May 9, 1933. A. G. GAGE 1,907,952

FLUID PRESSURE OPERATED WELL PUMP

Original Filed April 10, 1931 2 Sheets-Sheet 1

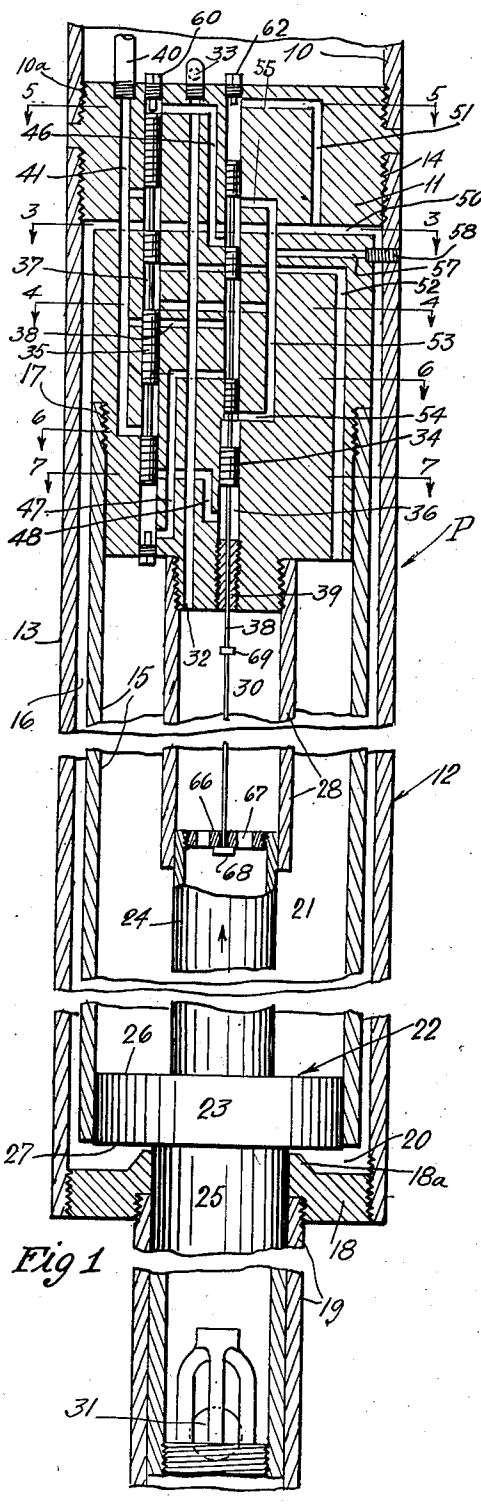
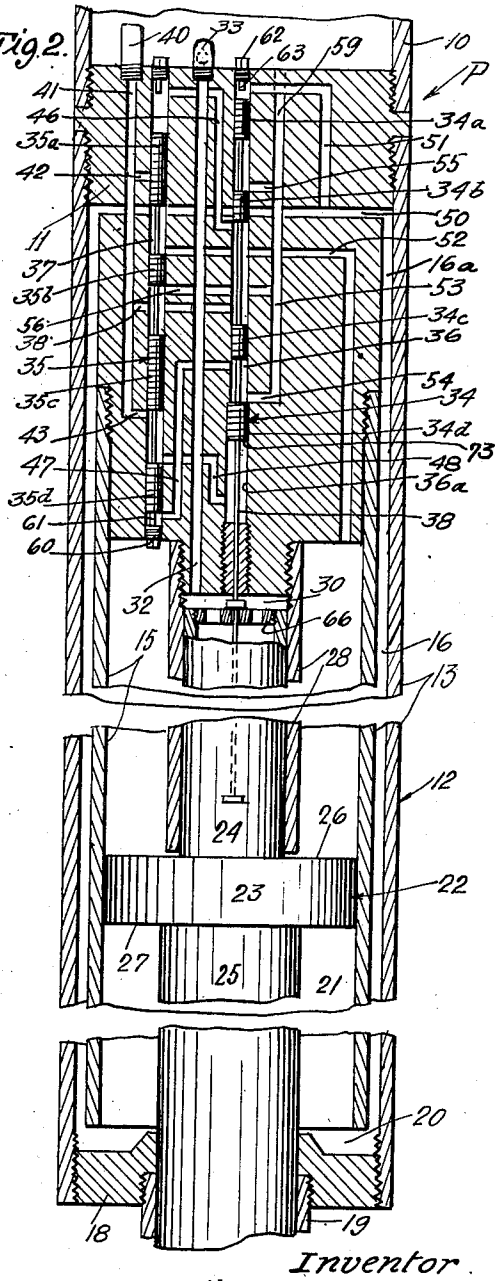


Fig 1

Fig 2.



