May 9, 1933. A. G. GAGE 1,907,949

WELL PUMP

Original Filed July 17, 1929 2 Sheets-Sheet 1

Fig. 1

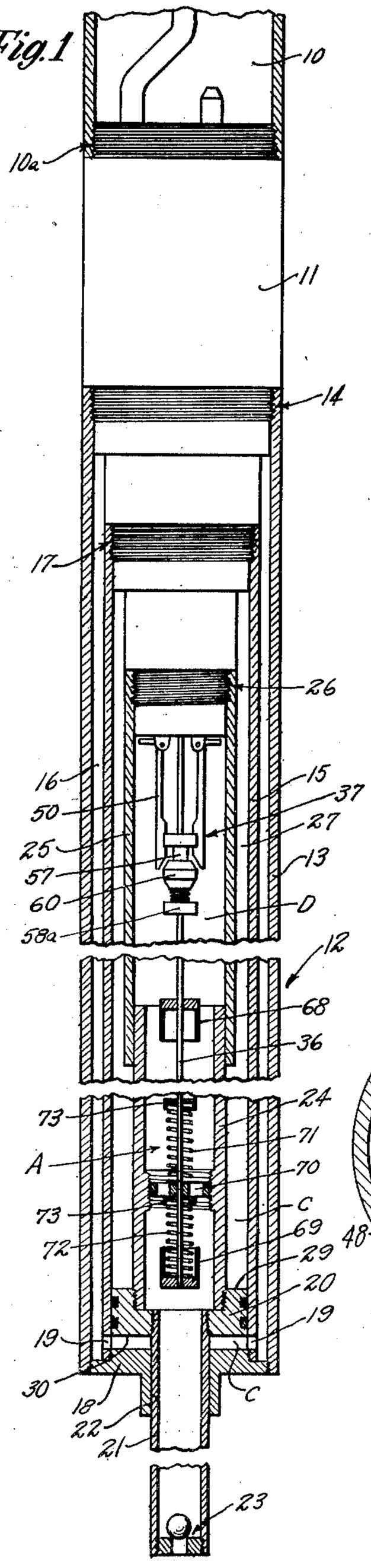


