Feb. 13, 1940. H. A. HOLZER 2,190,070

PUMPING UNIT

Filed Sept. 14, 1938 3 Sheets-Sheet 1

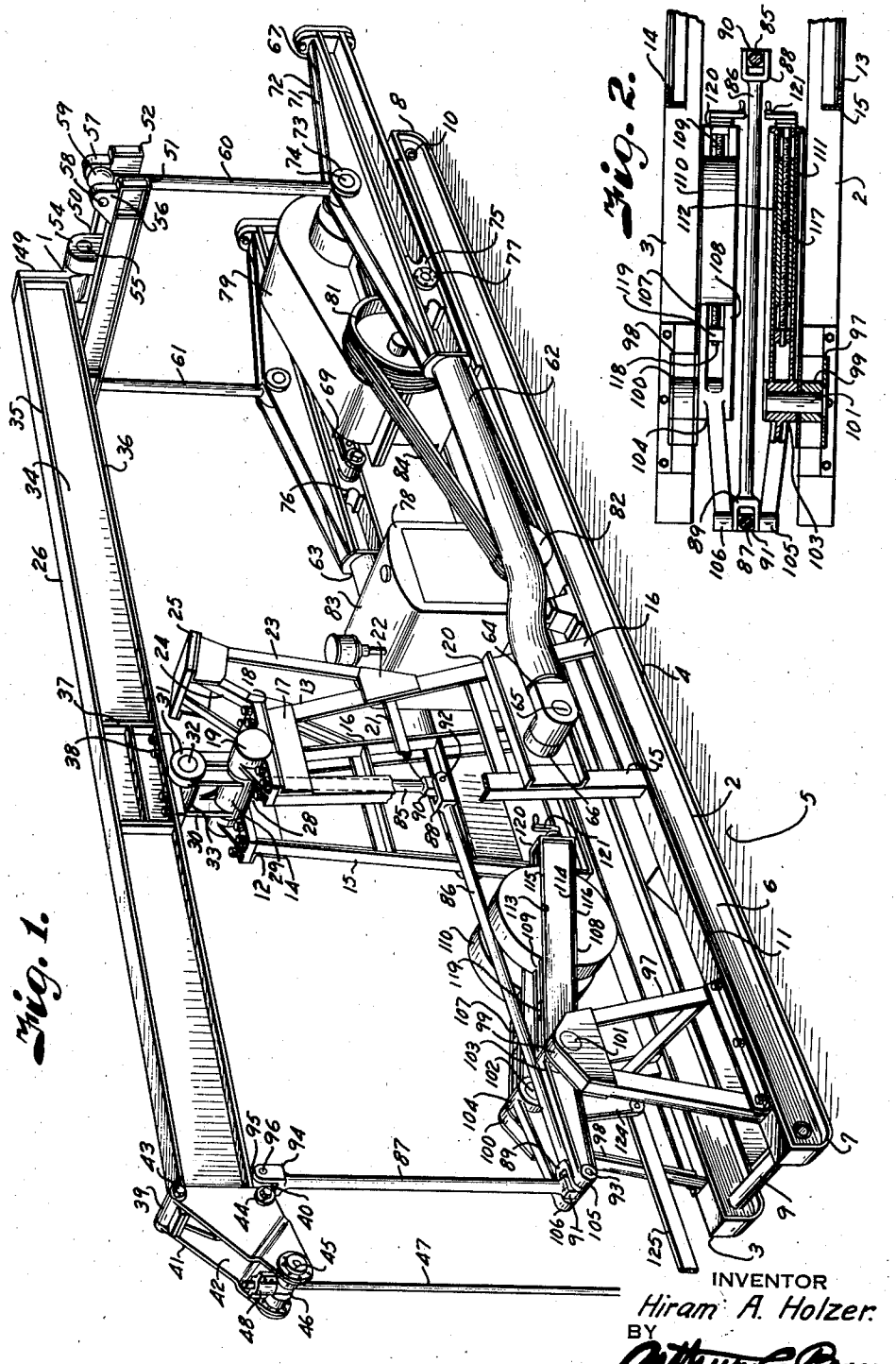


Fig. 1.

