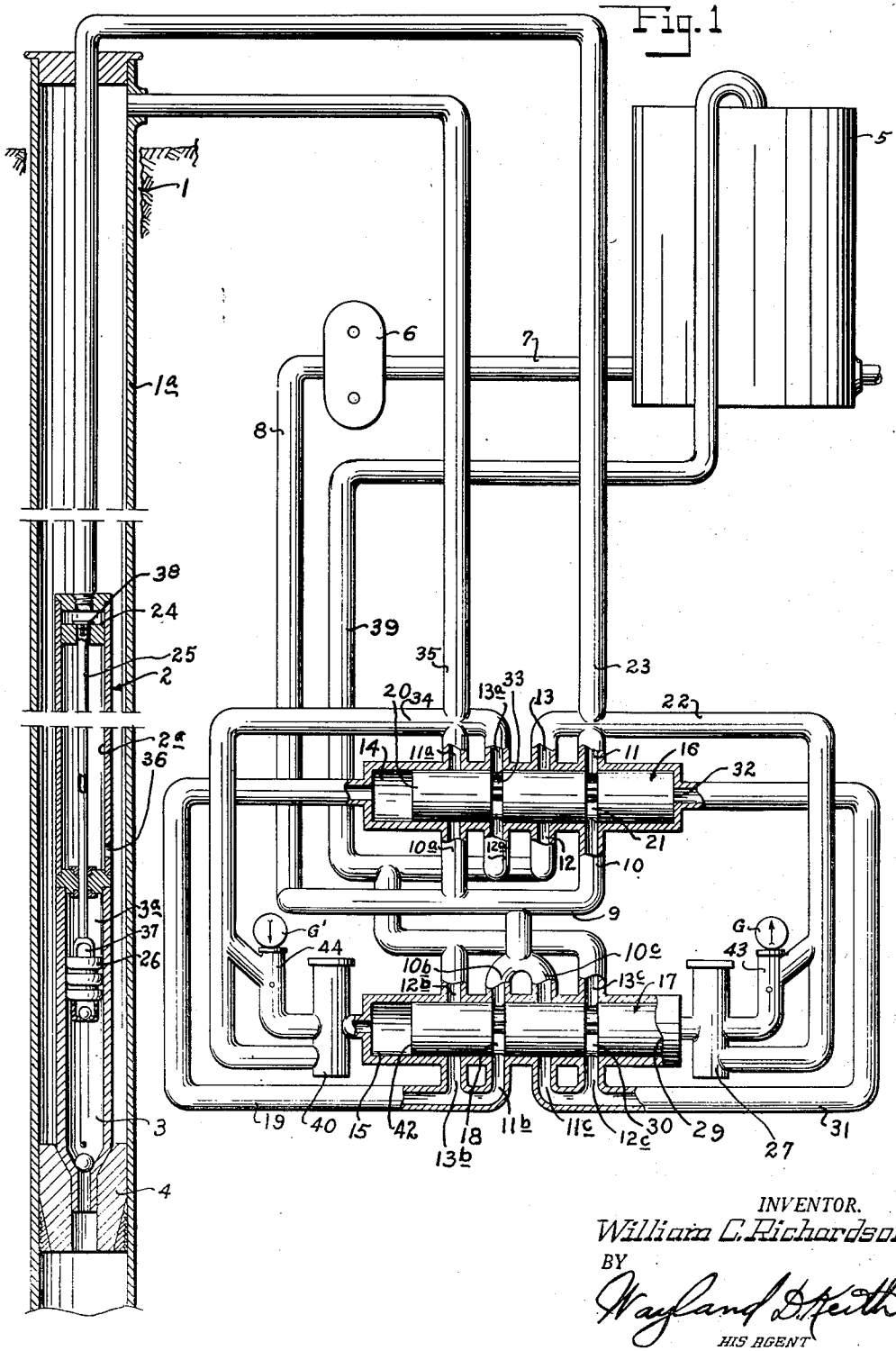
May 17, 1955 W. C. RICHARDSON 2,708,411

CONTROL MECHANISMS

Filed May 5, 1950

4 Sheets-Sheet 1

Fig. 1



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CONTROL MECHANISMS

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4 Sheets-Sheet 2

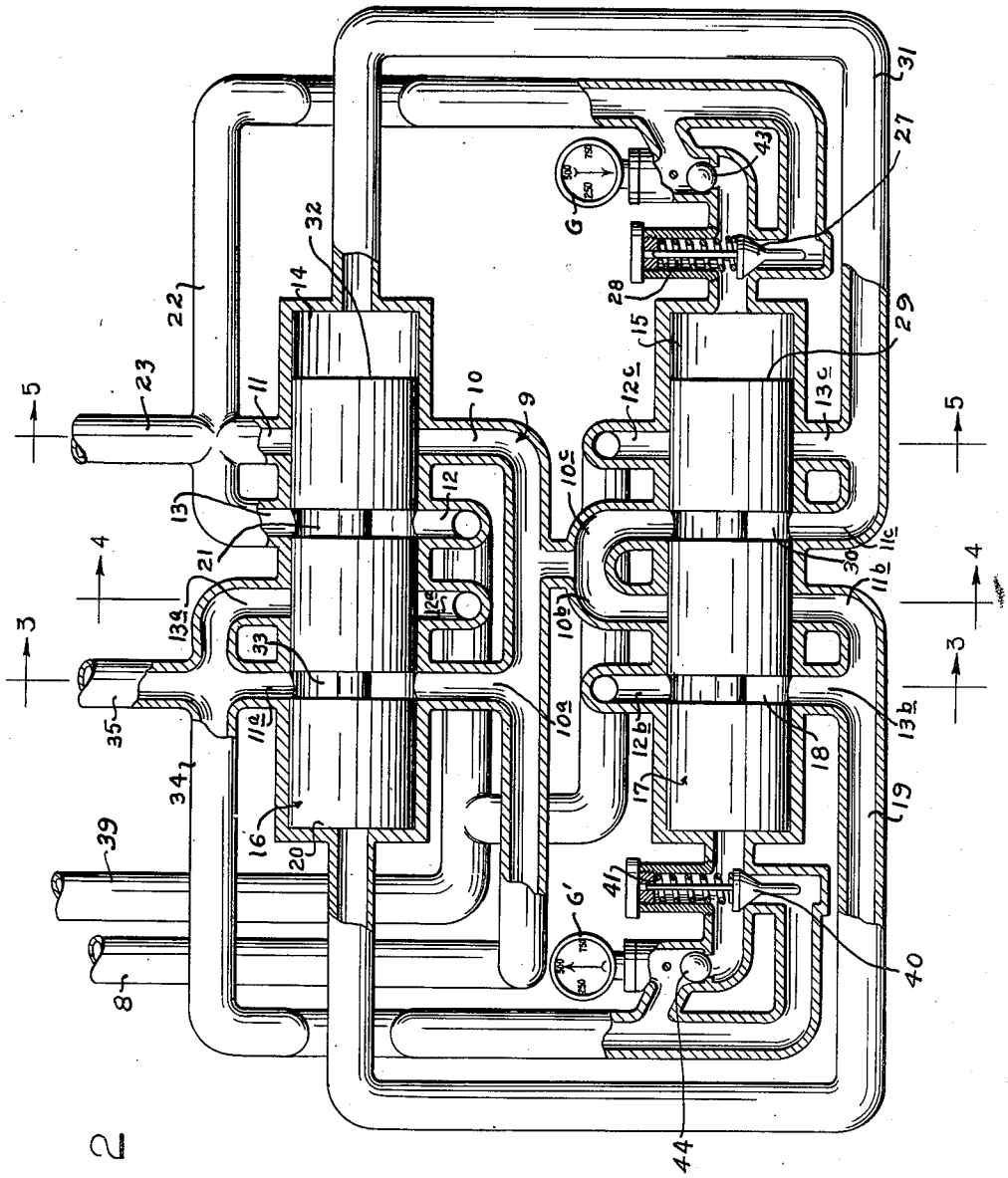

Fig. 2

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Fig. 3

