Dec. 15, 1931. A. G. GAGE 1,836,585

FLUID PRESSURE ACTUATED WELL PUMP

Filed July 17, 1929 2 Sheets-Sheet 1

Fig. 2.

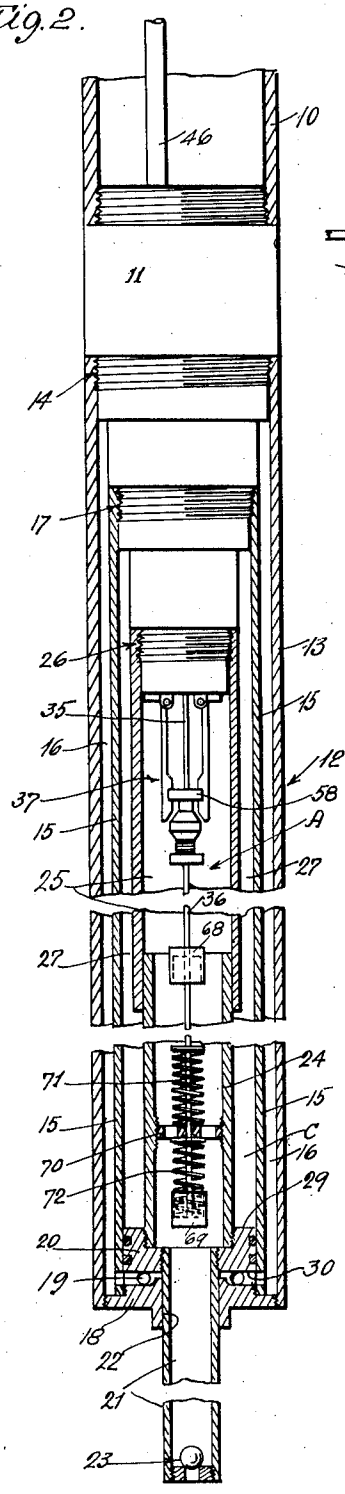
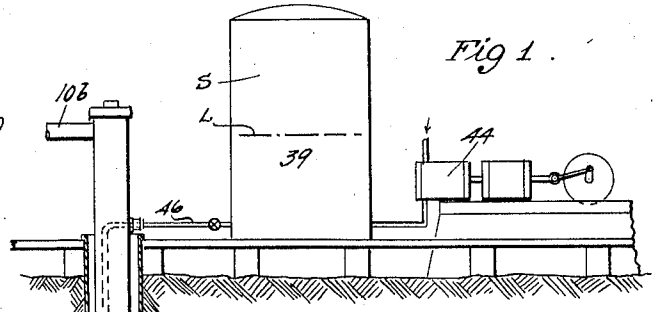


Fig 1.



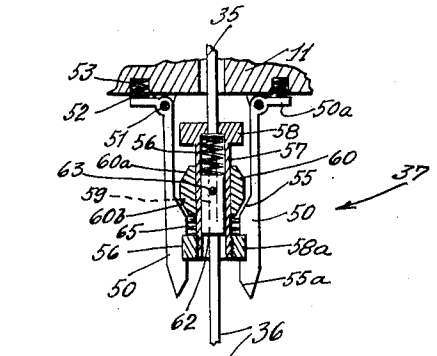
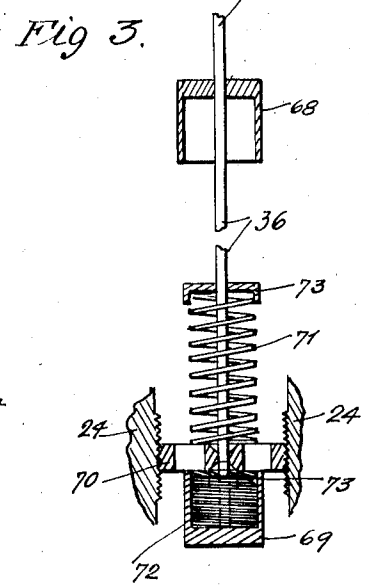
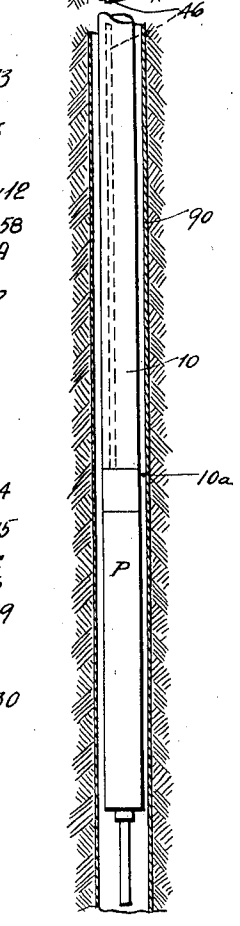


Fig 3.





