April 17, 1928. 1,666,227

E. G. WILLRICH

PUMP OPERATING MECHANISM

Filed Aug. 19, 1926

Fig. 1.

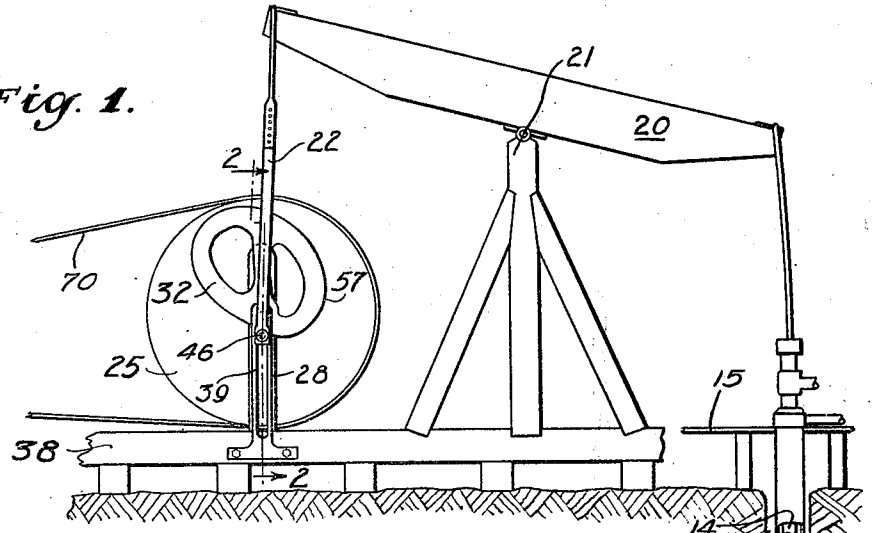
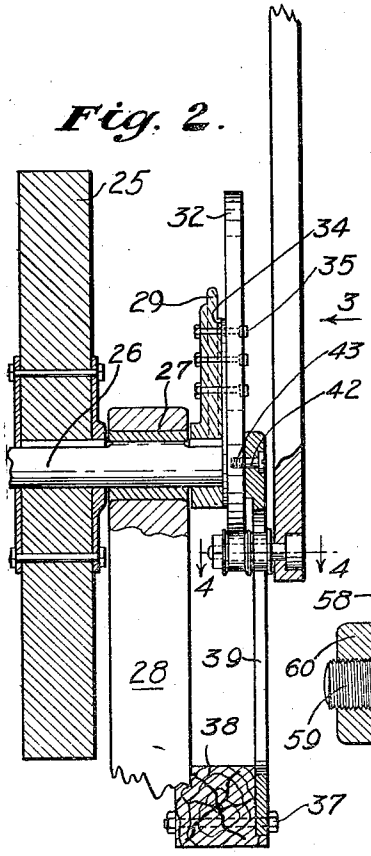


Fig. 2.



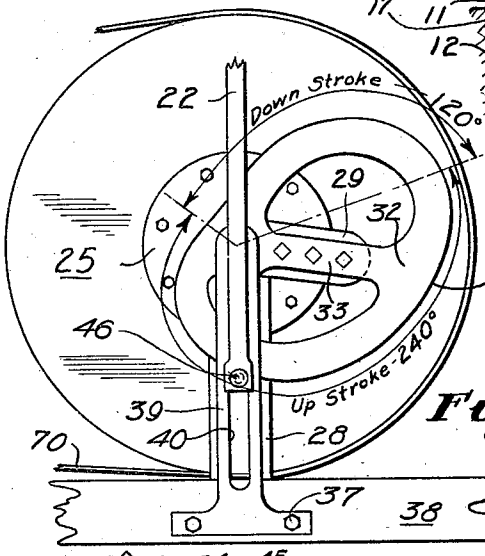


Fig. 3.

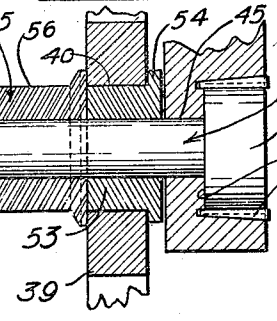


Fig. 4.