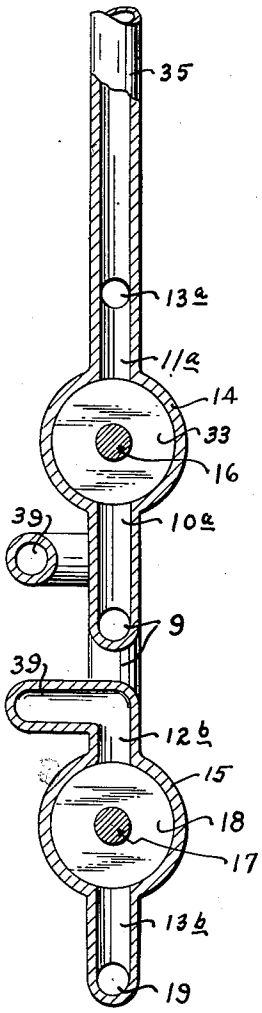


Fig. 4

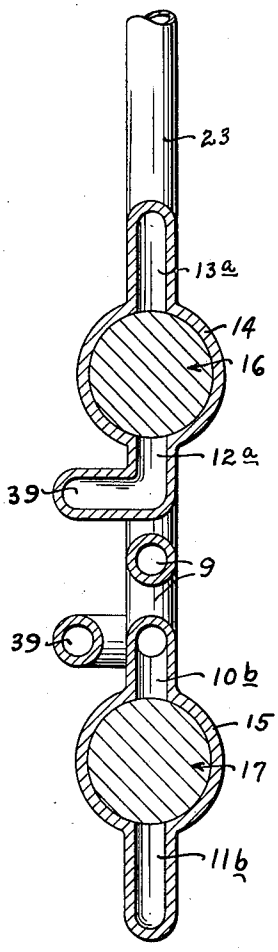
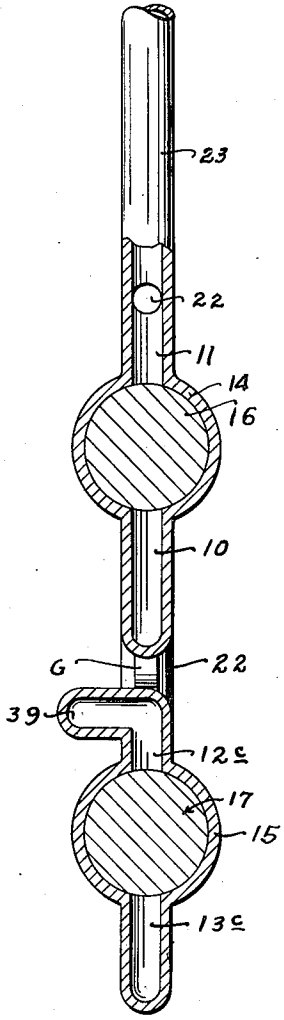


Fig. 5



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CONTROL MECHANISMS

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Fig. 6

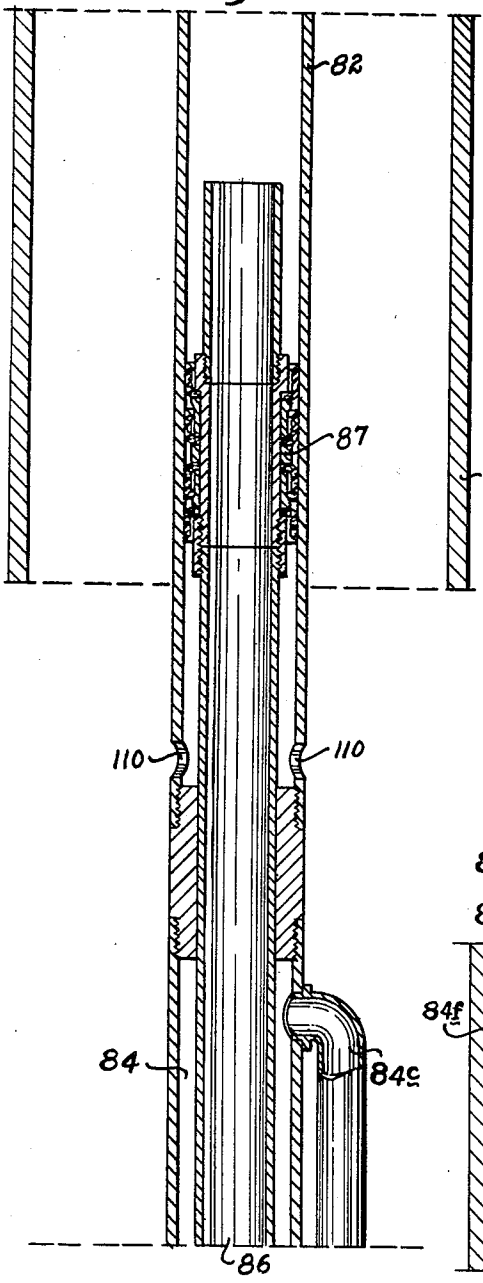
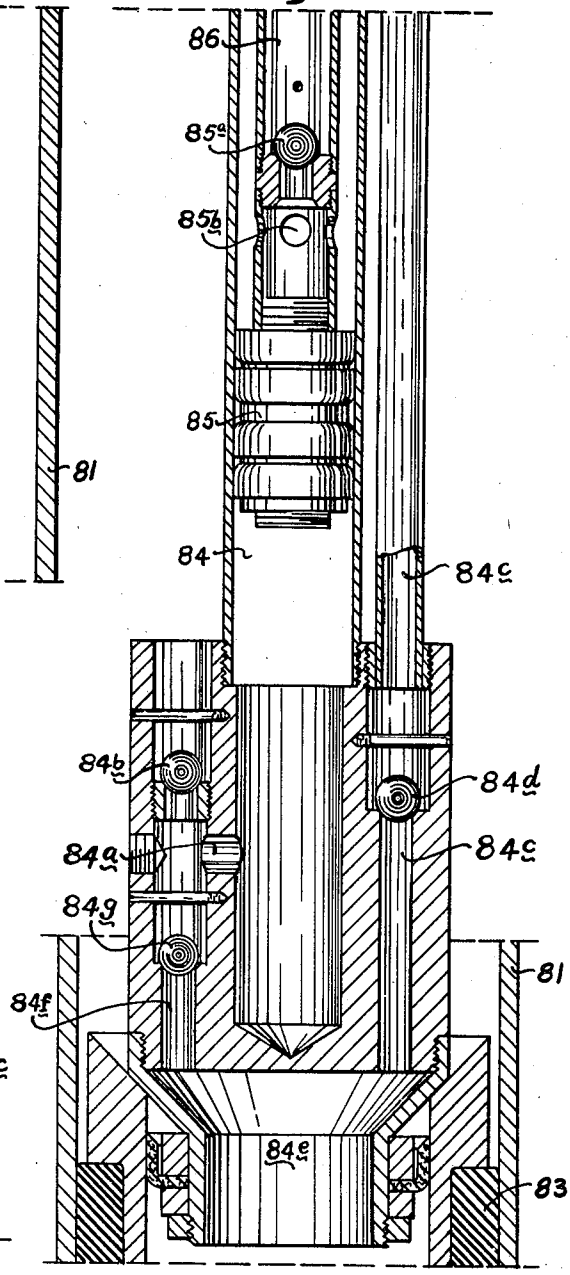


