May 25, 1937. C. J. COBERLY 2,081,223

FLUID OPERATED DEEP WELL PUMP

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Fig. 1.

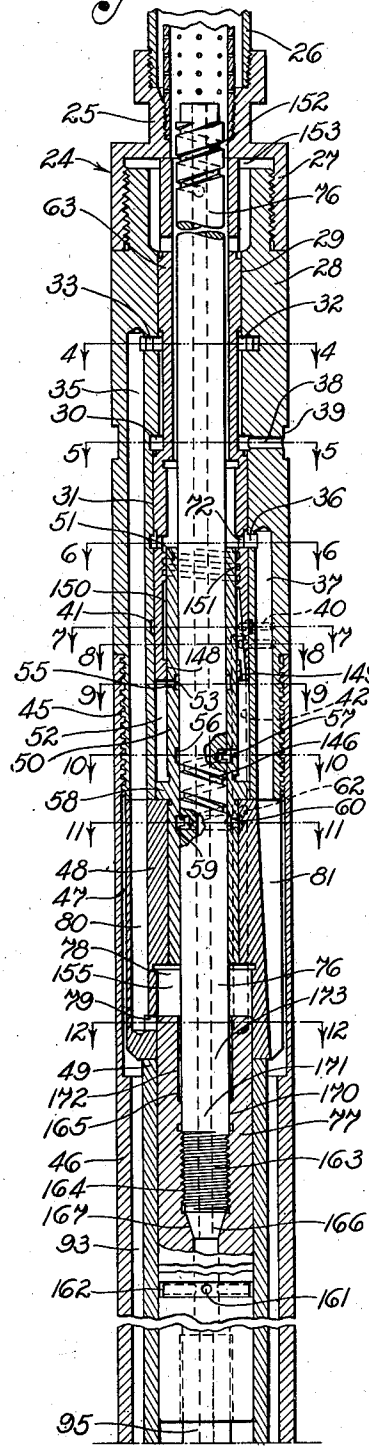


Fig. 2.

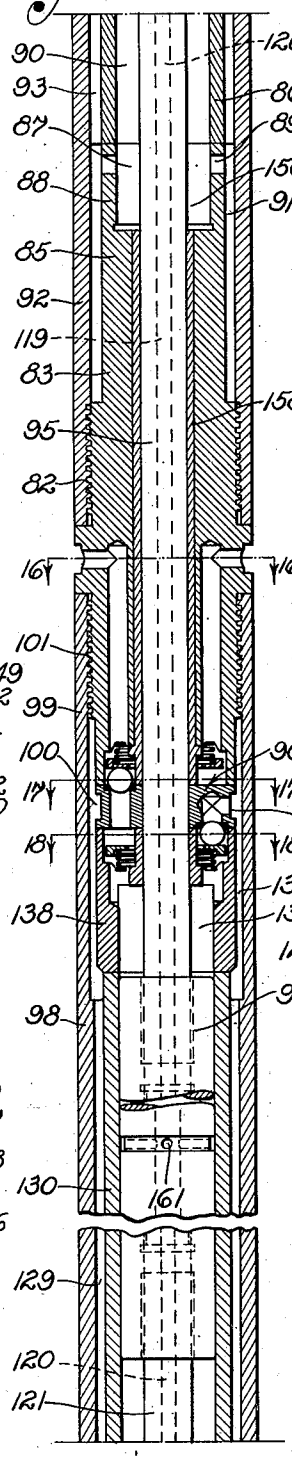
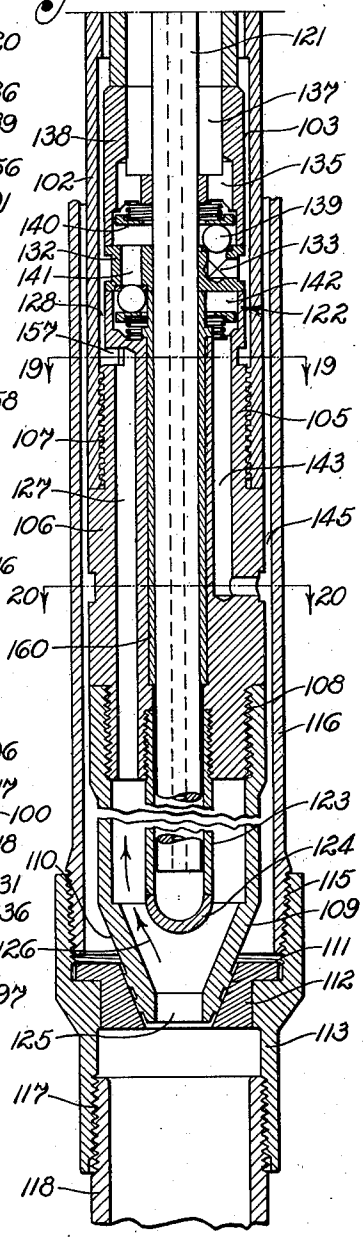


Fig. 3.



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Fig. 4.

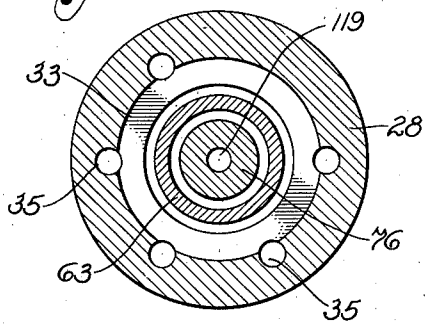


Fig. 5.

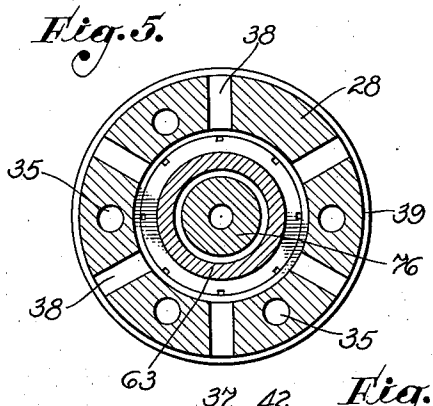


Fig. 6.

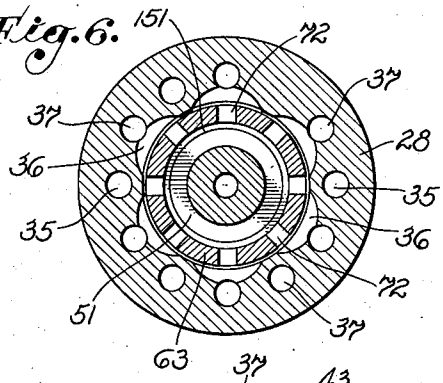


Fig. 7.

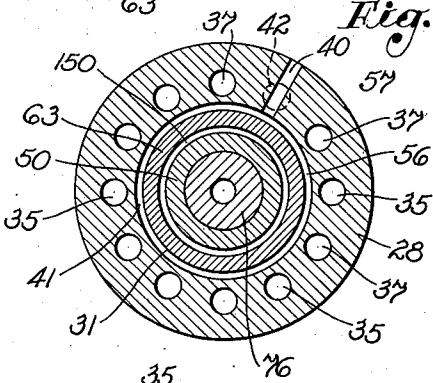


Fig. 8.

