

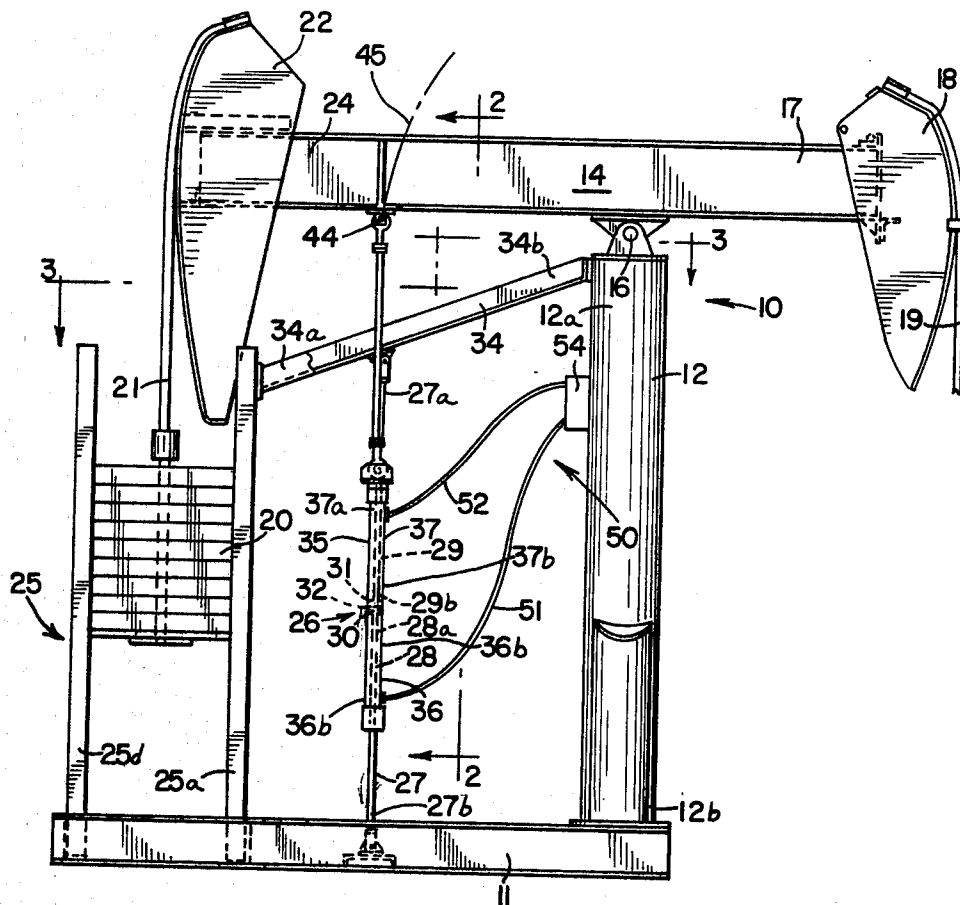
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[54] **PUMPING APPARATUS**
14 Claims, 4 Drawing Figs.

[52] U.S. Cl. 91/196
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[50] Field of Search 103/45,
45PS, 206, 179, 158, 155; 60/52PS: 91/216b, 196

ABSTRACT: An improved hydraulic operating mechanism for rocking a beam of a pumping apparatus to reciprocate a well pump disposed in a well pipe and connected to the beam. The operating mechanism includes first and second generally stationary piston rods with first and second stationary pistons thereon, first and second cylinder sections positioned respectively for reciprocating movement relative to the first and second pistons, and means for delivering fluid under pressure to the cylinder sections to drive the cylinder sections relative to the generally stationary piston rods to reciprocate the well pump in such a way that the principal forces placed on the piston rods are tension forces.