Fig. 7



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United States Patent Office

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CONTROL MECHANISMS

William C. Richardson, Electra, Tex.

Application May 5, 1950, Serial No. 160,209

14 Claims. (Cl. 103—44)

This invention relates to improvements in fluid actuating and control mechanisms and more particularly to the mechanism used for directing the flow of fluid medium, such as oil, to a hydraulic motor element within a well to actuate a reciprocating pump therein.

The present invention is an improvement over my prior Patent No. 2,245,501, Reciprocating Pumps, issued June 10, 1941, and over my prior application Ser. No. 696,483, Reciprocating Pumps, filed September 12, 1946, now Patent No. 2,628,565.

In the pumping of deep wells with a reciprocating pump, difficulty has been experienced because of the stretching of the rods, which prevents a full stroke of the pump and therefore impairs the efficiency thereof. The use of hydraulically operated pumps within the well has been practiced heretofore, but due to the complexity of the motor and valve arrangement of such mechanisms and the delicacy thereof such pumps readily get out of order and have been unsatisfactory under general working conditions.

In the present pump, operating factors have been taken into consideration and the pump control mechanism has been designed to operate on the oil or water that is being pumped from the well without having to use a special fluid or to filter out the foreign particles that may be present therein.

The primary object of this invention is to provide a simple, efficient hydraulic fluid control mechanism for reciprocating pumps that is positive in action and the valves of which will not clog, stick, or get on-center under normal operating conditions.

Another object of this invention is to provide a hydraulic fluid control mechanism which may be located above the ground so as to direct hydraulic actuating fluid to a hydraulic motor apparatus to operate either a single or double acting fluid pump positioned within a deep well.

Another object of the invention is to provide a hydraulic fluid control mechanism which does not require catch mechanisms to hold or to release the valves and which operates on a predetermined setting of a spring pressed valve.

Another object of this invention is to provide a unitary compact structure which may be easily installed and which will operate trouble free over a long period of time.

An embodiment of this invention is illustrated in the accompanying drawings in which:

Fig. 1 is a diagrammatic view, partly in elevation and partly in section of a fluid control unit, pump, storage tank, and a vertical section through a well showing the hydraulic motor and pump installed therein;

Fig. 2 is an enlarged view of the control mechanism shown in a different position from that shown in Fig. 1;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2, looking in the direction indicated by the arrows;

Fig. 4 is a sectional view taken on the 4—4 of Fig. 2, looking in the direction indicated by the arrows;

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 2, looking in the direction indicated by the arrows.

Fig. 6 is a fragmentary longitudinal sectional view of a portion of the reciprocating motor and the upper portion of the double acting reciprocating pump shown in a well casing; and

Fig. 7 is a longitudinal sectional view through the lower portion of the double acting reciprocating pump showing the pump resting on a packer within the well casing.

With more detailed reference to the drawing, the numeral 1 designates a deep well in which a hydraulically actuated reciprocating motor 2 is positioned. The hydraulic motor is designed to operate either a single or double acting pump 3, which may be attached to the lower end of the tubing in a well or it may be seated on a packer 4 so as to withdraw oil from the well 1. The system is supplied with a storage tank 5 which serves both to store the hydraulic fluid used in pumping the oil or water, and the oil or water that is being pumped from the well. A pump 6 is provided for withdrawing oil or hydraulic fluid from tank 5 through conduit 7 for discharging it through conduit 8 into manifold 9, which manifold has branch conduits or outlets 10, 10*a*, 10*b*, and 10*c*. Conduits 11, 11*a*, 11*b*, and 11*c* in the cylinders 14 and 15, connect with the respective branch conduit outlet openings 10, 10*a*, 10*b*, and 10*c*. Directional control slide valve member 16 and pilot slide valve member 17 each serve the double purpose of functioning as both pistons and valves, and are positioned within the respective cylinders 14 and 15. These slide valve members are so positioned as to shift when a predetermined amount of pressure is applied in the pump system by the pump 6. The hydraulic fluid is withdrawn from tank 5 through conduit 7 into pump 6 and is discharged through conduit 8 into manifold 9 with the slide valves 16 and 17 positioned as shown in Fig. 1, the fluid will be directed through conduit 10*b*, passage 18, in slide valve 17, into passage 11*b* and conduit 19 to react upon the end of piston 20 to hold the slide valve 16, as indicated in Fig. 1.

Simultaneously, with the above set forth action, fluid will be directed under pressure through conduit 10, annular passage 21, into conduit 11 and simultaneously into conduits 22 and 23. The fluid directed into conduit 23 will react on top of piston 24 in the hydraulic pump motor 2 to force the piston downward to the end of the stroke. In so doing the hollow connecting rod 25 will react on pump plunger 26 to move the plunger and valve downward. When the piston 24 reaches the end of the stroke, pressure will be built up in conduits 22 and 23 and when the fluid within conduit 22 reaches a predetermined amount of pressure, spring pressed valve 27 will be opened against tension of spring 28 to allow hydraulic fluid to react on piston face 29 which will move slide valve 17 to the opposite end of cylinder 15, as shown in Fig. 2. In so doing the slide valve 17 will close passage connecting conduits 10*b* and 11*b* and open passages between conduits 10*c* and 11*c*. This will direct fluid under pressure through manifold 9, through conduit 10*c*, passage 30 and into conduit 11*c* into conduit 31 to direct fluid pressure to the face of piston 32 which will move slide valve 16 to the position as shown in Fig. 2. In so doing the annular groove 21 will move out of register with openings in conduits 10 and 11 and move into register with conduit openings 12 and 13 and also cause annular groove 33, in slide valve 16, to move out of register with conduit openings 12*a* and 13*a* and into register with conduit openings 10*a* and 11*a*.