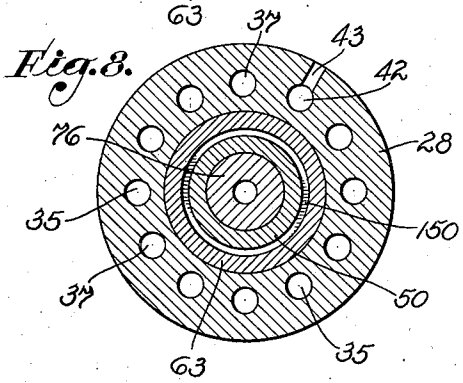


Fig. 9.

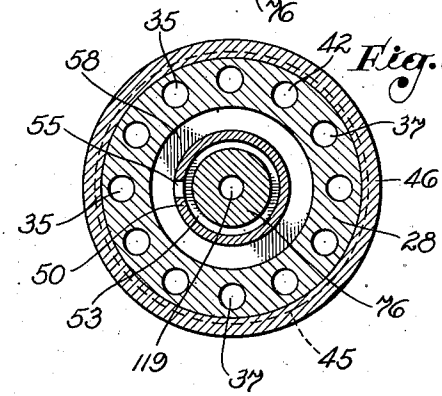
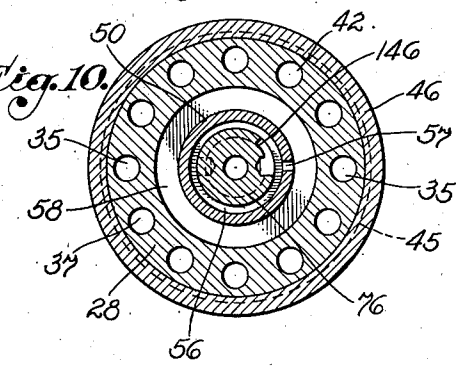


Fig. 10.



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Fig. 11.

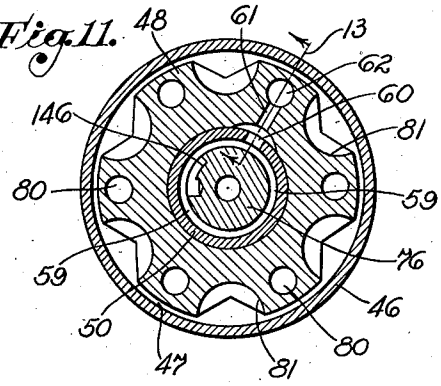


Fig. 12.

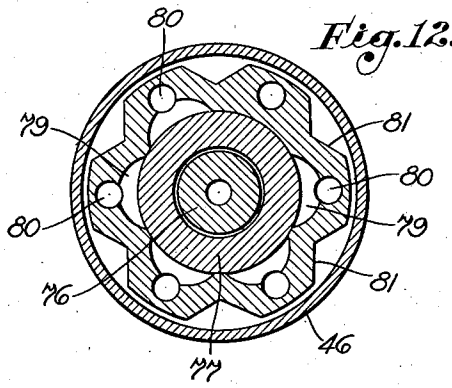


Fig. 16.

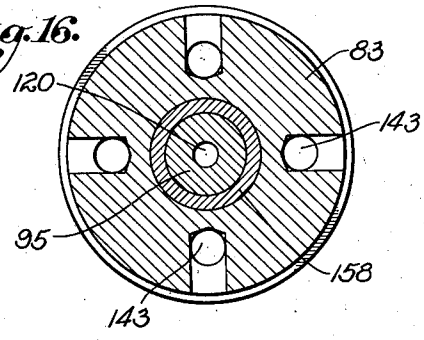


Fig. 17.

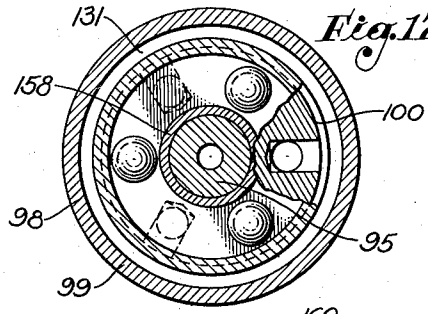


Fig. 18.

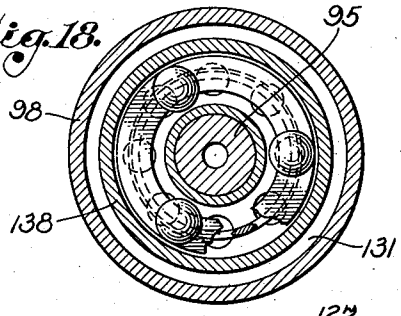


Fig. 19.

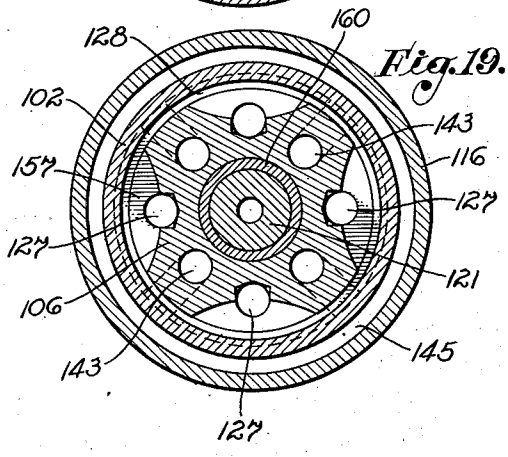
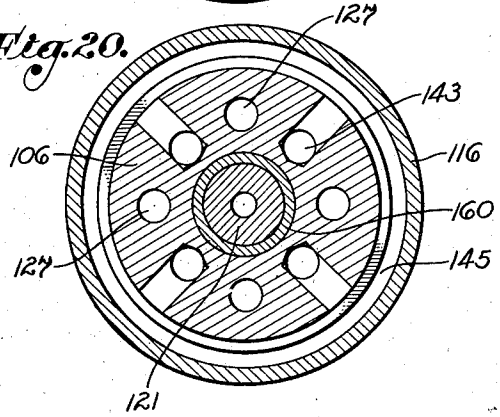


Fig. 20.



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FLUID OPERATED DEEP WELL PUMP

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Fig. 14.

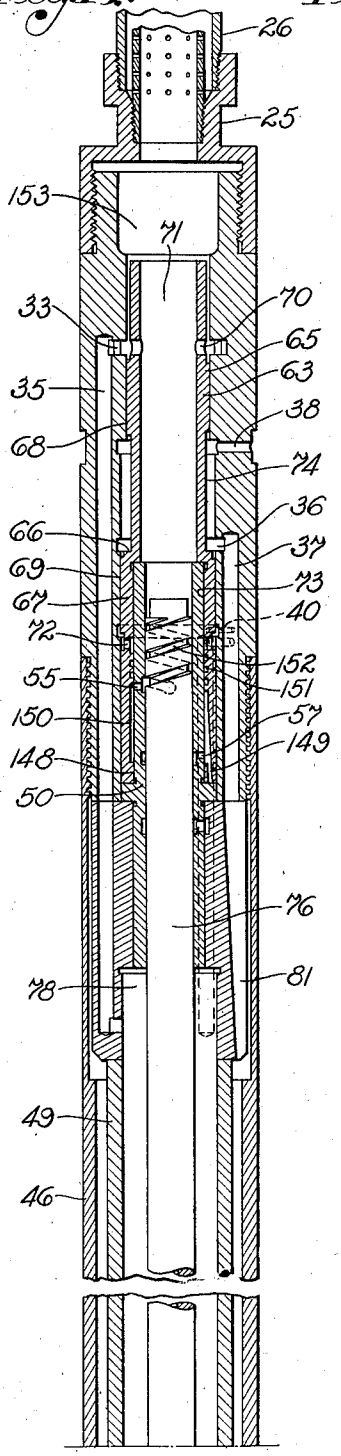


Fig. 15.