Fig. 4

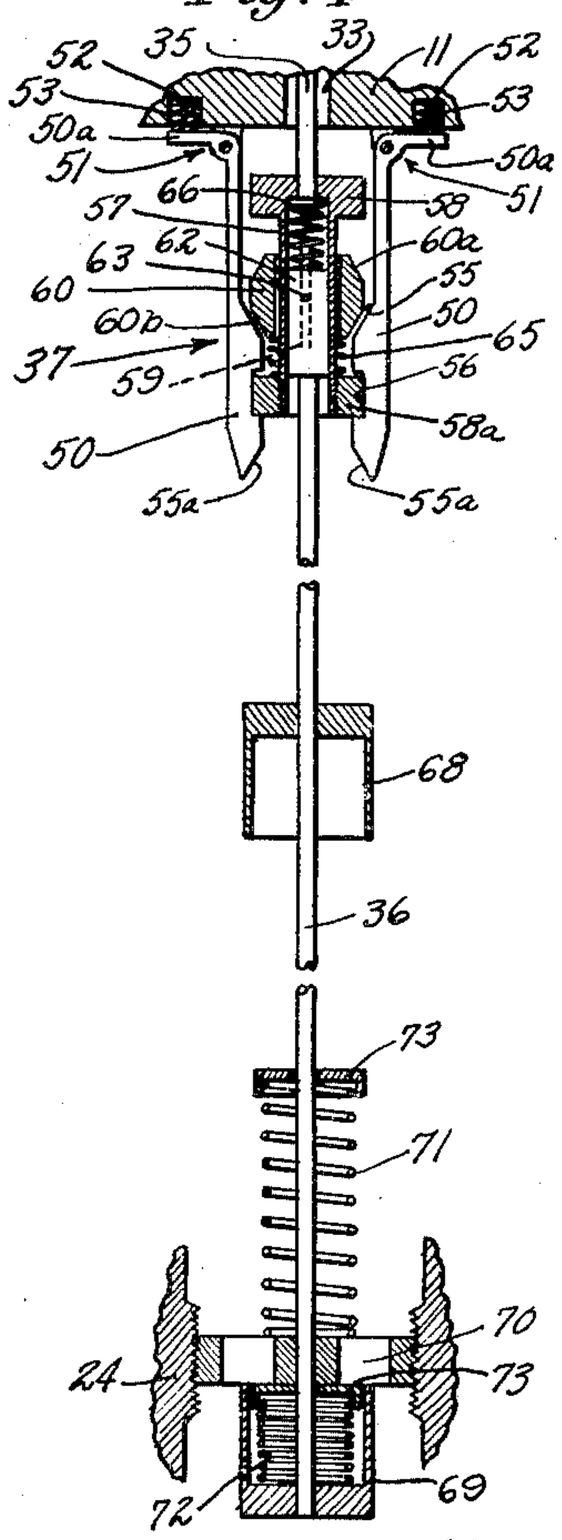


Fig. 5

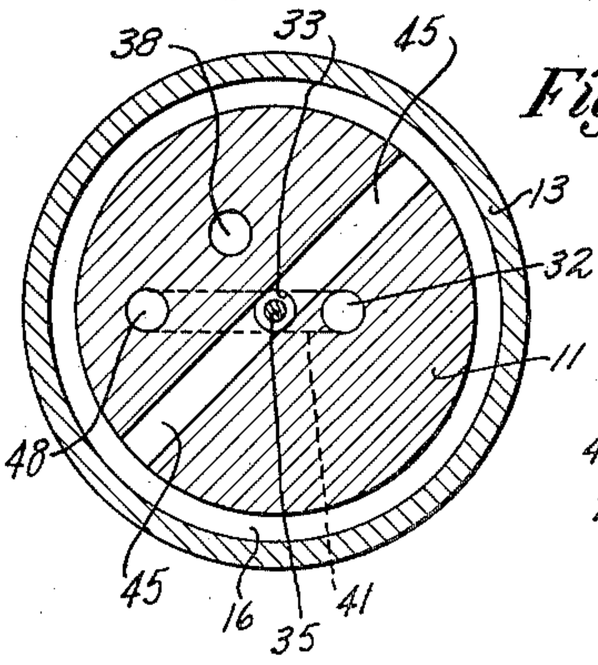
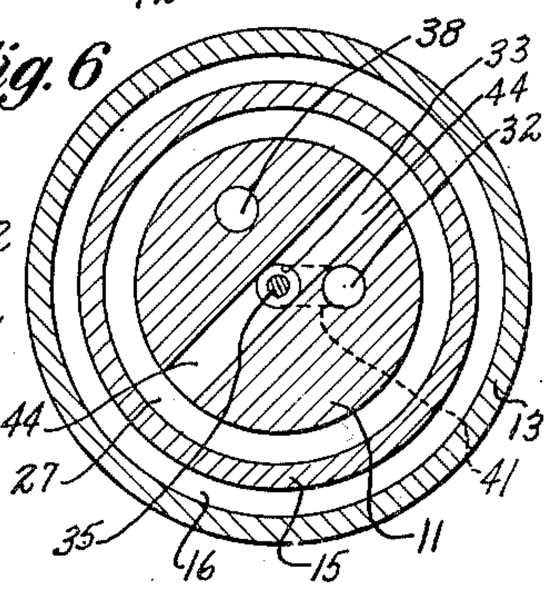