Inventor.
Arthur G. Gage.

Attorney.

May 9, 1933. A. G. GAGE 1,907,952

FLUID PRESSURE OPERATED WELL PUMP

Original Filed April 10, 1931 2 Sheets-Sheet 2

Fig. 3.

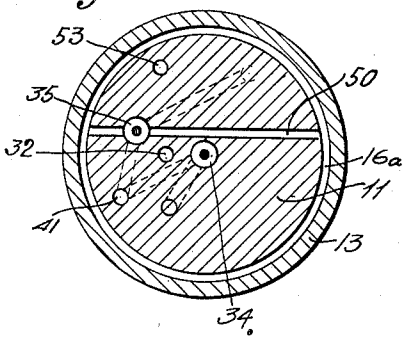


Fig. 4.

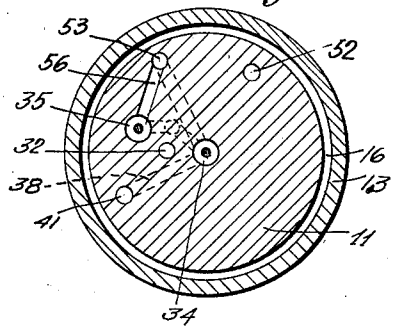


Fig. 6.

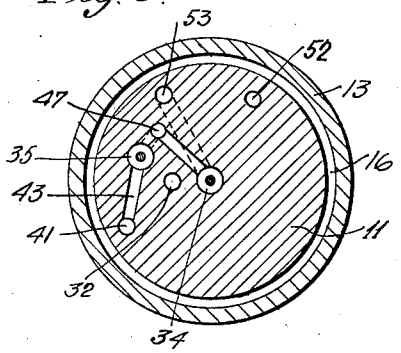


Fig. 5.

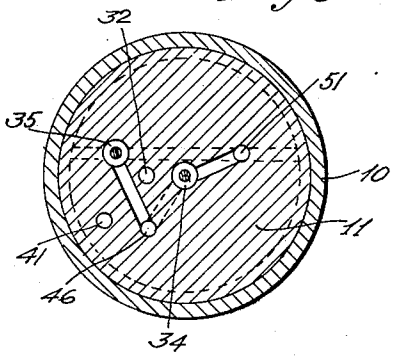
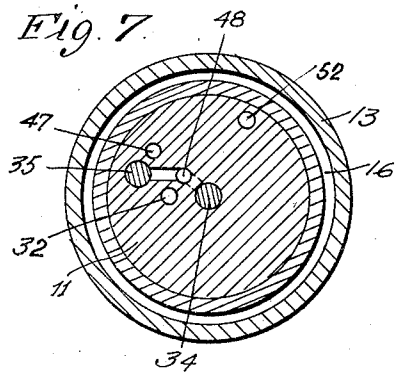


Fig. 7.



Inventor
Arthur G. Gage.

Attorney.

Patented May 9, 1933 1,907,952

UNITED STATES PATENT OFFICE

ARTHUR G. GAGE, OF LOS ANGELES, CALIFORNIA

FLUID PRESSURE OPERATED WELL PUMP

Application filed April 10, 1931, Serial No. 529,060. Renewed October 7, 1932.

This invention has to do with deep well pumps of the pressure fluid operated type in which the pump plunger or piston is operated by high pressure fluid delivered to the pump from the ground surface. And the invention may be further characterized as dealing more particularly with pumps of this character in which the plunger is operated by compressible fluid, such as gas or air.

