Sept. 3, 1940. A. M. BUTCHER 2,213,646

COUNTERBALANCING CRANK FOR PUMPING UNITS

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Fig. 1.

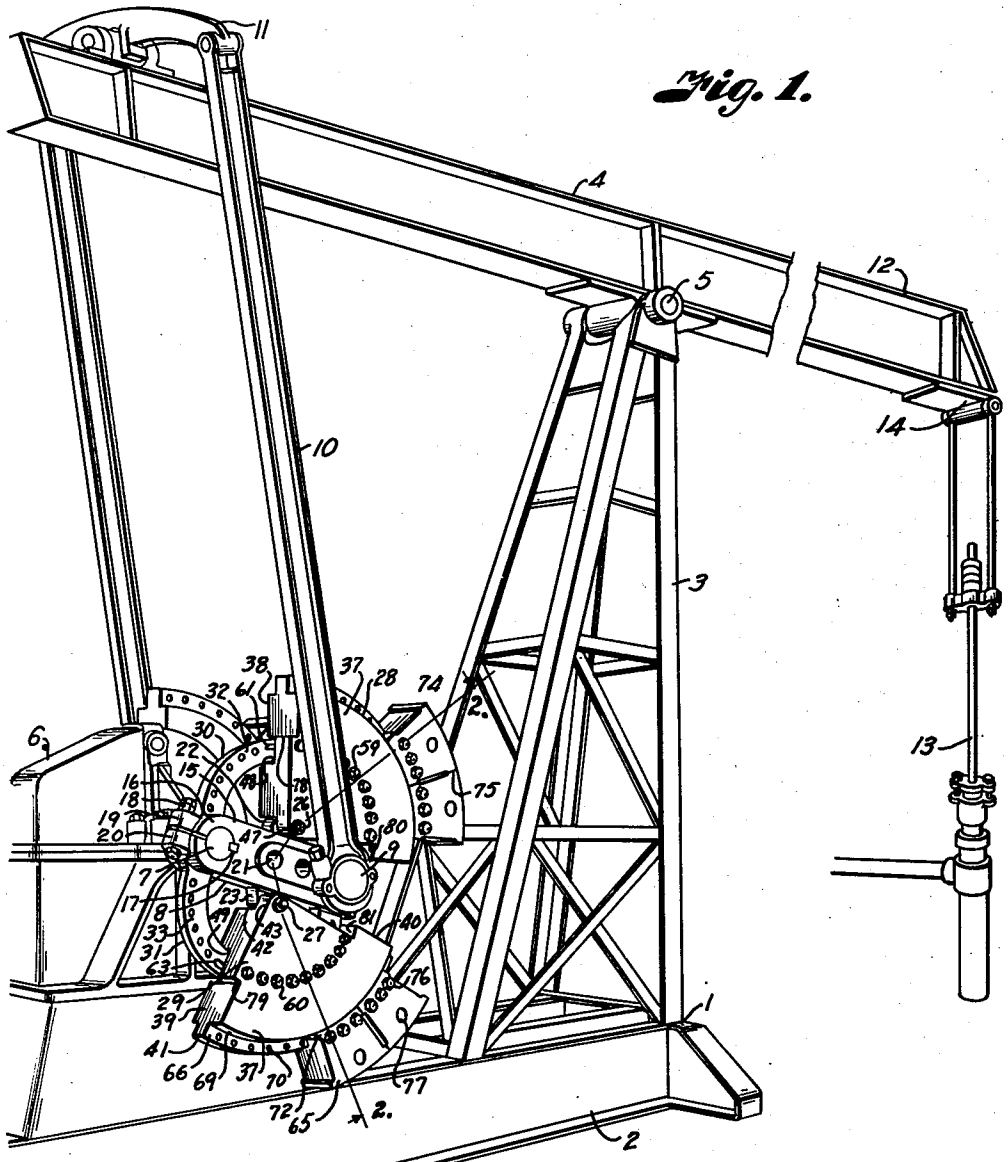
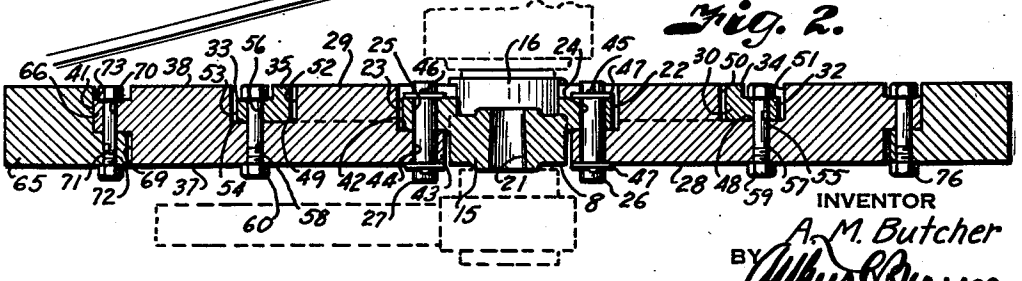


Fig. 2.