Fig. 2.

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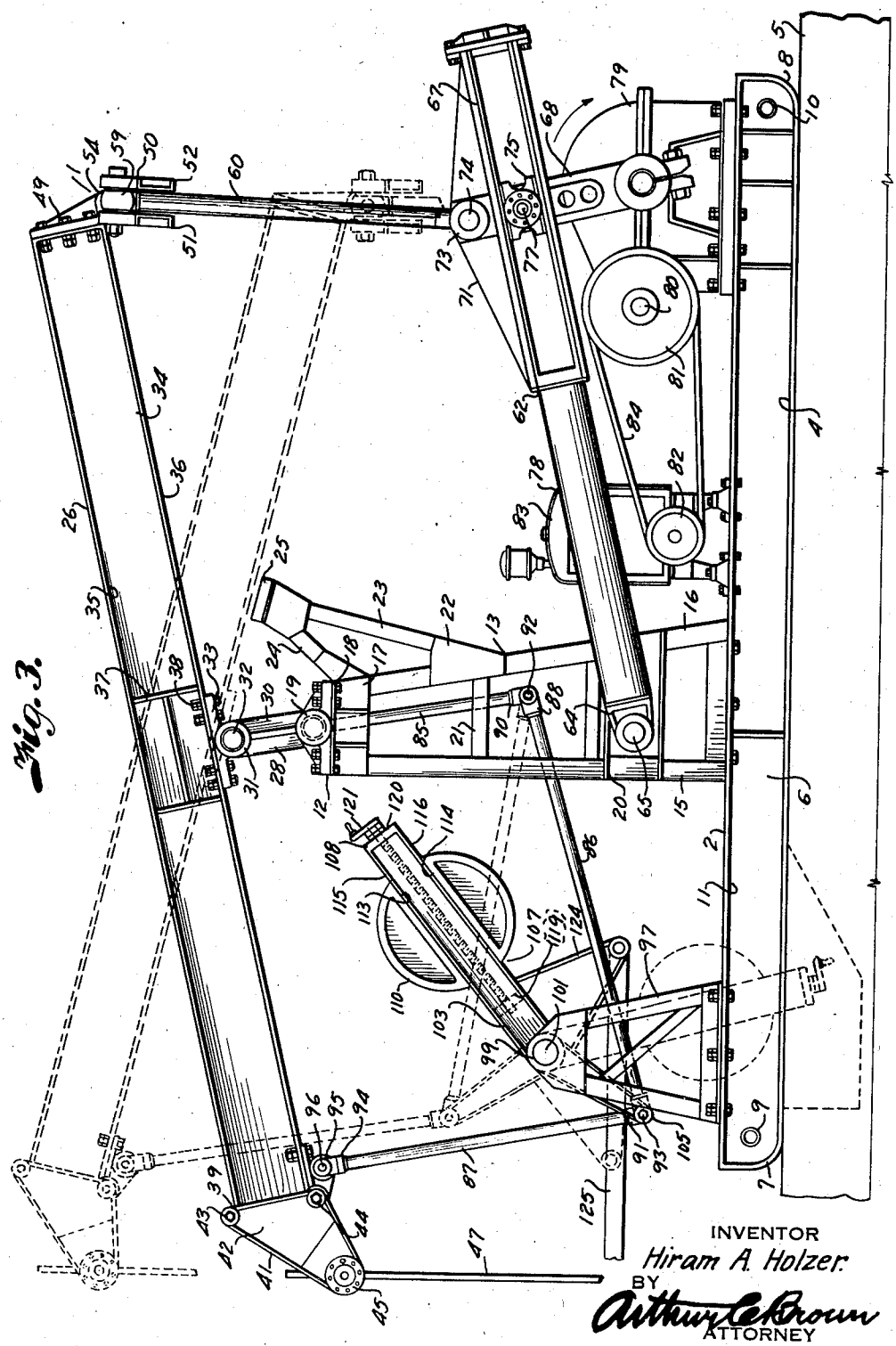


Fig. 3.