In certain common types of pressure fluid operated pumps, the pump plunger is moved by the alternate application of high pressure actuating fluid to opposing pressure areas on the plunger, and the pressure fluid used in operating the plunger on its pumping stroke is discharged to the well or to the column of well liquid being pumped, upon the return stroke of the plunger. The present type of pump differs broadly in one respect, from the usual fluid pressure operated pumps operated in the manner stated, in that the fluid used to move the plunger on its pumping stroke, instead of being discharged to the well or pumping column, is utilized in operating the plunger on its return stroke. In accordance with the invention, the compressible operating fluid is delivered to the plunger barrel below the plunger so as to move the latter on its up stroke, and at a predetermined point in the plunger travel, and substantially at the limit of its up stroke, the supply of pressure fluid to the pump from the supply conduit is cut off, and the fluid in the lower portion of the plunger barrel utilized in raising the plunger, is transferred to the upper portion of the barrel above the plunger so as to move the latter on its return or down stroke.

In my preferred embodiment of the invention, the delivery of the presure fluid to the plunger barrel to raise the plunger on its up stroke, and the transfer of that fluid from the lower interior of the barrel below the plunger to the upper interior thereof above the plunger, is regulated by a plunger controlled valve mechanism in the head of the pump above the plunger barrel. It is to be understood that in its broad aspects, the invention contemplates the provision of any suitable means for so controlling the application of pressure fluid, either directly, or indirectly, to the plunger, and that the hereinafter described type of valve construction and arrangement is to be considered merely as typical of any suitable means for controlling the operation of the plunger. I may state that the hereinafter described valve mechanism is generally similar to that described in my copending application on valve mechanism for Fluid pressure operated well pumps, Ser. No. 529,059, filed on even date herewith, which application deals with improvements whereby the valve parts are held or locked in position by means of fluid presure.

In the operation of the present pump, at substantially the limit of the plunger up stroke the interior of the plunger barrel below the plunger is put into communication with that above the plunger so as to permit the transfer of pressure fluid to the upper pressure area on the plunger. In order for the pressure so applied to the upper pressure area of the plunger to operate the plunger on its down stroke, means is provided whereby the effective pressure applied to the plunger to move it downwardly is greater than the pressure applied to the lower pressure area of the plunger resisting its downward movement. This application of differential pressures is brought about by so forming the plunger and the plunger barrel assembly that the pressure fluid acting downwardly against the plunger is applied to the comparatively greater pressure area on the plunger than the fluid in the lower interior of the barrel acting upwardly against the plunger. The present plunger and plunger barrel assembly construction is generally similar to that comprising the subject matter of my copending application on Oil well pump, Ser. No. 109,098, filed May 14, 1926.

During the up stroke of the plunger, the pressure applied to its upper end, and which pressure is overcome by the operating fluid pressure applied to the lower pressure area of the plunger, consists of the pumping column pressure applied to one portion of the upper end area of the plunger plus the well pressure or pumping column pressure applied to the remainder of that area. And on its down

stroke the piston is operated by the differential in pressure against the last mentioned area and pressure applied to the lower comparatively smaller pressure area of the plunger.

Having set forth the general aspects of the invention, I shall now proceed to a detailed description of a typical form of pump embodying the invention, from which description the various objects and structural features of the pump will be readily apparent. Reference is had for purposes of description to the accompanying drawings, in which:

Fig. 1 is a medial longitudinal and developed sectional view of the pump, the various valve parts and passages in the valve head being shown in a single plane for purposes of clarity; ,

Fig. 2 is a view similar to Fig. 1 showing the plunger at the opposite end of its stroke and the valve parts in corresponding positions; and

Figs. 3, 4, 5, 6 and 7 are sectional views on lines 3—3, 4—4, 5—5, 6—6, 7—7 of Fig. 1, the sectional views illustrated in Figs. 3 to 7 showing the true relative positions of the various valve parts, ports and passages in the valve head.

Referring first to Figs. 1 and 2, the pump, generally indicated at P is shown to be carried on the lower end of the well pipe 10, the latter being lowered within the well casing, not shown, and the pump during operation being submerged beneath the standing level of the well liquid. The pump comprises an upper valve head 11 threaded on the well pipe at 10*a*, and a lower plunger and plunger barrel assembly section, generally indicated at 12. The barrel assembly comprises an outer pipe or casing 13 joined to the valve head at 14, and a piston barrel 15 extending concentrically within the casing 13 and annularly spaced therefrom at 16, the piston barrel being similarly mounted on the valve head at 17. The lower end of the casing 13 is closed by a tubular plug 18 carrying a depending sleeve 19 within the lower reduced section of the plunger works, as will presently appear. The lower end of the plunger barrel 15 is spaced at 20 from the bottom closure 18 of the casing in order to provide for communication between the annular space 16 and the piston chamber 21.