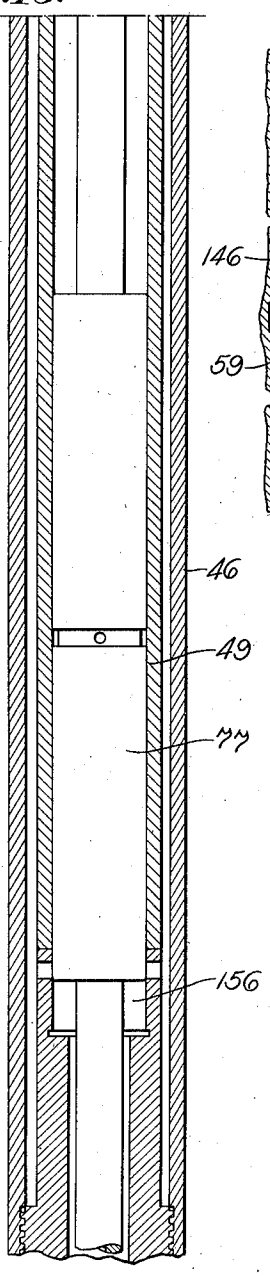
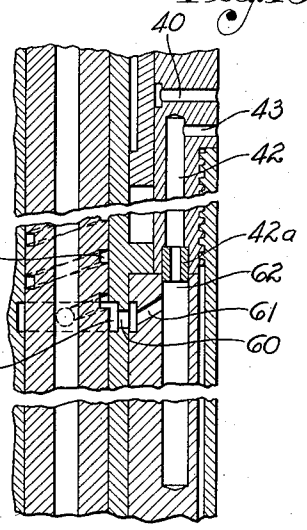


Fig. 13.



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Fig. 21.

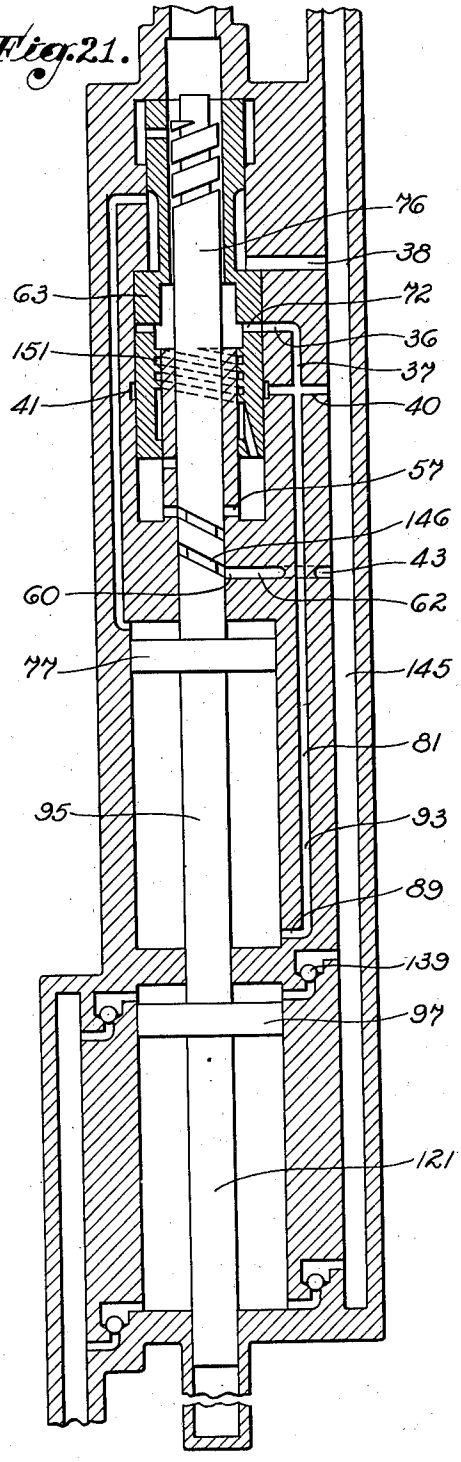
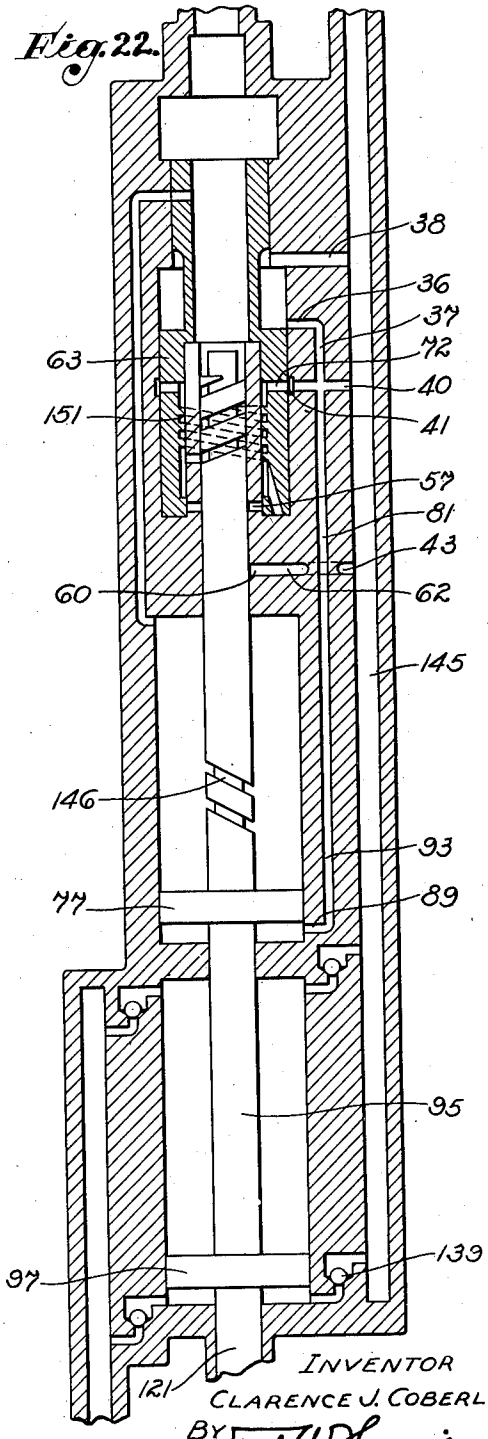


Fig. 22.



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Patented May 25, 1937 2,081,223

UNITED STATES PATENT OFFICE

2,081,223

FLUID OPERATED DEEP WELL PUMP

Clarence J. Coberly, Los Angeles, Calif., assignor to RoKo Corporation, Reno, Nev., a corporation of Nevada

Application April 11, 1934, Serial No. 720,061

14 Claims. (Cl. 103—46)

My invention relates to pumping devices and relates in particular to a pumping device which may be readily constructed so as to operate in a small space and at a location remote from the source of power. The invention is especially adapted to the pumping of oil from deep wells and is a continuation-in-part of the invention disclosed in my copending application Serial No. 623,171, filed July 18, 1932, and entitled "Liquid operated pump".

As is well known, the pumping of oil wells is accomplished chiefly through the use of sucker rod pumps which are relatively inefficient, especially where oil must be pumped from a considerable depth. The reversal of stresses in various parts of sucker rod operated pumps, namely, in the sucker rods and the pump tube, results in many failures of parts and necessitates frequent repairs which are often costly.