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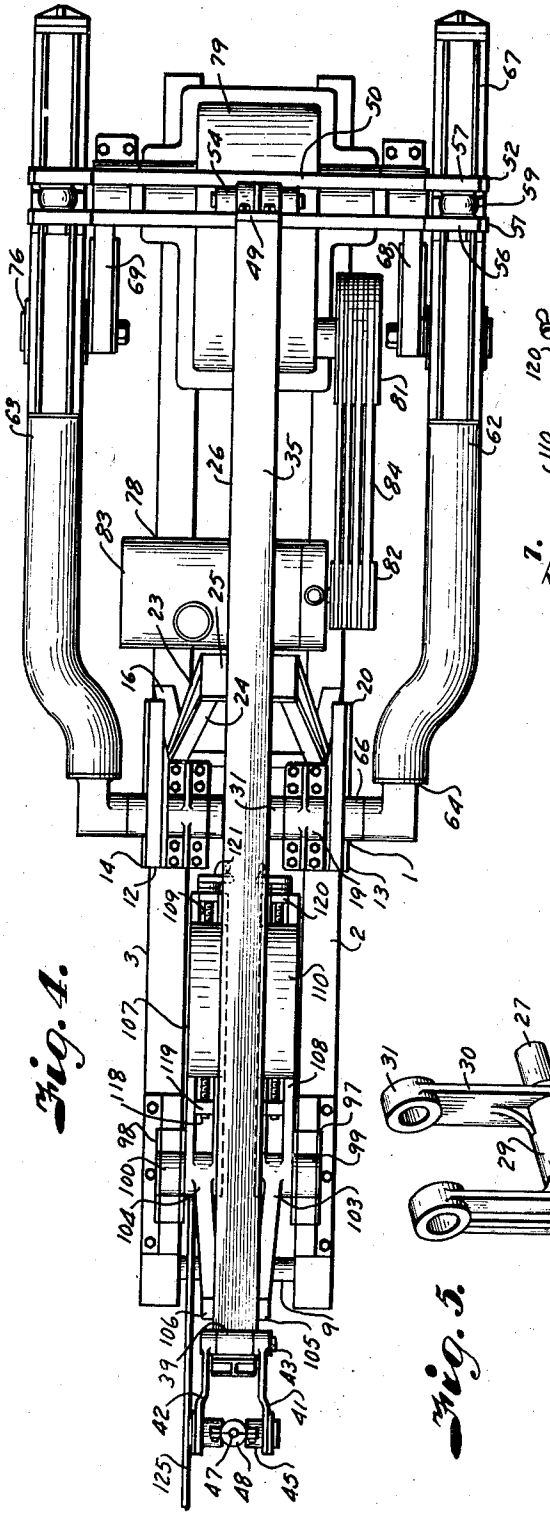


Fig. 4.

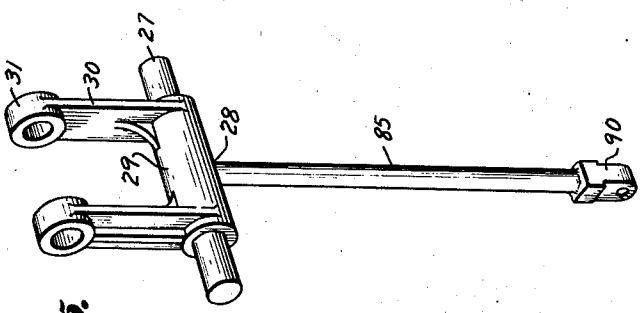


Fig. 5.

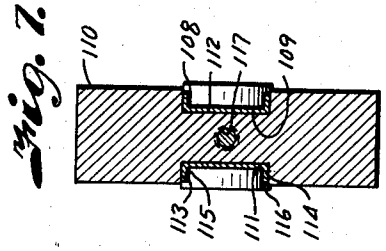


Fig. 7.