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Fig. 4

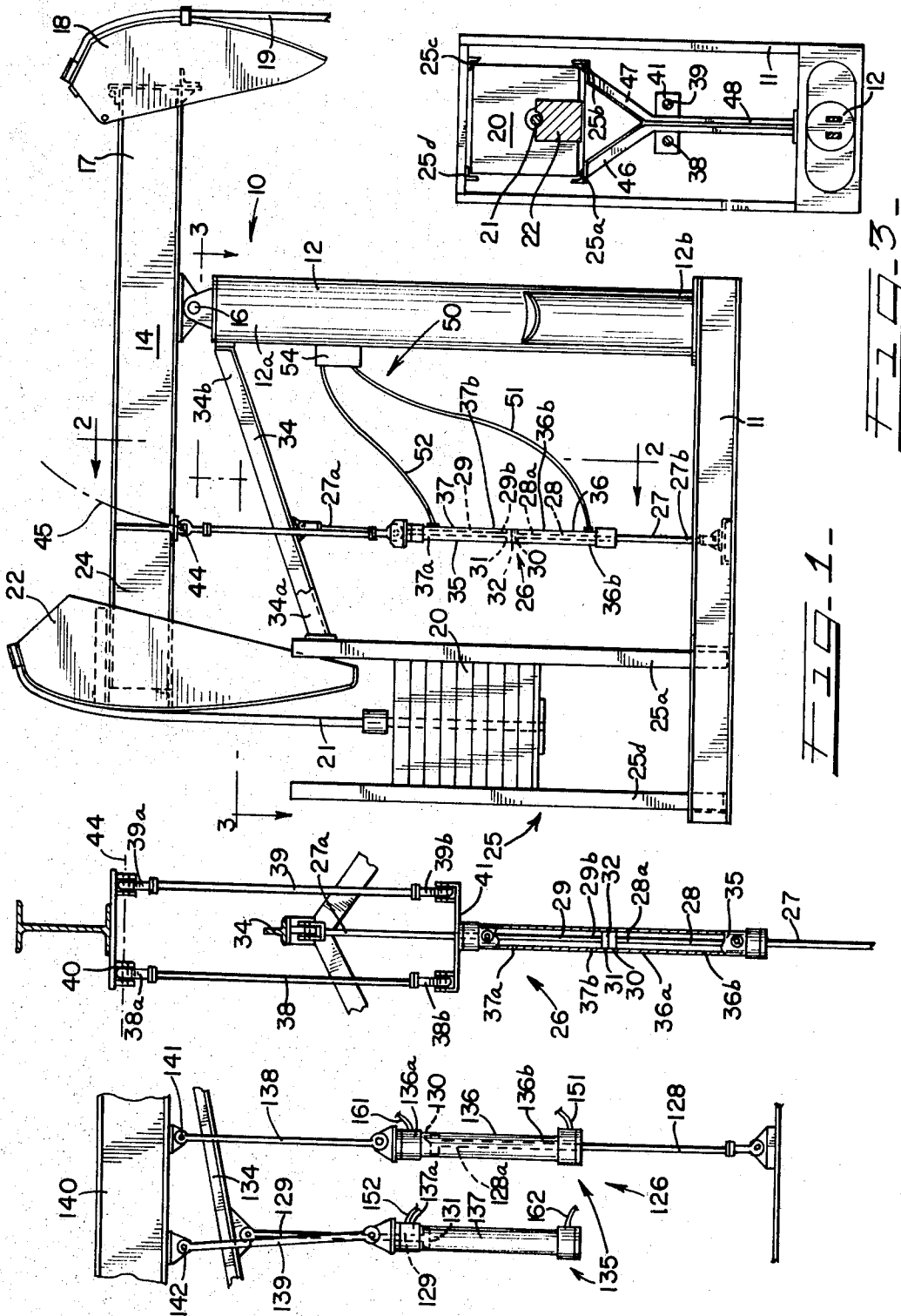


Fig. 1

Fig. 3

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PUMPING APPARATUS

This invention relates to an oil well pumping apparatus and more particularly to improvements and innovations in an hydraulic operating mechanism for reciprocating a well pump connected to the pumping apparatus.

In the recent past, efforts have been made to use an hydraulic operating mechanism as the driving force for a walking beam of a well pump apparatus. In one successful mechanism disclosed in U.S. Pat. No. 3,369,490, issued to Harry W. Hawk on Feb. 20, 1968, a well pump is connected to one end of a counterweighted pivoted walking beam and the beam is rocked about its pivot by an hydraulic operating mechanism which includes a cylinder pivotally anchored at its lower end to a base, reciprocating piston rod pivotally connected at its upper to the beam, and a piston received in the cylinder and fixed to the lower end of the piston rod. Pressurized fluid is alternately delivered to the lower and upper ends of the cylinder to reciprocate the piston rod in the cylinder. When pressurized fluid is delivered to the upper end of the cylinder to move the piston downwardly, a tension force is placed upon the piston rod. On the other hand, when pressurized fluid is delivered to the lower end of the cylinder to extend or move the piston upwardly, a compression force is placed upon the piston rod.