It is an object of my present invention to provide a pumping device in which the motivating power will be applied continuously and essentially constantly in one direction through a member leading from the top of the well to the pumping mechanism disposed near the bottom of the well. This uni-directional application of power, applied through a flow of fluid, is converted in the pump mechanism to a reciprocating movement which accomplishes a desired pumping of oil from the well.

It is an object of my invention to provide a pump structure having a fluid operated motor and a pumping mechanism, which pump structure is composed of relatively simple and durable parts secured together in cooperating relation so as to occupy a slender cylindrical space. The pump structure, therefore, although it may have a reasonably large capacity, may be installed in a minimum size of pipe at the lower end of a deep well. The conditions encountered in the drilling of wells result in the necessity for progressively reducing the size of the casing within the well as the well increases in depth, the result being that it is sometimes found necessary to employ at the bottom of a deep well a casing pipe 2½" in diameter or smaller.

An object of my invention is to provide in a pump structure of the above character novel parts which are secured together in a novel manner, such parts in a relatively simple manner forming intake and discharge passages which under ordinary principles of design cannot be incorporated in a structure of relatively minute size without a sacrifice of physical strength. In my invention ample strength for practical operation of the pumping device is preserved throughout the various cooperating parts thereof.

In the pumping of oil from wells, gas pockets sometimes form so as to be drawn into the pumping cylinder, thereby relieving the pumping load as long as the gas is present in the pumping cylinder. In my present invention I provide a means for practically eliminating injury to the pump structure due to the entrance of gas into the pumping cylinder. In ordinary types of piston pumps, the entrance of gas into the pumping cylinder often results in the hammering of reciprocating parts against the end walls of the cooperating parts in which they move. In my present invention the power cylinder is provided with dashpots at the ends thereof for receiving the impact of the power piston so that in event gas should pass into the pumping cylinder so as to relieve the pumping load, the pistons will not strike the ends of the cylinder in which they operate and accordingly will not be upset or injured by hammering action resulting from the entry of gas into the pumping cylinder.

A further object of the invention is to provide a simple and effective means for controlling the acceleration and deceleration of the pistons, this effect being contributed to by the dashpots hereinabove referred to and also by the control of fluid pressure by the slide valve, its characteristic movement, and the characteristic form of its fluid ports and passages.

Further objects and advantages of the invention will be made evident throughout the following part of the specification.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is a vertically sectioned view showing the upper end of a fluid operated pump embodying my invention.

Fig. 2 is a vertically sectioned view complementary to Fig. 1, showing the central section of the pump.

Fig. 3 is a vertically sectioned view complementary to Fig. 2, showing the lower end section of the pump.

Fig. 4 is a slightly enlarged cross section on a plane represented by the line 4—4 of Fig. 1.

Fig. 5 is an enlarged cross section on a plane represented by the line 5—5 of Fig. 1.

Fig. 6 is a cross section on a plane represented by the line 6—6 of Fig. 1.

Fig. 7 is an enlarged cross section on a plane represented by the line 7—7 of Fig. 1.

Fig. 8 is an enlarged cross section on a plane represented by the line 8—8 of Fig. 1.

Fig. 9 is a cross section on a plane represented by the line 9—9 of Fig. 1.

Fig. 10 is an enlarged cross section on a plane represented by the line 10—10 of Fig. 1.

Fig. 11 is an enlarged cross section on a plane represented by the line 11—11 of Fig. 1.

Fig. 12 is an enlarged cross section on a plane represented by the line 12—12 of Fig. 1.

Fig. 13 is a fragmentary section on a vertical plane taken as indicated by the line 13 of Fig. 11.

Fig. 14 is a vertically sectioned view corresponding to Fig. 1 but showing the valve member thereof in raised position and the pilot member in lowered position.

Fig. 15 is a vertically sectioned view showing the motor piston of the invention in the lowered position thereof when the pilot rod is likewise in lowered position as shown in Fig. 14.

Fig. 16 is a sectional view taken on the line 16—16 of Fig. 2.

Fig. 17 is a sectional view taken on the line 17—17 of Fig. 2.

Fig. 18 is a sectional view taken on the line 18—18 of Fig. 2.

Fig. 19 is a sectional view taken on the line 19—19 of Fig. 3.

Fig. 20 is a sectional view taken on the line 20—20 of Fig. 3.

Fig. 21 is a diagrammatic view of the pump structure with the movable parts thereof in raised position.

Fig. 22 is a diagrammatic view similar to Fig. 21 showing the pump with the parts thereof in lowered position.

In the pump structure 24, Figs. 1, 2, and 3, embodying my present invention, I employ an upper fitting 25 by which the pump structure is secured to the lower end of a fluid delivery pipe 26 by which operating fluid under relatively high pressure is delivered to the motor section of the pump structure 24. The fitting 25 has a threaded portion 27 for connection to the upper end of a valve body or valve casing 28. The valve body 28 has an axial minor bore 29 formed in the upper part thereof, which minor bore 29 is separated by a circular channel 30 from a major bore 31 axially formed in the lower portion of the valve body 28.

Substantially intermediately between the ends of the minor bore 29 is a circular channel 32 which communicates through ports 33 with the upper ends of primary fluid passages 35 which extend within the wall of the valve body 28 to the lower end thereof. Spaced below the channel 30 in the major bore 31 are a plurality of secondary ports 36 communicating with the upper ends of secondary fluid passages 37 which are formed within the wall of the valve body 28 and are placed between the passages 35, as shown in Fig. 6, and which secondary passages 37 extend to the lower end of the valve body 28. As further shown in Fig. 6, the ports 36 constitute circular depressions formed in the inner face of the major bore 31, preferably by the use of circular milling cutters.

As shown in Fig. 5, and also in Fig. 1, a plurality of discharge ports 38 connect the channel 30 with a channel 39 formed in the outer face of the valve body 28. As shown in Figs. 1 and 7, an auxiliary discharge channel or passage 40 connects between the exterior of the valve body 28 and a small channel 41 formed within the major bore 31 below the ports 36. As shown in Figs. 1, 8, and 13, a passage 42 extends upwardly from the lower end of the valve body 28 in a position between two of the passages 37, as shown by dotted lines in Fig. 7. The passage 42 accordingly is in the same vertical plane as the port 40 but stops below the port 40. Connecting the upper end of the passage 42 with the exterior of the valve body 28 is a port 43.

To threads 45 formed at the lower end of the valve body 28, a power cylinder 46 is secured, this power cylinder having an axial chamber 47 formed in the upper end thereof for receiving a plug body 48 which is held in fluid-tight engagement with the lower end of the valve body 28 and in fluid-tight engagement with the upper end of a cylinder liner 49 when the power cylinder 46 is connected to the valve body 28 as shown. Mounted in the upper part of the plug 48 is a valve liner 50 having an upper end portion 51 extending upwardly within the major bore 31 of the valve body 28 to a plane disposed a short distance below the ports 36, there being an annular space 52 formed within the major bore 31 around the upper end portion 51 of the valve liner 50. Internally formed intermediate the ends of the upper portion 51 of the valve liner 50 is a channel 53 which communicates with the space 52 through a port 55, and near the lower end of the upper portion 51 is an annular channel 56 which communicates with the space 52 through a port 57. The parts 53, 55, 56, and 57 are shown in the cross sectional views, Figs. 9 and 10. A shoulder or collar 58 is formed on the valve liner 50 in a position to rest against the upper end of the plug body 48 and to reside within the lower extremity of the major bore 31. Below the horizontal plane of the collar 58, a channel 59 is formed, which, as shown in Figs. 1, 11, and 13, communicates through a port 60 in the wall of the valve liner 50 and a passage 61 in the plug body 48 with a vertical passage 62 which connects with the lower end of the passage 42 formed in the lower portion of the valve body 28, so as to communicate with the exterior of the pump structure through the port 43 disposed at the upper end of the passage 42 as shown in Figs. 8 and 13. To preserve proper alignment of the cooperating passages in the valve body 28 and the plug body 48, a small sleeve 42*a* is placed in the lower end of the passage 42, as shown in Fig. 13, so as to project into the upper end of the passage 62 of the plug body 48.

