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LONG STROKE DEEP OIL WELL PUMPING JACK UNIT

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LONG STROKE DEEP OIL WELL PUMPING JACK UNIT

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1 Claim. (CL 74—37)

This invention relates to pumping jack units for deep oil wells and contemplates vertically arranged chain mechanism for actuating a cross head for reciprocation of a sucker rod string within a well, the rod string and the fluid pumped being partially counterbalanced to substantially equalize the weight lifted by the power unit on opposite strokes of the well pump. The present application is an improvement over and continuation-in-part of my co-pending application S. N. 300,606, filed October 21, 1939, for Long stroke pump jacks.

A principal object is to provide a pumping jack unit for applying vertical reciprocatory movement to a sucker rod string for pumping deep oil wells, and adapted to afford a long stroke for the rod string to minimize the effect of rod and tubing elongation incident to the transfer of the weight of the fluid raised from the tubing to the rod string and vice versa with each cycle of the well pump.

Another object is to provide mechanism wherein a part of the weight of the rod string and fluid raised on the upstroke of the well pump is balanced by counterweights, and a part of the weight of the counterweights is likewise counterbalanced on the down stroke of the pump, the balance of the load to be carried by the power unit on opposite strokes being equal to assure uniformity of movement and maintain a constant tension on the chains and associated mechanism.

Another object is the provision of a crosshead carrying transversely movable blocks connected to endless chains movable over pairs of vertically aligned sprockets to reciprocate the crosshead and a rod string connected thereto, in combination with novel means for lubricating said blocks and compensating for their wear.

Another object is to incorporate safety devices for automatically stopping the movement of the rod-actuating mechanism and for supporting the counterweights in any location throughout their range of travel in the event of the parting of the sucker rod string.

Still another object is to provide novel bearing supports for the sprockets carrying the chains by which the crosshead is reciprocated, contributing greatly to the strength of the apparatus and assuring proper alignment of the chains.

Another object is to provide a frame for the support of the mechanism of the character indicated, mounted on rails and having one side section thereof removable whereby the apparatus may be shifted over or off the well with facility, means being included for selectively releasing the jack onto a suitable firm foundation when properly aligned with the well or lifting it onto the rails for lateral movement from the well.

Still another object is the provision of guards located on the level with the derrick floor at opposite sides of the pump jack frame into which the counterweights are reciprocable, one or both of said guards being shiftable from their normal position to permit movement of the jack from the well.

Other objects and salient features of my invention, such for example as facility of control of the sucker rod and the pump structure actuated thereby, ease of manipulation and adjustment of all moving parts, adaptability of the frame structure to support a crown block for use in removing the rods and pump barrel, etc., and compact arrangement of the chains, sprockets and gear mechanism, will be apparent to those of skill in the art to which my invention appertains upon an examination of the following description read in the light of the accompanying drawings in which:

Fig. 1 is a perspective view of the entire unit assembled as in use;
Fig. 2 is a fragmentary view in elevation of one of the rails over which the apparatus may be moved, and one of the wheels for supporting the latter thereon;
Fig. 3 is a sectional view taken on line 3—3 of Fig. 2;
Fig. 4 is a fragmentary side view, in section and elevation, depicting the principal mechanism enclosed in the casing by which the sucker rod is actuated and showing the counterweights for equalizing the load carried by the crosshead on opposite strokes;
Fig. 5 is a fragmentary view in section and elevation of one of the lower bearing and sprocket assemblies;
Fig. 6 is a broken elevation, partially in section, of the crosshead and two of the chains by which it is actuated, illustrating the relation between these parts with the crosshead at the top of its stroke;
Fig. 7 is an elevation similar to Fig. 6, showing the crosshead intermediate the ends of its range of movement;
Fig. 8 is a plan view, showing particularly the relative arrangement of the chains, crosshead, and counterweights;
Fig. 9 is a detail view in elevation of a pair of
the master links by which the crosshead and chains are connected;

Fig. 10 is a detailed sectional view of the means for adjusting the tension of the crosshead-actuating chains;

Fig. 11 is a sectional view of one of the counterweights illustrating the guides therefore in elevation, and depicting particularly a means for locking the counterweight in the event of the breakage of their means of suspension;

Fig. 12 is a sectional view through the gear case illustrating the mechanism through which power is applied to the chains and crosshead;

Fig. 13 is a sectional view through the brake mechanism, illustrating also the safety device for locking the drive shaft against movement in the event that the crosshead should begin to move faster than the speed at which it is driven by the power unit;

Fig. 14 is a broken vertical section of one of the counterweights incorporating a modified form of locking device.