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Fig. 3.

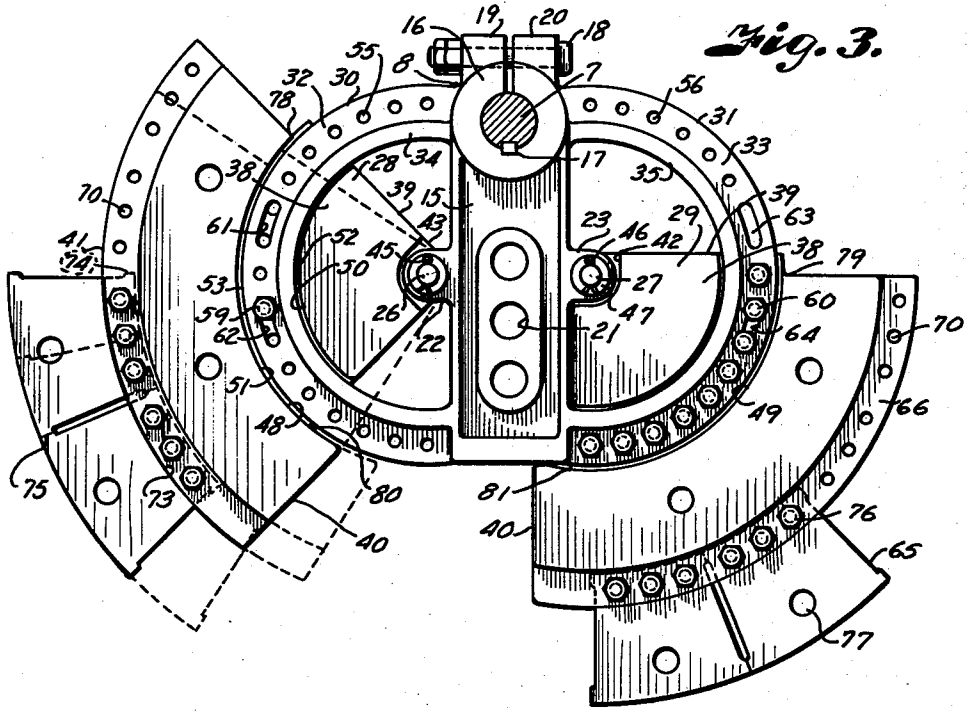
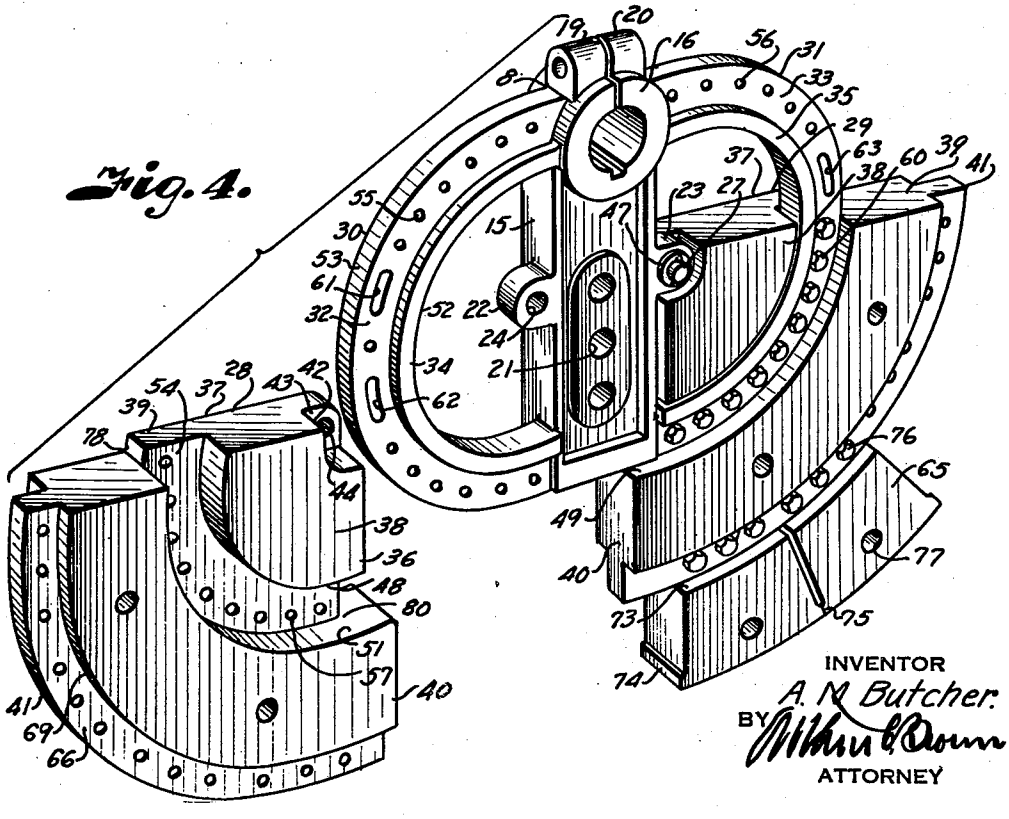