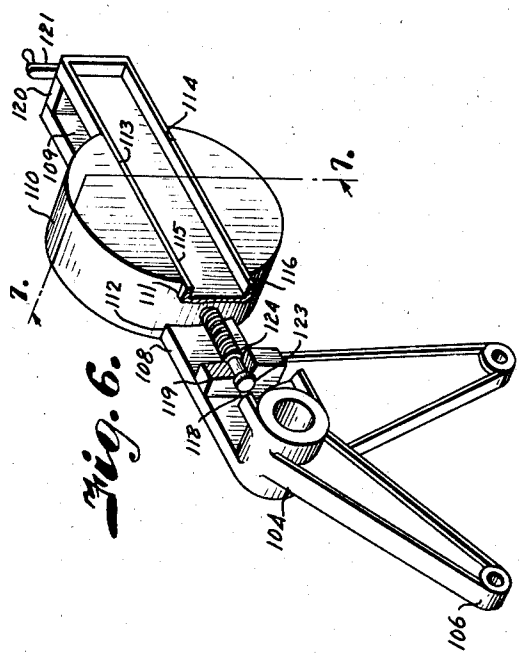


Fig. 6.

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Patented Feb. 13, 1940 2,190,070

UNITED STATES PATENT OFFICE

2,190,070

PUMPING UNIT

Hiram A. Holzer, Pittsburg, Kans., assignor to United Iron Works Company, Pittsburg, Kans., a corporation of Delaware

Application September 14, 1938, Serial No. 229,907

9 Claims. (Cl. 74—41)

This invention relates to a pumping unit such as employed in actuating the sucker rods of a well, and has for its principal objects to provide a unit of this character producing a straight lift on the rods, a variable differential application of power to the respective up and down movements of the rods, and to provide a variable counterbalance acting upon the rods incidental to oscillation of the beam of the pumping unit.

In accomplishing these and other objects of the invention, as hereinafter described, I have provided improved details of structure, the preferred form of which is illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective view of a pumping unit constructed in accordance with the present invention.

Fig. 2 is a fragmentary plan view of the pendulum counterbalance mechanism, a part of which is shown in section to better illustrate the construction thereof.

Fig. 3 is a side elevational view of the unit showing the beam at the end of the downstroke in full lines and at the end of the upstroke in dotted lines.

Fig. 4 is a plan view of the unit.

Fig. 5 is a detail perspective view of the beam supporting fork.

Fig. 6 is a detail perspective view of one of the pendulum counterbalances and its associated bell crank.

Fig. 7 is a cross-section through the pendulum on the line 7—7 of Fig. 6, showing adjustable mounting of a pendulum weight.

Referring more in detail to the drawings:

1 designates a pumping unit constructed in accordance with the present invention, and which includes longitudinal sills 2 and 3 preferably formed of I-beams and having base flanges 4 adapted to seat on a suitable foundation 5. The base flanges 4 of the sills curve upwardly over the ends of the web 6 as indicated at 7 and 8, to provide runners whereby the unit may be shifted to and from its position on the foundation 5. The sills 2 and 3 are connected at their ends by cross members 9 and 10 and at intermediate points along the length thereof with suitable cross bracing so that they rigidly support the operating units mounted on the upper flanges 11 thereof, as now to be described.

Mounted on the flanges 11, in spaced relation with the forward ends 7 of the sills, is a walking beam supporting structure or Samson post 12 comprising side frames 13 and 14 each having upwardly inclined legs 15 and 16 connected at their upper ends by structural members 17 having outwardly directed flanges 18 to mount bearings 19. The legs are also connected at their lower ends at a point spaced above the flanges 11, by cross members 20, and at intermediate points by smaller cross members 21 to form a rigid frame. Attached to the legs 16 of the respective side frames by gussets 22 are upwardly and rearwardly directed angles 23 cooperating with similar angles 24 to mount a rest or seat 25 for the walking beam 26 when it is to be moved to inoperative position. The side frames 13 and 14 may also be interconnected by suitable cross bracing to rigidly retain the spaced relation thereof. Oscillatably journalled in the bearings 19 are the trunnions 27 of a beam supporting and shifting fork 28 having a body portion 29 carrying the trunnions and upwardly extending arms 30 terminating in bearings 31 to mount the trunnions 32 of a conventional beam saddle 33.

