Jan. 5, 1954

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2,664,764

FOAM PRESSURE BALANCED WALKING BEAM
TYPE OIL WELL PUMPING JACK
Filed Sept. 15, 1951

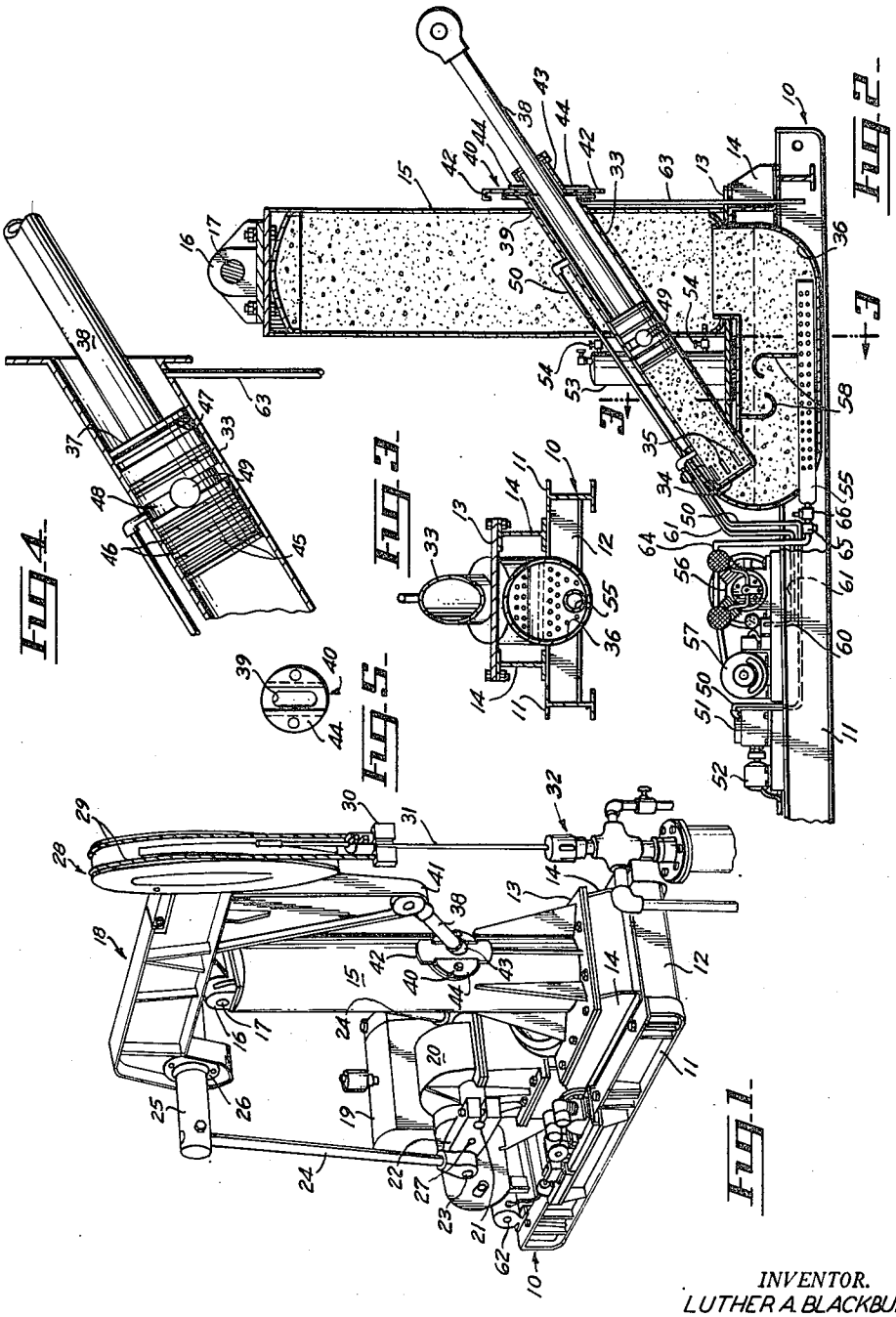


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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Patented Jan. 5, 1954

2,664,764

UNITED STATES PATENT OFFICE

2,664,764

FOAM PRESSURE BALANCED WALKING BEAM TYPE OIL WELL PUMPING JACK

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Application September 15, 1951, Serial No. 246,849

10 Claims. (Cl. 74—589)

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This invention relates to pressure balanced, walking beam type, oil well pumping jacks and more specifically contemplates improvements in the apparatus disclosed in my copending application, S. N. 213,387, filed March 1, 1951 for Hydraulic Lift, Walking Beam Type, Pumping Jacks, now abandoned, of which the present application is a continuation-in-part.