As is well known, a rod of a given diameter can handle or withstand a greater force in tension than in compression, since a compression force tends to bend a rod laterally of its longitudinal axis. Consequently, the size of the hydraulic mechanism disclosed in the patent referred to above is determined primarily by the magnitude of the compression of forces which will be placed upon the piston rod. That is to say, the magnitude of the compression forces determines the size of the piston rod, piston and cylinder, which, in turn, determine the amount or volume of fluid needed which, in turn, determines the size of the pump, control valves, reservoir and fluid connecting lines for the hydraulic system of the pumping apparatus.

Also, there is a smaller volume in the upper portion of the cylinder through which the rod extends than in the lower portion. This difference in volume requires more fluid on the upstroke and more force (i.e., to force fluid from the lower portion of the cylinder) on the down stroke, resulting in an unbalanced loading on the hydraulic system.

To reduce or minimize the size of the hydraulic system, and to balance the loading on the hydraulic system, the present invention proposes an improved hydraulic operating mechanism wherein only tension forces are placed upon the piston rod or rods of the mechanism. In other words, a piston rod or rods and a cylinder or cylinders are so arranged and mounted that when the mechanism is operated to rock the walking beam of the pumping apparatus only tension forces are imposed upon the piston rod or rods. To accomplish this, a cylinder is pivotally connected to the beam and disposed for movement on and relative to a generally stationary piston rod.

In one embodiment of the invention, two cylinder sections are movably mounted, respectively, on two piston rod portions. The cylinder sections are pivotally connected to the walking beam while the rod portions are anchored against axial movement. Each rod portion has a piston section received in one of the cylinder sections. Admission of pressurized fluid to one end of one of the cylinder sections will force that cylinder downwardly with a tension force being imposed on the rod portion associated with that cylinder section, while admission of pressurized fluid to one end of the other cylinder section will force that cylinder section upwardly with a tension force being imposed on the rod portion associated with that cylinder section.

A general object of the invention is to provide an improved hydraulic operating mechanism for a well pumping apparatus wherein only tension forces are applied to the piston rods of the mechanism so that the size of the piston rods need only be of a diameter sufficient to withstand tension forces to thereby reduce or minimize the size of the hydraulic system of the well pumping apparatus.

Another object of the invention is to provide an hydraulic operating mechanism for a well pumping apparatus wherein the piston rod is anchored at its lower and upper ends, and a cylinder is mounted for reciprocating movement of the piston rod in such a way that the working portions of the rod experience essentially only tension forces.

A further object of the invention is to provide a symmetrical or balanced hydraulic operating mechanism where the volume of fluid required for the upstroke of the cylinder is essentially equal to the volume of fluid required for the downstroke of the cylinder.

Additional objects and advantages of this invention will appear from the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a side elevational view of a well pumping apparatus embodying the principles of this invention;

FIG. 2 is an enlarged vertical sectional view taken along lines 2-2 of FIG. 1;

FIG. 3 is a fragmentary view taken along lines 3-3 of FIG. 1; and

FIG. 4 is a fragmentary side elevational view of a modified form of the invention shown in FIG. 1. Referring to FIG. 1 of the drawings, an oil well pumping apparatus embodying this invention is generally indicated at 10. Typically the oil well pumping apparatus 10 includes a base 11 on which is mounted the bottom end 12b of a so-called Samson post 12, preferably the post 12 is hollow and serves as a sump or reservoir for the hydraulic fluid used by the hydraulic operating mechanism of this invention. A walking beam 14 is pivotally supported above the base 11 at the top end 12a of the post 12 as indicated at 16. The walking beam 14 has a forward end 17 mounting a horse head 18 to which a conventional polish rod (not shown) is secured by means of one or more cables 19. The polish rod is connected in an appropriate manner to a well pump in a well pipe for lifting petroleum in a conventional manner during vertical reciprocation of the well pump. Counterweights 20 are supported by a cable 21 from the walking beam 14 rearwardly of the pivot support 16 for counterbalancing the forces acting on the forward end of the beam 14. As shown, the counterweights 20 are preferably secured by the cable 21 to a second horse head 22 at the rearward end 24 of the beam 14.