Slidable within the valve body 28 is a piston valve 63 which is shown again in Fig. 14. This valve member 63 is of tubular form and has a minor portion 65 which is separated by a radial shoulder 66 from a major portion 67. The minor portion 65 of the valve member 63 is of smaller diameter than the major portion 67 and has an external surface 68 which fits the minor bore 29 of the valve body 28 in fluid-tight relation. The major portion 67 of the valve member 63 has an external surface 69 which is slidable within and fits the major bore 31 of the valve body 28 in fluid-tight relation. In the upper part of the minor portion 65 of the valve member 63 are primary valve ports 70 which connect the bore 71 of the minor portion 65 with the primary ports 33 at the upper ends of the primary passages 35 when the valve member 63 is in lowered or primary position, as shown in Fig. 14. In the major portion 67 of the valve member 63 are secondary valve ports 72 which connect the bore 73 of the major portion 67 with the secondary ports 36 at the upper ends of the secondary passages 37, when the valve member 63 is in raised or secondary position, as shown in Fig. 1. At the lower end of the minor portion 65 of the valve

member 63 is a shallow channel 74 which extends circumferentially around the valve member and constitutes a port for connecting the primary passages 35 with the discharge passage or port 38, as shown in Fig. 1, when the valve member 63 is in raised position, and for connecting the secondary passages 37 with the discharge passage 38, as shown in Fig. 6, when the valve member 63 is in lowered position. Slidable within the bore of the valve liner 50 in fluid-tight relation, and movable within the bore of the valve member 63 in spaced relation thereto, between the raised and lowered positions thereof shown in Figs. 1 and 14, is a pilot rod 76, the lower end of which is connected to the upper end of a power piston 77 adapted to be reciprocated within the power cylinder 46. A cavity 78 formed in the lower end of the plug body 48 constitutes a continuation of the bore of the cylinder liner 49, and the portion thereof above ports 79 forms a dashpot chamber for holding a body of fluid to control the movement of the power piston 77 when it is at and near the upper end of its stroke. The ports 79 communicate with vertical passages 80 formed in the wall of the plug body 48 and are so placed as to connect with the lower ends of the primary fluid passages 35 of the valve body 28.

The secondary fluid passages 37, which lead downwardly from the ports 36, connect with fluid passages 81 having the form of grooves in the external face of the plug body 48. The lower end of the power cylinder 46 has threads 82 for connecting it to an intermediate plug 83 which has an upwardly projecting extension 85 adapted to engage the lower end 86 of the liner 49 in fluid-tight engagement. In the upper end of the extension 85 a dashpot cavity 87 is formed, the side wall 88 thereof having ports 89 which connect the lower cylinder space 90 with an annular space 91 formed between the extension 85 and the wall 92 of the power cylinder 46, which space 91 is connected to the chamber 47 at the upper end of the cylinder 46 by means of passages 93 which are formed between the cylinder 46 and its liner 49.

A piston rod 95 extends downwardly from the power piston 77 through the intermediate plug 83 and a valve structure 96 disposed at the lower end thereof into engagement with the upper end of a pumping piston 97 which is reciprocable in a pumping cylinder 98. The pumping cylinder 98 has the same characteristics as the power cylinder 46 in having an upwardly extending wall 99 forming a cavity 100 adjacent the lower end of the intermediate plug 83 to which it is connected by means of threads 101. The lower end of the cylinder 98 comprises a downwardly extending wall 102 which forms a cavity 103 adjacent the upper end of an extension 105 forming a part of a lower plug 106 to which the wall 102 is connected by means of threads 107. By means of threads 108, a fitting 109 is connected to the lower end of the lower plug 106, this fitting 109 having a downwardly tapering wall 110 at the lower end thereof adapted to engage a conical seat 111 formed in a valve insert member 112 which is supported in a reducing fitting 113 which is connected by means of threads 115 to the lower end of a string of pipe 116 which extends to the top of the well and is of such diameter that the pump structure may be lowered thereinto into engagement with the seat member 112 as shown in Fig. 3. The lower end of the fitting 113 is threaded at 117 to receive an intake member 118 which serves as a gas anchor.

It will be noted that the pilot rod 76, the power piston 77, the piston rod 95, and pumping piston 97 are all equipped with axial passages 119, which passages 119 connect with an axial passage 120 extending through a rod 121 which projects downwardly from the pumping piston 97 through the valve structure 122 contained within the cavity 103, and through the lower plug 106 into a tubular member 123 which extends downwardly from the lower plug 106 and has the lower end thereof closed by means of a wall 124. The axial passages 119 conduct the power fluid from the space 53 at the upper end of the pump structure to the interior of the tubular member 123 so that the fluid pressure against the lower end of the rod 121 will balance the fluid pressure against the upper end of the pilot rod 76. In this manner a balanced condition of the reciprocating structure of the mechanism is attained. This subject matter is disclosed and claimed in my copending application, Serial No. 623,171, entitled "Liquid operated pump", filed July 18, 1932, to which reference is hereby made.

Oil from the well, which is to be pumped by the pumping piston 97, passes into the lower end of the pump structure through an opening 125 in the foot fitting 109, upwardly through the space within the fitting 109, as indicated by arrows 126, through openings 127 formed within the wall of the lower plug 106 into the annular space 128 formed in the cavity 103 around the valve structure 122, and through passages 129 between the cylinder wall 98 and its liner 130, which passages 129 connect the space 128 with the space 131 in the cavity 100 around the valve structure 96. Each valve structure 96 and 122 includes an annular insert body 132 having three L-shaped passages 133 through which oil may pass from the spaces 128 and 131 and through passages 135 into the upper and lower ends 136 and 137 respectively of pumping cylinder spaces formed within insert bodies 138 which are held against the ends of the liner 130. The inner ends of the passages 133 are normally closed against an outflow of fluid by check valve balls 139 which are urged against the inner ends of the passages 133 by means of spring-pressed rings 140. Also formed in the insert bodies 132 are a plurality of passages 141 which connect the passages 135 with annular spaces 142 formed respectively in the lower and upper ends of the plugs 83 and 106, there being passages 143 in the plugs 83 and 106 connecting the spaces 142 with the exterior of the plugs and consequently with the annular space 145 formed around the pump structure 24 within the piping 116. Accordingly, in the operation of the pump oil is drawn from the spaces 128 and 131 through the passages 133 into the ends of the pumping cylinder and is forced from the pumping cylinder through the passages 141 and 143 into the space 145 within the piping 116 which carries the discharge oil to the top of the well. The discharge passage 38, Figs. 1 and 5, also connects with the space 145 so that the discharge from the power cylinder combines with the pumped oil in the piping 116 and is conducted to the top of the well.