With slide valves 16 and 17 in the position as shown in Fig. 2, and with the annular grooves 18 in register with conduit openings 12*b* and 13*b* and with annular

groove 30 out of register with conduit openings 12c and 13c, the mechanism is positioned for the reverse cycle operation of the pump. With the valve mechanism positioned as shown in Fig. 2, oil or other operating fluid will be withdrawn from tank 5 through conduit 7 by pump 6 and directed out through conduit 8 into manifold 9 through conduit outlet 10a into conduit 11a and thence simultaneously into conduits 34 and 35 into casing 1a of the well 1, which will direct fluid into openings 36 in the lower end of cylinder 2a of the hydraulic motor 2. This will cause piston 24 to move upward, which in turn moves the pump plunger 26 upward. The oil that is entrapped above the pump plunger 26 within the cylinder 3a of the pump 3 will be forced through opening 37 into hollow connecting rod 25 and outward through the upper end of piston 24 and through check valve 38 into conduit 23, conduit 13, annular groove 21 in slide valve 16 and into conduit 12 that connects with conduit 39 that leads to the storage tank 5.

Simultaneously with the application of pressure to conduits 34 and 35, fluid pressure will be directed through conduit 34 to the lower side of valve 40 and when the piston 24 reaches the upper-most point of its stroke the fluid pressure will be built up within conduits 34 and 35 to a predetermined amount, which will cause spring 41 to yield and react on the face of piston 42 to move slide valve 17 to the opposite end of cylinder 15. In so doing the fluid entrapped within the right hand end of cylinder 15 will be expelled outward past ball check valve 43 into conduit 22 and into conduits 13 and 39 leading to storage tank 5. After the slide valve 17 has moved into register with conduits 10b and 11b and 12c and 13c, the cycle is repeated.

A ball check valve 44 is provided to permit outward flow of fluid when slide valve 17 moves to the left in the repetition of the above mentioned cycles.

It is to be understood that the invention is directed primarily to the fluid control mechanism, as shown in Fig. 2 and in the schematic diagram shown in Fig. 1, and is indicated for use either with a single or double acting pump within a well. Both single and double acting pumps are disclosed in detail in Figs. 4 to 8, and 20 and 21 of my prior application Ser. No. 696,483, filed September 12, 1946, for Reciprocating Pumps, now Patent No. 2,628,565.

With the hydraulic pump control mechanism as shown in Fig. 2, any type of liquid medium may be used to pump any kind of liquid medium from a well to actuate and operate the pump within the well. In this manner the exhausted liquid medium is exhausted directly into the fluid system and be pumped either outward through the casing and conduit 35 through conduits 13a, groove 33 conduit 12a and into conduit 39 and into tank 5 or out through conduit 23, conduit 13, groove 21, conduit 12 into conduit 39 and into tank 5 when a double acting pump is used. By having the entire hydraulic control mechanism positioned above the ground, the valves 27—40, springs 28 and 41 and the ball check valves 43 and 44 are available for repair and adjustment in a very short time, without disturbing the pump or the hydraulically actuated motor in the well.

In order to change the actuation pressure of the hydraulic motor in the well, it is necessary only to replace the springs 28 and 41 with stronger or weaker springs to give a higher or lower actuation pressure on the hydraulic motor 2 in the well. The valves 27 and 40 may be made sufficiently large so they will not readily clog with small particles of foreign matter such as sand and the like.

A modified form of pump for use with the control mechanism as shown in Figs. 1 and 2, is shown in Figs. 6 and 7, which pump is of the double acting type, that is, the pump, when reciprocated, will pump fluid from the well on its down stroke, as well as on the up stroke. The numeral 81 designates a well casing which may be substituted for the lower portion of the casing 1a as shown below the upper break in Fig. 1, and the tubular portion 82 substituted for the lower portion of tubular conduit 23. This will enable pressure fluid forced down through tubular conduit 23 into cylinder 82 to react on reciprocating piston 87 of the hydraulic motor to force plunger rod 86 downward, which plunger rod interconnects piston 87 within the motor with piston 85 within the reciprocating pump. A check valve 85a prevents the hydraulic fluid passing downward through conduit 23 and pump cylinder 82 from entering the working barrel 84 of the fluid pump. Upon the hydraulic fluid forcing pistons 87 and 85 downward, the hydraulic fluid entrapped in cylinder 82 below piston 87 will be forced outward through openings 110 into casing 81 to flow upward through casing 1a and out through conduit 35. At the same time, fluid entrapped in cylinder 84 below piston 85 will be forced outward through passage 84a and upward past check valve 84b into casing 81 to flow upward therethrough and out into conduit 35 with the hydraulic fluid exhausted from the lower portion of cylinder 82. As the piston 85 travels downward in cylinder 84, a suction is created above piston 85 to draw fluid upward through passage 84c past check valve 84d through conduit 84e and into cylinder 84 above piston 85. When the pistons 84 and 85 reach the end of the down stroke, the hydraulic pressure built up within cylinder 82 will cause the pump 6, upon continued operation, to increase pressure in conduits 8 and 22, which will cause relief valve 27 to open and permit the entrance of hydraulic fluid into the end of cylinder 15 adjacent said valve. The spring 28 is so regulated as not to yield until the pistons 85 and 87 have reached the end of the down stroke, after which, the hydraulic pressure will move slide valve member 17 to the position indicated in Fig. 2 to cause passages 18 and 30 to become aligned with passages 12b and 13b; and 10c and 11c respectively. However, before doing so the hydraulic fluid and the fluid being pumped will exhaust through conduit 13a, through passage 33, conduit 12a into conduit 39 leading to reservoir 5.

After the valve 17 is switched, pump pressure is applied to the right hand end of valve 16 to switch the valve into the position as shown in Fig. 2, whereupon the pressure from pump 6 will be directed through conduits 8 and 10a, through passage 33 into conduit 35 to exert a pressure upon the annular space within casing 1a—81 and with the openings 110 in communication with the annular space in the casing, the piston 87, connecting rod 86 and piston 85 will be moved upward and the fluid being pumped entrapped above piston 85 within cylinder 84 will be forced into tubular connecting rod 86 through openings 85b and upward past check valve 85a through the upper end of cylinder 82 into conduit 23 and exhaust with the hydraulic fluid being discharged from cylinder 82 through conduit 13, passage 21, conduit 12, into conduit 39 leading to the reservoir 5. The discharge will continue until the pistons 85 and 87 are forced to the upper end of the stroke. As the piston 85 moves upward, suction is exerted in the lower portion of cylinder 84, passage 84a to cause fluid in the well below packer 83 to be drawn upward through opening 84e, through passage 84f, past check valve 84g to fill the lower portion of cylinder 84. Whereupon the pump exerting continuous pressure upon the conduit will cause a rise in pressure to open relief valve 40 so that the hydraulic pressure will react on the left hand end of slide valve member 17 to move it from the position as shown in Fig. 2 to the position as shown in Fig. 1, causing the fluid entrapped within the right hand end of cylinder 15 to be discharged past check valve 43 into conduit 22 that is in communication with conduit 39 leading to the storage reservoir 5. After the valve 17 has moved into the position as shown in Fig. 1 passages 18 and 30 will register with the passages 10b and 11b; and 10c and 11c respectively, so as to direct hydraulic fluid under pressure from

pump 6 to the left hand end of cylinder 14 to move slide valve member 16 to the right to cause passages 21 and 33 to register with passages 10, 11; and 12*a* and 13*a* respectively. In so doing the hydraulic fluid entrapped in the right hand end of cylinder 14 will be forced outward through conduit 31 and into conduit 39 leading to the storage reservoir 5.