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FLUID PRESSURE ACTUATED WELL PUMP

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Fig. 4.

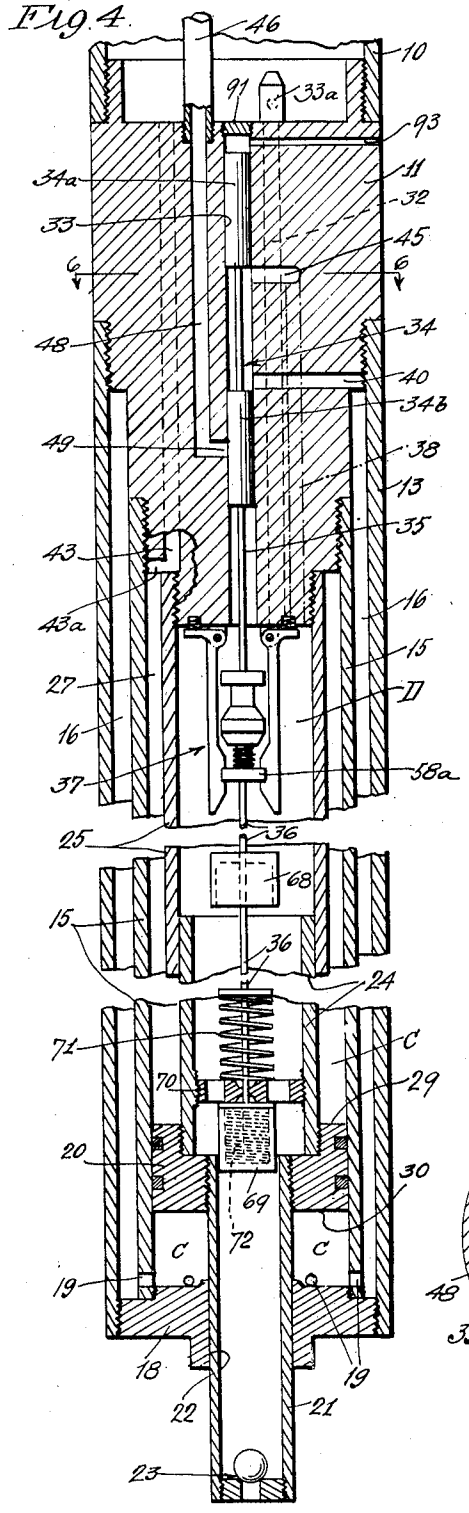


Fig. 5.

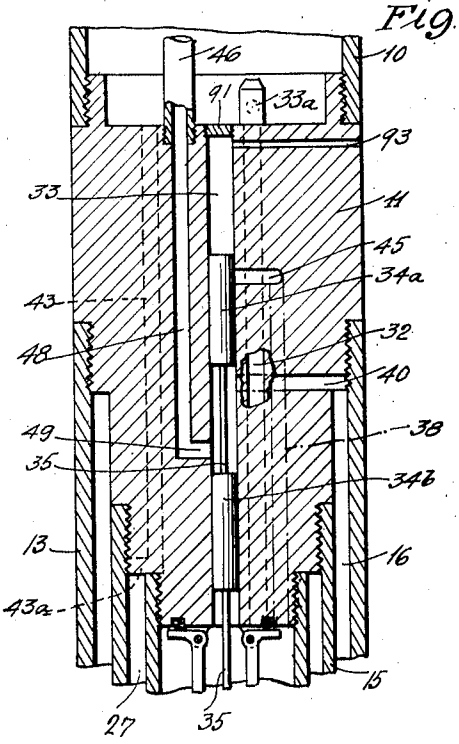
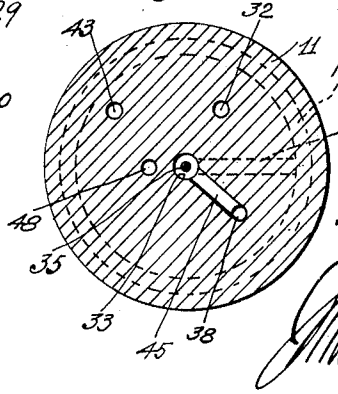