Referring to the drawings in detail, the numerals of which indicate like parts throughout the several views, 15 designates generally each of a series of beams arranged to form a rectangle between which extend a pair of transverse parallel cross beams 16. Four upstanding channel studs 17 are secured to cross beams 16 to define the corners of the upstanding portion of the structure. The pairs of channel studs 17 mounted upon respective beams 16 define opposite sides of the structure; the position of studs 17 of each of these pairs is reinforced by cross angles 18 parallel and spaced apart vertically to the top of the structure. Angle braces 20 further reinforce the vertical position of the studs 17 at each side of the frame. Each stud 17 is connected to a like stud of the pair thereof forming the corners of the opposite side of the apparatus, which is nearest the adjacent thereto, respectively, by girders 22. The ends of the frame across which girders 22 extend are enclosed by plates 21 which are removable secured to the studs by suitable means.

The sides of the apparatus between each pair of vertically aligned cross beams 16 are enclosed by panels 22 and doors 23, the latter affording access to the mechanism within. The middle portion of the beam 15 at one end of the supporting frame is cut away as at 24 to enable, upon removal of the adjacent lowermost plate 21, unrestricted access from the exterior to the center of the structure, whereby the apparatus can be moved laterally over or from a wall. In order to facilitate this movement, I provide a pair of rails 25 which are mounted on a suitable foundation (not shown) at opposite sides of the wall. The side beams 15 of the frame carry bearings 26 adjacent to each corner of the frame, in which the ends of crank pins 27 are journaled with the laterally offset portions 28 of the pins protruding from the bearings over the rail 25 adjacent thereto. A flanged wheel 29 is journaled on the outer end of each crank pin 27 directly over the adjacent rail 25. The outer end of each crank pin 27 is provided with a squared portion 30 whereby it may be turned to lower the wheel 29 thereon onto the rail 25 and elevate the adjacent corner of the frame and entire structure. The portion of each crank 27 enclosed by its bearing 26 is 30 formed with a radial opening 31 to receive a pin 32, slidably vertically in the upper part of the bearing, when the offset outer portion of crank 27 is in its lowermost position relative to the part of the pin journaled in the bearing. It will thus be seen that by applying a tool to the squared outer end portion 30 of each of the crank pins and turning the latter, successive corners of the structure may be elevated with respect to the wall and moved laterally of the wall over rails 25.

A suitable power unit 33 of any conventional type is mounted to a suitable foundation afforded by the beams 15 so as to turn by a belt 34 or chain 35 a drive pulley 36 disposed on the end of a drive shaft 36 journaled in bearings 37 at opposite sides of the frame. A pair of horizontal girders 38 supported in spaced relation at each side of the structure by auxiliary studs 39, provide support for bearings 37. A gear 40 is secured on shaft 36 between each pair of bearings 37 to mesh with larger pinions 41 mounted on short shafts 42 journaled in bearings 43 (Fig. 5) carried by the girders 38 of each pair thereof, respectively, with the shafts 42 at opposite sides of the structure in coaxial alignment. Pinions 41 in turn mesh respectively with identical pinions 44 similarly mounted on shafts 45 journaled in bearings 46 carried by the girders 38. It will thus be seen that through the reduction gearing described, the power of the unit 33 as applied is increased and that the speed of the shafts 42 and 45, regardless of the speed of the pulley, will be coordinately due to the identity of the pinions 41 and 44 at each side of the structure are enclosed in a gear case comprising a lower section 47 hung from the girders and an upper section 48 which is removable for inspection and servicing of the gears and bearings, a ladder 49 being provided from the derrick floor to girders 38 on each side to facilitate access to the gear cases. The inner ends of each of the shafts 42 and 45 are supported by bearing blocks 50 suspended from an adjacent cross beam 16 thereof. Each bearing block 50 is formed with a cut-out for the reception and rotation of a sprocket 51 mounted on and turned by the shaft journaled in the corresponding bearing block.

Two pairs of vertically-disposed angle irons 52 extend between the uppermost cross angles 18 at each side of the structure, each pair being in transverse alignment with the pair at the opposite side of the apparatus, with the area between irons 52 of each pair being in vertical alignment with the axis of one of the shafts 42 or 45 respectively. A U-shaped bearing block 53 is secured to each pair of irons 52 by a pair of screws 54 extending therebetween, the heads of the screws engaging the outer surfaces of the irons. The blocks 53 are each supported from below by screws 55 threaded through blocks 53 secured rigidly to the adjacent cross angle 18 therebelow. A cat walk 57 attached to each side of the structure at the level of the last-named cross angle 18 offers support to a person adjusting the screw 55 for varying the elevation of bearing blocks 53. A sprocket 59 journaled through each bearing block 53 carries an idler sprocket 59 in a recess of the block which is held in vertical alignment with a sprocket 51 carried and driven by one of the four shafts 42 or 45. Four endless chains 60 extend around respective pairs of vertically aligned sprockets 59 and 51 so as to be driven by the lower sprocket 51 for reciprocating the cross head 61 suspended from chains 60 in a manner about to be described.