In the embodiment of the invention illustrated in FIGS. 1 and 3 a guard framework, generally indicated at 25, is provided for receiving and guiding the counterweights 20. Preferably, guard framework 25 includes four corner posts 25a, 25b, 25c and 25d rigidly secured at their lower ends to the base 11. As shown in FIG. 3, each corner post 25a-d has an L-shaped cross section whereby the corner posts 25a-d can be arranged to form corners of a square for receiving square counterweights 20. As explained in the patent referred to above, a guard framework or housing is provided for shielding the counterweights from outside forces which may disturb or unbalance the forces acting on the walking beam, e.g., for shielding the counterweights from high winds which might shift the center of gravity of the counterweights and thereby alter the disposition of the forces acting on the walking beam. Although the framework 25 is shown as comprising four corner posts 25a-d, it is to be understood that the guard framework can take different forms, such as an enclosed housing of the type shown in the patent referred to above. Also, it is to be understood that the foregoing arrangement is typical or conventional and forms no part of the invention.

The improved operating mechanism of the invention, for rocking the beam 14 about the pivot support 16, is generally indicated at 26 in FIG. 1. This mechanism 26 includes a piston rod 27 having a first (lower) rod or rod portion 28 and a second (upper) rod or rod portion 29. A first piston (or piston section) 30 is mounted at the upper end 28a of the first rod 28 and a second piston (or piston section) 31 is mounted at the lower end 29b of the second rod 29. As shown in FIGS. 1 and 2, the second rod 29 is situated above and axially in line with the first rod 28 and preferably the pistons 30 and 31 are in-

tegral with one another to form a single piston 32 located intermediate the upper and lower ends 27a and 27b of the rod 27. To rigidly secure the rod 27 to the apparatus 10, the lower end 27b of the rod 27 is secured to the base 11 while the upper end 27a of the rod 27 is secured to a frame member 34 of the pumping apparatus 10. As shown in FIG. 1, one end 34a of the frame member 34 is rigidly fastened to the guard framework 25 which forms one end support for the frame member 34 and the other end 34b is rigidly fastened to the Samson post 12 which forms the other end support for the frame member 34. It is to be understood that the rods 28 and 29 need not be integral to form rod 27. Instead, they can be separate parts and, if desired, a small space can exist between pistons 30 and 31.

In the illustrated embodiment, the rod 27 passes through a cylinder 35 which is adapted for reciprocal movement on the rod 27 relative to the stationary piston 32. The cylinder 35 includes a first or lower cylinder section 36 which cooperates with the first rod 28 and a second or upper cylinder section 37 which cooperates with the second rod 29. As best seen in FIG. 2, the upper end 37a of the second cylinder section 37 is pivotally connected to the beam 14 by means of two connecting rods 38 and 39. The upper ends 38a and 39a of the connecting rods 38 and 39 are pivotally connected to a shoe 40 which is secured to the underside of beam 14. The lower ends 38b and 39b of the connecting rods 38 and 39 are pivotally connected to a bracket 41 which is secured to the upper end 37a of the second cylinder section 37.

The pivot connections of the connecting rods 38 and 39 compensate for the nonlinear movement of the connecting rods as a result of the arcuate movement of the pivot axis 44 of the pivot connection at the upper ends 38a and 39a of the connecting rods 38 and 39. Thus, when the walking beam 14 shown in FIG. 1 is rotated counterclockwise, the pivot axis 44 will travel an arcuate path as indicated at 45, and the pivot connections of the connecting rods 38 and 39 permit lateral displacement of the upper ends 38a and 39a of the connecting rods 38 and 39 during the arcuate travel of the axis 44.

As illustrated in FIG. 3, the two connecting rods 38 and 39 straddle the frame member 34 and the rod 27. This arrangement of the connecting rods 38 and 39 provides: (1) a space or clearance between the connecting rods 38 and 39 and the frame member 34 and the rod 27; (2) a direct line of force from the cylinder 35 to the beam 14 which passes through the vertical axis of the cylinder 35 and the longitudinal horizontal axis of the beam 14; and, (3) strong connection between the cylinder 35 and the beam 14 sufficient to withstand the compression forces placed on the connecting rods 38 and 39 when the cylinder 35 is moved upwardly.