Fig. 6



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WELL PUMP

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Fig. 2

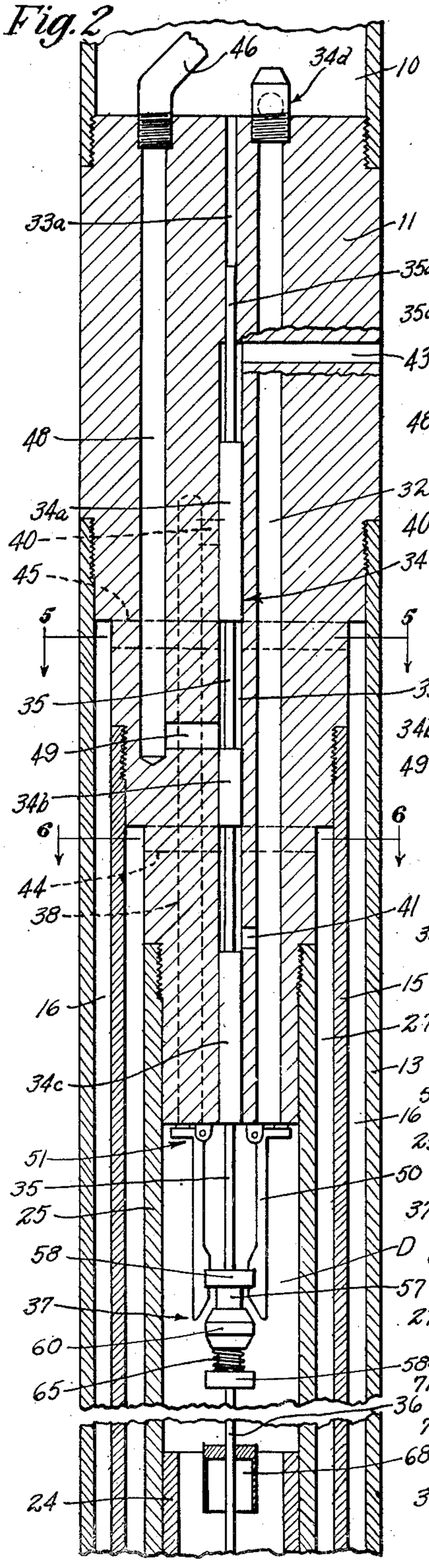
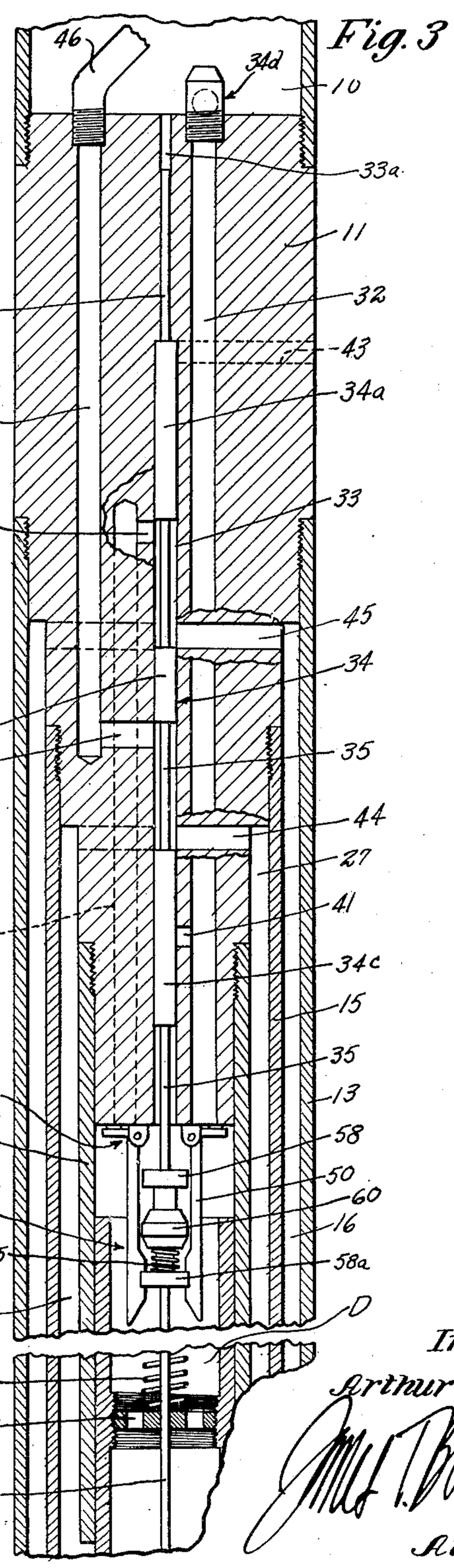


Fig. 3



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Patented May 9, 1933 1,907,949

UNITED STATES PATENT OFFICE

ARTHUR G. GAGE, OF LOS ANGELES, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO ALTA VISTA HYDRAULIC COMPANY, LTD., OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA

WELL PUMP

Application filed July 17, 1929, Serial No. 378,923. Renewed October 7, 1932.

This invention has reference to deep well pumps and is concerned particularly with pumps of the fluid pressure actuated type such as comprise the subject matter of my copending application single valve well pump, filed July 17, 1929, Ser. No. 378,921, and on valve actuating device, filed August 29, 1928, Ser. No. 302,737. The invention has its preferred embodiment in a form of pump generally similar to that described in the referred application on single valve well pump, certain aspects of the invention being directed to variations in structure and operation over the pump described in that application. The type of pump dealt with in Ser. No. 378,921, may be described generally as comprising a pumping piston actuated by high pressure fluid alternately applied to the ends of the piston and exhausted directly into the pumping column, and a single fluid pressure actuated valve for regulating the delivery of the actuating and pumped fluid to and from the piston chamber. The valve is releasably locked in adjusted position by means of a locking device of the nature disclosed in the referred application Ser. No. 302,737, the locking device being actuated by the piston to release the valve and to permit its movement by differential fluid pressures. During each stroke of the piston, the actuating fluid delivered into the piston chamber to actuate the piston during its previous stroke, is exhausted into the pumping column.