Essential structure comprising a part of the present invention and common to the application for patent last above-referred to, includes a walking beam pivotally supported intermediate its ends upon a Sampson post adjacent the well. To one end of the beam, power is applied for vertically swinging a horse-head carried by the opposite end of the beam and connected to the polish rod. The load upon the jack changes with each stroke. On the down stroke of the sucker rod string in the well, the weight of the rods constitutes the chief component of the load, while on the upstroke, the weight of the column of fluid being raised is also carried by the walking beam. It is a general object of the present invention to provide a device of this type characterized by embodiment therein of a pressure-actuated ram operable to oppose gravitation of the rods and fluid in the well throughout the cycle of operation of the device while alternately opposing and supplementing the prime power source.

More specifically, an object hereof is to provide mechanism for producing a foam pressure cushion to counterbalance, within a predetermined range, the weight of the sucker rod string and approximately one-half the weight of the fluid column in the well.

Another object is the provision of means associated with the ram to produce an oil-containing foam within the ram cylinder so as to assure lubrication of the piston throughout its stroke and assist in preserving an effective seal between the piston and cylinder wall.

Still another object is to provide a counterbalancing normally sealed foam pressure system embodying a pressure reservoir and a ram, operable to exert an upward thrust against the walking beam in opposition to the direction of imposition of the load thereon, providing for a variation in pressure during each stroke of the rod string, with the pressure range being determined primarily by the displacement of the piston relative to the capacity of the pressure reservoir, wherein the pressure increases during the downstroke of the rod string in opposition to the prime mover to retard the reversal of direction of movement of the rods at the bottom of the stroke, relieving

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the shock upon the rods as they assume the load of the fluid column in the well, and decreases during the upstroke of the rod string while supplementing the prime mover to correspondingly retard the reversal of direction of movement of the rods at the top of the stroke.

Other objects and salient features of my invention include the provision of auxiliary means for lubricating the piston under pressure at the upper end of its stroke, a pressure cylinder closed at opposite ends and having orifices in the wall thereof through which components of the foam are drawn and expelled, and for the provision of baffles within the pressure reservoir to induce agitation of the foam during successive strokes of the piston.

The above and numerous other objects will be apparent from an examination of the following description read in the light of the accompanying drawings, in which:

Fig. 1 is a perspective view of a pump jack embodying my invention.

Fig. 2 is a longitudinal section through the unit, illustrating particularly the pressure ram and reservoir assembly.

Fig. 3 is a sectional view, taken on line 3—3 of Fig. 2.

Fig. 4 is an enlarged broken sectional view through the ram cylinder depicting particularly the construction of the piston.

Fig. 5 is an elevation of the closure assembly for the upper end of the cylinder, omitting the sliding plate carried by the piston rod.

Referring to the drawings in detail, the numerals of which indicate similar parts throughout the several views, 10 designates generally the foundation of the unit comprising spaced, parallel H-beams 11 and transverse beams 12. A pedestal 13, mounted upon H-beams 14, carried by the foundation 10, supports a vertically disposed tank 15, comprising a pressure reservoir. The tank 15 serves the additional function of a Sampson post, having mounted on its upper end a bearing 16 for a pivot pin 17 upon which the walking beam 18 is fulcrumed. An engine 19 for actuating the walking beam 18, is mounted upon the rearward end of the foundation 10, the power being transmitted through suitable reduction gearing enclosed in a case 20, so as to rotate a shaft 21 projecting from opposite sides of the gear case. Crank arms 22, secured to the ends of the shaft 21, carry crank pins 23, upon which are pivoted the lower ends of actuating links 24. The upper ends of the links 24 are secured to a transverse shaft 25

which extends through a self-aligning bearing 26 carried by the walking beam 18. It will thus be appreciated that upon activation of the engine 19 the walking beam is pivotally reciprocated upon its fulcrum pivot 17, the length of the stroke of the opposite working end of the beam 18 being determined by the effective length of the crank arms 22 which are provided with a plurality of holes 27 to permit selective variation in this respect. The working end of the walking beam 18 supports a double-pivoted horsehead 28 of the type shown in my copending application, S. N. 213,387, above referred to. The details of construction of the horsehead 28, forming no part of the present invention, are accordingly not described in detail. Connected to the horsehead are a pair of cables 29, the lower ends of which are secured to opposite sides of a polish rod clamp 30. The polish rod, indicated by the numeral 31, is secured in the clamp 30 and extends downwardly through the usual well flow-fittings 32, being reciprocated for actuation of the pump with which its lower end is connected by the usual sucker rod string (not shown) incident to pivotal reciprocation of the walking beam.