To each series of vertically aligned girders 22, a vertical angle iron 62 is secured intermediate the channel studs 17 forming the ends of the structure so as to extend from below the lower
sprockets 51 to above the idler sprockets 59. One side of each angle iron 62 extends inwardly to provide a guide rail 63. The opposite sides of each rail 63 are slidably engaged by an end of cross head 61. Cross head 61 comprises preferably a pair of channels 64 which are held in spaced relation by the rail-engaging members 65 disposed between the corresponding ends of the channels. A spacing member 65a is similarly positioned between the channels intermediate the ends of the latter. One or more shims 65b are interposed between the upper channel and each member 65 and the member 65a. A pair of blocks 66, each carrying four parallel rollers 67 between opposite corners thereof are disposed between the channels 64 of the cross head and between the upstanding sides of the lower channel 64, the latter tending to retain blocks 66 against any substantial motion laterally of cross head 61. The blocks 66 are moved toward and away from one another by the end members 65 of the cross head by the chains 60. To this end a connecting rod 68 is journaled in each of blocks 66 and extends to oppose sides thereof into proximity with runs of chains 60 at opposite sides of the structure, and terminating in the male balled-shaped ends 69. The master links 70 of the rods 68 are received by master links 70 of the respective chains in which they are rotatably retained.

Exact spacing of channels, 64 comprising the crosshead, may be accomplished by the use of shims 65b of the proper thickness. The effect of wear on the shims, rollers 67, and associated parts of the crosshead may be offset by the insertion of additional shims or the substitution of shims of greater thickness. The lower rollers may be lubricated by oil deposited in the lower channel between members 65 and the central spacing member 65a. It will thus be seen that the cross head 61 will be alternately raised and lowered as chains 60 are driven over their respective sprockets, the master links 70 being moved alternately upwardly and downwardly in unison with movement of the chains, operatively connected with a respective block 66, in opposite directions, the relative reversal of movement being effected through the reduction gearing 40, 41 and 44.

Vertically-aligned openings, are formed in the center of the channels 64 comprising cross head 61 and in spacing member 65a for the extension of the upper end of the pump rod indicated at 71. The rod 71 is secured in the cross head against vertical movement relative thereto by a clamp 72 of any suitable construction carried by the upper channel 64.

On the upstream of pump rod 71 the weight of the rod string and the fluid in the well being raised is counterbalanced in part by a pair of counterweights 13 which are retained, respectively, for vertical travel, between pairs of channel studs 17 defining the opposite ends of the structure. Beam 74 extends across and connects the upper ends of the channel studs at each side of the structure. A bearing block 75 is mounted adjacent each end of each of the uppermost cross beams 74 with the blocks 78 at corresponding ends of the beams in transverse alignment. Each pair of transverse aligned bearings 75 affords rotary support for an arm 16 on which a sprocket 77 is centrally mounted. Adjacent each end of cross head 61 a pair of lugs 78 are mounted, equispaced from clamp 72. One end of a chain 79 extends over each sprocket 77, and is retained between lugs 78 therebelow, respectively, by a pin 80. A series of transversely-aligned holes 81 are formed in each pair of lugs 78 to selectively receive the ends of pins 82 so as to provide a fine adjustment for the effective length of chains 19. Chains 19 passing upwardly over sprockets 77 extend downwardly at the opposite side thereof between the channel studs 17 outside of plates 21 enclosing the ends of the device, for attachment to counterweights 13. The counterweights 13 comprise a series of superimposed sections 82 preferably of a variety of sizes and weights whereby their total weight may be varied to meet specific requirements. A tie bolt 83 extends vertically through each side of the respective weight sections to hold them together as a unit. Winged angle brackets 34 are secured to the top and bottom of each tie bolt 83 with the wings thereof engaging opposite surfaces of the outer side of the adjacent channel stud 17 so as to retain the counterweights 13 against lateral motion and guide them in their vertical travel. To the uppermost weight section 82 of each counterweight a pair of lugs 85 are secured in spaced relationship. A U-shaped member 86 is slidably engaged between lugs 85.

