June 6, 1939. P. C. JACKSON 2,161,298

PUMPING UNIT

Filed May 2, 1938 2 Sheets-Sheet 1

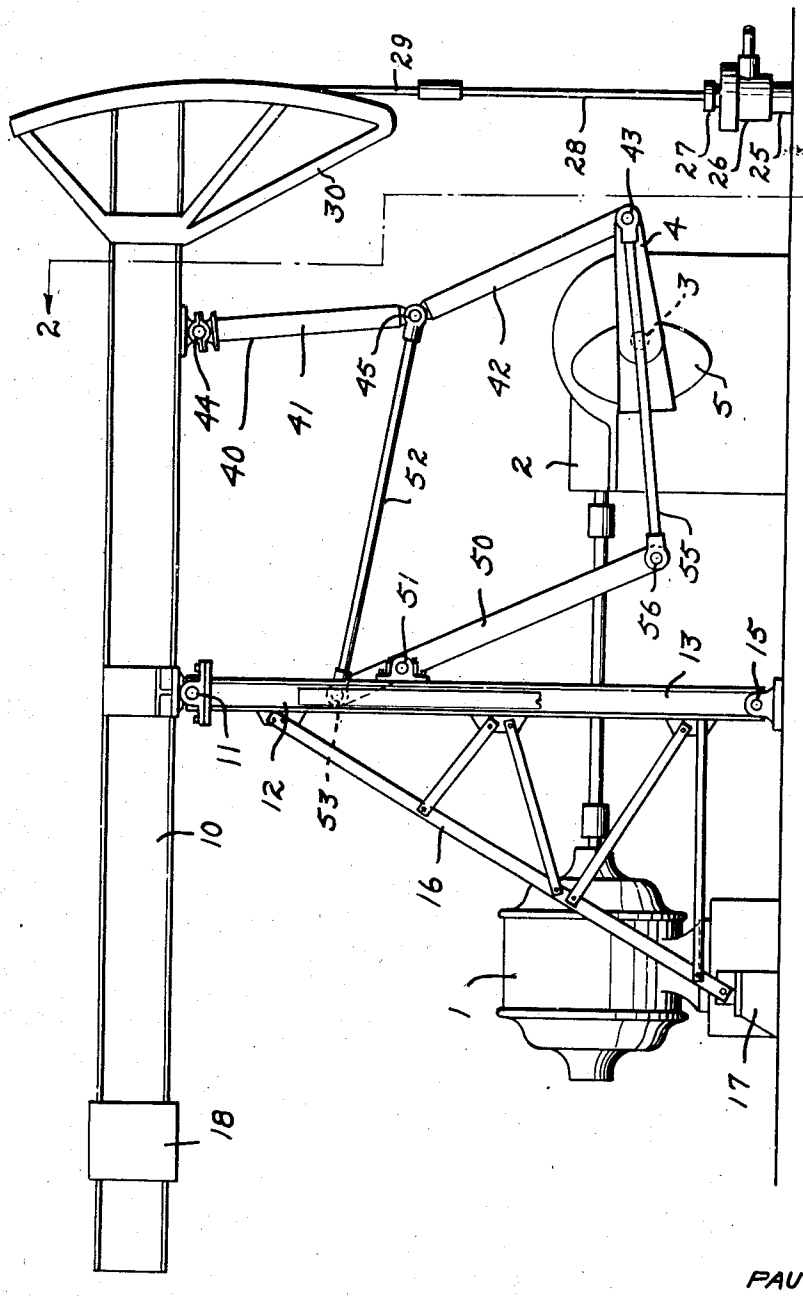


Fig. 1.

Inventor
PAUL JACKSON
Jesse R Stone
Lester B Clark

By

Attorneys

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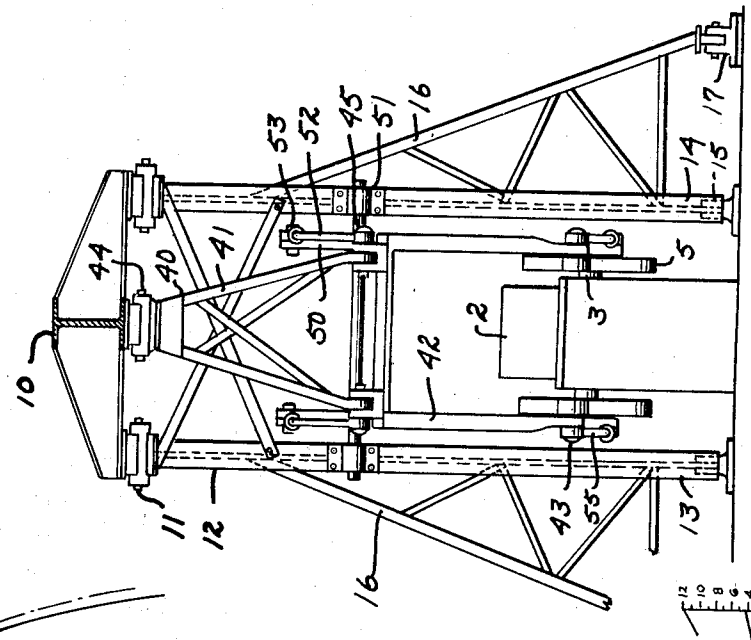