It will be appreciated that the principal component of the load on the downward stroke of the rod string comprises the weight of the rods, and that on the upstroke the weight of the fluid column being raised in the well is added to the weight of the rod string. In order to minimize insofar as practicable the power required to actuate the jack, I provide pressure means arranged to exert an upward thrust, varying within a predetermined pressure range, against the working end of the walking beam 18 so as to oppose the downward movement of the rod string and supplement the prime power source during the upstroke of the rod string.

To this end, I provide a ram comprising a cylinder 33 which projects obliquely through, and in a diametric plane of, the tank 15. The lower end of the cylinder 33, which is supported by the pedestal 13 is closed by a plate 34. Adjacent the end of the cylinder 33, the latter is formed with a series of circumferentially spaced slots 35, through which the bore of the cylinder is maintained in open communication at all times with the bore of one end of a U-shaped foam reservoir 36. The opposite end of the reservoir is in open communication with the lower end of the tank 15. A piston 37, reciprocably disposed within the cylinder 33, is pivotally connected to one end of a piston rod 38 which projects through an elongated slot 39 formed in a closure plate 40 (Fig. 5) secured over the flanged upper end of the cylinder. The upper end of the piston rod 38 is pivotally connected to the lower end of a triangular arm 41 depending from, and secured rigidly to, the underside of the walking beam 18 intermediate the fulcrum pivot 17 and horsehead 28. In order to completely close the upper end of the cylinder against the admission of dirt and the like the closure plate 40 is superposed by an elongated sliding plate 42 through which the piston rod 38 projects. Integral with the plate 42 is a hub 43 which snugly encircles the rod. The plate 42 is retained for vertical sliding movement over the closure plate 40 by retainer segments 44 which are secured to the lateral sections of the closure plate and overlie edges of plate 42. Thus, with each stroke of the walking beam 18, the piston 37 is moved through its

corresponding stroke within the cylinder 33 while the upper end of the cylinder is effectively closed by the plates 40 and 42, the latter making sliding compensation for progressive angular variation of the piston rod 38 throughout the cycle of operation of the walking beam.

The piston 37 is formed with a series of annular grooves 45 in which expansible split rings 46 are fitted. Adjacent to the bottom and to the top of the piston 37 are a pair of circumferential grooves 47 adapted to provide oil seals with the cylinder wall. A wider groove 48 encircles the body of the piston 37 in transverse alignment with the wrist pin 49 by which the rod 38 is connected to the piston 37. A tube 50, leading from a force-feed lubricator 51, actuated by a motor 52, is connected to the upper end of the cylinder 33 so as to conduct oil from a suitable source of supply within the lubricator 51 through the cylinder wall and into the groove 48 of the piston when the latter is at the upper end of its stroke so as to assure effective lubrication of the wrist pin 49.

A foam-producing liquid reservoir tank 53 is mounted upon the pedestal 13 adjoining the tank 15 and is provided at its top and bottom with valved connections 54 with the latter tank. By opening the valves 54 the liquid is initially supplied by gravity feed to the tank 15 and reservoir 36 to the level of the dotted lines in Fig. 2, i. e., below the slots 35 in the lower end of the cylinder 33. The liquid may be composed of any of a wide variety of ingredients but is characterized principally by its oil content which with the liquid transformed into foam is effective to maintain constant lubrication of the cylinder wall, and further, by one or more components capable of producing a foam of substantially the entire volume of the liquid. Without limiting myself to any particular composition of the liquid, the following formula is submitted as illustrative of a composition which proves effective for the purposes described:

	Per cent
Coconut oil	22
Stearic acid	35
Oleic acid	43

saponified by the action of sodium hydroxide in required amount. The above ingredients in the percentages noted, as measured by volume, and constituting 8% of the whole, are mixed with a solution composed of:

	Per cent
Water	41
Refined petroleum oil	41
Ammonia	5
Methyl cellulose	5
Saponin	2

Upon agitation this liquid transforms completely into a foam. The ammonia causes the oil to effectively mix with the water and also contributes to the foam-producing function.