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UNITED STATES PATENT OFFICE.

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PUMP-OPERATING MECHANISM.

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My invention relates to the oil producing industry and it relates particularly to oil well pumping equipment.

A common form of pumping equipment used for taking oil from the ground has a pump barrel which is placed near the bottom of a well and which is attached to the lower end of a pump tubing. The pump tubing extends into the well from the surface of the ground. Adapted to reciprocate in the pump barrel is a pump plunger which is attached to the lower end of a string of sucker rods. The string of sucker rods extends through the pump tubing and a stuffing box is secured at the upper end of the pump tubing, and is connected to one end of a walking beam pivoted on a Samson post which is placed on the floor of a derrick of a well. The walking beam is oscillated by a walking beam crank which is secured to the shaft of a band wheel, the walking beam crank being operatively connected to the end of the walking beam opposite to the string of sucker rods by means of a pitman. When the walking beam is in operation the pump plunger is reciprocated (through the interconnecting mechanism), thus pumping oil to the surface of the ground through the pump tubing.

In the common arrangement of crank and pitman as mentioned above, the motion of the string of sucker rods is approximately simple harmonic. It is a characteristic of this type of motion that it is undergoing constant acceleration, either positive or negative, and that there is therefore a constant change in the sucker rod stresses and in engine load with peak stresses and loads at the point of maximum positive acceleration. Due to the elasticity of the rods this peak in deep well pumping with the usual velocities, is thrown out of phase 180° and occurs at or near the top of the rod stroke instead of at the bottom as would be expected. Experiments have shown further that the live loads induced by the acceleration of the rods may be equal to the dead-loads. In other words, the total load will be 200% of the dead-load. Furthermore, due to the elastic reaction of the rods, a disproportionate amount of the work is done by the engine during about 45° of the revolution of the crank, and a severe peak-load is imposed on all of the surface equipment. The excess energy delivered by the engine during this portion of the stroke is stored internally in the rods, to be given out later, as the peak is passed and the rods contract. These conditions cause considerable economic losses because of break downs of the equipment and concurrent loss of production.

One of the foremost deficiencies of this type of pumping equipment is the breakage of the string of sucker rods. This type of breakage of the string of sucker rods subjected to variable stresses is what is known as "fatigue failure" or "progressive fracture" which occurs as follows. Under the stress of a falling load, some part of the rod where there is a local weakness (as a kink or a scratch on the surface of the metal which brings about a localized stress of high intensity) will start to fail. This failure will consist in a fracture of one of the minute crystals of the metal near one of its cleavage planes. This fracture sets up a stress of high intensity in an adjacent crystal which in turn will fail, and so on, until the rod severs at this place. It has been demonstrated that this character of failure is greatly effected in two manners by stresses placed upon the sucker rods; first, it depends upon the maximum stress, the higher the maximum stress the sooner the breakage will take place; and, second, a function of the range of stress, the greater the difference between maximum and minimum stresses the sooner failure will occur.

It is an object of this invention to provide an apparatus for operating the plunger of a reciprocating pump of the character mentioned, in such a manner that the maximum stress placed on the sucker rods will be lowered and the range of maximum and minimum loads will be less than in the ordinary pumping equipment.

I have found that the desired results may be satisfactorily obtained when the time of the up stroke is extended over a greater period of time than is usual practice. In my invention I find it advantageous to make the up stroke of the plunger substantially one-third greater than that in the ordinary crank and pitman arrangement.

A still further object of this invention is to provide a pump operating mechanism of the character specified in which the walking beam is operated by a cam and follower arrangement driven by the ordinary band wheel.

Further objects and particular advantages

of this invention will be made evident in the following description which is taken in connection with the drawing, in which

Fig. 1 is a view illustrating a mechanism embodying the features of the invention.

Fig. 2 is an enlarged section taken on the line 2—2 of Fig. 1.

Fig. 3 is a view of the cam and follower arrangement of the invention taken as indicated by the arrow 3 of Fig. 2 but showing the cam in a different position.