Within the barrel assembly is a tubular plunger, generally denoted at 22, comprising an intermediate piston section 23 and upper and lower reduced diameter extensions 24 and 25, the latter working within sleeve 19 and having a sliding fit therewith. It will be noted that the lower plunger section 25 is of somewhat greater diameter than section 24, so that there is provided an upwardly facing pressure surface 26 on the piston 23 of greater area than the downwardly facing pressure surface 27, reasons for which will hereinafter appear. Plug 18 is formed with a centrally raised area 18*a* to arrest the downward travel of the plunger at a point such that the piston section 23 will not be permitted to cover the annular opening at 20 and thereby cut off communication between space 16 and the piston chamber 21. The upper plunger section 24 projects upwardly within a pipe sleeve 28 depending from the lower end of the valve head 11, the plunger having a sliding fit within said sleeve.

It may be mentioned at this point that during the down stroke of the plunger, throughout which the latter is moved by fluid pressure applied to the piston area 26, well liquid is taken upwardly through the plunger into the pumping chamber 30, a foot valve 31 being placed within the lower tubular plunger section 25 for the usual purpose. During the upward movement of the plunger as a result of the application of fluid pressure to the downwardly facing piston area 27, the well liquid taken into the pumping chamber 30 is discharged through the valve head into the well pipe, 10, or what will hereinafter be termed the pumping column.

The liquid in chamber 30 is discharged upwardly into the pumping column by way of bore 32 extending continuously through the valve head 11, there being a check valve 33 at the upper end of said bore to prevent return flow into the pumping chamber. The delivery of pressure fluid to the piston chamber, and also the transfer of the fluid from said chamber below the piston to the upper interior above the piston, is controlled by a valve mechanism comprising a pilot valve 34 and a master valve 35 contained within bores 36 and 37, respectively. Valve 34 comprises a plurality of piston sections 34*a*, 34*b*, 34*c*, and 34*d*, interconnected by rod sections of reduced diameter. It will be noted that the lower portion 36*a* of the pilot valve bore is of somewhat increased diameter, and that the diameter of the lower plunger section 34*d*, correspondingly increased, reasons for which, will appear hereinafter. Depending from the lower piston section 34*d* is a valve operating rod 38 extending downwardly into the pumping chamber 30 through a stuffing box sleeve 39 in the lower end of the pilot valve bore. The master valve 35 also comprises a plurality of piston sections 35*a*, 35*b*, 35*c* and 35*d* interconnected by reduced diameter rod sections.

The high pressure fluid for operating the plunger is delivered to the pump by way of conduit or tube 40 extending downwardly within the well pipe 10 and connecting with the valve head at the upper end of bore 41. The latter is communicable with the master valve bore 37 by way of ports 42 and 43, and with the pilot valve bore 36, by way of port 38. The master valve bore is communicable at its upper and lower ends at points

beyond the valve, with the pilot valve bore by way of passages 46 and 47, there also being a passage 48 interconnecting the said valve bores. Master valve bore 37 communicates with space 16 between plunger barrel tubes 13 and 15 by way of the annular space 16*a* between the valve head and casing 13, and a transverse passage 50 extending to space 16*a* in opposite directions from the valve bore. Passage 51 leading from bore 50 to the upper end of bore 36 above the pilot valve serves to put the master valve bore into communication with the pilot valve bore. The master valve bore also communicates with the piston chamber 21 by way of a passage 52.

Extending transversely from bore 53 are ports 54, 55, and port 56 opening into the pilot and master valve bores, respectively. In Fig. 1 I show a passage 57 leading from bore 53 transversely through the valve head and casing 13 into the well, a nipple 58 being inserted through an opening in the casing and into bore 57 to conduct the flow across the annular space 16*a*. In Fig. 2, I show instead of a passage leading from bore 53 to the well, a passage 59 leading from bore 53 into the pumping column, or interior of the well pipe. As will hereinafter appear, bore 53 may lead either to the well or pumping column in accordance with the preferred method of operating the pump.