Fig. 4.



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COUNTERBALANCING CRANK FOR PUMPING UNITS

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Application June 11, 1938, Serial No. 213,204

6 Claims. (Cl. 74—591)

This invention relates to a counterbalancing apparatus particularly employed in a pumping unit to counterbalance or offset weight of the pump rods, thereby reducing power consumption of the pumping unit and eliminating whipping tendency of the rods that ordinarily result in their rapid deterioration.

The principal object of the invention is to provide a counterweight of this character that is adapted for adjustable mounting to compensate for change in load or adjustment in the effective throw of the crank.

Other important objects of the invention are to provide a counterbalance structure that is adjustable by small increments thereby giving a desired counterweighting effect; to provide a counterbalance that is adapted for support in a more effective position on the crank; to provide a counterbalance that facilitates attachment to the crank and which may be adjusted with safety on the part of the operator; to provide a counterbalance that has permanent off-center pivotal mounting to prevent accidental throw-off of the counterbalancing elements; and to provide an attachment that eliminates shear of the attaching devices.

In accomplishing these and other objects of the invention, as hereinafter pointed out, 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 well pumping unit equipped with a counterbalancing apparatus embodying the features of the present invention.

Fig. 2 is an enlarged section through the counterbalancing apparatus on the line 2—2 of Fig. 1 with the adjacent parts of the pumping unit shown in dotted lines.

Fig. 3 is an elevational view of the side of the counterbalancing apparatus nearest the pumping unit and showing the crank-shaft in section.

Fig. 4 is a detail perspective view of the apparatus showing one of the counterbalancing elements in removed spaced relation to better illustrate the structure.

Referring more in detail to the drawings:

1 designates a conventional type of pumping unit which includes a base 2 carrying a Samson-post structure 3 mounting a walking beam 4 that oscillates about a shaft 5. Mounted on the base of the unit is a transmission indicated by the housing 6 which is actuated by a suitable prime mover (not shown) to rotate a crank-shaft 7. Mounted on the projecting ends of the crank-shaft 7 are crank-arms 8 having wrist pins 9 connecting pitmans 10 with an equalizer bar 11 that is pivotally mounted on the rear end of the walking beam.

The unit thus described is mounted adjacent the well so that the forward end 12 of the walking beam projects over the well hole to connect with the sucker rods 13 through a beam hanger 14.

When the unit is in operation the pump rods are reciprocated to lift fluid to the top of the well. Upon the upstroke the power must lift the entire weight of the rods, plus the load of fluid in the well tubing, and on the following downstroke the rods drop with an abrupt jerk which places an undue strain upon the pumping unit and causes a whipping action to occur in the rods, with the result that excessive power is required and the equipment is rapidly deteriorated. To overcome these difficulties counterweights have been attached to the arms of the cranks to assist rotation on the upstroke of the rods, when the power is operating under maximum load, and to control dropping of the rods on the downstroke. These counterweights are usually mounted for adjustment with respect to the axis of the crank so as to change the counterbalancing effect upon change in load or adjustment in throw of the crank to obtain a shorter or longer stroke. Since the weight of the rods in deep wells is tremendous, the counterweights must be correspondingly heavy with the result that it is difficult to securely anchor such heavy weights in adjusted position on the cranks. The extremely heavy weight of the counterbalances also renders adjustment difficult and is hazardous to the operator making the adjustment. As above pointed out, it is the object of the present invention to provide a counterweighting structure which is more effective and overcomes these difficulties, as now to be described.