The beam 26 is illustrated in the drawings as comprising an I-beam having a vertical web 34 and upper and lower horizontal flanges 35 and 36, the central portion of the beam preferably being stiffened by vertical and longitudinal webbing 37 on the respective sides of the beam web as shown in Figs. 1 and 3. The beam saddle 33 is secured to the lower flange of the beam by suitable fastening devices 38 as in conventional practice. Fixed to the forward end of the beam by brackets 39 and 40 respectively attached to the upper and lower flanges thereof is a head or rod hanger 41 consisting of plates 42 attached to the brackets by fastening devices such as bolts 43 and 44 extending through adjacent corners thereof, one of the bolts being removable so that the other may serve as a pivot to swing the hanger upwardly over the top of the beam when pulling rods or servicing the well as in customary practice.

The plates 42 extend downwardly and forwardly and carry bearings 45 to journal a rod support 46 through which a polish rod 47 extends and is supported by a rod clamp 48 clamped thereon and seated against the upper portion of the support as clearly shown in Fig. 1.

Fixed to the rear end of the beam is a bracket 49 carrying an equalizer 50 consisting of spaced channel members 51 and 52 connected at their centers by a bracket 53 having upwardly extending arms 54 to cooperate with the bracket 49 in mounting a connecting pin 55 by which the equalizer is pivotally connected with the beam. Supported on the outer ends of the chan-

nel members 51 and 52 of the equalizer are bearings 56 and 57 mounting a cross pin 58, carrying bearings 59 that connect with the upper ends of pitmans 60 and 61 having their lower ends connected with actuated levers 62 and 63.

The actuating levers are arranged longitudinally of the respective sides of the pumping unit and have their forward ends 64 journalled on studs 65 projecting from brackets 66 mounted on the webs of the cross channels 20, previously mentioned. The rear ends of the levers are formed to provide slotted wrist pin box guides 67 which are of sufficient length to accommodate throw of the cranks 68 and 69 of a power unit 70. Extending upwardly from the levers are spaced webs 71 and 72 carrying bearings 73 mounting pivot pins 74 to which the lower end of the pitman rods 60 and 61 are pivotally connected.

Slidable in the slotted guideway of the respective levers are wrist pin boxes 75 and 76 journalling the wrist pins 77 of the crank arms 68 and 69.

The power unit 78 is mounted on the rear ends of the sills and includes a speed reducing mechanism indicated by the housing 79, the power input shaft 80 of which carries a pulley 81 that is driven from a drive pulley 82 of a prime mover 83 through driving belts 84 as clearly shown in Figs. 1 and 3. The prime mover in the illustrated instance is an internal combustion engine mounted on the upper flanges of the longitudinal sills at a point in the rear of the Samson-post structure previously described.

In order to shift the beam during oscillation thereof so as to maintain a straight lift on the rods, the fork 28 has a depending arm 85 that is connected by a link 86 with an arm 87 pivotally depending from the forward end of the beam. The connecting link 86 has yoke-shaped ends 88 and 89 for receiving the heads 90 and 91 on the depending ends of the arms 85 and 87 respectively, and which are pivotally connected therewith by cross pins 92 and 93. The upper end of the arm 87 has a yoke 94 pivotally connected with a depending ear 95 on the beam by a cross pin 96.

Mounted on the forward ends of the sills are bearing supporting brackets 97 and 98 having bearings 99 and 100 and mounted therein are stub shafts 101 and 102 carrying bell cranks 103 and 104 having forwardly directed arms 105 which have their terminal ends provided with bearings 106 journalled on the ends of the pin 93 previously mentioned.