Fig. 6



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1,836,585

UNITED STATES PATENT OFFICE

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FLUID PRESSURE ACTUATED WELL PUMP

Application filed July 17, 1929. Serial No. 378,922.

My invention relates to deep well pumps of the fluid pressure actuated type in which the pump piston is operated by high pressure fluid delivered to the well pump from the ground level, the well liquid being exhausted by the pump upward into a standing or pumping column in the usual manner. It may be mentioned that the hereinafter described preferred form of pump embodying the invention has certain characteristics similar to the types of pumps described in my copending applications on well pump, Ser. No. 378,923, filed July 17, 1929, and single valve well pump, Ser. No. 378,921, filed July 17, 1929, the present pump, however, differing most essentially in the method of operating the piston by fluid pressure.

In the operation of the pumps described in the referred to copending applications, the pump piston is moved throughout both its pumping and suction strokes by the high pressure actuating fluid, this operation being effected by alternately applying the actuating fluid and pumping column pressures to the opposite ends of the piston. Thus the piston is caused to move through both of its strokes by virtue of differential pressures between the actuating and pumping column fluids. In the present type of pump, the piston is moved on its pumping stroke by the high pressure actuating fluid, and is moved on its return stroke by pumping column instead of the actuating fluid pressures, the high pressure fluid delivered to the pump to move the piston through its pumping stroke being discharged into the displacement chamber for admixture with the well liquid being pumped, during the return stroke of the piston. This latter feature is of particular advantage in that should the well liquid contain large amounts of sand which ordinarily would cause the pump to become stalled, the clean actuating fluid from the piston chamber serves to dilute the well liquid and so reduce its proportional sand content to the extent that it may readily be handled without causing the pump to become sanded.

The actuating fluid, preferably a clean oil, is delivered under pressure to the well pump by means of a suitable pump at the ground level. According to the characteristics of operation of the well pump, the high pressure fluid is utilized but intermittently in actuating the piston, and in order to enable the supply pump to operate continuously, and without necessitating the bypassing of the actuating fluid during the intervals in which no delivery is made to the well pump, the efficiency of the system may be materially increased by the provision of a suitable form of accumulator in the high pressure fluid line between the surface and well pumps. Thus during the suction strokes of the pump piston through which the latter is moved by pump column pressure, the actuating fluid is delivered to the accumulator, the supply pump serving to build up pressure in the accumulator, which pressure is utilized in actuating the well pump piston during its pumping strokes.

It will be understood that although for purposes of illustration I have shown a single valve type of pump, the invention in certain of its aspects and as defined by the broader claims, is not limited to the particular form of pump shown. Also, although the illustrated forms of piston and pump chamber assembly, as well as the valve actuating device, are preferred and are particularly suited for this type of pump, the structure of these parts is capable of wide variation without departure from the spirit of the invention. The features set forth hereinabove as well as further details of the invention will be understood most clearly from the following detailed description throughout which reference is had to the accompanying drawings, in which:

Figure 1 is a general diagrammatic illustration of the entire pumping system;

Fig. 2 is an enlarged medial section through the well pump, the valve head and a portion of the valve actuating device being shown in elevation;

Fig. 3 is a detailed and enlarged sectional view of the valve actuating and locking device indicated at A in Fig. 2;

Fig. 4 is an enlarged medial section through

the valve head, the valve and the locking device being in their upper positions of adjustment, and the location of port 45 and the fluid passage 46 being varied from their true positions as shown in Fig. 6, for purposes of illustration;

Fig. 5 is a fragmentary view of the valve head similar to that of Fig. 4 and showing the valve in its lower position; and

Fig. 6 is a section on line 6—6 of Fig. 4.