As best seen in FIG. 3, the frame member 34 is preferably in the form of a Y to provide a strong structural support for the upper end 27a of the rod 27. Accordingly, the frame member 34 has two short arms 46 and 47 (forming the end 34a) which are connected at their outer ends to the corner posts 25a and 25b of the guard framework 25 and a longer arm 48 extending from the junction of the three arms 46, 47 and 48 to an outer end (forming the end 34b) which is connected to the Samson post 12. In the illustrated embodiment, the short arms 46 and 47 have a generally L-shaped cross section and the longer arm 48 has an inverted T-shaped cross section to enhance the strength of the frame member 34. It is to be understood, of course, that the frame member 34 can be formed and connected in a different manner, so long as the frame member provides an adequate structural support for the rod 27.

As shown in FIG. 1, an hydraulic fluid control system is generally indicated at 50 and includes a first or lower fluid line 51 coupled or connected to the lower end 36b of the first cylinder section 36 and a second or upper fluid line 52 coupled or connected to the upper end 37a of the second cylinder section 37. The first and second fluid lines 51 and 52 are also connected to a control mechanism indicated generally at 54 in FIG. 1, which mechanism 54 includes a control valve of known type. As shown, the control mechanism 54 is mounted on the Samson post 12 and is connected to a reservoir or sump

(preferably in the Samson post 12) for the hydraulic fluid used by the hydraulic operating mechanism 26 and to a pump (not shown) which develops the pressurized fluid required. It is to be understood that the control mechanism 54 can be similar or identical to the hydraulic control systems shown in FIGS. 1 or 9 of the Hawk patent referred to above. In other words the control mechanism 54 can include various fluid lines, check valves, relief valves, etc. of known type, and the control mechanism 54 forms no part of this invention.

The control valve operates in known manner to alternately deliver pressurized fluid through one of the fluid lines 51 or 52 to one of the respective ends 36b or 37a of the cylinder 35 while fluid is displaced from the other end 37a or 36b of the cylinder 35 through the other one of the fluid lines 52 or 51 and discharged to the reservoir or sump in the post 12.

The pressurized fluid delivered through the fluid line 51 to the cylinder 35 will act on the lower end of the cylinder 35 and react on the rod connected side of the piston 30 causing a downstroke of the cylinder 35 to tilt or rock the walking beam 14 counterclockwise as viewed in FIG. 1. Alternately, when pressurized fluid is delivered through the fluid line 52 to the cylinder 35, it will act on the upper end of the cylinder 35 and react on the rod connected side of piston 31 causing an upstroke of the cylinder 35, to tilt or rock the walking beam 14 clockwise as viewed in FIG. 1. With this operation, during the downstroke and upstroke of the cylinder 35, the main or principal force imposed on each rod or rod portion 28 and 29 forming rod 27, will be a tension force.

Since, only tension forces are imposed upon the rod 27, the rod 27 need only be of a size (diameter) sufficient to withstand the tension forces necessary to reciprocate the cylinder 35. It is to be understood, that a given rod will withstand a very much greater force in tension than in compression. Consequently, by allowing only tension forces to be imposed upon the rod 27, a much smaller rod can be utilized than would be the case if compression forces were also imposed upon the rod 27. As a result, a smaller cylinder 35 and a smaller piston 32 can be utilized which in turn require a smaller volume of hydraulic fluid. Less fluid reduces the capacity required of the pump, the reservoir, the control valves and the fluid lines. Thus, the end result is a smaller, and thereby simpler, hydraulic system of the pumping apparatus 10.

Another advantage of the hydraulic operating mechanism of the present invention is that with the rod 27 extending through the cylinder, the upper portion of the mechanism 26 above piston 32 is essentially symmetrical to the lower portion below piston 32 such that the volume of hydraulic fluid used for the upstroke of the cylinder 35 will be essentially the same as for the downstroke of the cylinder 35, thereby providing a balanced loading on the hydraulic system. Also, the speed of one stroke can easily be raised or lowered relative to the speed of the other stroke by suitable control means connected to the fluid lines 51 and 52.