The depending arm 87, including the bell cranks 103 and 104, constitutes a part of a pendulum counterbalance unit 107 to counterbalance weight of the rods and fluid for facilitating lift thereof, thereby imparting a smoother operation. The pendulum mechanism includes the other lever arms 108 of the respective bell cranks which project rearwardly from the hubs of the bell cranks 103 and 104 at such an angle that when the forward end of the beam is at the upper end of its stroke the arms are located at an angle of approximately 15° with respect to perpendicular. The rearwardly extending arms have vertically slotted guideways 109 for adjustably mounting counterbalance weights 110. The counterbalances are illustrated as consisting of substantially circular disks having diametrical grooves 111 and 112 on the opposite side faces thereof to accommodate the side portions of the pendulum arms, the upper and lower side faces 113 and 114 of the grooves being slidable on laterally projecting flanges 115 and 116 of the arms. In the illustrated instance the weights are diametrically bored and threaded as at 117 to threadedly connect with adjusting shafts having ends 118 journalled in bearings 119 adjacent the hubs of the bell cranks and their opposite ends journalled in a plate 120 closing the slots in the free ends of the pendulum arms as best shown in Fig. 2. The rear ends of the screw shafts have operating cranks 121 and the forward ends have groove shoulders 122 and 123 engaging the respective sides of the bearings 119 so that when the screw shafts are rotated by the cranks the weights are adjusted along the respective arms to vary moments of the counterbalancing forces acting on the pendulum levers. If desired, the bell cranks may be provided with arms 124 to connect with the pull rod 125 of a conventional pumping jack (not shown), so that the pumping unit may be used in pumping one or more wells.

The operation of a pumping unit constructed and assembled as described, is as follows:

Assuming the beam to be in the position shown in full lines in Fig. 3, and the cranks rotating in the direction of the arrow, the wrist pin box slides toward the rear ends of the guides swinging the lever arms downwardly and moving the forward end of the beam upwardly incidental to the pull exerted on the pitman rods 60 and 61. As the wrist pins move across top dead center the speed of the rods gradually increases to maximum when the wrist pins are swinging across horizontal centers. As the wrist pins are carried below horizontal position with respect to axis of rotation, the speed of the rods gradually decreases to the point where the wrist pins cross lower dead center where the lift approaches zero and the beam comes to rest at the upper end of its stroke. At the wrist pins move upwardly from bottom dead center direction of the beam is reversed and the effective leverage acting upon the lever arms gradually shortens since the wrist pins are moving toward the fulcrum points thereof, consequently the arcuate movement of the lever arms increases to produce a more rapid downward movement of the rods, which gradually accelerates toward the horizontal position of the beam and then gradually retards until the beam comes to rest at its lowermost position as the wrist pins are moving across top dead center.

It is thus apparent that the sliding wrist pin box connection of the pitman control levers with the cranks causes the rods to move downwardly at a more rapid rate and lift at a slower rate which is in correspondence to load carried on the beam. Maximum power is applied when the beam is lifting the weight of the rods, including the well fluid, and minimum power when the rods are moving downwardly in the well. The forward end thereof is kept in a perpendicular line of travel so that the pull of the rods is applied directly in line with the axis thereof. For explanation, as the depending arm 87 is reciprocated incidental to rocking movement of the beam, the bell cranks 103 and 104, connected therewith, are moved in an arcuate path as indicated in Fig. 3, to effect horizontal swinging movement of the depending arm 85 through the link connection 86. Swinging movement of the arm 85 causes oscillatory movement of the fork to shift the beam in a forward direction as it passes above and below horizontal

center whereby the rod carrier of the beam hanger is kept in a perpendicular line of travel to impart straight lift to the rods.

Oscillation of the beam also effects swinging of the pendulum weights 110 about the axis of the trunnions 101 and 102 from a position substantially below the axis of the trunnions when the beam is in its uppermost position and where the effective leverage of the weights is only sufficient to maintain stretch of the rods incidental to the weight of the fluid acting thereon. As the pin moves downwardly the pendulum counterbalances swing upwardly to gradually apply a counterbalancing effect on the weight of the rods as they move downwardly in the well. As the movement of the beam is reversed the pendulum weights swing downwardly toward the dotted line position, Fig. 3, and as they cross horizontal center, the effective leverage thereof gradually reduces as the rods approach a stop prior to reversal of movement of the beam.