Referring particularly to Fig. 1 of the drawings, the upper end of the well pump P is joined at 10*a* to the lower end of the well pipe 10, the latter being lowered within the casing 90, and the pump during operation being submerged beneath the standing level of the well liquid, in the usual manner. The pump comprises an upper valve head block 11, and the lower piston and cylinder assembly section generally indicated at 12. The latter section embodies an outer pipe 13 secured to the valve head at 14, and a piston cylinder 15 extending concentrically within the outer pipe and annularly spaced therefrom at 16, the piston cylinder being similarly mounted on the valve head at 17. A cap 18 is provided for the lower ends of pipe 13 and the piston cylinder, the annular space 16 communicating with the chamber C within the piston cylinder, by way of ports 19. Within cylinder 15 is a vertically reciprocating piston 20 having a tubular extension 21 depending therefrom, the latter having a sliding fit within a bore 22 in the bottom closure 18, and carrying at its lower end the usual foot valve 23.

A pipe sleeve 24 is carried on the upper end of piston 20, the sleeve having a sliding fit within barrel 25 which is mounted at 26 on the lower end of the valve head and annularly spaced at 27 from the inside of the piston cylinder. By virtue of the described piston construction and the concentrically and spaced arrangement of the outer pipe 13, piston cylinder and barrel 25, provision is made for differential pressure areas between the upper and lower faces 29 and 30 respectively, of the piston. It may be mentioned at this point that to move the piston on its upward or pumping stroke, high pressure fluid is introduced to chamber C below the piston by way of space 16 and ports 19, and to move the piston downward on its return stroke, the pressure of the liquid in the pumping column, as hereinafter described, is directed against the upper face 29 of the piston by way of space 27.

Referring particularly to Figs. 4 and 5, a bore 32 extends longitudinally through the valve head 11 and opens at its lower end into the displacement chamber D above the piston, a check valve 33*a* being provided at the upper end of the bore to prevent return flow therethrough of liquid within the well pipe 10. A valve bore 33 also extends longitudinally within the head 11, the upper end of the valve bore being closed by the plug 91, and the valve bore communicating with the pump exterior, or the well, by way of port 93. Within bore 33 is a vertically reciprocable valve 34 having piston sections 34*a* and 34*b*. The valve stem or rod 35 depends from the lower piston section and is connected with the valve actuating rod 36 by way of the locking device generally indicated at 37. As will later be explained, the valve and the locking device 37 are adapted to be actuated intermittently by the piston assembly through the rod 36. A fluid passage 38 extends upward within the valve head from the lower end thereof, and opens into the valve bore at a predetermined point therein through port 45. The valve bore also communicates with the annular space 16 between the outer pipe and the piston cylinder at a point below port 45, by way of port 40. Communication is established between the pipe 10 and the annular space 27 between barrel 24 and the piston cylinder by way of passage 43 extending through the valve head and opening at 43*a* into space 27. The high pressure piston actuating fluid is delivered to the well from a pump 44 at the ground level, by way of the accumulator 39 and a pipe or conduit 46 within the pipe 10, the actuating fluid conduit opening into passage 48 in the valve head and the actuating fluid being delivered from said pasage to the valve bore through port 49.

As indicated in Fig. 5, when the valve 34 is in its lower position, high pressure fluid is discharged into the outer annular space 16 by way of the valve bore between pistons 34*a* and 34*b*, and through port 40. It may also be noted at this point that the piston chamber C above the piston communicates at all times with the interior of the well pipe 10 by way of passage 43, and therefore at all times, pumping column pressure, that is the pressure of the column of liquid within pipe 10, is applied to the upper face 29 of the piston. When the valve is in its upper position shown in Fig. 4, the high pressure fluid is cut off from communication with the piston chamber by the lower valve piston 34*b* closing port 49. Also in this position of the valve, the piston chamber beneath the piston communicates with the displacement chamber D within barrel 24 above the piston by way of the annular space 16, port 40, the valve bore between pistons 34*a* and 34*b*, port 45 and the passage 38. Thus it will be noted that with the lower end of the pump piston exposed to the well pressure or to that within chamber D, which may be considered substantially atmospheric, the piston is caused to move downward on its suction stroke by virtue of the pumping column pressure applied to its upper face through passage 43 and the annular space 27. During the downward movement of the piston, the foot valve

23 becomes unseated and the well liquid is taken into the displacement chamber, within barrel 25 and sleeve 24, by way of the lower pipe 21.