In the present invention the cranks 8 are of special design and each includes an arm portion 15 having a split hub or collar 16 that is secured to the crankshaft by a spline 17 and is rigidly clamped thereon by a bolt 18 extending through aligning ears 19 and 20 on opposite sides of the split portion of the collar, as clearly shown in Fig. 4. The arm 15 is of sufficient length to give the desired maximum throw of the walking beam and is provided with a series of wrist pin openings 21 so as to furnish a plurality of crank throws merely by changing the position of the wrist pin.

Extending laterally from the sides of the crank-arm, at a point substantially midway of the length thereof, are ears 22 and 23, having openings 24 and 25 to pass pivot pins 26 and 27 for

pivotally attaching counterbalancing elements 28 and 29, later described. Also projecting from the sides of the arm, in concentric relation with the axis of the openings 24 and 25, are arcuate guides 30 and 31 which are substantially semi-circular and of L-shaped cross-section to provide radially extending flanges 32 and 33, and lateral ribs or flanges 34 and 35. The arcuate guides are preferably integral with the respective arm portions of the crank and have their ends respectively connecting the collars 16 with the outer ends of the arms, as clearly shown in Fig. 4.

The counterweighting elements 28 and 29 are also best illustrated in Fig. 4 and each includes a substantially quadrant-shaped body 36 of sufficient size so that the combined weight of both elements is that required to effectively balance weight of the rods. The counterweights have thickness substantially conforming in thickness to the crank-arm and have flat side faces 37—38, bounded by radial ends 39—40, and an arcuate outer face 41. Formed at the juncture of the ends 39 and 40 is a recess 42 of sufficient depth to accommodate the ears 22 and 23 so that the front face 37 lies substantially flush with the front face of the crank. The recess, being only of the required depth to accommodate the ear, leaves sufficient metal to form a cooperating ear 43 having an opening 44 adapted to align with the opening 24 or 25, to pass the pivot pins 26 and 27 which are retained therein by cotter pins or the like 45 and 46 which extend through the projecting ends of the pins and engage washers 47, as best shown in Fig. 2. The rear faces of the counterweights have arcuate-shaped grooves 48 and 49 which are concentric with the respective pivot pins and of sufficient size so that the inner and outer arcuate edges 50 and 51 thereof slidably engage the inner and outer arcuate faces 52 and 53 of the guides 30 and 31 and are of a depth so that the bottom faces 54 engage the front faces of the flanges 32 and 33. The flanges 32 and 33 have a series of regularly spaced apertures 55 and 56 and the bottoms of the grooves have similarly spaced apertures 57 and 58 to pass sets of fastening devices, such as bolts 59 and 60, whereby the weights are secured in selected positions on the crank-arm.

In order to facilitate positioning of the counterbalance weights in increments, selected adjacent openings in the flanges 30 and 31 are connected by slots 61—62 and 63—64 on the respective sides of the center line passing through the ears 22 and 23. In some instances it may be desirable to provide the counterweights just described with supplemental counterweights 65 that are arranged in series about the outer arcuate faces 41. Therefore the arcuate faces of the counterbalances have flanges 66 of narrower width than the body portions of the weights to form inset arcuate shoulders 69. These flanges have a series of apertures 70 which cooperate with similar apertures 71 in attaching flanges 72 of the supplemental weights, the flanges of the supplemental weights being of sufficient size to fit snugly within the shoulders 69, as best shown in Fig. 2. The supplemental weights are also of arcuate form and have inset shoulders 73 which engage the outer edges of the arcuate flanges and the ends thereof have projecting ribs 74 and 75 adapted to engage corresponding ribs on an adjacent supplemental weight. The supplemental weights are secured by fastening devices, such as bolts 76, that pass through selected registering apertures.

To facilitate positioning and handling of the weights, they are preferably provided with openings 77 to pass a crowbar or similar tool. In order that the counterweights may have maximum movement about the arcuate guide portions of the cranks, the upper radial ends 39 thereof are recessed, as at 78 and 79, to accommodate the ends of the clamping bolt 18. The weights may be correspondingly extended at the opposite ends, as at 80 and 81, so that they may overlap the ends of the crank, thereby providing a maximum amount of weight in metal.

In adjusting a counterbalancing apparatus as described, and assuming that it is necessary to move the weights so as to provide a greater counterbalancing effect, the crank-arms are stopped on bottom dead center. The bolts attaching one of the weights, for example the weight 28, are removed with exception of those in the upper portions of the slots 61 and 62 for that weight. The weight, however, will be retained by these bolts in its original position. Upon loosening the nuts of these bolts, the clamping action is relieved and the counterbalance pivots on its pin 26 in sliding contact with the arcuate guide 30, a distance limited by the length of the slots. Another bolt will then be inserted in the upper ends of the slots to pass through registering openings in the weights, and tightened, whereupon the lower bolts will be removed leaving the upper bolts retaining the counterweights. Upon loosening these bolts the counterweight will again swing downwardly. It is thus apparent that the weight may be adjusted downwardly toward the outer end of the crank in increments governed by the length of the slots until it is in desired counterbalancing position. The other weight is then likewise adjusted.