It will be readily appreciated that the hydraulic fluid withdrawn from the reservoir 5 and used by pump 6 in applying pressure to conduits 23 and 35 is the fluid pumped from the well, once the pumping operation is established. However, before establishing pumping operations, conduits 23 and 35, casing 1*a*—81, and cylinder 82 are filled with fluid, after this has been done only the reaction pressure of the pump will be exerted on the fluid in the well, alternately to opposite sides of the piston 87 and the motivating fluid plus the fluid being pumped from the well will be discharged from the conduit opposite that to which the pressure is applied and once the operation is established, no additional fluid other than that being pumped will enter the well, therefore the gravity of the oil or other fluid being pumped will be uniformly maintained. Both motivating and pumped fluids discharge through the control mechanism.

While the invention has been described in one embodiment thereof, it is to be understood that changes may be made in the minor details of constructions and adaptations made to different operating conditions without departing from the spirit of the invention as claimed.

Having thus clearly shown and described the invention what is claimed as new and desired to secure by Letters Patent is:

1. A control mechanism for controlling the admission of motivating fluid to a double acting, fluid actuated reciprocating motor mechanically connected to a reciprocating pump and controlling the discharge of said fluid from said reciprocating motor and said reciprocating pump, comprising a valve mechanism, a fluid pressure generating means adapted to be connected by a conduit to said valve mechanism for directing fluid thereto, which valve mechanism comprises a fluid directional movable control valve and a separately movable pilot valve connected together by conduits for directing fluid to said fluid directional, movable control valve for moving said fluid directional control valve to an alternate position, a pair of conduits connecting said valve mechanism with said reciprocating motor, conduit means interconnecting said reciprocating pump with said reciprocating motor for directing the flow of pumped fluid to said reciprocating motor, pressure responsive means within said conduits connecting said fluid directional, movable control valve and said separately movable pilot valve for causing said valve mechanism to alternately direct motivating fluid from said pressure generating means under pressure into alternate conduits connected to said valve mechanism and to said reciprocating motor, and to simultaneously direct the fluid being pumped and the motivating fluid being discharged from said motor alternately out, in reverse order, through said alternate conduits connected to said valve mechanism and said reciprocating motor, and conduit means for directing fluid being pumped and said discharged motivating fluid from said valve mechanism.

2. In a control mechanism for controlling the admission of motivating fluid to a double acting, fluid actuated reciprocating motor mechanically connected to a reciprocating pump and controlling the discharge of said fluid from said reciprocating motor and said reciprocating pump at a point remote from said motor and said pump, a valve mechanism, which valve mechanism comprises a fluid directional, movable control valve and a separate movable pilot valve for directing fluid to said fluid directional, movable control valve for moving said fluid directional control valve, a pair of conduits connecting said valve mechanism with said motor, conduit means interconnecting said reciprocating pump with said reciprocating

motor for directing the flow of pumped fluid through said reciprocating motor, a fluid pressure generating means adapted to be connected to said valve mechanism for directing fluid thereto, pressure responsive means within said valve mechanism to direct fluid under pressure alternately to said conduits leading to said motor, and to direct fluid being pumped and the motivating fluid being discharged from said motor simultaneously out through the other of said conduits connecting said reciprocating motor and said valve mechanism, said pressure responsive means having a valve connected thereto and being so formed as to give a uniform increase or decrease in volume of motivating fluid to said pilot valve upon opening or closing of said pressure responsive valve, and conduit means for directing said fluid being pumped and discharged motivating fluid from said valve mechanism.

3. In a mechanism for controlling a hydraulically operated reciprocating motor and a reciprocating fluid pump connected together in hydraulic relation by a conduit in a well, a piston in said motor, a plunger in said pump, a connecting member interconnecting said piston and said plunger for unitary movement, a reservoir, a pressure supply pump, a conduit leading from said pressure supply pump to a pair of valve cylinders each having a slide valve member positioned therein, each of said slide valve members having a pair of passages formed therein for passing fluid therethrough, four conduits positioned along a side of each of said cylinders and in communication therewith, one of each two of said conduits connected to each cylinder and registering with one of said passages in each of said slide valve members when in one position, four other conduits positioned along the opposite side of each of said cylinders and in communication therewith, a pair of conduits interconnecting with certain of said conduits on said slide valve cylinders, with said reciprocating motor and said reciprocating pump, one of each two of said last mentioned conduits connected to each cylinder and registering with each of said passages respectively in each of said slide valves when in said position to form passages between two of said first mentioned conduits and two of said last mentioned conduits to direct fluid through each of said respective valve cylinders to said hydraulically operated motor to operate said piston therein in one direction and from said hydraulic motor, means for shifting said slide valves so said passages will close communication between said pairs of the aforesaid conduits and open other pairs of passages between pairs of other conduits in the respective valve cylinders for directing fluid through said slide valves to reverse the movement of said hydraulically operated reciprocating motor and the discharge therefrom to complete the cycle of operation, said reciprocating pump having the fluid outlet thereof connected to a conduit leading to and through said valve cylinders, and an outlet conduit connected to certain of said conduits on said cylinders for discharging fluid therefrom.

4. In a control mechanism for controlling a hydraulically operated motor and a reciprocating fluid pump connected together in hydraulic relation by conduits in a well, a piston in said motor, a plunger in said pump, a connecting member interconnecting said piston and said plunger for unitary movement, a reservoir, a pressure supply pump, a conduit leading from said pressure supply pump to a pair of valve cylinders each having a slide valve member positioned therein, each of said slide valve members having a pair of annular grooves formed therearound for passing fluid therethrough, four conduits positioned along a side of each of said valve cylinders and in communication therewith, each of two of said conduits connected to each cylinder and registering with one of said annular grooves in each of said slide valve members when in one position, four other conduits positioned along the opposite side of each of said cylinders and in communication therewith, a pair of conduits interconnecting with certain of said conduits on said slide valve cyl-

inders, with said reciprocating motor and said reciprocating pump, each of two of said last mentioned conduits connected to each cylinder and registering with each of said respective grooves in each of said slide valve members when in said position to form passages between two of said first mentioned conduits and two of said last mentioned conduits to direct hydraulic fluid through each of the respective valve cylinders to said motor to move said piston therein in one direction and from said hydraulic motor, resiliently restrained pressure means for shifting one of said slide valves so pressure will be directed to the other of said slide valves to move said slide valve member so said annular grooves will close communication between said pairs of aforesaid conduits and open other pairs of annular grooves for directing fluid through said slide valves to reverse the movement of said hydraulically operated motor which has discharge conduits leading therefrom to and through said slide valve members, which motor operates a reciprocating pump piston in said reciprocating fluid pump, a discharge leading from each side of said piston in said reciprocating pump into the conduits discharging from said hydraulically operated motor for discharging fluid pumped by said pump through said slide valve members with the fluid that is actuating said hydraulic motor, and an outlet conduit connected to certain of said conduits on said cylinders for discharging fluid therefrom.