Agitation of the liquid within the reservoir 36, and tank 15 is induced primarily by the introduction of air into the reservoir 36 below the surface of the liquid through a laterally ported tube 55 which is connected, by a tube 64, to a compressor 56, actuated by a motor 57. During operation of the jack, resulting in the reciprocation of the piston 37, foam within the lower end of the cylinder is expelled from the latter, causing a movement of foam in the reservoir 36. In order to utilize this action of the piston 37 to maintain, by continuing the agitation, the

characteristic condition of the foam, I provide a pair of perforated baffles 58 and 59 within the bore of reservoir 36, through and between which baffles the laterally moving foam is compelled to pass.

The foam pressure maintained within the tank is determined by a regulator 60 connected to the cylinder 33 by a tube 61. The regulator 60 which controls the operation of the compressor 56 in an obvious manner, is adjusted, with the piston 37 equi-spaced from the ends of its stroke, to actuate the compressor whenever the foam pressure falls below an amount required to counterbalance the weight of the rod string plus one-half the weight of the fluid column raised by the rods during the upstroke of the latter. A generator 62 (Fig. 1), actuated by the engine 19, provides power for the motors 52 and 57. Liquid from the tank 53 may be supplied to the tank 15 during operation of the unit by opening the valves 54, which permits its gravitation into the reservoir 36.

The operation of my invention is further briefly described as follows: After filling the reservoir 36 to the level indicated in Fig. 2 and with the walking beam tilted to a position intermediate the ends of its stroke so as to place the piston 37 in a position approximately equi-spaced from the ends of its stroke the compressor 56 is energized to force air into the reservoir 36 and tank 15. The forcible expulsion of air through the ports of tube 55 into the liquid transforms the latter into foam, filling the tank 15 and cylinder 33. The pressure is preferably raised, as above indicated, until the weight of the sucker rods and one-half of the weight of the fluid in the tubing string is counterbalanced.

As the fluid in the well is carried by the tubing string during the downstroke of the rods, the pressure behind the piston 37 opposing the weight of the rods, is sufficient to maintain the jack inactive. The operation is initiated by starting the engine 19 which supplies sufficient power to overcome the balance of pressure within the ram and by raising the outer end of the walking beam lowers the rod string in the well. Incident to this operation, the piston is correspondingly lowered in the cylinder 33, progressively increasing the pressure within the ram reservoir 36 and tank 15. The increase in pressure is effective to slow the movement of the rod string as the latter approaches the lower end of its stroke. During the initial phase of the upward movement of the rod string, the rods assume the weight of the fluid in the tubing, but as the velocity of their movement is retarded, due to the progressively greater pressure produced in the tank by the piston moving in opposition to the downward movement of the string, the stretching of the rods is gradually accomplished, the stress upon the tool joints is minimized. Reversal of direction of movement of the rods also reverses the direction of movement of the piston, and accordingly the pressure within the tank is exerted against the walking beam in an upward direction, supplementing the action of the engine. Thus at the beginning of the upward movement the velocity of movement of the rod string is accelerated to compensate for the retardation of the movement of the string during the preceding stroke. However, as the piston and the rod string continue their upward movement, the pressure within the tank is progressively dissipated and, accordingly, the velocity of the string is again retarded so as to effect a slower reversal of direction of movement at the top of the cycle.

It will be observed that, disregarding the variation in pressure of the ram during each cycle of operation, the range of which variation is dependent upon the displacement of the piston relative to the capacity of the tank 15 and reservoir 36, the effective load upon the engine 19 is substantially the same on each stroke, and is generally measured by the power required to raise the rod string and one-half the fluid weight. It will be understood that the compressor 56 is energized in response to actuation of the regulator 60 only when foam pressure within the tank 15, and transmitted to the regulator through the tube 61, falls below the minimum required to counterbalance the weight of the rod string plus one-half the weight of the fluid in the well when the string is intermediate the ends of its stroke.

Any foam or oil leaking past the piston is permitted to drain from the cylinder through a tube 63. The tube 64 from the compressor 56 to the perforated tube 55 is equipped with a check valve 65 and a shut-off valve 66, manually operated, to facilitate control of pressure within the reservoir, cylinder and tank, as will be obvious.

The single embodiment of my invention shown in the drawings hereof and described above, is only illustrative of numerous modifications which may vary from the specific form depicted in number, shape, size, design and proportion of the various parts, and that any such changes that fall within the definitions of the claims appended hereto are included within the scope of the present invention.