A link pin 87 at the end of each chain 79 hung from the sprocket 77 thereof extends transversely between the upright portions of the member 86, with its ends thereof protruding through vertical slots 88 in the respective lugs. The U-shaped member 86 is thus free to move vertically between lugs 85 within the limits defined by the ends of the slots 88. A lift rod 89 extends slidably through the weight sections 82 of each counterweight 13, its upper end being secured to the bottom of member 86. A block 90 of greater diameter than the openings in weight sections 82 of the respective counterweights through which the rod 88 extends is secured to the lower end of each rod by suitable means and is normally disposed in a concavity 91 formed in the lowermost weight section for support of the counterweight.

A leaf spring 92 extends through each block 90 and is arranged with its opposite ends normally in close proximity with the bottoms of the channels 17 between which the respective counterweights are disposed. In such position each leaf spring 92 is bowed upwardly by the weight of the sections 82 on the outer portions thereof, and accordingly exerts a downward tension on the rod 89 and block 90 with which it is associated. In the event that the chains 79 by which the counterweights are suspended or either of them breaks and the restraint on the rod or rods 89 is thus relieved the bowed springs 92 will tend to straighten. A series of lugs 92a are secured to each channel stud in spaced relation and in the vertical plane of the adjacent spring 92. The straightening of the springs in response to a sudden drop of the counterweights causes their ends to immediately engage with lugs 92a, which will brake the fall and support the counterweights until repairs are made. It will be obvious that the operation of the braking mechanism just described for each counterweight 13 is independent of the operation of like mechanism associated with the other counterweight.

93 indicates a cap adapted to fit over the upper ends of the channel studs 17 and beams 14, so as to cooperate with the panels 22, 23, 25, and doors 29 hereinabove generally alluded to, in keeping dust and dirt from the chains 60 and 79, and the various bearings, etc.

The drive shaft 36 extends laterally of the apparatus at the side thereof opposite to that at which the pulley 35 is carried, for the support...
4 of a brake drum 84. A brake band 85 encircling drum 84 is formed with radially projecting ears 95 through which a bolt 97 extends. One side of brake bands 95 adjacent to one of the ears 96 is secured to the adjacent supporting structure for the bearings 93 and gears 40 at the corresponding side of the unit to resist displacement upon tightening of the band 95 on the drum 84 by means almost to be described. A brake rod 98 is journaled in a tube the bearing 99 extending between opposite sides of the structure under the girders 38, with one end of the rod 98 terminating adjacent to bolt 97. A finger 100 is secured on the last-named end of rod 98 to normally bear against the end of bolt 97 extending through the movable ear 96 of band 95 so that by rotation of the rod 98 the ear 96 may be urged toward its counterpart, thus tightening band 95 on the drum. The rod 98 is adapted to be turned by a system of levers 101 connected to the end of the rod opposite the end to which finger 100 is secured, and is actuated by a handle 102 pivoted to the supporting beam 17 adjacent power unit 33.

A locking device is associated with the drive shaft 36 and pulley 35, through which power is transmitted to the shaft. The locking device is adapted to lock the mechanism in the event shaft 36 should turn faster than the pulley in response to excessive weight suspended from the crosshead. The end of the shaft is angularly grooved to receive the end of the screw 103 or the link threaded through the pulley to resist movement of the pulley longitudinally of the shaft but which permits the pulley to rotate relative to the shaft. Pulley 35 is formed with a hub ratchet 104 having a series of teeth 105 on the edge thereof. A ratchet sleeve 106, slideable on shaft 36, and carrying gear teeth 107 and 108 at opposite ends thereof, is keyed to the shaft as at 109 against rotation with respect thereto, but is movable longitudinally of the shaft. The teeth 107 at one end of sleeve 106 are normally in engagement with the teeth 105 on hub 104 of the pulley, whereby rotation of the pulley by the power unit 33 will be transmitted to the shaft 36.

On the shaft at the opposite side of the sleeve 106 from the pulley a locating ratchet 110 is disposed, being secured to the frame by suitable means and having teeth 111 adapted to engage with adjacent teeth 108 of sleeve 106 when the latter is moved longitudinally of the shaft out of engagement with teeth 105 of pulley hub 104. It will be seen that should shaft 36 be moved at a greater speed than drive pulley 35, the teeth 107 on sleeve 106 will be moved over teeth 105 of pulley hub 104 which will cause the sleeve to shift longitudinally of the shaft, locking the teeth 103 on the opposite side of the sleeve with teeth 111 of the locking ratchet 110, thus preventing further movement of shaft 36, chains 60, and the pump rod 71.