When the valve member 63 is in raised position as shown in Figs. 1 and 21, operating fluid under high pressure is delivered through the upper bore of this valve member 63, through the secondary valve port 72 and the ports 36, into the passages 37, from whence it is carried to the lower cylinder space 90 through the passages 81 and 93, the

space 91, and the ports 89. The force of the actuating fluid moves the power piston 77 upwardly. For the purpose of explaining the operation of the valve mechanism, let it be assumed that the power piston 77 in Fig. 21 has just reached its raised position, bringing the pilot rod 76 likewise into raised position and causing a spiral port or passage 146 formed intermediately in the pilot rod 76 to connect the port 60, also shown in Figs. 1, 11, and 13, with the port 57 which leads into the annular space 52 below the piston valve member 63. This will connect the space 52 with the body of fluid existing at low pressure exterior of the pump structure 24 so that fluid under pressure may readily flow from the space 52 outwardly through the port 57, downwardly through the spiral passage 146, and outwardly to discharge, as best shown in Fig. 13, through the channel 59 formed within the lower portion of the valve liner 50, the port 60, the passage 61, the passage 62, the passage 42, and the discharge passage or port 43 which communicates with the space 145 formed exteriorly of the pump structure 24 by the discharge piping 116.

The release of fluid from the annular space 52 in the manner just described permits the pressure of fluid against the upper end of the valve member 63 to move such valve member 63 downwardly toward a lowered position such as shown in Figs. 14 and 22, in which the primary ports 70 will communicate through the ports 33 leading into the upper ends of the primary passages 35, and in which position the shallow channel 74 of the valve member 63 will connect the ports 36 at the upper ends of the secondary passages 37 with the discharge port or passage 38. For producing a slow movement of the valve member 63 as it approaches the end of its downward movement, I provide a means for throttling the discharge of fluid from the space 52 through the port 57. Such means comprises an inner cylindrical wall portion 148 at the lower end of the valve member 63 which will close the port 57 as the valve member 63 approaches close to the end of its downward travel, so that the discharge of fluid from the space 52 will be practically shut off and so that further discharge of fluid from the space 52 must take place at reduced speed through a vertical passage 149 in the lower end of the valve member 63 which connects through a shallow annular space 150 in the lower portion of the valve member 63 with a spiral orifice or groove 151 formed in the major portion of the valve member 63 below the secondary ports 72. When the valve member 63 nears the lowered position in which it is shown in Fig. 1, the ports 72 will communicate with the channel 41 formed in the major portion 31 of the bore of the valve body 28, this channel 41 being connected through a passage 40 with the fluid under low or discharge pressure existing in the space 145 around the pump structure 24. Accordingly, fluid may flow slowly outwardly from the lower portion of the annular space 52 and through the flow restricting spiral orifice 151, and the downward movement of the valve member 63 may be completed at a reduced rate of speed.

The pilot rod 76 does not start to move downwardly from the raised position in which it is shown in Fig. 21 until the valve member 63 has moved from the position of Fig. 1 to the position of Fig. 22. The reversal of the flow of fluid to and from the power cylinder 46 causes the power piston 77 to move downwardly until finally the lower end of its movement is reached and the pilot rod 76 arrives at the position in which it is shown in Fig. 22, wherein a spiral port 152 at the upper end of the pilot rod 76 will connect the fluid under high pressure in the upper bore of the valve liner 50 with the port 55 which now, as shown in Figs. 14 and 22, communicates through the shallow annular space 150 and the passage 149 of the valve member 63 with the lower end of the annular space to introduce fluid under pressure into the lower end of the space 52 and against the lower end of the valve member 63. In view of the fact that the cross sectional area of the lower end of the piston 63 is greater than the cross sectional area of the upper end of the member 63, the fluid operating under high pressure in the lower end of the annular space 52 will force the valve member 63 upwardly against the downward pressure of fluid in the space 153 at the upper end of the valve body 28, and consequently the valve member 63 will move upwardly toward the raised position in which it is shown in Figs. 1 and 21. As the valve member approaches the upper end of its movement, the annular wall portion 148 will close the port 55 so that fluid under pressure cannot thereafter enter the space 52 through such port 50 but must travel downwardly through the spiral orifice 151 which is now in such condition near the upper end of the valve liner 50 that it may receive fluid under pressure from the space 153 through the bore of the valve member 63. Accordingly, the remainder of the upward movement of the valve member 63 will be controlled to a slow speed by the reduction of the flow of fluid into the space 52 by the spiral orifice 151. The spiral orifice 151 communicates with the orifice or discharge passage 40 when the valve member is in lowered position, as shown in Figs. 14 and 22, and the spiral orifice 151 communicates with fluid under pressure through the bore of the valve member 63 when such valve member is in raised position, as shown in Figs. 1 and 21. Accordingly, the spiral orifice operates in both lowered and raised positions of the valve member 63 to provide a locking means for holding the valve member 63 in its extreme positions during the periods of time consumed by the travel of the pilot rod 76 between its raised and lowered positions. It is to be understood that the diagrammatic Figs. 21 and 22 do not represent the actual method of assembling the elements, and that they are provided merely for the purpose of facilitating an understanding of the method of operation of the invention.

In a pump of the character shown difficulty has been experienced from the encountering of pockets of gas in the oil to be pumped, and the various expedients employed, such as gas anchors, etc., have not been successful in avoiding injury of the pump due to racing thereof and due to the reciprocating parts striking walls at the ends of their paths of movement. It is found that where gas enters the pumping cylinder so that the pumping load is practically removed, the pump will start to race, and there is great danger of the pump pistons becoming injured or upset at the ends due to striking the end walls of the pump cylinder. In my invention I provide an effective means for controlling the acceleration and deceleration of the piston and cooperating reciprocating parts at and near the ends of their upward and downward strokes and cushioning the ends of the movement of the reciprocating parts of the pump so that certain of the walls of the pumping unit are relieved of sudden strains and

so that danger of injury to the pump due to racing is decreased to a minimum. This I accomplish by forming a fluid or dashpot space 155 in the upper part of the cavity 78 above the inlet ports 79 leading into the upper end of the power cylinder, and also a dashpot space 156 in the lower part of the cavity 87 below the ports 89 forming fluid inlets for the lower end of the power cylinder. The piston 77 at the upper end of its movement is received against a body of fluid contained in the dashpot space 155 so that it is stopped with a cushioned effect and without metal-to-metal contact with the upper end wall of the cavity 78. Likewise, at the end of its downward movement, as shown in Fig. 15, the piston 77 comes against a body of fluid in the dashpot space 156, and its downward movement is accordingly brought to a cushioned stop.

The upper dashpot space 78 is formed within the lower end of the plug body 48 which is clamped between the lower extremity of the valve body 28 and the upper end of the power cylinder liner 49 when the power cylinder 46 is threaded onto the lower end of the valve body 28, as shown in Fig. 1.

Illustrative of the method of controlling the acceleration and deceleration of the piston structure, it may be pointed out that at the ports 79 and 89 the forward end portions of the side walls of the dashpots 155 and 156 are flared or given a material clearance over the diameter of the piston 77 and are constricted rearwardly to a small clearance over the piston diameter. For example, the dashpots may have a clearance of .100 inch at their outer ends and .002 inch at their rearward or inner ends. By the use of an arrangement such as set forth above, the flow of fluid from the dashpot spaces at the ends of the piston will be controlled so as to bring the piston to a smooth and gradual stop at the end of each stroke, and the control of fluid into the dashpot spaces at the ends of the piston will produce a gradual start of the piston from a position of rest.