From the foregoing it is obvious that I have provided a pumping unit applying a variable and differential speed of the up and down strokes imparted to the rods and wherein the lifting forces are kept in axial alignment with the rods thereby avoiding bending tendency of the polish rod.

It is also obvious that the rods are counterweighted by means of a variable applied counterbalance to provide for smoother operation, reduced power consumption, and less failure of the rods.

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

1. In a pumping unit of the character described, a fixed support, a walking beam, a link having one end pivotally mounted on the support, means swingingly fulcruming the walking beam on the other end of the link, means for oscillating the walking beam, a bell crank having a fixed pivotal support, a link connecting one arm of the bell crank with the walking beam, a counterbalance weight on the other arm of the bell crank, and means connecting the bell crank with said link that is mounted on the fixed support to effect shifting movement of the beam incidental to oscillation thereof.

2. A pumping unit of the character described including a supporting frame, a standard on the supporting frame, a walking beam, means swingingly fulcruming the walking beam on the standard, means for oscillating the walking beam, a bell crank, means pivotally supporting the bell crank on said frame, a link connecting one arm of the bell crank with the walking beam at a point spaced from said swinging fulcrum means, a counterbalance weight on the other arm of the bell crank, and means connecting the bell crank with said fulcruming means to effect shifting movement of the beam incidental to pivotal movement of the bell crank.

3. A pumping unit of the character described including a supporting frame, a standard on the supporting frame, a walking beam, means swingingly fulcruming the walking beam on the standard, a lever pivotally connected with the standard and having a guide track, a pitman connecting the lever with the beam, an operating crank having a wrist pin, a box for said wrist pin slidable in the guide track, a lever arm, means pivotally supporting the lever arm on said frame, a link connecting the lever arm with the walking beam, and means connecting the lever arm with said fulcruming means to effect shifting movement of the beam.

4. A counterbalance for pumping units including a bell crank having an arm adapted to be connected with a walking beam of a pumping unit, a counterbalance weight, means adjustably supporting the counterbalance weight on the other arm of the bell crank, and means on said other arm for connecting a second pumping unit.

5. In a pumping unit having an oscillating beam, a counterbalance including a bell crank, means pivotally supporting the bell crank, means connecting one arm of the bell crank with the beam, a counterbalance weight, means supporting the counterbalance weight on the other arm of the bell crank, and means on the bell crank for connecting a second pumping unit.

6. A pumping unit of the character described including a standard, a walking beam, means pivotally mounting the walking beam on the standard, means for oscillating the walking beam including means for applying variable power to said beam, and a counterbalancing mechanism including a bell-crank lever having a counterbalance arm and an arm pivotally connected with the walking beam, said arms of the bell-crank being arranged at an angle to each other for effecting variable moments of counterbalance leverage in synchronism with said variable power means.

7. A pumping unit of the character described including a standard, a walking beam, means pivotally mounting the walking beam on the standard, means for oscillating the walking beam, a support, a bell-crank pivoted on the support and having a counterbalance arm and a second arm arranged at an angle to the counterbalance arm, a counterbalance on said counterbalance arm, and a link having one end pivotally connected with said second arm and having its other end connected with the walking beam, said link being of sufficient length to maintain said counterbalance arm in depending relation when the walking beam is at the upper limit of its movement whereby the moment of said counterbalance gradually increases to a maximum as the walking beam approaches its lower limit.

8. A pumping unit of the character described including a standard, a link pivotally mounted on the standard, a walking beam pivoted to the link, an arm rigidly depending from the link, a bell-crank lever, means pivotally supporting the bell-crank lever, means connecting an arm of the bell-crank with the walking beam, a link connecting said arm of the bell-crank lever with said depending arm, and a counterbalance on another arm of said bell-crank lever.

9. A pumping unit of the character described including a supporting frame, a standard on the frame, a walking beam, means swingingly fulcruming the walking beam on the standard, a lever pivotally connected with the standard and having a guide track, a pitman connecting the lever with the beam, an operating crank having a wrist pin, a boss for said wrist pin slidable in the guide track, a variable moment counterbalance means connected with the walking beam, and means connecting said counterbalance means with said fulcruming means to shift the walking beam.

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