The upper and lower ends of the master valve bore are closed by means of plugs 60 provided with small extensions 61 which project within a bore a distance sufficient to arrest the travel of the valve at such points that it will not close off the openings of passages 46 and 47 into the valve bore. The pilot valve bore is similarly closed at its upper end by means of plug 62 having an extension 63 which is engaged by the valve to prevent closing off passage 51. The pilot valve 34 is intermittently operated by the plunger by way of the depending valve rod 38. A spider 66 having openings 67 to permit the passage of fluid therethrough, is carried in the end of the upper plunger section 24, the valve rod 38 extending through a central opening in the spider and having a pair of spaced lugs 68 and 69 which are engaged by the spider near the ends of the down and up strokes, respectively of the plunger.

I shall now describe the operation of the pump assuming first the plunger and valve parts to be in the positions shown in Fig. 1. A compressible high pressure operating fluid, such as gas or air, is delivered to bore 41 through conduit 40 and is conducted through port 42, the master valve bore between valve sections 35*a* and 35*b*, passage 50, and to the lower end of the piston chamber 21 beneath the piston 23 by way of the annular space 16. The pressure so applied to the lower pressure area 27 of the piston causes the plunger to move on its up stroke. In Fig. 1, the master valve is held in raised position by virtue of the differential in pressure between the operating fluid pressure and the well pressure. Thus the operating fluid pressure is applied to the lower end of the valve by way of port 38, the pilot valve bore between valve sections 34*b* and 34*c*, and passage 47. Well pressure is applied to the upper end of the master valve by communication of the valve bore with the well through passage 46, the pilot valve bore between valve sections 34*a* and 34*b*, port 55, bore 53 and passage 57. In case, as in Fig. 2, bore 53 is put into communication with the pumping column (by bore 59) instead of the well, pumping column pressure will be applied to the upper end of the master valve, by way of passage 46, the pilot valve bore, port 55, and bore 59. The operating fluid pressure will of course be substantially greater than the well or pumping column pressure, and the differential therebetween will be sufficient to hold the master valve in raised position. I may state at this point that as the master valve is raised from its lower to upper position, fluid in the upper end of the valve bore is displaced, in Fig. 1, into the well, and in Fig. 2 into the pumping column, to permit upward movement of the valve by way of passage 46, port 55 and passage 57, and passage 46 port 55, and bore 59, respectively.

As the plunger nears the end of its up stroke, the spider 66 engages the upper valve lug 69, causing the pilot valve to be raised to the position of Fig. 2. The master valve is thereupon thrown down to its lower position by the application of high pressure fluid to its upper end by way of port 38, the pilot valve bore between valve sections 34*b* and 34*c*, and passage 46. According to the passage arrangement in Fig. 1, well pressure is applied to the lower end of the valve through passage 47, port 34, and passages 53 and 57. In Fig. 2, pumping column pressure is applied to the lower end of the master valve due to the communication of bore 53 with the pumping column through bore 59, instead of with the well.

Upon movement of the master valve to its lower position, delivery of high pressure operating fluid to the pump is cut off by the closing of port 42 by the upper piston section of the valve. At the same time the piston chamber beneath the piston 23 is put in communication with the upper portion of the chamber above the piston by way of the annular space 16, passage 50, the master valve bore between valve sections 35*a*, 35*b*, and passage 52. A comparatively greater pressure is applied to the plunger to move the latter downward than the upwardly applied pressure acting against its downward movement, by virtue of the differential areas of the opposing piston faces 26 and 27. Because of

the greater cross sectional areas of the piston chamber above the piston as compared with the cross sectional area of the chamber below the piston, as the plunger moves downward the pressure fluid will eventually occupy a greater volume in the chamber above the piston than its original volume below the piston when the plunger was in its upper position. Therefore as the plunger moves downward, there will be an expansion of pressure fluid in said chamber above the piston, and of course, a decrease in the pressure differential on the piston areas 26 and 27. However, the relative diameters of the upper and lower plunger sections 24 and 25 will be so proportioned that a differential in pressure will at all times be maintained on the pressure areas of the piston sufficient to move the plunger throughout its down stroke even though the actual pressure of the fluid may decrease. The weight of the plunger will of course also, in addition to the pressure differential, be effective in causing its downward movement.