As previously mentioned, the valve is locked in its upper and lower positions of adjustment by means of the locking device generally indicated at 37, this device being included in the subject-matter of the application on well pump identified hereinabove. Referring to Fig. 3, the locking device embodies a pair of latch arms 50 pivotally mounted at 51 on the lower end of the valve head 11 and having toe portions 50*a* at its upper ends, the arms being urged to swing readily inwardly in the axial plane of the valve stem 35 by means of coil springs 52 placed in recesses 53 in the valve head and bearing against the toe portions 50*a*. The arms each are provided with oppositely inclined cam engaging faces 55 and 55*a*, notches 56 being formed midway between the inclined faces as shown. A sleeve 57 having integral upper and lower detent flanges 58 and 58*a* is mounted on the lower end of the valve stem. Slidably mounted on sleeve 57 is an annular spreader cam 60 having the upper and lower tapered cam faces 60*a* and 60*b* respectively, a cylindrical block 62 within the sleeve bore being fixed to the cam 60 by means of a pin 63 extending through the block and through longitudinal slots 59 in the sleeve. A spring 65 is placed on the sleeve and is confined between the spreader cam and the lower flange 58*a*, and a second spring 56 is confined between the end of the sleeve bore and the upper end of block 62, the combined effect of these springs being to counter-balance one another when the device is in the position shown in Fig. 4.

A rod 36, depending from the lower end of block 62, carries a pair of vertically spaced and integral piston engaging elements shown typically in the form of cups 68 and 69, the distance between opposed open ends of these cups being less than the length of stroke of piston 20 as will later be understood. An adjustable abutment or spider 70, is carried within the interior of pipe sleeve 24 and is adapted to move vertically with the sleeve and to engage the open ends of cups 68 and 69 to actuate the valve locking device. Coil springs 71 and 72 are placed around rod 36 above and below the spider 70, the springs preferably being provided with suitable means, for instance caps 73, for centering them relative to rod 36. It may be noted that each of the springs is capable of being compressed and contained within its respective cup, these springs necessarily being weaker than the previously described springs 56 and 65 embodied in the locking device, the reason for which will appear presently.

Upon downward movement of the piston 20, the valve and the locking device being in the positions indicated in Fig. 2, the spider 70 engages the upper end of the lower spring 72, compressing the spring within cup 69 as indicated in Fig. 3. Spring 72 being substantially weaker than the lower spring 65 in the locking device, no appreciable downward movement of rod 36, or at least movement to the point of causing cam 60 to come into spreading engagement with the arms, occurs during the downward movement of the piston until the spider is brought into engagement with the lower cup 69. At this point, however, the spider, by virtue of its engagement with the cup, serves to move the cam 60 downward into engagement with arms 50, whereby the latter are spread apart sufficiently to release the lower detent flange 58*a* from notches 56. At the point of release of flange 58*a*, the lower spring 72 tends to resume its normal expanded position, and in so doing causes the actuating rod 36, together with the valve 34 and the attached sleeve 57, to move downward to the position indicated in Fig. 2, and to the point at which further downward movement is arrested due to the upper detent flange 58 becoming held within notches 56.

Upon upward movement of the piston from the position shown in Fig. 2 a reverse procedure occurs. The upper spring 71 is raised by the spider and compressed within cup 68 until the spider is brought into engagement with the lower end of the cup, whereupon cam 60 is brought into engagement with the lower inclined faces 55*a* of the arms, causing them to spread outward to release the upper flange 58 and to permit spring 71, upon expanding, to throw the rod 36 together with the valve and sleeve 57 upward to their raised positions in Fig. 4, and at which point flange 58*a* is again retained within the arm notches. It will be noted that after the point of releasing the locking device, and therefore the valve, by the described action of the piston, no further direct force is necessarily imparted by the piston to the valve to effect the movement of the latter during either its upward or downward travel between the limits permitted by the locking device.