During operation of the apparatus the counterweights will be reciprocated between opposite pairs of the channel studs 17. At the lower ends of their reciprocatory movement the weights move into guards 112, each of which are hinged at one side as at 13, whereby they may be swung outward to facilitate assembly of the weight sections and servicing of the emergency braking mechanism therefor, and to enable movement of the pump jack to and from the well.

A modified form of braking mechanism with the counterweights is illustrated in Fig. 14 wherein the lower end of lift rod 89 passes through the center of a lever 114 which is in turn supported on a nut 115 carried by the end of rod 89. The lowermost weight section 83a is provided adjacent each of its ends with a pair of depending lugs 116 for support of pins 107 by which toggles 118 are pivoted. Each toggle is in the form of a right angle and is pivoted on pin 117 at the vertex of its angle. The inner ends of the toggles are pivoted by suitable means to opposite ends respectively of lever 114. With the weight sections 83 assembled on section 83a, the weight of the assembled sections will normally maintain lever 114 and the portions of toggles 118 to which the lever is connected, parallel to the underside of the weight section 83a. The outer ends of toggles 118 are thus vertically disposed in spaced relation with the studs 17. The underside of section 83a is formed with a recess 119 in which a spring 120, encircling lift rod 89 is disposed, bearing at its upper end against section 83a and at its lower end against lever 114. In the event that either of the chains 79 should break or the suspension of the weights should fail for any other reason, spring 120 will immediately urge the lever downward with respect to the weight sections so as to throw the outer ends of toggles 118 outwardly away from the channel studs where they will engage a pair of lugs 92a carried by the studs respectively.

The operation of my invention is briefly described as follows: The polished rod 71 is secured to crosshead 61 by clamp 72, and is then raised to the top of the stroke. The counterweights 73 comprising any number of weight sections 82 are attached to chains 78 respectively. The power unit 33 is then operated to drive the pulley 35 continuously in the same direction so as to move the chains 82 at each side of the structure in opposite directions, i.e., the inner runs being driven upwardly continuously, and the outer runs downwardly. The master links 69 thus alternately raise and lower the blocks 66 to reciprocate crosshead 61 between drive sprockets 51 and the idle sprockets 55. It will be observed that the movement of the crosshead at each end of its stroke will be gradually retarded as master links 69 alternately move through the first lower quarter of the arc of the drive sprockets 51 and the first upper quarter of the sprockets 55. As the links 69 are moved into the second quarters of the arc of the sprockets the reversal of the movement of crosshead 61 will be slowly begun and the speed gradually increased until links 69 leave the sprockets. The elongation and contraction of the sucker rod string, chiefly in response to the alternate assumption of the weight of the fluid in the well by the rod string and tubing at the end of each pump stroke, will thus be extended over a sufficient time to avoid excessive strain on the rod without interruption or variance in the speed of operation of the power unit 33. With the tubing filled with fluid, the weight of the counterweights 73 should be sufficient to counterbalance the greater part of the weight of the rod string and the fluid column on the upstroke of the pump rod 71, leaving a balance of weight to be carried by power unit 33 equal to the difference in weight between the rod string and the counterweights 73 on the downstroke, whereby the power is supplied for constant speed of the chains 60 and cross head 61 throughout the pump cycle will be uniform. For example, in a well employing a three-fours inch rod of a length of five thousand feet for actuating a two-inch plunger the weight of the oil of thirty gravity would be approximately 2,351,183.
5,100 pounds, and the weight of the rod string on the upstroke 8,376.60 pounds, thus making a total weight to be lifted on the upstroke of 13,476.60 pounds. The rod weight on the downstroke will be approximately 7,441.20 pounds. By utilizing a total counter weight of 10,458.50 pounds, the weight balance to be carried by the power unit will be substantially the same on each stroke of the pump, i.e., 3,017.50 pounds.

It will thus be seen that I have provided a deep well pump jack unit in which opposite ends of the crosshead are supported from moving points continuously equi-spaced from the center of the cross head. Moreover, each end of the cross head is suspended from opposite sides by separate chains to equally distribute the weight of the sucker rod string and the fluid in the well through the four chains.

While I have disclosed but one embodiment of my invention, and have catalogued only a few of the advantages and uses inherent therein, it will be understood by those engaged in the art that the essence of my invention is capable of many modifications and of constructions varying widely in size, design, proportion, and number of the various parts as specifically disclosed, within the scope of the appended claim.

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

In a device of the character described, a crosshead comprising a pair of parallel members, a block movable in said crosshead, a pin extending laterally from said block and terminating in a ball-shaped end, a chain, a master link in said chain having a socket therein for the reception of said end of said pin to transmit motion from said chain to said pin and block.

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