Fig. 4 is a section taken on the line 4—4 of Fig. 2.

Referring particularly to Fig. 1, the numeral 11 represents a well, at the lower end of which an oil well pump 12 is placed. The oil well pump 12 has a barrel 13 which is attached to the lower end of a pump tubing 14 which extends upward to the surface of the ground and through the floor of a derrick 15. The oil well pump 12 has a plunger 16 which is attached to the lower end of a string of sucker rods 17. The string of sucker rods 17 extends upward through the pump tubing 14 and the upper end thereof is attached to a walking beam 20 which is pivoted at the upper end of a Samson post 21. The opposite end of the walking beam has a pitman 22 connected to it. A band wheel 25 is attached to a band wheel shaft 26 which is rotatably supported by bearings 27 which are mounted at the upper ends of posts 28. Attached to one end of the band wheel shaft 26 is a walking beam crank 29. The parts which have been specified above are ordinary derrick equipment.

My invention provides a cam 32 which is secured to the walking beam crank 29. The cam 32 has a central cross bar 33 having a protruding portion which has a machined face 34 secured tightly against the walking beam crank by bolts 35. Secured by bolts 37 to a horizontal beam 38 of a derrick 15 is a vertical guide 39 having a vertical guide slot 40. A vertical axis extending through the guide slot 40 passes through the axis of rotation of the cam 32 and the band wheel shaft 26. The upper end of the guide 39 is made rigid by means of a pin 42 which extends through the upper end thereof and is threadedly secured at 43 to the cam 32 on the axis of rotation thereof. The lower end of the pitman 22 is provided with an opening 45 through which a shaft 46 is extended. The opening 45 is enlarged at 47 to receive a head 48 of the shaft 46 which is rigidly secured to the lower end of the pitman 22 by suitable keys 50. The shaft 46 extends through the guide slot 40 of the guide 39. Rotatably mounted on the shaft 46 is a slide roller 53 having an annular flange 54 which engages the face of the guide 39 adjacent to the pitman 22. The diameter of the slide roller 53 is such that a sliding fit is provided between it and the side walls of the guide slot 40. Placed on the shaft 46 adjacent to the slide 53 is a cam follower 55. The cam follower 55 has a cylindrical face 56 which is adapted to engage a cam face 57 of the cam 32. Formed at opposite ends of the face 56 are rims 58, which hold the cam follower 55 and the cam 32 in proper alignment. The extended end of the shaft 46 is reduced and threaded as indicated at 59. A nut 60 is screwed onto the threaded end 59 of the shaft 46 for holding the slide 53 and the cam follower 55 in their proper respective positions.

Referring to Fig. 3, the cam 32 is so designed that substantially 240° of the rotation of the band wheel 25 is required for the up stroke of the plunger 16. When the pitman is moved downward the plunger 16 is moved upward as is obvious from an inspection of Fig. 1. The remainder of the rotation of the band wheel is used for the down stroke of the plunger, this remainder being 120° of the rotation of the band wheel 25.

The operation of the mechanism just described is substantially as follows:

The band wheel 25 which is rotated by means of a belt 70, which belt 70 is driven by an engine, is set into rotation. The cam 32 is revolved around the axis of rotation of the band wheel shaft 26 and the follower which follows the cam face 57 is caused to move up and down. The follower 55 is moved downward during 240° of the revolution of the band wheel and is moved upward during 120° of the revolution of the band wheel. The follower 55 and the lower end of the pitman 22 are caused to move up and down in a straight line by reason of the slide 53 which operates in the guide slot 40. The upper end of the pitman 22, however, must swing through an arcuated path since it is attached to one end of the walking beam 20. The pitman 22 being attached to the shaft 46 is free to rotate around its axis so that a lateral deflection of the upper end of the pitman from vertical movement is permitted The walking beam 20 reciprocates the string of sucker rods 17 and the pump plunger 16 is reciprocated thereby.