Throughout the up stroke of the plunger, the well liquid in pumping chamber 30 is discharged into the pumping column through bore 32, and during the plunger down stroke, the well liquid is taken into the pumping chamber upwardly through the plunger past the foot valve 31. The spent plunger actuating fluid in chamber 21 above the piston section may be discharged, during the plunger up stroke, either to the well by way of passage 52, the master valve bore between valve sections 35*b*, 35*c*, port 56 and passages 53 and 57, in Fig. 1, or to the pumping column as shown in Fig. 2, through passage 59 leading from 53. The latter method of operation may be preferred in some instances due to the effect of the gas released into the passage column, in acting in the manner of a gas lift to aid in raising the pumped liquid to the ground surface.

I have previously pointed out that the master valve is held, or substantially locked, in its upper and lower positions by virtue of differential fluid pressures applied to its opposite ends. It will also be noted that the pilot valve likewise is held in its two positions of adjustment by differential fluid pressures at its opposite ends. Thus in Fig. 2, operating fluid pressure is applied to the lower annular area 73 of the valve section 34*d*, by way of port 43, the master valve bore between valve sections 35*c* and 35*d*, and passage 48. The pressure within the piston chamber is applied to the upper end of the pilot valve by way of annular space 16, passage 50, and passage 51. As previously mentioned, pilot valve section 34*d* is of comparatively greater diameter than the upper section 34*a*. This provision is made in order that the pressure area 73 on the lower valve section will be made more nearly equal, or if desired greater than the pressure area on the upper end of the valve so as to increase the pressure differential holding the valve up. An additional downward pressure on the valve is of course exerted in accordance with the pumping column pressure applied to an area on the upper end of the lower valve section 34*d*, representing the differential in area between the pressure area on 34*d* and that on the under side of 34*c*. However, it will be readily apparent that although the upwardly facing pressure area on the valve is increased by increasing the downwardly facing area 73, the pressure differential supporting the valve will be increased by increasing the area against which the high pressure fluid is applied.

The pilot valve similarly is held in the lower position of Fig. 1, by the application of high pressure fluid to its upper end through port 42, and passages 50 and 51. The lower end of the valve however is sealed off from the application of fluid pressure thereto, by the closing of passage 48 by the lower section 35*d* of the master valve.

I claim:

1. A fluid pressure operated well pump comprising, a plunger barrel adapted to be submersed in the well liquid, a tubular plunger in said barrel and a check valve in the plunger, well liquid being taken upwardly through said tubular plunger, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger in one direction, and means for applying the fluid utilized in moving the piston in said direction, against an opposing pressure area on said plunger to move the plunger in a reverse direction.

2. A fluid pressure operated well pump comprising, a plunger barrel adapted to be submersed in the well liquid, a tubular plunger in said barrel and a check valve in the plunger, well liquid being taken upwardly through said tubular plunger, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger in one direction, means for cutting off the supply of actuating fluid to said barrel at a predetermined point in the piston travel, and means for applying the fluid utilized in moving the piston in said direction, against an opposing pressure area on said plunger to move the plunger in a reverse direction.

3. A fluid pressure operated well pump comprising, a plunger barrel adapted to be submersed in the well liquid, a tubular plunger in said barrel and a check valve in the plunger, well liquid being taken upwardly through said tubular plunger, said plunger having oppositely facing and differential pressure areas, means for applying gaseous actuating fluid to one of said pressure areas to move the plunger in one direction, and means for applying the fluid utilized in moving the piston in said direction, against the

opposing pressure area on the plunger to move the plunger in a reverse direction.

4. A fluid pressure operated well pump comprising, a vertically extending plunger chamber adapted to be submersed in the well liquid a tubular plunger in said chamber and a check valve in the plunger, well liquid being taken upwardly through said tubular plunger, means for applying gaseous actuating fluid to the lower portion of said chamber and against a downwardly facing pressure area on the plunger to move the plunger on its up stroke, and means for transferring the fluid used in moving the plunger on its up stroke, to an upper portion of said chamber and for applying said fluid to an upwardly facing pressure area on said plunger to move the latter on its down stroke.

5. A fluid pressure operated well pump comprising, a vertically extending plunger chamber, a plunger in said chamber, means for applying gaseous actuating fluid to the lower portion of said chamber and against a downwardly facing pressure area on the plunger to move the plunger on its up stroke, means for transferring the fluid used in moving the plunger on its up stroke, to an upper portion of said chamber and for applying said fluid to an upwardly facing pressure area on said plunger to move the latter on its down stroke, and means for then exhausting the spent actuating fluid into the well.