The general operation of the present pump differs essentially from that described in Ser. No. 378,921 in that during one stroke of the piston the actuating fluid delivered to the piston chamber during the previous stroke of the piston, instead of being exhausted into the pumping column, is delivered to the pump displacement chamber into which the well liquid is taken. This is of particular advantage in that should well liquid contain a large amount of sand which ordinarily would cause stalling of the pump, the liquid 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 invention is particularly directed to an improved form of valve locking and actuating device by means of which a reciprocating pump valve may be locked in adjusted position at the limits of its reciprocating movement during the intermediate portions of the piston strokes, said device serving to release the valve at the ends of the piston strokes and to move the valve throughout its length of travel independent of the movement of the piston. In Ser. No. 302,737 I have shown a form of locking device whereby the valve may be releasably locked in adjusted position, the piston serving both to release the lock and to move the valve throughout its travel after the point of release. Although the present valve locking and actuating device has certain characteristics similar to that described in the referred application on valve actuating device, and preferably embodies that form of locking device, the present type comprises means not only for releasably locking the valve in adjusted position but also for actuating the valve independently of the movement of the piston. And although this improved device is particularly adapted for use in single valve pumps, in which connection the invention is described herein, to provide a positive means for actuating the valve to preclude any possibility of the pump becoming stalled on dead center, it will be understood that the present valve locking and actuating device is adaptable for use in other forms of pumps and which may embody one or more valves. I have shown herein a single valve pump in which the valve may be capable of being actuated by differential fluid pressures but it may be mentioned that I have done so only for purposes of illustration and that movement of the valve may not necessarily be aided by fluid pressure, and in fact the valve actuating device may be equally effective in cases where movement of the valve is resisted rather than aided.

The above and additional features of the invention will be understood most readily and clearly from the following detailed de-

scription of a preferred embodiment of the invention, reference being had throughout the description to the accompanying drawings, in which:

Fig. 1 is a sectional view of the pump, the valve head and a portion of the valve actuating device being shown in elevation;

Fig. 2 is an enlarged medial section through the valve head, the valve and the locking device being in their lower positions of adjustment, and the location of port 45 being varied from its true position as shown in Fig. 5, for purposes of illustration;

Fig. 3 is generally similar to Fig. 2, and illustrates the valve and locking device in their upper positions;

Fig. 4 is a detailed and enlarged view of the valve actuating and locking device indicated at A in Fig. 1;

Fig. 5 is a section on line 5—5 of Fig. 2; and

Fig. 6 is a section on line 6—6 of Fig. 2.

Referring to the drawings, the upper end of the pump is joined at 10*a* to the lower end of the tubing 10, the latter being adapted to be lowered within the well casing (not shown) 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 the pipe 13 and the piston cylinder, the annular space 16 communicating with the chamber C, within said 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 pipe having a sliding fit within a 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 concentric and spaced arrangement of the outer pipe 13, piston cylinder and barrel 25, provision is made for differential pressure area 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 high pressure actuating fluid is directed against the upper face 29 of the piston by way of space 27.

Referring particularly to Figs. 2 and 3, bores 32 and 33 extend longitudinally through the valve head 11 and open at their lower ends into the displacement chamber D above the piston, a check valve 34*d* being provided at the upper end of bore 32, and the upper end 33*a* of bore 33 being comparatively restricted as indicated. Within bore 33 is a vertically reciprocable valve 34 having a plurality of piston sections 34*a*, 34*b* and 34*c*. The valve stem or rod 35 extends at its upper end 35*a* within the reduced bore 33*a*, the lower end of the valve stem being 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 rod 36. An exhaust fluid passage 38 extends upward within the valve head from the lower end thereof, and serves to establish communication between the pump displacement chamber D and the valve bore 33 at a predetermined point therein, by way of port 40. The valve bore likewise communicates with the exhaust passage 32 through port 41. The enlarged portion 33 of the valve bore is communicable with the well at the exterior of the pump, through the horizontal port 43 immediately below the reduced valve bore 33*a*. Intercommunication between the valve bore and the annular space 27 between piston cylinder 15 and the barrel 25, is established by way of ports 44 at the upper end of space 27, the annular space 16 between the pump cylinder and outer pipe 13 likewise communicating with the valve bore through ports 45. The high pressure piston actuating fluid is delivered to the well from a pump (not shown) at the ground level by way of a pipe or conduit 46 within the pipe 10, the high pressure fluid conduit opens into passage 48 in the valve head, the actuating fluid being delivered from said passage to the valve bore through port 49.