What I claim and desire to secure by Letters Patent is:

1. In a foam counterbalanced oil well pumping jack for actuating a sucker rod in a well tubing string, a Sampson post comprising a foam pressure tank, a walking beam pivoted intermediate its ends upon said Sampson post, means carried by said beam to connect the forward end thereof to the sucker rod string, a cylinder disposed with its axis in the vertical plane of said walking beam, extending obliquely through and sealed to said tank, and having its lower end in open communication with said tank, a piston in said cylinder, a piston rod pivoted to said piston and extending from the upper end of said cylinder, an arm depending from the forward end of said walking beam and pivoted to said piston rod, power means connected to the rearward end of said walking beam for pivotally reciprocating the latter, means for producing a foam lubricant within said tank, means for maintaining said lubricant under pressure sufficient to counterbalance a weight in excess of the weight of the sucker rod string and one half the weight of the fluid in the tubing string during the initial stages of the upstroke of said rod string and piston.

2. In a foam counterbalanced oil well pumping jack for actuating a sucker rod in a well tubing string, a Sampson post comprising a foam pressure tank, a walking beam pivoted intermediate its ends upon said Sampson post, means carried by said beam to connect the forward end thereof to the sucker rod string, a cylinder extending through said tank in a vertical plane, obliquely to the vertical axis of said tank, and having its lower end in open communication with said tank, a piston in said cylinder, a piston rod pivoted to said piston and extending from the upper end of said cylinder, an arm depending from the forward end of said walking beam and

pivoted to said piston rod, power means connected to the rearward end of said walking beam for pivotally reciprocating the latter, means for producing a foam lubricant within said tank, means for maintaining said lubricant under pressure sufficient to counterbalance a weight in excess of the weight of the sucker rod string and one half the weight of the fluid in the tubing string during initial stages of the upstroke of said rod string and piston, said pressure tank and lower end of said cylinder being sealed whereby the pressure in said tank increases during the downstroke to the rod string and piston.

3. In a foam pressure counterbalanced oil well pumping jack for actuating a sucker rod in a well tubing string, a Sampson post comprising a foam pressure tank, a walking beam pivoted intermediate its ends upon said Sampson post, means carried by said beam to connect the forward end thereof to the sucker rod string, a cylinder disposed with its axis in the vertical plane of oscillation of said walking beam, extending obliquely through said tank, sealed thereto, and having its lower end in open communication with said tank, a piston in said cylinder, a piston rod pivoted to said piston and extending from the upper end of said cylinder, an arm depending from the forward end of said walking beam and pivoted to said piston rod, power means connected to the rearward end of said walking beam for pivotally reciprocating the latter, a perforated tube within said tank, a compressor connected to said tube to inject air under pressure through the perforations of said tube into said tank, a quantity of foam-producing liquid in said tank to fill said tank with foam in response to actuation of said compressor, and means to maintain said foam under sufficient pressure to counterbalance a portion of the load upon said walking beam during the upstroke of said rod string.

4. In a foam pressure counterbalanced oil well pumping jack for actuating a sucker rod in a well tubing string, a Sampson post comprising a foam pressure tank, a walking beam pivoted intermediate its ends upon said Sampson post, means carried by said beam to connect the forward end thereof to the sucker rod string, a cylinder disposed with its axis in the vertical plane of said walking beam, extending obliquely through said tank, sealed thereto, and having its lower end in open communication with said tank, a piston in said cylinder, a piston rod pivoted to said piston and extending from the upper end of said cylinder, an arm depending from the forward end of said walking beam and pivoted to said piston rod, power means connected to the rearward end of said walking beam for pivotally reciprocating the latter, a perforated tube within said tank, a compressor connected to said tube to inject air under pressure through the perforations of said tube into said tank, a quantity of foam-producing liquid in said tank to fill said tank with foam in response to actuation of said compressor, and means to produce and maintain said foam under minimum pressure sufficient to counterbalance a load upon said beam in excess of the weight of the rod string.

5. In a foam pressure counterbalanced oil well pumping jack for actuating a sucker rod in a well tubing string, a Sampson post comprising a foam pressure tank, a walking beam pivoted intermediate its ends upon said Sampson post, means carried by said beam to connect the forward end thereof to the sucker rod string, a cylinder disposed in the plane of oscillation of said walking beam, extending obliquely through said tank, sealed thereto, supported thereby, and having its lower end in open communication with said tank, a piston in said cylinder, a piston rod pivoted to said piston and extending from the upper end of said cylinder, an arm depending from the forward end of said walking beam and pivoted to said piston rod, power means connected to the rearward end of said walking beam for pivotally reciprocating the latter, a perforated tube within said tank, a compressor connected to said tube to inject air under pressure through the perforations of said tube into said tank, a quantity of foam-producing liquid in said tank to fill said tank with foam in response to actuation of said compressor, and means to maintain said foam under sufficient pressure to counterbalance a portion of the load upon said walking beam, the pressure in said tank being variable in direct relation to the movement of said piston in said cylinder in response to movement of said beam.