Although the embodiment of the invention disclosed in FIG. 1 provides a very sturdy operating mechanism by virtue of the connections of the upper and lower ends 27a and 27b of the rod 27 to the rigid frame member 34 and the base 11, respectively, the invention can be practiced in other embodiments such as the one shown in FIG. 4. In this modified form of the invention, first and second rods or rod portions 128 and 129 are situated (generally vertical) on different axes with a first piston 130 at the upper free end 128a of the first rod 128 and a second piston 131 at the lower free end 129b of the second rod 129. A cylinder means 135 is provided which includes separate first and second cylinders or cylinder sections 136 and 137 disposed respectively for movement on the rods 128 and 129. The upper end 136a of the first cylinder 136 is connected to a walking beam 140 at a first point 141 by appropriate linkage 138 (similar to connecting rods 38 and 39). The upper end 137a of the second cylinder 137 is also connected to the walking beam 140 by appropriate linkage 139 (also similar to connecting rods 38 and 39), but at a second

point 142 spaced from the first point 141. The lower end 128b of the first rod 128 is rigidly connected to the base 11 while the upper end 129a of the second rod 129 is rigidly secured to a structural member 134 of the well pumping apparatus. This structural member 134 can be a frame member similar or identical to the frame member 34 shown in FIGS. 1 to 3.

A first fluid line 151 is connected to the lower end 136b of the first cylinder 136 and, a second fluid line 152 is connected to the upper end 137a of the second cylinder 137.

The operation of the modified form of hydraulic operating mechanism 126 shown in FIG. 4 is similar to the operation of the operating mechanism 26 shown in FIG. 1. Thus, when pressurized fluid is delivered to the lower end 136b of the first cylinder 136 via fluid line 151, a force acting between the rod connected side of the piston 130 and the lower end 136b of the first cylinder 136 will drive the cylinder 136 downwardly on the first rod 128 resulting in downward movement of the portion of the walking beam 140 shown in FIG. 4. Alternately, when pressurized fluid is delivered to the upper end 137a of the cylinder 137, a force acting between the rod connected side of piston 131 and the upper end 137a of the second cylinder 137 causes the second cylinder 137 to move upwardly relative to the second rod 129 resulting in upward movement of the portion of the walking beam 140 shown in FIG. 4. When fluid is flowing through the line 151 or 152 to the cylinder 136 or 137, fluid is being discharged through the line 152 or 151 from the cylinder 137 or 136 to a reservoir (not shown) by virtue of the movement of the piston 131 or 130. Also, relief means, such as return lines 161 and 162, may be provided to relieve any fluid or air from the cylinders 136 and 137 which might otherwise impede movement of the pistons 130 and 131.

In the operation of the modified form of operating mechanism 126, the principal forces imposed upon the rods 128 and 129 are tension forces, and essentially the same advantages obtained with the operating mechanism 26 are obtained with the operating mechanism 126.

In the FIG. 4 embodiment, the dimensions of the cylinders 136 and 137 (as well as the rod and the piston associated with each cylinder) can be different. Different sized cylinders may be desired where there is a significant difference between the force needed to move the beam 140 clockwise and the force needed to move the beam 140 counterclockwise.

It will be apparent that other modifications and changes can be made in the foregoing embodiments without departing from the principles of the invention. For example, the operating mechanism 26 or 126 can be situated between the forward end 17 of the beam 16 and the Samson post 12. Therefore, the scope of this invention is to be limited only as required by the following claims.

I claim:

1. An hydraulic operating mechanism for use in a well pumping apparatus wherein a beam is pivotally supported for rocking movement at a point above a base, said mechanism including first and second piston rods secured against axial movement, with first and second pistons fixed respectively on said first and second rods, cylinder means including first and second movable cylinder sections which are mounted on said first and second rods respectively and adapted for reciprocating movement relative to said first and second rods, means for operatively connecting said cylinder means to said beam, and fluid control means for delivering pressurized fluid to said cylinder sections in such a way that when the pressurized fluid alternately causes said cylinder sections to move relative to said rods to rock said beam about its pivot support, the forces imposed upon said rods are mainly tension forces.

2. The operating mechanism of claim 1 in which said first and second cylinder sections are separate cylinders and said connecting means operatively connects the upper end of said first cylinder to said beam at a first point on said beam and operatively connects the upper end of said second cylinder to said beam at a second point on said beam spaced from said first point, and said first rod is spaced away from, and extends along an axis generally parallel to, said second rod.

3. The operating mechanism of claim 1 in which a post having a bottom end and a top end is fixed at said bottom end on said base, said beam being pivotally supported above said base at the top end of said post, a frame member is rigidly secured at one end to said post, and the upper end of said second rod is connected to said frame member.