From the foregoing description and as previously explained, it will be understood that the mechanism of this invention changes the motion of the sucker rods and plunger by using 240° of the rotation of the band wheel for the up stroke instead of using 180° and by using only 120° of the rotation of the band wheel for the down stroke instead of using 180° as is done with the ordinary crank and pitman pump operating arrangement. If desirable, the up stroke of the plunger may be increased and the down stroke reduced even more than the figures given. Instead of a continuously accelerated motion as is given by the crank and pitman, my invention gives a uniform ve-

locity, consequently a uniform stress to the rods, during substantially 180° of the 240° of the up stroke. As a result it will load the engine and belt more uniformly and reduce the live load very greatly. The live load is reduced by reason of the fact that the maximum inertia load is considerably reduced because of the fact that the up stroke is given substantially one-third more time than is done in ordinary practice. The lineal velocity of the rods on the up stroke will only be 75% of the velocity of the rods with the crank and pitman arrangement for the same number of strokes per minute. The reduction of stresses and loads, however, will be in greater proportion than this because of the more uniform velocity. It will be seen that the stress of the sucker rods is greatly reduced by lowering the maximum live load and thus decreasing the range of maximum and minimum stresses which are imposed on the string of sucker rods.

Comparing the mechanism of my invention with the ordinary crank and pitman arrangement, the acceleration at the beginning of the up stroke is less than that of the simple harmonic motion produced by the crank and pitman; and after the first 45° of travel there are twelve equal time intervals during which there is uniform velocity with no acceleration; consequently, there is no induced live load. The time allowed for raising the pump plunger in my invention is one-third longer than in the case of the ordinary crank pitman but the actual load reduction, as pointed out heretofore, is considerably more than one-third because of the more uniform motion of the plunger 16 during the up stroke, being about 180° of the rotation of the band wheel.

One important feature of the invention is that the cam and follower arrangement may be readily used with a major part of the standard derrick equipment. The cam 32 is designed so that it may be attached to the walking beam crank 29. The guide 39 is designed so that it may be attached to one of the beams of the derrick equipment in the position shown in the drawings. The follower guide and pin arrangement are designed so that they may be installed at the lower end of the ordinary pitman of the derrick equipment. The phrase "band wheel assembly" as used in the following claims refers to the band wheel, the band wheel shaft, and the walking beam crank.

I claim as my invention:

1. In combination: a pump having a pump plunger; a string of sucker rods attached to said plunger; a walking beam, said string of sucker rods being attached to said walking beam; a pitman joined to said walking beam; a band-wheel assembly, a cam connected to said band-wheel assembly; a follower connected to said pitman, said follower operating on a cam face of said cam; a vertical guide; and a slide associated with the lower end of said pitman, said slide operating in said vertical guide.

2. In combination: a pump having a pump plunger; a string of sucker rods attached to said plunger; a walking beam, said string of sucker rods being attached to said walking beam; a pitman joined to said walking beam; a band-wheel assembly; a cam connected to said band-wheel assembly; a follower connected to said pitman, said follower operating on a cam face of said cam; a vertical guide placed below the axis of rotation of said cam; and a slide associated with the lower end of said pitman, said slide operating in said vertical guide.

3. In combination: a pump having a pump plunger; a string of sucker rods attached to said plunger; a walking beam, said string of sucker rods being attached to said walking beam; a pitman joined to said walking beam; a walking-beam crank; a band-wheel by means of which said walking-beam crank is rotated; a cam secured to said walking-beam crank; a follower connected to said pitman, said follower being operated by said cam; a vertical guide; and a slide associated with the lower end of said pitman, said slide operating in said vertical guide.

4. In combination: a pump having a pump plunger; a string of sucker rods attached to said plunger; a walking beam, said string of sucker rods being attached to said walking beam; a pitman joined to said walking beam; a walking-beam crank; a band-wheel by means of which said walking-beam crank is rotated; a cam secured to said walking-beam crank; a follower connected to said pitman, said follower being operated by said cam; a vertical guide placed below the axis of rotation of said cam; and a slide associated with the lower end of said pitman, said slide operating in said vertical guide.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 13th day of August, 1926.

EDGAR G. WILLRICH.