As indicated in Fig. 2, 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 ports 45. It may also be noted at this point that in the upper position of the valve, liquid from the pump chamber C at pumping column pressure, that is the static pressure due to the column of pumped liquid in pipe 10, is discharged from space 27 into the exhaust fluid passage 32 and thence into pipe 10, by way of ports 44 and 41, and the valve bore between pistons 34*b* and 34*c*. When the valve is in its upper position shown in Fig. 3, the high pressure fluid is conducted

to space 27 by way of the valve bore between pistons 34*b*, 34*c*, and ports 44, exhaust fluid from space 16 being discharged into passage 38 and thence into the displacement chamber D, through ports 45, 40 and the valve bore between pistons 34*a* and 34*b*.

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 comprising the subject matter of the application on valve actuating device identified hereinabove. Referring to Fig. 4, 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 are each 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 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 counterbalance 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 Figs. 3 and 4, the spider 70 engages the upper end of the lower spring 72, compressing the spring within cup 69 as indicated in Fig. 4. 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 serves, by virtue of its engagement with the cup, 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 caused 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. It may be considered that the valve locking and actuating device comprises a pair of relatively movable members, one being the rod 35 and sleeve 65, the other comprising a cam 60, block 62 and rod 36, and that the release of the valve locking means is effected upon relative movement of these members.

Upon upward movement of the piston from the position shown in Fig. 1 a reverse procedure occurs. The upper spring 21 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, this feature distinguishing over the action of the device described in the referred copending appli-

cation on valve actuating devices in that the movement of the valve after the point of release is independent of the movement of the piston.

It will be understood that the valve is actuated in this manner irrespective of the hereinafter described pressure differential applied to the ends of the valve which may be effective in causing or at least facilitating its movement. Thus although the present pump is shown to embody a valve capable of movement by virtue of pressure differentials, the actuating device is not limited to use in combination with the particular form of valve shown and in fact the actuating device may be equally effective in case the movement of the valve is resisted instead of aided as in the present instance. From the foregoing it will be seen that the comparative strengths of the springs embodied in the entire actuating device are such that springs 56 and 57 are capable of supporting the parts depending from the cylindrical block 62 without yielding sufficiently to cause cam 60 to actuate the arms, and without yielding to that extent during the time springs 71 and 72 are being compressed within the caps.

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. 1, the corresponding position of the valve being shown in Fig. 2. High pressure fluid delivered to passage 38 through the conduit 46 is delivered to the piston chamber C beneath the piston by way of port 49, the valve bore between pistons 34*a*, 34*b*, and ports 45, into the annular space 16, and thence through ports 19 in the bottom of the pump cylinder. As the piston is forced upward by the high pressure fluid, well liquid contained within the displacement chamber D, within pipes 24, 21 and barrel 25, is forced upward through passage 32 in the valve head into the well pipe 10, through which the oil is conducted to the ground surface. The actuating fluid within chamber C above the piston, delivered thereto during the previous down stroke of the piston, is discharged upward through the annular space 27 into the discharge passage 32 by way of ports 44 and 41 and the valve bore between pistons 34*b* and 34*c*.

It will be noted that during the up stroke of the piston, the pressure on the lower end of the valve 34 and on the upper end of the valve stem within the reduced bore 33*a*, is that pressure corresponding to the static head of oil in the pumping column, or in other words the column of liquid within pipe 10. The upper annular face of the valve piston 34*a* however is exposed to comparatively low well pressure due to the communication of bore 33 at its upper end with the well by way of port 43. Therefore a pressure differential on the upper and lower ends of the valve exists in proportion to the difference in areas between that of the lower end of the valve or the cross section area of the valve bore, and that of the reduced bore 33, the result being that by virtue of this differential pressure, the movement of the valve upwardly from the position of Fig. 2 to that of Fig. 3, when released by the locking device, may be aided, although it will be understood that such aid may be desirable, but not essential, in the movement of the valve by the previously described actuating device.