5. In a mechanism for controlling a hydraulically operated reciprocating motor and a reciprocating pump connected together in hydraulic relation by a conduit in a well, a piston in said motor, a plunger in said pump, a connecting member interconnecting said piston and said plunger for unitary movement, a reservoir, a pressure supply pump, a conduit leading from said pressure supply pump to a pair of valve cylinders each having a slide valve member positioned therein, each of said slide valve members having a pair of annular grooves formed therearound for passing fluid therethrough, two conduits, each of said two conduits having a two-branched conduit connected thereto and positioned along a side of each of said cylinders and in communication therewith, one branch of each branched conduit connected to each cylinder and registering with one of said grooves in each of said slide valve members when in one position, two conduits each having two branches positioned along the opposite side of each of said cylinders and in communication therewith, a pair of conduits interconnecting certain of said branch conduits on said slide valve cylinders, with said reciprocating motor and said reciprocating pump, one branch of each of said last mentioned branched conduits connected to each cylinder and registering with one of said grooves in each of said slide valve members when in said position so as to form passages between two of said first mentioned branches of the conduits and said last mentioned branches of the conduits to direct hydraulic fluid to said motor to move the piston of said motor in one direction, pressure means for shifting said slide valve members so said annular grooves will close communication between two pairs of aforesaid branches of said conduits and open two other pairs of said branch conduits for directing fluid through each of said slide valve members to obtain a reverse movement of said hydraulically operated reciprocating motor and reciprocating piston within said reciprocating pump so as to direct fluid being pumped from said reciprocating pump into one of the conduits leading from said reciprocating motor to and through said slide valve members.

6. In a mechanism for controlling the flow of hydraulic motivating fluid generated by a hydraulic pump for operating a reciprocating motor and a reciprocating fluid pump connected together in hydraulic relation by a conduit in a well, a piston in said motor, a plunger in said pump, a connecting member interconnecting said piston and said plunger for unitary movement, a reservoir, a pressure supply pump, a conduit leading from said pressure supply pump to a pair of valve cylinders each having a slide valve member positioned therein, one of said valve cylinders having a spring pressed, pressure responsive valved inlet at each end thereof for controlling the shifting of said slide valve member therein, a check valve outlet at each end of said cylinder for discharging fluid therefrom, each of said slide valve members having a pair of annular grooves formed therearound for passing fluid therethrough, two conduits, each of said two conduits having a two-branched conduit connected thereto and positioned along a side of each of said cylinders and in communication therewith, one branch of each branched conduit connected to each cylinder and registering with one of said annular grooves in each of said slide valve members when in one position, two conduits each having two branches positioned along the opposite side of each of said cylinders and in communication therewith, a pair of conduits interconnecting certain of said branch conduits on said slide valve cylinders, with said reciprocating motor and said reciprocating pump, one branch of each of said last mentioned branched conduits connected to each cylinder and registering with one of said grooves in each of said slide valve members when in said position so as to form passages between two of said first mentioned branches of the conduits and said last mentioned branches of the conduits to direct hydraulic fluid to said motor to move said piston of said motor in one direction, conduits connected to each end of each of said slide valve cylinders and to certain of said pressure responsive valved inlets of said cylinder so as to admit pressure for shifting said slide valve members so said annular grooves will close communication between two pairs of aforesaid branches of said conduits and open two other pairs of said branch conduits for directing fluid through each of said slide valves to obtain a reverse movement of said hydraulically operated reciprocating motor and reciprocating pump piston within said reciprocating pump so as to direct fluid being pumped from said reciprocating pump into a conduit leading from said reciprocating motor to and through said slide valve members.

7. In a mechanism for controlling a hydraulically operated, double acting, reciprocating motor and a reciprocating fluid pump connected together in hydraulic relation by a conduit within a well, a piston in said motor, a plunger in said pump, a connecting member interconnecting said piston and said plunger for unitary movement, a reservoir, a pressure supply pump, a conduit leading from said pressure supply pump to a pair of valve cylinders each having a slide valve member positioned therein, each of said slide valve members having a piston at each end thereof, each of said slide valve members having two annular grooves formed therearound intermediate the ends thereof for passing fluid therethrough, two conduits, each of said two conduits having a two-branched conduit connected thereto and positioned along a side of each of said cylinders and in communication therewith, one branch of each branched conduit connected to each cylinder and registering with one of said grooves in each of said slide valve members when in one position, two conduits each having two branches positioned along the opposite side of each of said cylinders and in communication therewith, a pair of conduits interconnecting with certain of the conduits on said slide valve cylinders and said reciprocating motor and said reciprocating pump, one branch of each of said last mentioned conduits connected to each cylinder and registering with one of said grooves in each of said slide valve members when in said position so as to form passages between two of said first mentioned branches of the conduits and said last mentioned branches of conduits to direct hydraulic fluid to said motor to move said piston of said motor in one direction, pressure means for shifting said slide valve members so said annular grooves will close

communication between two pairs of aforesaid branches of said conduits and open other pairs of said branch conduits for directing fluid through each of said slide valve members to obtain a reverse movement of said hydraulically operated motor and reciprocating pump piston within said pump so as to direct fluid being pumped from said reciprocating pump into one of the conduits leading from said reciprocating motor to and through said slide valve members.

8. In a mechanism for controlling the flow of hydraulic motivating fluid generated by a hydraulic pump for operating a double acting, reciprocating motor and a double acting reciprocating fluid pump connected together in hydraulic relation by conduits in a well, a piston in said motor, a plunger in said pump, a connecting member interconnecting said piston and said plunger for unitary movement, a reservoir, a pressure supply pump, a conduit leading from said pressure supply pump to a directional control valve cylinder and a pilot valve cylinder each having a cylindrical slide valve member positioned therein, a piston formed on each end of each of said cylindrical slide valve members, a two-branch conduit, said pilot valve cylinder having an opening formed in each end thereof and a conduit leading therefrom and connecting to said two-branched conduit, one branch of each of said branched conduits having a spring pressed pressure restraining valve forming an inlet therethrough into each end of said pilot valve cylinder for controlling the shifting of said slide valve member therein, the other branch of each of said branched conduits having a check valve therein and forming an outlet therethrough from each end of said pilot valve cylinder, the outer ends of each pair of branched conduits connecting to a conduit for applying pressure and permitting exhaust of hydraulic fluid alternately from each end of said pilot valve cylinder having said spring pressed valved inlets, each of said cylindrical slide valve members having a pair of annular grooves formed therearound for passing fluid therethrough, two conduits each having a two-branched conduit connected thereto and positioned along a side of each of said cylinders and in communication therewith, one branch of each branched conduit connected to each cylinder and registering with one of said grooves in each of said slide valve members when in one position, two conduits each having two branches positioned along the opposite side of each of said cylinders and in communication therewith, a pair of conduits interconnecting with certain of the conduits on said slide valve cylinders, said reciprocating motor and said reciprocating pump, one branch of each of said last mentioned branch conduits connected to each cylinder and registering with one of said grooves in each of said slide valve members when in said position so as to form passages between two of said first mentioned branches of the conduits and said last mentioned branches of the conduits to direct hydraulic fluid to said motor to move the piston thereof in one direction, said pressure restraining valved inlets of said pilot valve cylinder admitting pressure for shifting said slide valve members so said annular grooves will close communication between two pairs of aforesaid branches of said conduits and open two other pairs of said branch conduits for directing fluid through each of said slide valve members to obtain a reverse movement of said piston in said reciprocating motor and said reciprocating plunger of said pump so as to direct fluid being pumped from said reciprocating pump into the conduits leading from said reciprocating motor to and through said slide valve members.