Contributing to the present invention is the novel manner of forming the parts so that the many, and somewhat complex, fluid passages may be readily formed and so that the wear sustaining parts may be replaced after the pump has outlived its original usefulness. It is necessary to form in the valve body 28 primary and secondary fluid passages 35 and 37 and to provide means for connecting these fluid passages respectively with the upper and lower ends of the power cylinder. In my present structure this is accomplished through the use of the plug body 48 in which a plurality of holes 80 are drilled downwardly in positions to communicate with the lower ends of the passages 35. By use of a small milling cutter, shallow depressions are cut in the wall forming the cavity 78 so as to form ports 79 connecting with the lower ends of the passages 80. In order to connect the secondary passages 37 of the valve body 28 with the lower end of the power cylinder, I first provide external grooves 81 in the plug body 48, and then form the liner 49 with external grooves so that when the cylinder 46 is shrunk upon the liner 49, passages 93 will exist, which passages connect the channels 81 of the plug body 48 with the annular space 91 in the lower end of the cylinder 46, connection with the cylinder space being finally accomplished through the ports 89 in the wall 88 which separates the dashpot space 156 from the annular space 91.

It is also necessary in a pump of this character to provide a means for delivering the fluid which is to be pumped to both the upper and lower ends of the pumping cylinder 98 and to provide valve means within the pump structure for controlling the intake and discharge of fluid relative to both ends of the pumping cylinder space. To simplify the construction in this respect, I provide an annular space around each of the valve structures 96 and 122, respectively within the tubular end walls 99 and 102 of the pumping cylinder 98, and connect these respective annular spaces 131 and 128 with the inlet tube 118 which extends downwardly from the fitting 113 with which the lower end of the pump structure 24 is in sealed engagement as the result of the lower extremity 109 of the fitting 108 resting within the seat 111. The lower plug 106 has passages 127 which extend upwardly from the lower end thereof and through lateral ports 157 connect with the space 128, which space in turn connects with the passages 129 leading upwardly around the liner 130 of the pumping cylinder 98 into the space 131 around the valve structure 96. The valve structure 96, which includes an insert plug 138, is clamped between the lower end of the intermediate plug 83 and the upper end of the liner 130, and the lower valve structure 122, which includes an insert plug 138, is clamped between the lower end of the liner 130 and the upper end of the lower plug 106. Before the walls 99 and 102 are threaded tightly onto the intermediate and lower plugs 83 and 106 respectively, such walls 99 and 102 are heated so as to produce expansion thereof. They are then screwed up tightly with respect to the plugs 83 and 106 and contract on cooling so as to move the ends of the liner 130 respectively toward the plugs 83 and 106, thereby clamping the valve structures 96 and 122 in fluid-tight relation to those parts with which they have end-to-end engagement, as shown in Figs. 2 and 3.

It will be recognized that the valve liner 50 and the plug body 48 could have been made in a single part, but the valve liner 50 is subject to wear, and replacement thereof may be now made without the necessity of providing a new plug body 48, since the plug body 48 may be expanded and the worn valve liner removed therefrom, after which a replacement valve liner 50 may be inserted in the plug body 48, enabling the plug body 48 to be continuously employed. The intermediate plug 83 is provided with a removable liner 158 which is initially made slightly oversize and is placed within the bore of the intermediate plug by pressing into place. The liner 158 is in this manner placed under an initial stress so that it will not undergo an additional circumferential reduction due to high pressure fluid which may work into the bore of the intermediate plug 83 around the exterior of the liner 158. The lower plug 106 is likewise fitted with a replaceable liner 160. The rods 76, 95, and 121 are hollow for the purpose of transmitting fluid under high pressure to the space within the tubular extension 123 so as to balance the fluid pressures against the ends of the rod assembly, and so as to deliver clean fluid under pressure through axial passages 161 in the pistons 77 and 97 to the intermediate external grooves 162 of such pistons 77 and 97, to amply lubricate the power piston 77, and to wash the wall of the liner 130 and the exterior face of the piston 97 with clean fluid while at the same time lubricating these surfaces.

The rods 76, 95, and 121 are connected to the pistons 77 and 97, in the manner shown, by use

of external threads 163 on the rods which engage threads 164 formed near the inner ends of counterbores 165 in the pistons 77 and 97, the rods having conical ends 166 at the extreme ends thereof which engage conical seats 167 at the inner extremities of the counterbores 165 so that a positive fluid seal is thereby formed between the ends of the rods and the pistons which they engage. A feature of the invention is to provide a means for connecting the rods to the pistons so that they will be practically concentric, but at the same time the rods are provided with sufficient flexibility of connection with the pistons to compensate for small deviations from perfect axial alignment of cooperating parts. To accomplish this result, each of the counterbores 165 has an intermediate bore portion 170 formed adjacent the outer ends of the threads 164 which is ground to fit snugly that portion 171 of the rod adjacent the threads 163, thereby producing an axial alignment of the end of the rod which is independent of the threads 163 and 164. Each of the counterbores 165 has an outer bore portion 172 which is ground to a diameter slightly larger than the rod so that the portion 173 of the rod within the outer end of the counterbore 165 may flex laterally should the rod be slightly out of alignment with other parts of the pump structure with which it cooperates. For this purpose the outer bore portion 172 may be ground to a diameter approximately .002 inch greater than the diameter of the portion 173 of the rod. By use of a construction as hereinabove described, the end of each rod 76, 95, and 121 is given a spaced two-point centralizing engagement with the piston to which it is attached. For instance, the conical end 166 of each rod engages a conical seat 167 at the inner end of a counterbore 165, and a portion 171 of the rod spaced from the end thereof engages an intermediate portion 170 of the counterbore 165. Beyond the intermediate portion 170 the rod may flex within the outer end portion 172 of the counterbore 165 should minute disalignment of cooperating parts require the same.

Although I have herein shown and described my invention in simple and practical form, it is recognized that certain parts or elements thereof are representative of other parts, elements, or mechanisms which may be used in substantially the same manner to accomplish substantially the same results; therefore, it is to be understood that the invention is not to be limited to the details disclosed herein but is to be accorded the full scope of the following claims.

I claim as my invention:

1. A deep well pump of the character described, including: a vertically elongated tubular structure having a power cylinder and a pumping cylinder formed therein; a power piston in said power cylinder; a pumping piston in said pumping cylinder; a rod connecting said pistons together; valve means operative to control the delivery of fluid pressure to said power cylinder to actuate said power piston; check valve means for controlling the inlet and discharge of pumped fluid relative to said pumping cylinder; and walls forming dashpots at both ends of said power cylinder for controlling the ends of the reciprocating movement of said power piston therein.

2. A deep well pump of the character described, including: a vertically elongated tubular structure having a power cylinder and a pumping cylinder formed therein; a power piston in said power cylinder; a pumping piston in said pumping cylinder; a rod connecting said pistons together; valve means operative to control the delivery of fluid pressure to said power cylinder to actuate said power piston; check valve means at both ends of said pumping cylinder for controlling the inlet and discharge of pumped fluid relative to said pumping cylinder; and walls forming dashpots at both ends of said power cylinder for controlling the ends of the reciprocating movement of said power piston therein.