6. A fluid pressure operated well pump comprising, a plunger barrel, a plunger in said barrel, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger in one direction, means for applying the fluid utilized in moving the piston in said direction, against an opposing pressure area on said plunger to move the plunger in a reverse direction, and means for then exhausting the spent actuating fluid into the well.

7. A fluid pressure operated well pump adapted to exhaust the well liquid upwardly into a pumping column, comprising a plunger barrel, a plunger in said barrel, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger in one direction, means for applying the fluid utilized in moving the piston in said direction, against an opposing pressure area on said plunger to move the plunger in a reverse direction, and means for then discharging the spent actuating fluid into said pumping column.

8. A fluid pressure operated well pump comprising, a valve head, a plunger chamber below the valve head, a tubular plunger in said chamber and a check valve in said plunger, well liquid being taken into said plunger and discharged upwardly through the valve head, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger on its up stroke, means for transferring the fluid used in moving the plunger on its up stroke, to an upper portion of said chamber and for applying said fluid to an upwardly facing pressure area on said plunger to move the latter on its down stroke, and the first mentioned means including valve means in said head for controlling the delivery of actuating fluid to said plunger chamber.

9. A fluid pressure operated well pump comprising, a valve head, a plunger chamber below the valve head, a tubular plunger in said chamber and a check valve in said plunger, well liquid being taken into said plunger and discharged upwardly through the valve head, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger on its up stroke, means for transferring the fluid used in moving the plunger on its up stroke, through the valve head to an upper portion of said chamber and for applying said fluid to an upwardly facing pressure area on said plunger to move the latter on its down stroke, both said means including piston controlled valve means in said head for controlling the delivery of actuating fluid to said plunger chamber and the transference of the actuating fluid from the lower to the upper portion of said chamber.

10. A fluid pressure operated well pump comprising, a valve head, a plunger chamber below the valve head, a plunger in said chamber, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger on its up stroke, means for transferring the fluid used in moving the plunger on its up stroke, to an upper portion of said chamber and for applying said fluid to an upwardly facing pressure area on said plunger to move the latter on its down stroke, and valve means in said head comprising a piston actuated pilot valve, and a fluid pressure operated master valve controlled by the pilot valve.

11. In a well pump adapted to discharge the well liquid upwardly into a pumping column, the combination comprising, a pumping barrel and a piston barrel, a plunger having an upper section in said pumping barrel and a comparatively larger diameter piston section in said piston barrel, means for applying gaseous actuating fluid to said piston chamber and against a downwardly facing area on said piston section to move the plunger on its up stroke, and means for applying the fluid utilized in moving the plunger on its up stroke to an upwardly facing pressure area on said piston section to move the plunger downwardly.

12. In a well pump adapted to discharge the well liquid upwardly into a pumping column, the combination comprising, a pumping barrel and a piston barrel, a plunger having an upper section in said

pumping barrel and a comparatively larger diameter piston section in said piston barrel, means for applying gaseous actuating fluid to said piston chamber and against a downwardly facing area on said piston section to move the plunger on its up stroke, and means for applying the fluid utilized in moving the plunger on its up stroke to an upwardly facing pressure area on said piston section to move the plunger downwardly, the last mentioned pressure area of the piston being comparatively larger than said downwardly facing area.

13. In a well pump adapted to discharge the well liquid upwardly into a pumping column, the combination comprising, a pumping barrel and a piston barrel, a plunger having an upper section in said pumping barrel and a comparatively larger diameter piston section in said piston barrel, means for applying gaseous actuating fluid to said piston chamber and against a downwardly facing area on said piston section to move the plunger on its up stroke, means for applying the fluid utilized in moving the plunger on its up stroke to an upwardly facing pressure area on said piston section to move the plunger downwardly, and means for discharging spent actuating fluid from said piston barrel into the well.

14. In a well pump adapted to discharge the well liquid upwardly into a pumping column, the combination comprising, a pumping barrel and a piston barrel, a plunger having an upper section in said pumping barrel and a comparatively larger diameter piston section in said piston barrel, means for applying gaseous actuating fluid to said piston chamber and against a downwardly facing area on said piston section to move the plunger on its up stroke, means for applying the fluid utilized in moving the plunger on its up stroke to an upwardly facing pressure area on said piston section to move the plunger downwardly, and means for discharging spent actuating fluid from said piston barrel into said pumping column.

