to operate the valves.

15. Apparatus according to claim 14 in which a pair of motive fluid inlet valves and a pair of motive fluid outlet valves are provided in line on a common operating stem, a motive fluid inlet port in the valve block leading to a chamber between the two inlet valves, chambers above and below said inlet valves each communicating with a vertical passage to the open lower end of the valve block, a motive fluid outlet port leading to a chamber between the two outlet valves, ports in said third casing communicating the lower open end of the valve block with the interior of said inner casing, and a port through the valve block from said discharge conduit for upward discharge of pumped liquid.

16. Apparatus according to claim 14 in which said connection includes a valve stem common to all of the valves, a lost motion connection between said rod and valve stem, toggle springs engaging grooves in the rod and in the said third casing, and a spring adjustably seated on the third casing and engaging said rod to urge the same upwardly.

17. Apparatus according to claim 14 in which said weight is of elongated sectional formation, including conical ends provided on the weight sections, said inner casing having its lower end sealed and provided with ports in its wall for passage of liquid, to prevent the rush of liquid into and out of the pump from prematurely moving the weight.

18. In a liquid pump according to claim 1, said buoyant member acted upon by the buoyancy of the liquid for operating said valves being of non-magnetic material.

19. Apparatus according to claim 7 in which said weight is constructed and arranged to exert at all times a downward force on the rest of the valve operating means.

20. Apparatus according to claim 7 in which said weight is sectionalized, each section being sufficiently strong as a column to resist the force affecting it as a column, said force being caused by the pressures to which it is subjected.

In testimony whereof I affix my signature.

SAMUEL W. TRAYLOR, JR.