3. In a deep well pump of the character described, the combination of: a valve body adapted to be secured to the lower end of a pressure fluid delivery tube; walls forming a power cylinder at the lower end of said valve body, there being passages extending from said valve body to the upper and lower ends of said power cylinder; a power piston operative in said power cylinder; control valve means in said valve body for controlling the delivery of pressure fluid into said passages and the opening of said passages to discharge in a manner to produce reciprocation of said power piston; a connecting rod extending downwardly from said power piston; a plug member at the lower end of said power cylinder having an opening through which said rod extends; a pumping cylinder connected to the lower end of said plug member; a pumping piston operative in said pumping cylinder, said pumping piston being connected to the lower end of said connecting rod; check valve means for said pumping cylinder; and walls at the upper and lower ends of said power cylinder forming dashpots for controlling the end movements of said power piston.

4. A deep well pump of the character described, including: a vertically elongated tubular structure having a power cylinder and a pumping cylinder formed therein; a power piston in said power cylinder; a pumping piston in said pumping cylinder; a rod connecting said pistons together; a pipe member for conveying an operating fluid from a source of supply to the pump structure; valve means between said pipe member and said power cylinder operative to control the delivery of operating fluid to said power cylinder to actuate said power piston, there being means for controlling the flow of said operating fluid to and from the end of said power cylinder whereby to control the acceleration and deceleration of said pistons; and check valve means for controlling the inlet and discharge of pumped fluid relative to said pumping cylinder.

5. A deep well pump of the character described, including: a vertically elongated tubular structure having a power cylinder and a pumping cylinder formed therein; a power piston in said power cylinder; a pumping piston in said pumping cylinder; a rod connecting said pistons together; valve means operative to control the delivery of fluid pressure to said power cylinder to actuate said power piston, there being means for controlling the flow of fluid to and from the ends of said power cylinder whereby to control the acceleration and deceleration of said pistons; and check valve means for controlling the inlet and discharge of pumped fluid relative to said pumping cylinder.

6. A deep well pump of the character described, including: a pipe member for receiving an operating fluid from a source of supply and delivering the same to the pump; a vertically elongated tubular structure having a power cylinder and a pumping cylinder formed therein; a power piston in said power cylinder; a pumping piston in said pumping cylinder; a rod connecting said

pistons together; valve means disposed between said pipe member and said power cylinder to control the delivery of operating fluid to said power cylinder to actuate said power piston; check valve means for controlling the inlet and discharge of pumped fluid relative to said pumping cylinder; and walls forming a dashpot in an end of said power cylinder for controlling the end movement of said power piston.

7. A deep well pump of the character described, including: a pipe member for extending down into a well to convey an operating fluid from a source of supply; a pump body having a double acting power cylinder and a pumping cylinder formed therein; a double acting power piston in said power cylinder; a pumping piston in said pumping cylinder; means connecting said pistons together; valve means between said pipe member and said power cylinder to control the delivery of operating fluid to said power cylinder whereby to reciprocate said power piston; valve means for controlling the inlet and discharge of pumped fluid relative to said pumping cylinder; and dashpot means connected to said power piston so as to control the end movement of said power piston, said dashpot means comprising chambers receiving operating fluid which has been delivered to said pump body through said pipe member.

8. A deep well pump of the character described, including: a pipe member for receiving an operating fluid from a source of supply and delivering the same to the pump; a vertically elongated tubular structure having a power cylinder and a pumping cylinder formed therein; a power piston in said power cylinder; a pumping piston in said pumping cylinder; a rod connecting said pistons together; valve means disposed between said pipe member and said power cylinder to control the delivery of operating fluid to said power cylinder to actuate said power piston; check valve means for controlling the inlet and discharge of pumped fluid relative to said pumping cylinder; and walls forming a dashpot means connected to said power piston, said dashpot means being connected so as to receive operating fluid which has been delivered through said pipe member from said source of supply.

9. In a deep well pump, the combination of: a fluid operated motor, including a power cylinder having two ends and a power piston adapted to reciprocate therein; means for delivering an operating fluid under pressure to said motor so as to reciprocate said power piston; a fluid pump adapted to pump fluid from a well, including a pumping cylinder having a pump piston therein; means for operatively connecting said power piston to said pump piston so that actuation of said power piston will actuate said pump piston to pump fluid from said well; and means associated with said power piston and said power cylinder to prevent hammering of said power piston against either end of said power cylinder when the pumping load on said pump is substantially decreased.

10. In a deep well pump, the combination of: a fluid operated motor, including a power cylinder having two ends and a power piston adapted to reciprocate therein; means for delivering an operating fluid under pressure to said motor and alternatively to opposite ends of said power piston so as to reciprocate said power piston; a fluid pump adapted to pump fluid from a well, including a pumping cylinder having a pump piston therein; means for operatively connecting said power piston to said pump piston so that actuation of said power piston will actuate said pump piston to pump fluid from said well; and means associated with said power piston and said power cylinder to prevent hammering of said power piston against either end of said power cylinder when the pumping load on said pump is substantially decreased.

11. In a deep well pump, the combination of: a fluid operated motor, including a power cylinder and a power piston adapted to reciprocate therein; valve means for delivering a continuous flow of operating fluid under pressure alternatively to opposite ends of said power piston so as to reciprocate said power piston; a fluid pump adapted to pump fluid from a well, including a pumping cylinder having a pump piston therein; means for operatively connecting said power piston to said pump piston so that actuation of said power piston will actuate said pump piston to pump fluid from said well; and a dashpot in each end of said power cylinder for controlling end movement of said power piston.

12. In a deep well pump, the combination of: a fluid operated motor, including a power cylinder and a power piston adapted to reciprocate therein; valve means for delivering a continuous flow of operating fluid under pressure alternatively to opposite ends of said power piston so as to reciprocate said power piston; a fluid pump adapted to pump fluid from a well, including a pumping cylinder having a pump piston therein; means for operatively connecting said power piston to said pump piston so that actuation of said power piston will actuate said pump piston to pump fluid from said well; and a dashpot in each end of said power cylinder for controlling acceleration of said power piston at the beginning of each stroke thereof.

13. In a deep well pump, the combination of: a fluid operated motor, including a power cylinder and a power piston adapted to reciprocate therein; valve means for delivering a continuous flow of operating fluid under pressure alternatively to opposite ends of said power piston so as to reciprocate said power piston; a fluid pump adapted to pump fluid from a well, including a pumping cylinder having a pump piston therein; means for operatively connecting said power piston to said pump piston so that actuation of said power piston will actuate said pump piston to pump fluid from said well; and a dashpot in each end of said power cylinder for controlling deceleration of said power piston at the end of each stroke thereof.

14. In a deep well pump, the combination of: a fluid operated motor, including a power cylinder and a power piston adapted to reciprocate therein; valve means for delivering a continuous flow of operating fluid under pressure alternatively to opposite ends of said power piston so as to reciprocate said power piston; a fluid pump adapted to pump fluid from a well, including a pumping cylinder having a pump piston therein; means for operatively connecting said power piston to said pump piston so that actuation of said power piston will actuate said pump piston to pump fluid from said well; and a dashpot in each end of said power cylinder for controlling acceleration and deceleration of said power piston at the beginning and end of each stroke thereof.

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Disclaimer

2,081,223.—*Clarence J. Coberly*, Los Angeles, Calif. FLUID OPERATED DEEP WELL PUMP. Patent dated May 25, 1937. Disclaimer filed Dec. 17, 1951, by the assignee, *Dresser Equipment Company.*

Hereby enters this disclaimer to claims 1, 4, 5, 6, 7, 8, and 9 of said patent.

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