In describing the operation of the pump it may be assumed first that the piston is starting on its upward travel from the position of Fig. 2, the corresponding position of the valve being shown in Fig. 5. High pressure fluid delivered to passage 48 through the conduit 46 is delivered to the piston chamber C beneath the piston by way of the valve bore between the valve pistons 34*a*, 34*b*, port 40, and the annular space 16. The upward movement of the piston of course is resisted by the pumping column pressure on its upper end, the piston, however, being forced upward by virtue of the greater pressure of the actuating fluid and the increased area of the lower piston face 30. During the upward

movement of the piston, well liquid taken into the displacement chamber during the down stroke of the piston is discharged upwardly through passage 32 into the pumping column in pipe 10 and thence through the outlet 10*b* at the ground level. It will be understood that the term "pumping column" is applied to the standing column of liquid within the well pipe 10 below outlet 10*b* and above the pump P. As the piston approaches the upper limit of its stroke, the valve locking device is actuated as previously described to release the valve and to permit its movement to the position shown in Fig. 4 by virtue of the action of spring 72.

Upon movement of the valve to its upper position, the high pressure fluid is cut off from the piston chamber, and the pumping column pressure applied to the upper end of the piston through passage 43 and the annular space 27 becomes effective in causing the piston to move on its downward stroke, during which movement the actuating fluid delivered to chamber C beneath the piston to move the piston on its upward pumping stroke is discharged into the displacement chamber D by way of the annular space 16, bores 40 and 45 and passage 46. Thus by virtue of the actuating fluid being discharged from the piston chamber to the displacement chamber D during the down stroke of the piston, a volume of clean oil is mixed with the well liquid in the displacement chamber. Should the well liquid normally contain such a high percentage of sand as would tend to cause the pump to stall by becoming sanded, the clean oil from the piston chamber serves to dilute the well liquid and to reduce its proportional sand content to such an extent that the liquid mixture may readily be handled without causing the pump to become stalled.

It will be noted that the high pressure fluid is utilized but intermittently for actuating the piston, since during the down stroke of the piston port 49 is closed by the valve piston 34*b*, and in order to enable the actuating fluid supply pump 34 to operate continuously without necessitating by-passing of the actuating fluid during the intervals in which no delivery is made to the well pump. A suitable air compression space S is maintained in the accumulator above the liquid level L therein in order that during the down stroke of the well pump piston, the actuating fluid may be delivered into the accumulator by pump 44, during which time the air or gas in the space S is compressed in accordance with the rise in level of the liquid within the accumulator. Upon release of the actuating fluid by the valve piston 34*b* to move the pumping piston 20 on its upward stroke, the pressure of the compressed gas in space S in the accumulator becomes effective in discharging the actuating fluid from the accumulator through conduit 46 into the piston chamber. Thus the advantage gained by the use of an accumulator in the pumping system is to store up the energy developed by the supply pump 44 during the down stroke of the pump piston and to release this energy and thereby aid the supply pump in delivering the actuating fluid to the well pump in moving the piston on its pumping stroke. It will be understood that the simple form of accumulator illustrated is merely typical of a means for storing up the energy developed by the actuating fluid pump during the intervals of no delivery to the well pump, and that the term "accumulator" in the claims is to be considered as broadly contemplating any suitable accumulator system or means for storing up and utilizing the energy of the supply pump in the manner described.

It will be understood the drawings and description are to be considered merely as illustrative of and not restrictive on the broader claims appended hereto, for various changes in design, structure and arrangement may be made without departing from the spirit and scope of said claims.

I claim:

1. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, an actuating fluid passage communicable with the chamber, valve means adapted to be actuated by the piston for controlling the delivery of said actuating fluid to the piston chamber, said piston being moved during one of its strokes by the actuating fluid pressure, and means for moving the piston during its return stroke by the pumping column pressure.

2. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, an actuating fluid passage communicable with the chamber, a single valve adapted to be actuated by the piston for controlling the delivery of said actuating fluid to the piston chamber, said piston being moved during one of its strokes by the actuating fluid pressure, and means for moving the piston during its return stroke by the pumping column pressure.

3. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, an actuating fluid passage communicable with the chamber, valve means for controlling the delivery of said actuating fluid to the piston, and means actuated by the piston for releasably locking said valve

means in adjusted position, said piston being moved during one of its strokes by the actuating fluid pressure and during its return stroke by the pumping column pressure.

4. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, an actuating fluid passage communicable with the chamber, a single valve for controlling the delivery of said actuating fluid to the piston, and means actuated by the piston for releasably locking said single valve in adjusted position, said piston being moved during one of its strokes by the actuating fluid pressure and during its return stroke by the pumping column pressure.

5. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, an actuating fluid passage communicable with the chamber, a valve for controlling the delivery of said actuating fluid to the piston, means for locking said valve in adjusted position, and means adapted to be actuated by the piston for releasing the valve from said locking means and for moving the valve independent of the movement of the piston, said piston being moved during one of its strokes by the actuating fluid pressure and during its return stroke by the pumping column pressure.

6. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, and an actuating fluid passage communicable with the chamber, said piston being moved during one of its strokes by the actuating fluid pressure, means for moving the piston during its return stroke by the pumping column pressure, a displacement chamber communicable with said pumping column and with the piston chamber, and means for discharging the actuating fluid from the piston chamber during said return stroke of the piston to said displacement chamber.

7. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, a displacement chamber comunicable with the pumping column and with said piston chamber, an actuating fluid passage communicable with the piston chamber, and valve means for regulating the discharge of actuating fluid to the piston chamber and the discharge of exhaust fluid from the piston chamber to the displacement chamber, the piston being moved during one of its strokes by the actuating fluid pressure, means for moving the piston during its return stroke by the pumping column pressure, and the actuating fluid delivered to the piston chamber being discharged into the displacement chamber for admixture with the well liquid.

8. The combination comprising, a well pump adapted to exhaust the well liquid upward into a pumping column and embodying a piston chamber communicable with said pumping column, a vertically movable piston in said chamber, an actuating fluid passage intermittently communicable with said chamber, said piston being moved during one of its strokes by the actuating fluid pressure, means for moving the piston during its return stroke by the pumping column pressure; and a pump for delivering said actuating fluid to the well pump and an accumulator in the actuating fluid line between said pumps.

9. A well pump of the character described adapted to exhaust the well liquid upwardly into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, said piston having differential pressure areas on its opposite ends, and an actuating fluid passage communicable with said chamber, said piston being moved during one of its strokes by said actuating fluid, and means for moving the piston and during its return stroke by the pumping cloumn pressure.

10. A well pump of the character described adapted to exhaust the well liquid upwardly into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, said piston having differential pressure areas on its opposite ends, an actuating fluid passage communicable with said chamber, means for intermittently applying the actuating fluid pressure to one end of said piston having a relatively large pressure area, to move the piston through one of its strokes, the piston being actuated on its return stroke by pumping column pressure applied to the opposite end of the piston.

11. A well pump of the character described adapted to exhaust the well liquid upwardly into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, said piston having differential pressure areas on its opposite ends, an actuating fluid passage communicable with said chamber, a displacement chamber communicable with said piston chamber, means for intermittently applying the actuating fluid pressure to the lower end of the piston having a relatively large pressure area, to move the piston on its upward stroke, means

for applying the pumping column pressure to the upper end of the piston to move it during its return stroke, and means for discharging into said displacement chamber during the down stroke of the piston, the actuating fluid delivered to the piston chamber to move the piston on its previous upward stroke.

12. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, said piston having a comparatively upwardly facing annular pressure area and a larger downwardly facing annular pressure area, an actuating fluid passage communicable with the chamber, said piston being moved during its up stroke by the actuating fluid pressure applied to said downwardly facing area, and means for moving the piston during its return stroke by the pumping column pressure applied to said upwardly facing piston area.

13. A well pump of the character described adapted to exhaust the well liquid upward into a pumping column, embodying a piston chamber communicable with said pumping column and a vertically movable piston in said chamber, said piston having a comparatively small upwardly facing annular pressure area and a larger downwardly facing annular pressure area, and an actuating fluid passage communicable with the chamber, said piston being moved during its up stroke by the actuating fluid pressure applied to said downwardly facing area and during its return stroke by the pumping column pressure applied to said upwardly facing area, the pumping column pressure being constantly applied to said upwardly facing area on the piston.

In witness that I claim the foregoing I have hereunto subscribed my name this 27th day of June, 1929.

ARTHUR G. GAGE.