6. In a foam-pressure counterbalanced oil well pumping jack for actuating a sucker rod in a well tubing string, a Sampson post comprising a foam pressure tank, a walking beam pivoted intermediate its ends upon said Sampson post, means carried by said beam to connect the forward end thereof to the sucker rod string, a cylinder disposed in the plane of oscillation of said walking beam, extending obliquely through said tank, sealed thereto, supported thereby, and having its lower end in open communication with said tank, a piston in said cylinder, a piston rod pivoted to said piston and extending from the upper end of said cylinder, an arm depending from the forward end of said walking beam and pivoted to said piston rod, power means connected to the rearward end of said walking beam for pivotally reciprocating the latter, a perforated tube within said tank, a compressor connected to said tube to inject air under pressure through the perforations of said tube into said tank, a quantity of foam-producing liquid in said tank to fill said tank with foam in response to actuation of said compressor, and means to maintain said foam under pressure sufficient to counterbalance a progressively greater proportion of the load during the downstroke of the rod string.

7. In a foam-pressure counterbalanced oil well pumping jack for actuating a sucker rod in a well tubing string, a Sampson post comprising a foam pressure tank, a walking beam pivoted intermediate its ends upon said Sampson post, means carried by said beam to connect the forward end thereof to the sucker rod string, a cylinder disposed in the plane of oscillation of said walking beam, extending obliquely through said tank and having its lower end in open communication with said tank, a piston in said cylinder, a piston rod pivoted to said piston and extending from the upper end of said cylinder, an arm depending from the forward end of said walking beam and pivoted to said piston rod, power means connected to the rearward end of said walking beam for pivotally reciprocating the latter, a perforated tube within said tank, a compressor connected to said tube to inject air under pressure through the perforations of said tube into said tank, a quantity of foam-producing liquid in said tank to fill said tank with foam in response to actuation of said compressor, and means to maintain said foam under sufficient pressure to counterbalance a portion of the load upon said walking beam

during the upstroke of said rod string, and means comprising a regulator to actuate said compressor whenever pressure within said tank falls below a predetermined level.

8. In an oil well pumping jack for actuating a sucker rod string in an oil well tubing string, a foam-balance pressure tank, a cylinder extending obliquely through and sealed to the tank and thereby supported, with the axis of said cylinder intersecting and disposed in the vertical plane of the axis of said tank, means connecting the lower end of the tank to the lower end of said cylinder, a piston in said cylinder, a walking beam pivoted on said tank, an arm depending from the underside of one end of said walking beam, a piston rod pivotally interposed between said piston and the lower end of said arm, power means connected to the other end of said walking beam to pivotally reciprocate the latter upon said tank, said cylinder, tank and said first-named means being sealed whereby the pressure in said tank varies in direct relation to movement of said piston on successive strokes.

9. In an oil well pumping jack for actuating a sucker rod string in a well tubing, a foam-balance pressure tank, a cylinder extending obliquely through and sealed to the tank, with the axis of said cylinder intersecting and disposed in the vertical plane of the axis of said tank, means connecting the lower end of said tank to the lower end of said cylinder, a piston in said cylinder, a walking beam pivoted on said tank, an arm depending from the underside of one end of said walking beam, a piston rod pivotally interposed between said piston and the lower end of said arm, power means connected to the other end of said walking beam to pivotally reciprocate the latter upon said tank, the downward movement of said piston in said cylinder being effective to raise the pressure in said tank and increase the resistance of said cylinder and piston assembly to upward movement of the end of said walking beam to which said power means is connected so as to retard said movement.

10. In an oil well pumping jack for actuating a sucker rod string in a well tubing, a foam-balance pressure tank, a cylinder extending obliquely through the tank, with the axis of said cylinder intersecting and disposed in the vertical plane of the axis of said tank; means connecting the lower end of said tank to the lower end of said cylinder, a piston in said cylinder, a walking beam pivoted on said tank, an arm depending from the underside of one end of said walking beam, a piston rod pivotally interposed between said piston and the lower end of said arm, power means connected to the other end of said walking beam to pivotally reciprocate the latter upon said tank, and means to increase the pressure within said tank during the upstroke of the end of said walking beam to which said power means is connected.

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