9. In a mechanism for controlling a hydraulically operated reciprocating motor located within a well, a hydraulic pressure generating means which hydraulically operated reciprocating motor is connected with said pressure generating means for supplying hydraulic pressure, said hydraulic motor being connected by conduits to a well pump having a discharge pipe discharging into one of the conduits leading from said motor, a pair of cylinders each having longitudinally spaced ports formed in a side thereof, longitudinally spaced ports formed in another side of each of said cylinders and being transversely aligned with respect to said first mentioned longitudinally spaced ports, each of said cylinders having a slide valve member positioned therein, each of said slide valve members having a pair of annular passages formed therein for the flow of fluid therethrough, one of said passages in each of said slide members connected to each cylinder and registering with a pair of said ports in each of said cylinders to permit the flow of fluid therethrough from said pressure generating means, a pair of conduits leading from opposite ends of said reciprocating motor and said reciprocating pump interconnected with certain of the conduits on the said slide valve cylinders, the other of said passages in each of said slide valve members being adapted to register with a pair of said ports in each of said cylinders to permit the flow of fluid therethrough exhausting from said hydraulic motor and said well pump, each of said cylinders having a port formed in each end thereof, a two-branch conduit, the first of said cylinders having said two-branch conduit connected to each of said end ports, one of said branches of each of said branched conduits having a pressure actuated relief valve therein which permits restrained flow of hydraulic fluid selectively to the ends of said cylinder, and the other branch of each of said branched conduits having a check valve therein in parallel to said relief valve to permit ready flow of fluid outward therefrom, a pair of conduits each connecting with the respective outer ends of said branched conduits on the respective ends of said cylinder, each of said pair of said first mentioned conduits connecting with said respective conduits leading from opposite ends of said hydraulic reciprocating motor, said pair of said first mentioned conduits also connecting with longitudinally spaced passages formed in the second of said cylinders so as to alternately connect opposite ends of said first cylinder with said conduits leading from said pump so as to alternately exert pressure greater than the predetermined setting of said relief valves at the ends of the respective power strokes of said hydraulic motor so as to shift the slide valve member of said first cylinder longitudinally so the passage in register with said first mentioned ports will be shifted to register with a pair of ports so as to direct pressure from said hydraulic pressure generating means to the opposite ends of said second cylinder to shift the slide valve member of said second cylinder so said valve member will close said first mentioned ports and register with another pair of said ports so as to direct hydraulic fluid from said hydraulic pressure generating means in reverse direction to the opposite ends of said hydraulically actuated reciprocating motor, a discharge conduit connected with said slide valve cylinders, with the other of said conduits exhausting the hydraulic fluid and the fluid being pumped from the well into the other of said conduits and through said passage of said slide valves of said first and second cylinders into a conduit for directing said hydraulic fluid and the fluid being pumped from the well into said discharge storage reservoir.

10. In a mechanism for controlling a fluid operated reciprocating motor, a fluid supply, a pressure supply pump having an inlet opening formed therein for admission of fluid thereinto and connected with said fluid supply, a discharged opening formed therein for discharge of fluid under pressure, a conduit leading from said discharge opening and having branch outlet conduits within the length thereof, a piston fitted in said reciprocating motor and adapted to reciprocate therein, a pair of valve chambers each having a slide valve member positioned therein, one of said slide valve members being a pilot valve, the other of said slide valve members being a directional control valve for fluid being pumped, each of said slide valve members having a pair of passages formed therein

for passing fluid therethrough, four conduits positioned along a side of each of said valve chambers and in communication therewith, a pair of each of said branch outlet conduits adapted to connect with two of each four of said conduits connected to each chamber and being adapted to register with one of said passages in each of said slide valve members when the respective slide valve members are in one position, four other conduits positioned along another side of each of said chambers and in communication therewith, a pair of conduits leading from said reciprocating motor and each conduit having three conduits branching therefrom within the length of said conduits leading from said reciprocating motor, a pair of said last mentioned branch conduits on each conduit being connected with the four conduits on a side of the chamber having the directional slide valve positioned therein and in communication therewith, the other of each of said branch conduits leading from said motor being connected with the respective fluid ends of the chamber of said pilot slide valve, a conduit leading from each of the respective fluid ends of said directional slide valve control chamber and connected to a side of the pilot control valve chamber and transversely positioned from the first four mentioned conduits thereon, a discharge conduit leading from the valve chamber and having two pairs of branch conduits within the length thereof, which branch conduits connect with two of each four of said first mentioned conduits on each of said chambers and means for directing fluid pressure alternately to opposite ends of the respective slide valve members.

11. In a mechanism for controlling a hydraulically operated reciprocating motor and a reciprocating fluid pump, conduits for hydraulically connecting said reciprocating motor and said reciprocating fluid pump together in a well, a reservoir, a pressure supply pump, a conduit connecting said reservoir with an inlet opening formed in said pressure supply pump, a discharge opening formed in said pressure supply pump, a conduit leading from said discharge opening and having a pair of branch outlet conduits within the length thereof, a piston fitted in said reciprocating motor, a plunger fitted in said reciprocating fluid pump, a member interconnecting said piston and said plunger in aligned relation for unitary movement, a pair of valve cylinders each having a slide valve member positioned therein, one of said slide valve members being a pilot slide valve, the other of said slide valve members being a directional control valve for hydraulic fluid, each of said slide valve members having a pair of passages formed therein for passing fluid therethrough, four conduits positioned along a side of each of said cylinders and in communication therewith, a pair of each of said branch conduits adapted to connect with two of each four of said conduits connected to each cylinder and being adapted to register with one of said passages in each of said slide valve members when the respective valve members are in one position, four other conduits positioned along another side of each of said cylinders and in communication therewith, a pair of conduits leading from said reciprocating motor and each conduit having three conduits branching therefrom within the length of each of said conduits leading from said reciprocating motor, a pair of said branch conduits on each conduit connecting with the four conduits on a side of the cylinder having the directional slide valve positioned therein and in communication therewith, the other of each of said branch conduits leading from said motor connecting with the respective fluid ends of the cylinder of said pilot slide valve, a conduit leading from each of the respective fluid ends of said directional slide valve control cylinder and connecting with the other of said four conduits connected to a side of the pilot control valve cylinder and transversely disposed with respect to said first four mentioned conduits thereon, a discharge conduit leading from said valve cylinders having two pairs of branch conduits within the length thereof which branch conduits connect with two of each four of said first mentioned conduits on each of said cylinders, and means for directing pressure alternately to opposite ends of the respective slide valve members.