To facilitate adjustment of the weights in the opposite direction, the cranks will be rotated until they are in top dead center position, whereupon the weights may be moved in increments in the manner above described closer to the axis of the crank-shaft. If additional counterweight is required, the supplemental weights 65 of required number may be applied to the peripheral flanges 66 and secured by attaching the bolts 76. After adjustment of the counterweights, bolts will be passed through all of the apertures in the respective weights to rigidly clamp the weights in their adjusted position.

Attention is directed to the fact that when the weights are moved the maximum distance toward the shaft, the weight is substantially equally disposed about the shaft so that the counterbalancing effect is nil but when they are moved in the opposite direction the counterbalancing effect gradually increases to maximum.

From the foregoing it is obvious that I have provided a counterweight apparatus that is efficient in operation and which may be readily adjusted to give the desired counterbalance on the rods, thereby reducing the power consumption when the crank is moving in a direction to lift the rods and fluid in the well, and which will prevent whipping action on downward movement of the rods since the counterbalance weights will tend to resist rotation of the crank under weight of the rods.

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

1. A device of the character described including a crank, an arcuate guide projecting from one side of the crank with the axis of curvature spaced radially from the axis of crank rotation

and having an arcuate series of spaced apertures, a counterweight having a series of correspondingly arranged apertures, means pivotally mounting the counterweight on the crank in the axis of said arcuate guide, certain of said apertures being connected to form a slot, fastening devices extending through the apertures in the counterweight and through selected apertures in the guide for clamping the counterweight in a selected position on the crank, and a similar fastening device extendable through the slot and a selected aperture to facilitate step by step adjustment of the counterweight on said guide.

2. A device of the character described including a crank, an arcuate guide projecting from one side of the crank and having a series of spaced apertures and an intermediate slot, a counterweight having a series of correspondingly spaced apertures, means pivotally mounting the counterweight on the crank in the axis of said arcuate guide, and fastening devices extending through the apertures in the counterweight and through selected apertures in the guide for clamping the counterweight in a selected position on the crank, with at least one of the fastening devices extending through the slot, whereby the counterweight is adapted for adjustment about said arcuate guide upon loosening of the fastening device extending through said slot when the other fastening devices are removed and a fastening device is alternately applied and removed in selected registering apertures with shift of said fastening device to the respective ends of the slot.

3. A device of the character described including a crank arm, an arcuate guide projecting from one side of the crank arm and having an arcuate rim provided with a series of spaced apertures, a counterweight having an arcuate groove to accommodate said rim and provided with correspondingly spaced apertures, means pivotally connecting the counterweight with the crank arm in the axis of said guide, and fastening devices extending through the apertures in the counterweight and through selected apertures in the guide to retain said counterweight in a selected pivotal position.

4. A device of the character described including a crank, an arcuate guide having its ends connected with one side of the crank and having an arcuate series of spaced apertures extending through said guide, an ear on said side of the crank having a pin opening in the axis of said guide, a counterweight having a portion engaged with said guide and provided with an arcuate series of correspondingly spaced apertures, a pin extending through the counterweight and through said ear opening for pivotally mounting the counterweight, and fastening devices extending through the apertures in the counterweight and through selected apertures in the guide to retain said counterweight in a selected pivotal position.

5. A counterbalancing crank including a central arm portion having a hub at one end and a wrist pin near the other end, ears on the respective sides of said arm portion and substantially equally spaced from a plane passing through the axis of said hub and wrist pin, arcuate wings on the respective sides of said arm portion and having ends connected with the ends thereof whereby said arcuate wings are concentric with said ears, segmental weights pivotally connected with said ears and having arcuate grooves in the faces thereof for guidingly accommodating the arcuate wings, and fastening devices extending through said wings and through the segmental weights to clamp the segmental weights in selected adjusted positions relatively to said wings.

6. A device of the character described including a crank having an arcuate guide projecting from one side of the crank and having a series of spaced apertures, a counterweight having a series of correspondingly spaced apertures, means pivotally mounting the counterweight on the crank in the axis of said arcuate guide, certain of said apertures being connected to form a slot, fastening devices extended through selected apertures in the guide and counterweight, and a fastening device extending through said slot and one of said apertures for facilitating step by step adjustment of the counterweight on said guide.

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