Fig. 2.

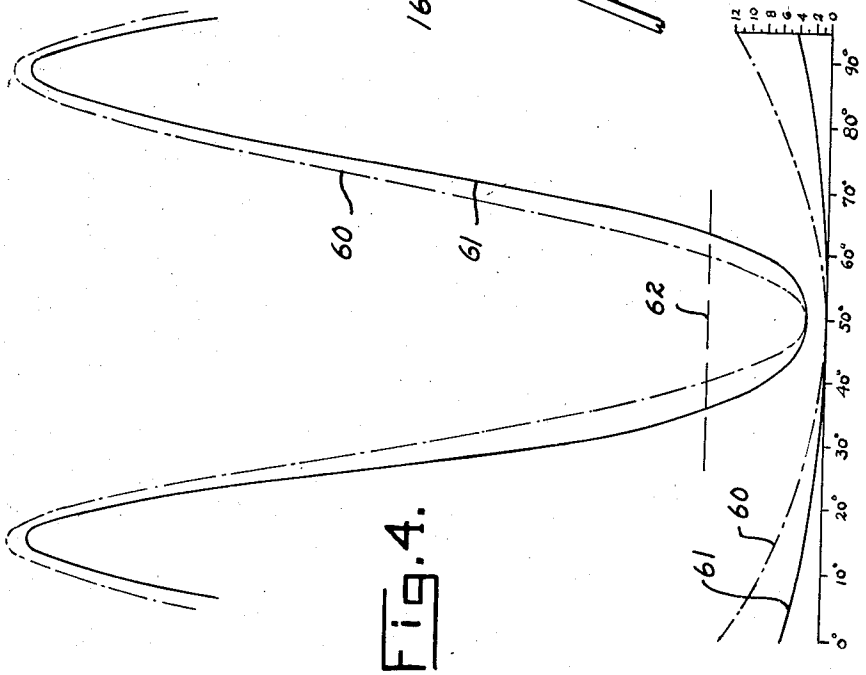


Fig. 3.

Fig. 4.

Inventor
PAUL JACKSON
Jesse R. Stone
Lester B Clark

Attorneys

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UNITED STATES PATENT OFFICE

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PUMPING UNIT

Paul C. Jackson, Houston, Tex.

Application May 2, 1938, Serial No. 205,445

7 Claims. (Cl. 74—41)

The invention relates to pump jacks, more particularly of the type wherein the walking beam is adapted to reciprocate a pump rod in a vertical line and with such reciprocatory motion that there is a maximum of pumping efficiency and a minimum of stresses set up in the equipment. While the invention is particularly applicable to use with pumps, it is obviously capable of extensive use for similar purposes.

In the pumping of liquid from wells and particularly when lifting liquid for long distances as in deep oil wells, it is essential that power from the crank shaft be converted in the straight line vertical movement of the pump rod to avoid vibration of the rod and friction between the rod and associated parts. Various constructions have been devised to accomplish these functions. It is equally important however, to so design such equipment that the stresses to which equipment is subjected be minimized and applied gradually in order to prevent destructive effects on the equipment. Heretofore little attention has been paid to the nature of the movement imparted to the reciprocating rod of pumping devices and considerable difficulty has been experienced due to failures from fatigue arising from undesirably applied stresses.

It is the primary object of the invention to provide a construction of the class described wherein the reciprocatory straight line movement of the pump rod is of such nature that friction, vibration and the effects due to rapid changes in stress are minimized.

A further object is to provide a simple construction in which there is a minimum of wear and the pumping efficiency thereof is increased.

Still another object is the provision of a device in which the rate of deceleration and acceleration at or near the point of reversal are greatly decreased.

Still another object is to provide a pump jack having an articulated pitman rod, mechanism being provided for control of movement of the articulating pivot whereby desired reciprocatory movement of the pump rod is effected.