12. In a mechanism for controlling a hydraulically operated reciprocating motor and a reciprocating pump, conduits for hydraulically connecting said reciprocating motor and said reciprocating fluid pump together in a well, a reservoir, a pressure supply pump, a conduit connecting said reservoir with an inlet opening formed in said pressure supply pump, a discharge opening formed in said pressure supply pump, a conduit leading from said discharge opening and having a pair of branch outlet conduits within the length thereof, a piston fitted in said reciprocating motor, a plunger fitted in said reciprocating fluid pump, a member interconnecting said piston and said plunger in aligned relation for unitary movement, a pair of valve cylinders each having a slide valve member positioned therein, one of said slide valve members being a pilot slide valve, the other of said slide valve members being a directional control valve for hydraulic fluid, each of said slide valve members having a pair of passages formed therein for passing fluid therethrough, four conduits positioned along a side of each of said cylinders and in communication therewith, a pair of each of said branch conduits adapted to connect with two of each four of said conduits connected to each cylinder and being adapted to register with one of said passages in each of said slide valve members when the respective valve members are in one position, four other conduits positioned along another side of each of said cylinders and in communication therewith, a pair of conduits leading from said reciprocating motor and each conduit having three conduits branching therefrom within the length of each of said conduits leading from said reciprocating motor, a pair of said branch conduits on each conduit connecting with the four conduits on a side of the cylinder having the directional slide valve positioned therein and in communication therewith, the other of each of said branch conduits leading from said motor connecting with the respective fluid ends of the cylinder of said pilot valve, a conduit leading from each of the respective fluid ends of said directional slide valve control cylinder and connecting with the other of said four conduits connected to a side of the pilot control valve cylinder and transversely disposed with respect to said first four mentioned conduits thereon, a discharge conduit leading from said valve cylinders having two pairs of branch conduits within the length thereof which branch conduits connect with two of each four of said first mentioned conduits on each of said cylinders, and pressure responsive means for directing fluid pressure alternately to opposite ends of the respective slide valve members.

13. In a mechanism for controlling a hydraulically operated reciprocating motor and a reciprocating fluid pump, conduits for hydraulically connecting said reciprocating motor and said reciprocating fluid pump together in a well, a reservoir, a pressure supply pump, a conduit connecting said reservoir with an inlet opening formed in said pressure supply pump, a discharge opening formed in said pressure supply pump, a conduit leading from said discharge opening and having a pair of branch outlet conduits within the length thereof, a piston fitted in said reciprocating motor, a plunger fitted in said reciprocating fluid pump, a member interconnecting said piston and said plunger in aligned relation for unitary movement, a pair of valve cylinders each having a slide valve member positioned therein, one of said slide valve members being a pilot slide valve, the other of said slide valve members being a directional control valve for hydraulic fluid, each of said slide valve members having a pair of passages formed therein for passing fluid therethrough, four conduits positioned along a side of each of said cylinders and

in communication therewith, a pair of each of said branch conduits adapted to connect with two of each four of said conduits connected to each cylinder and being adapted to register with one of said passages in each of said slide valve members when the respective valve members are in one position, four other conduits positioned along another side of each of said cylinders and in communication therewith, a pair of conduits leading from said reciprocating motor and each conduit having three conduits branching therefrom within the length of each of said conduits leading from said reciprocating motor, a pair of said branch conduits on each conduit connecting with the four conduits on a side of the cylinder having the directional slide valve positioned therein and in communication therewith, the other of each of said branch conduits leading from said motor connecting with the respective fluid ends of the cylinder of said pilot slide valve, a conduit leading from each of the respective fluid ends of said directional slide valve control cylinder and connecting with the other of said four conduits connected to a side of the pilot control valve cylinder and transversely disposed with respect to said first four mentioned conduits thereon, a discharge conduit leading from said valve cylinders having two pair of branch conduits within the length thereof which branch conduits connect with two of each four of said first mentioned conduits on each of said cylinders, and spring pressed, pressure responsive relief valve means for directing fluid pressure to opposite ends of the respective slide valve members alternately.

14. In a mechanism for controlling a hydraulically operated reciprocating motor and a reciprocating fluid pump, conduits for hydraulically connecting said reciprocating motor and said reciprocating fluid pump together in a well, a reservoir, a pressure supply pump, a conduit connecting said reservoir with an inlet opening formed in said pressure supply pump, a discharge opening formed in said pressure supply pump, a conduit leading from said discharge opening and having a pair of branch outlet conduits within the length thereof, a piston fitted in said reciprocating motor, a plunger fitted in said reciprocating fluid pump, a member interconnecting said piston and said plunger in aligned relation for unitary movement, a pair of valve cylinders each having a slide valve member positioned therein, one of said slide valve members being a pilot slide valve, the other of said slide valve members being a directional control valve for hydraulic fluid, each of said slide valve members having a pair of passages formed therein for passing fluid therethrough, four conduits positioned along a side of each of said cylinders and in communication therewith, a pair of each of said branch conduits adapted to connect with two of each four of said conduits connected to each cylinder and being adapted to register with one of said passages in each of said slide valve members when the respective valve members are in one position, four other conduits positioned along another side of each of said cylinders and in communication therewith, a pair of conduits leading from said reciprocating motor and each conduit having three conduits branching therefrom within the length of each of said conduits leading from said reciprocating motor, a pair of said branch conduits on each conduit connecting with the four conduits on a side of the cylinder having the directional slide valve positioned therein and in communication therewith, the other of each of said branch conduits leading from said motor connecting with the respective fluid ends of the cylinder of said pilot slide valve, a conduit leading from each of the respective fluid ends of said directional slide valve control cylinder and connecting with the other of said four conduits connected to a side of the pilot control valve cylinder and transversely disposed with respect to said first four mentioned conduits thereon, a discharge conduit leading from said valve cylinders having two pairs of branch conduits within the length thereof which branch conduits connect with two of each four of said first mentioned conduits on each of said cylinders, and spring pressed relief valve means and check valve means interposed in said conduit leading from the fluid end of said pilot slide valve to the conduits on a side of said directional control slide valve cylinder for directing fluid pressure alternately to opposite ends of the respective slide valve members.

References Cited in the file of this patent

UNITED STATES PATENTS

2,018,215	Lausen	Oct. 22, 1935
2,263,086	Hall	Nov. 18, 1941
2,287,709	Ringman	June 23, 1942
2,309,897	Hall	Feb. 2, 1943
2,347,302	Twyman et al.	Apr. 25, 1944
2,367,248	Vickers et al.	Jan. 16, 1945
2,503,986	Alley	Apr. 11, 1950
2,517,243	Rose	Aug. 1, 1950