Upon movement of the valve to its upper position shown in Fig. 3, the application of the actuating fluid to the upper and lower ends of the pump piston 20 is reversed. Thus in this position, the high pressure fluid is delivered to the chamber C above the piston to force the latter down, by way of the valve bore between pistons 34*b* and 34*c*, ports 44 and the annular space 27, the liquid in chamber C beneath the piston being discharged into the exhaust passage 38 and into the displacement chamber D by way of the annular space 16, ports 45 and 40, and the valve bore between pistons 34*a* and 34*b*. And as in the previous instance, when the piston approaches the lower limit of its stroke and the locking device 37 is actuated through rod 36 to release the valve, and the latter again is returned to its lower position. During the down stroke of the piston it will be noted that the foot valve 23 is unseated to permit the well liquid to rise within pipes 21 and 24, the pressure on the lower end of the valve therefore being that within the well, and which may be considered substantially atmospheric. Thus during the downward movement of the piston, the pressure differential on the valve is that corresponding to column pressure on the upper end of the valve stem within bore 33*a*, and well pressure on the lower end of the valve, and again this differential may serve to aid the actuating device in returning the valve to its lower position when released by the locking device.

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. Thus 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 on account of the sand.

It will be understood the drawings and de-

scription 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 fluid pressure actuated well pump embodying a piston chamber and a piston in said chamber, an actuating fluid passage communicating with said chamber, the actuating fluid being adapted to move the piston through one of its strokes, a spring actuated valve for controlling the delivery of said actuating fluid to the piston, said valve having two operative positions of adjustment, means for locking said valve in one position, and means adapted to be actuated by the piston for releasing the valve from said locking means and for moving the valve to its other position independently of the movement of the piston.

2. A fluid pressure actuated well pump embodying, a valve head, a piston cylinder carried on the lower end of said valve head and a piston in said cylinder, means forming a displacement chamber from which well liquid is adapted to be pumped by the piston through a passage in the valve head, said displacement chamber being separate from the piston chamber but communicable therewith, an actuating fluid conduit communicable through a passage in the valve head with said piston cylinder, the high pressure fluid from said conduit being adapted to move the piston through one of its strokes, and valve means in said valve head for regulating the delivery of actuating fluid to the piston cylinder and the discharge of exhaust fluid from the piston cylinder to the displacement chamber, the actuating fluid delivered to the piston cylinder to move the piston through one of its strokes being discharged into the displacement chamber during the reverse stroke of the piston.

3. A fluid pressure actuated well pump embodying a piston chamber and a piston in said chamber, a displacement chamber from which well liquid is adapted to be pumped by the piston, said displacement chamber being communicable with the piston chamber, high pressure and exhaust fluid passages communicable with said piston chamber, and valve means for regulating the fluid flow through said passages whereby the ends of the piston each are alternately exposed to the actuating fluid pressure, the actuating fluid delivered to the piston chamber to move the piston through one of its strokes being discharged into the displacement chamber during the reverse stroke of the piston.

4. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in position at one end of its travel, and piston actuated means for releasing said valve and for thereafter moving it independent of the movement of the piston, substantially throughout its length of travel.

5. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in position at one end of its travel, and means adapted to be actuated by engagement with the piston for releasing said valve and for thereafter moving it independent of the movement of the piston, substantially throughout its length of travel.

6. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in position at the ends of its reciprocating movement, and means adapted to be actuated by the piston for releasing said valve and for reversing its positions, said valve being moved substantially throughout its length of travel independent of the movement of the piston.

7. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying a pair of interconnected and relatively movable members, one joined to said valve and the other adapted to be actuated under control of the piston, yielding means resisting relative movement of the members, means for locking the first mentioned member against movement with the other member, said locking means being releasable upon relative movement of the members, and means actuated by the piston and acting to move the valve independent of the piston movement.

8. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in adjusted position at one limit of its travel, and a spring actuated member adapted to be intermittently actuated by the piston to release said locking means, and adapted upon release of the locking means, to move the valve throughout its length of travel.

9. In a well pump of the character de-

scribed, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in adjusted position at one limit of its travel, and a spring actuated member interconnected with said valve and movable relative thereto, said member being adapted to be intermittently actuated by the piston to release said locking means, and adapted upon release of the locking means to move the valve throughout its length of travel.

10. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in adjusted position at one limit of its travel, a piston actuated valve and lock actuating member, and yielding means resisting relative movement between said member and the piston, said member being adapted to actuate the locking device to release said valve and to move the valve throughout its length of travel.

11. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in adjusted position at the limits of its travel, a normally stationary valve and lock actuating member adapted to be actuated by the piston, and yielding means between said member and the piston and resisting their relative reciprocating movement, said member being adapted to actuate the locking device to release said valve, and to actuate the valve throughout its reciprocating movements.

12. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in adjusted position at one limit of its travel, a valve and lock actuating member adapted to be moved by the piston, and a spring between said member and the piston and resisting their relative movement, said member being actuated by the piston to compress said spring and to release the locking means, and being actuated thereafter by the spring to move said valve throughout its travel.

13. In a well pump of the character described, a cylinder and a fluid pressure operated pumping piston in said cylinder, a reciprocating valve for controlling the operation of said piston; and a valve locking and actuating device embodying means for locking said valve in adjusted positions at the limits of its reciprocating movement, a spring actuated member interconnected with said valve and movable relative thereto, said member being adapted to be intermittently engaged by the piston to release said locking means, and yielding means resisting relative movement between said member and the piston, said valve being adapted to be moved throughout its length of travel by said member when released from the locking means.

14. In a well pump, a valve head and a fluid pressure operated pumping piston below the head, a vertically reciprocating valve in said head for controlling the operation of said piston, a pair of oppositely disposed and downwardly extending arms mounted at their upper ends on said valve head and adapted to yieldingly resist lateral displacement, a pair of vertically alined and relatively longitudinally movable members, the upper member being connected with said valve and normally locked against vertical movement between said arms, the lower member being adapted to be intermittently engaged by the piston to spread said arms and to release the first mentioned member, and yielding means resisting relative movement between the last mentioned member and the piston.

15. In a well pump, a valve head and a fluid pressure operated pumping piston below the head, a vertically reciprocating valve in said head for controlling the operation of said piston, a pair of oppositely disposed and downwardly extending arms mounted at their upper ends on said valve head and adapted to yieldingly resist lateral displacement, a pair of vertically alined and relatively longitudinally movable members, the upper member being connected with said valve and normally locked against vertical movement between said arms, an abutment on said piston and vertically movable therewith, a pair of spaced engaging elements on the lower member above and below said abutment, and a spring between each of said elements and the abutment, the lower member being adapted to be actuated by the abutment to spread said arms to release the upper member and to compress said springs, and both members and the valve then being actuated upon expansion of the compressed springs.

16. In a well pump, a valve head and a fluid pressure operated pumping piston below the head, a vertically reciprocating valve in said head for controlling the operation of said piston, and a valve locking and actuating device embodying means for locking said valve in adjusted position at the limit of its travel, a vertically extending valve and lock actuating rod operatively connected with said valve and locking means,

an abutment on said piston and vertically movable therewith, a pair of spaced engaging elements on the rod above and below said abutment, and a spring between each of said elements and the abutment, said rod being adapted to be actuated by the abutment to release said locking means and to compress one of said springs, the spring then actuating said rod to operate the valve.

17. In a pump, a hollow plunger carrying an operating piston and a pumping piston, means confining a hydraulic column in communication with the upper side of the operating piston, means including a tube surrounding the plunger and the said means, confining a hydraulic column and conveying pressure therefrom to the lower side of the operating piston, means confining a third hydraulic column, means automatically operated by the movements of the plunger to superimpose the third column on the other two columns alternately, and a pump barrel containing the pumping piston.

18. In a pump, a well casing and a pump mechanism suspended from the casing and insertable through the casing and withdrawable therefrom, the pump mechanism comprising the following, a head suspended from the casing, a well tubing coaxially connected to and pendent from the head, concentric pump barrels within the tubing, a pump plunger having an operating piston and a pumping piston, the operating piston working in the larger barrel, means including the tubing and the larger barrel for confining two hydraulic columns one communicating pressure to the lower side of the operating piston and the other to the upper side thereof, means confining a third hydraulic column, and a valve automatically operated to superimpose the third column upon the other two columns alternately, the pumping piston working in the smaller barrel.

In witness that I claim the foregoing I have hereunto subscribed my name this 10th day of June 1929.

ARTHUR G. GAGE.