4. The operating mechanism of claim 1 in which counterweights are supported by and suspended from said beam, a guard framework for receiving and guiding said counterweights is fixed on said base, a frame member is rigidly secured at one end to said guard framework, and the upper end of said second rod is connected to said frame member.

5. The operating mechanism of claim 1 in which a post having a bottom end and a top end is fixed at said bottom end on said base, said beam being pivotally supported above said base at said top end of said post, counterweights are supported by and suspended from said beam, a guard framework for receiving and guiding said counterweights is fixed on said base at a point spaced from said bottom end of said post, said post and said guard framework serving as end supports for a frame member which has a first end rigidly secured to said post and a second end rigidly secured to said guard framework, and the upper end of said second rod is connected to said frame member.

6. The operating mechanism of claim 5 in which said frame member is generally Y-shaped having one long arm extending in one direction for securement to one of said end supports and first and second short arms extending in a generally opposite direction for securement to the other of said end supports.

7. The operating mechanism of claim 6 in which said long arm is rigidly secured to said post and said first and second short arms are rigidly secured to said guard framework.

8. The operating mechanism of claim 1 in which said first rod and said second rod are situated on the same axis, said first piston being situated on said first rod at approximately the upper end thereof and said second piston being situated on said second rod at approximately the lower end thereof, and the upper end of said first cylinder section is connected to the lower end of said second cylinder section to form said cylinder means as one integral cylinder which is disposed for sliding and reciprocal movement on said first and second rods.

9. The operating mechanism of claim 8 in which the upper end of said first rod is connected to the lower end of said second rod to form a single rod, and said first and second pistons are connected together to form a unitary double acting piston.

10. In a well pumping apparatus having a base, a walking beam having a forward end and a rearward end, said forward end of said beam being adapted to support a well pump, said beam being pivotally supported on said base and being adapted to support counterweight means at a point rearwardly of the pivot support on said base for counterbalancing the forces acting on said forward end of said beam, and a frame member rigidly fixed to said apparatus and positioned above said base, the improvement comprising means for rocking said beam including a rod having a lower end fixed to said base and an upper end fixed to said frame member, a piston fixed on said rod at a point between said upper and lower ends of said rod, a cylinder slidably positioned on said rod over said piston and having a closed upper end and a closed lower end, and fluid coupling means connected to the upper and lower ends of said cylinder for alternately delivering fluid pressure to one end of said cylinder while fluid is displaced from the other end of said cylinder.

11. The well pumping apparatus of claim 10 in which said means for connecting said cylinder to said beam includes at least one connecting rod pivotally connected at one end to said beam and pivotally connected at the other end to said cylinder.

12. The well pumping apparatus of claim 10 in which said means for connecting said cylinder to said beam includes two connecting rods, each of said connecting rods having an upper end pivotally connected to said beam and a lower end pivotally connected to said cylinder.

13. The well pumping apparatus of claim 12 in which said connecting rods are positioned to straddle said frame member.

14. In a well pumping apparatus having a base, a beam having a forward end and a rearward end and being pivotally supported on said base at a point between said forward end and said rearward end, said forward end of said beam being adapted to support a well pump, said beam also being adapted to support counterweight means at a point rearwardly of the pivot support on said base for counterbalancing the forces acting on said forward end of said beam, and a frame member rigidly fixed to said apparatus and positioned above said base, the improvement comprising means for rocking said beam including a first rod portion having a lower end fixed to said base and an upper end situated above said base below said frame member, a first piston section fixed on said first rod portion, a second rod portion having an upper end fixed to said frame member and a lower end situated below said frame member above said base, a second piston section fixed on said second rod portion, cylinder means including first and second cylinder sections, means for connecting said cylinder means to

said beam, said first cylinder section being slidably positioned on said first rod portion with said first piston section disposed in said first cylinder section, said second cylinder section being slidably positioned on said second rod portion with said second piston section disposed in said second cylinder section, first fluid coupling means connected to said first cylinder section to apply pressure against the rod connected side of said first piston section so that the principal force applied to said first piston rod portion, when pressurized fluid is delivered to said first cylinder section to move said beam in one direction about said pivot support, will be a tension force, and second fluid coupling means connected to said second cylinder section to apply pressure against the rod connected side of said second piston section so that the principal force applied to said second rod portion, when pressurized fluid is delivered to said second cylinder section to move said beam in the opposite direction about said pivot support, will be a tension force.

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