Other objects together with the foregoing will be apparent by consideration of the following description taken in connection with the drawings in which:

Fig. 1 is a side elevation of a construction embodying the present invention.

Fig. 2 is an end view of the construction shown in Fig. 1 taken on the line 2—2 of Fig. 1.

Fig. 3 is a diagrammatic illustration showing the relative movement of the crank arm and the pumping rod at the lower end of the pump stroke.

Fig. 4 is a graphical illustration comparting the pump rod movement of the present invention with substantial harmonic motion of the pump rod in conventional pumping equipment.

As is best illustrated in Fig. 1 a suitable prime mover such as an electric motor 1 supplies power to drive a mechanism 2 through which rotation is imparted to a shaft 3 carrying the crank arm 4, which may have a weight 5 attached thereto.

A walking beam 10 is pivotally mounted at 11 upon a Samson post generally designated as 12 and comprising spaced vertical members 13 and 14, pivotally connected to fixed supports at 15. Composite strut members 16 are secured to the members 13 and 14, extending rearwardly and outwardly therefrom and are anchored to fixed supports 17 at their lower ends.

A pump for raising liquid from the well is positioned within the well from which a casing 25 extends upwardly and terminates in a casing head 26 having a stuffing box 27. A polish rod 28 passes through the stuffing box and has connected thereto the string of sucker rods within the well by means of which the reciprocating elements of the pump may be actuated from the surface. To the upper end of the polish rod 28 is attached a cable 29 which is in turn attached to a horsehead 30 on the end of the walking beam 10 whereby the polish rod may be reciprocated in a straight line by the rocking of the walking beam 10 about its pivot 11.

In order to obtain desired movement of the walking beam 10 whereby certain advantages of the invention are realized, the pitman rod generally designated as 40 and connecting the crank 4 to the walking beam 10 is articulated and comprises an upper member 41 and a lower member 42 which have their outer ends pivotally connected to the crank 4 and the walking beam 10 at 43 and 44 respectively. The inner ends of the members 41 and 42 are pivotally interconnected at 45. Desired movement of the walking beam 10 may be obtained by controlling the movement of the pivot point 45 in a desired manner. In the disclosed embodiment movement of the pivot point 45 is controlled by means of a construction that will now be described.

A lever 50 is pivoted at 51 upon the Samson post 12 and extends in opposite directions from this pivot. An upper arm 52 is connected to the lever 50 at 53, the opposite end thereof being connected at the pivot point 45 in the articulated pitman rod 40. A lower arm 55 is connected to the crank 4 at any suitable point and is here

shown as connected to the wrist pin **43**. The opposite end of the lower arm is connected to a lever **50** at **56**. By means of this construction it is apparent that the movement of the articulating pivot **45** is controlled through movement imparted to the lever **50** from the crank **4**. Such controlled movement is in turn responsible for the movement of the walking beam **10** and hence of the pump rod reciprocated thereby.

The construction as thus described is instrumental in effecting a straight line movement of the polish rod **28** and its associated sucker rod string. This mode of operation tends to reduce both vibration and wear of the associated parts. Vibration and wear are further reduced by the nature of the straight line movement imparted to the pump rod in accordance with the invention. Reference is now made to this phase of the invention by referring to Figs. 3 and 4 of the drawings.

In Fig. 4 the broken curve **60** illustrates the type of movement imparted to the pump rod in conventional constructions. Analysis of this curve reveals that the pump rod movement represented thereby is substantially harmonic motion. This type of motion causes no serious difficulty where the load to be lifted is small. On the other hand, however, where the load is large, considerable difficulty arises from fatigue effects arising from vibration and rapid and large changes in stress during acceleration and deceleration in reciprocating parts of the mechanism.

The full line curve **61** illustrates the modified motion produced in the present invention. This modification of reciprocatory movement is particularly important at the lower end of the stroke where the pump rod is decelerated and reverses to pick up the load to be lifted during the succeeding upstroke of the pump.

Fig. 3 is an elongated graphical illustration of the modified movement of the pump rod in accordance with the present invention. In this figure the ordinates represent the distance of travel of the pump rod while the abscissae represent the angular movement of the crank **4** which effects such movement of the pump rod. Curves **60** and **61** of this figure are portions of the similarly identified curves of Fig. 4, such portions being below the line **62** of that figure.