15. In a well pump adapted to discharge the well liquid upwardly into a pumping column, the combination comprising, a valve head, a pumping barrel and a piston barrel, a plunger having an upper section in said pumping barrel and a comparatively larger diameter piston section in said piston barrel, fluid passages in the valve head for conducting gaseous actuating fluid to said piston chamber and against a downwardly facing area on said piston section to move the plunger on its up stroke, means for transferring the fluid used in moving the plunger on its up stroke, through said valve head into the piston chamber above an upwardly facing area on the piston, thereby moving the plunger on its down stroke, said means comprising a pilot valve operated by the plunger, and a fluid pressure operated master valve controlled by said pilot valve, said valves controlling the flow of actuating fluid to said piston chamber and the transference therein from the under side to the upper side of the piston.

16. A fluid pressure operated well pump comprising, a plunger barrel, a plunger in said barrel, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger in one direction, means for applying the fluid utilized in moving the piston in said direction, against an opposing pressure area on said plunger to move the plunger in a reverse direction, the first mentioned means including a valve adapted to be intermittently operated by said plunger, and means for holding said valve in one position by fluid pressure.

17. A fluid pressure operated well pump comprising, a plunger barrel, a plunger in said barrel, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger in one direction, means for applying the fluid utilized in moving the piston in said direction, against an opposing pressure area on said plunger to move the plunger in a reverse direction, the first mentioned means including a valve adapted to be intermittently operated by said plunger, and means for holding said valve in two positions by fluid pressure.

18. A fluid pressure operated well pump comprising, a plunger barrel, a plunger in said barrel, said plunger having oppositely facing and differential pressure areas, means for applying gaseous actuating fluid to one of said pressure areas to move the plunger in one direction, means for applying the fluid utilized in moving the piston in said direction, against the opposing pressure area on the plunger to move the plunger in a reverse direction, the first mentioned means including a valve for controlling the application of said actuating fluid to the plunger, and means for holding said valve in one position by fluid pressure.

19. A fluid pressure operated well pump comprising, a plunger barrel, a plunger in said barrel, said plunger having oppositely facing and differential pressure areas, means for applying gaseous actuating fluid to one of said pressure areas to move the plunger in one direction, means for applying the fluid utilized in moving the piston in said direction, against the opposing pressure area on the plunger to move the plunger in a reverse direction, the first mentioned means including a valve for controlling the application of said actuating fluid to the plunger, and means for alternately applying differential pressures to opposite ends of said valve.

20. A fluid pressure operated well pump comprising, a plunger barrel, a plunger in said barrel, means for applying gaseous actu-

ating fluid to a pressure area on said plunger to move the plunger in one direction, means for applying the fluid utilized in moving the piston in said direction, against an opposing pressure area on said plunger to move the plunger in a reverse direction, the first mentioned means including a valve for controlling the application of said actuating fluid to the plunger, and means for holding said valve in one position by fluid pressure.

21. A fluid pressure operated well pump comprising, a plunger barrel, a plunger in said barrel, means for applying gaseous actuating fluid to a pressure area on said plunger to move the plunger in one direction, means for applying the fluid utilized in moving the piston in said direction, against an opposing pressure area on said plunger to move the plunger in a reverse direction, the first mentioned means including a valve for controlling the application of said actuating fluid to the plunger, and means for alternately applying the plunger actuating fluid pressure to opposite ends of said valve.

22. A fluid pressure operated well pump comprising, a valve head, a plunger chamber below the valvehead, a plunger in said chamber, means forming fluid passages for conducting gaseous actuating fluid to a pressure area on said plunger to move the plunger on its up stroke, means forming fluid passages for transferring the fluid used in moving the plunger on its up stroke, to an upper portion of said chamber and for applying said fluid to an upwardly facing pressure area on said plunger to move the latter on its down stroke, and valve means in said head comprising a piston actuated pilot valve and a fluid pressure operated master valve controlled by the pilot valve, said master valve controlling the application of actuating fluid to the piston, and means for alternately applying differential fluid pressures to opposite ends of said valves.

In witness that I claim the foregoing I have hereunto subscribed my name this 4th day of September 1930.

ARTHUR G. GAGE.