From Fig. 3 it may be seen that when the pump rod movement is substantially harmonic, as indicated by curve **60**, the crank **4** rotates substantially through 90° in carrying the pump rod through its lowermost twelve inches of travel. Curve **61** shows that in accordance with the invention the same angular movement of the crank **4** carries the pump rod through approximately its lowermost four inches of travel. It is apparent that since this condition exists, the rate of deceleration of the reciprocating parts is materially reduced and, of greater importance, the rate of acceleration after the pump rod reaches its lowermost point is similarly reduced. As the forces resulting from deceleration and acceleration are proportional to the rates of change of velocity in the moving parts, it is apparent that the rate of loading and the amplitude of the load are materially reduced by means of the present invention. Furthermore, vibration is also reduced and the total of the forces tending to cause fatigue and ultimate failure of machine parts, are greatly reduced. At the same time the dissipation of pumping energy in the form of heat is reduced so that pumping efficiency is increased.

The disclosed device embodying the invention includes, in addition to the weight **5** on the crank **4**, a counterbalance weight **18** mounted upon the walking beam **10**. This weight **18** is so constructed that it may be suitably positioned upon the beam **10** so that the pump and associated reciprocating elements may be properly and accurately counterbalanced as an additional feature to reduce distructive effects due to vibration and rapidly changing stresses.

It is believed that the operation of the device provided by the invention will be apparent from the foregoing detailed description. The motor **1** normally operates to continuously rotate the crank **4** which in turn reciprocates the walking beam **10** whereby the polish rod **28** and the attached sucker rod string are reciprocated. The nature of the reciprocatory motion so produced is desirably controlled by controlling the movements of the articulating pivot **45** in the pitman rod **40**. In the disclosed embodiment such control of the articulating pivot is effected through the linkage mechanism indicated by reference characters **50** to **56**. It is obvious that such control may be effected through other constructions that will be apparent to those skilled in the art and it is intended that the invention shall include such equivalent constructions.

What is claimed as new is:

1. A pumping device including in combination, a Samson post, a walking beam pivoted thereon, a pump rod connected to the walking beam to be reciprocated thereby, a crank, a pitman rod connected to the crank and the walking beam, said pitman rod comprising upper and lower members pivoted at their inner ends, a lever pivotally mounted upon the Samson post, an arm having its ends connected to said lever and to the pivot connection of the pitman rod members, and a second arm in spaced relation with said first arm and having its ends connected to the lever and crank respectively.

2. In a pumping installation and combination of a walking beam, a pump rod member connected to the end of said beam, a crank, means for driving the walking beam from said crank, said means including articulated upper and lower pitman rod members connected to the beam and crank respectively, a lever pivotally mounted upon a support in spaced relation with the crank, means connecting one end of the lever to the crank, and means connecting the other end of the lever to the point of articulation of the pitman rod members.

3. In a pumping installation the combination of a walking beam, a pump rod connected to said beam, a crank, means for driving the walking beam from said crank, said means including a pitman rod comprising articulated upper and lower members connected to the beam and crank respectively, a lever pivotally mounted upon a support in spaced relation with the crank, and means connecting spaced points on the lever to spaced points on the pitman rod members to control the movement imparted to the walking beam by the crank.

4. In a pumping installation the combination of a walking beam, a pump rod connected to said beam, a crank, means for driving the walking beam from the crank, said means including a pitman rod comprising articulated upper and lower members connected to the beam and crank respectively, a lever pivotally mounted upon a support in spaced relation with the crank and means connecting the ends of the lever to spaced points on the pitman rod members to control the move-

ment imparted to the walking beam by the crank.

5. A pumping device including, in combination, a Samson post, a walking beam pivoted thereon, a pump rod, means connecting the pump rod to the walking beam so that the pump rod will move in a straight line when the beam is rocked on its pivot, a crank, an articulated pitman rod connecting the crank to the beam, and means for moving the articulated members toward and from a position of alignment as the crank angularly approaches and recedes respectively from the position at which the pump rod passes through its lowermost position of rest.

6. In a device of the class described, in combination, a walking beam, a pump rod connected to one end thereof, a driving crank, a pitman rod connecting the crank to the walking beam, said pitman rod comprising upper and lower members, a pivot connection between said members, and means operatively connected to said pivot connection and crank to reduce the deceleration and acceleration of the pump rod as such rod approaches and recedes respectively about its lowermost position.

7. In a device of the class described, in combination, a walking beam, a pump rod connected thereto, a crank, a pitman rod connected to the crank and to the walking beam, said pitman rod comprising articulated upper and lower members, and means operatively connected to the pitman rod to reduce and to increase the effective length of the pitman rod as the pump rod approaches and recedes from its lowermost position, whereby the pump rod is slowly decelerated and accelerated about its lowermost position.

PAUL C. JACKSON.