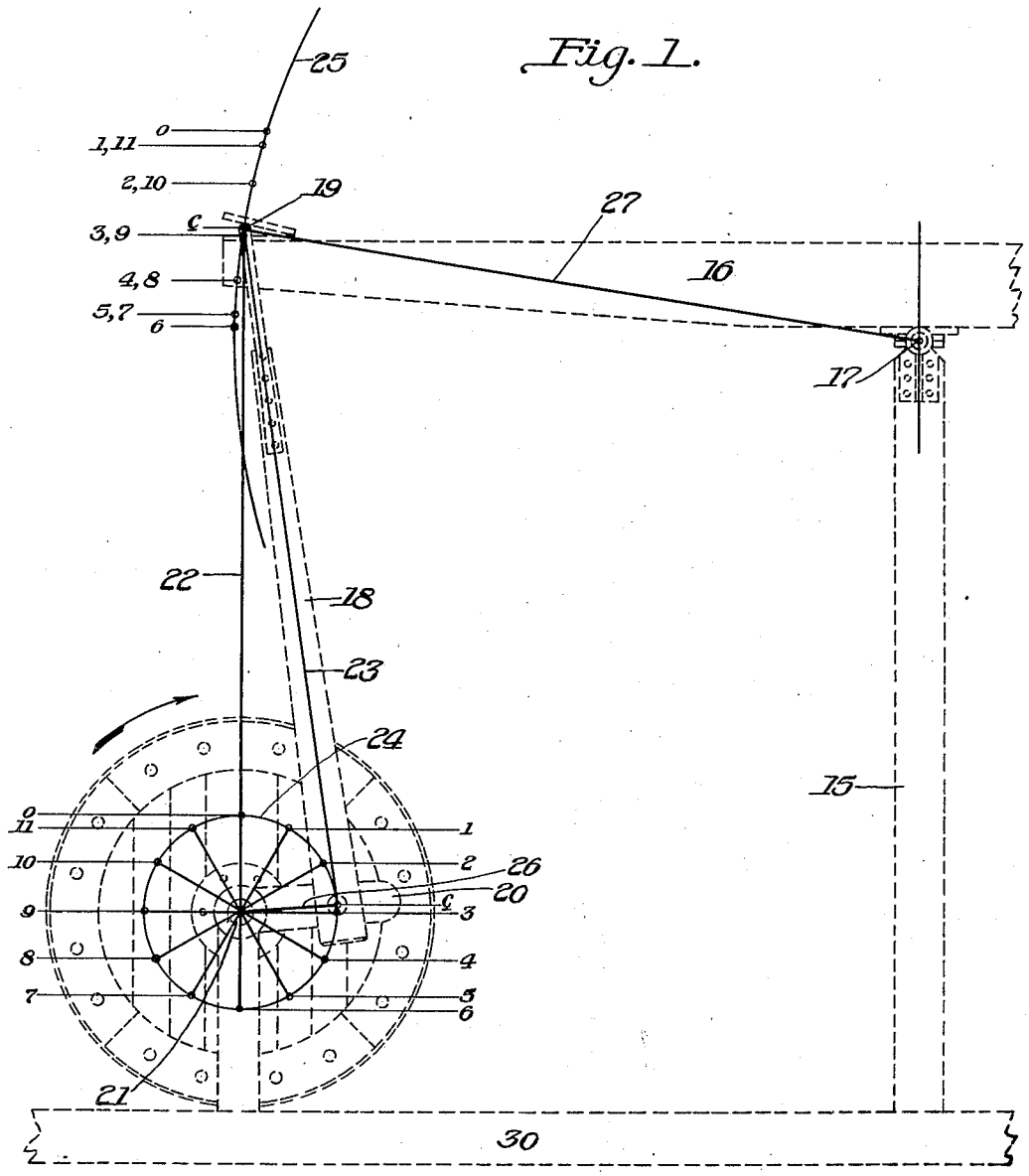
Dec. 13, 1932. A. L. FABER 1,890,807

METHOD OF AND APPARATUS FOR PUMPING WELLS

Filed Dec. 31, 1930 3 Sheets-Sheet 1

Fig. 1.



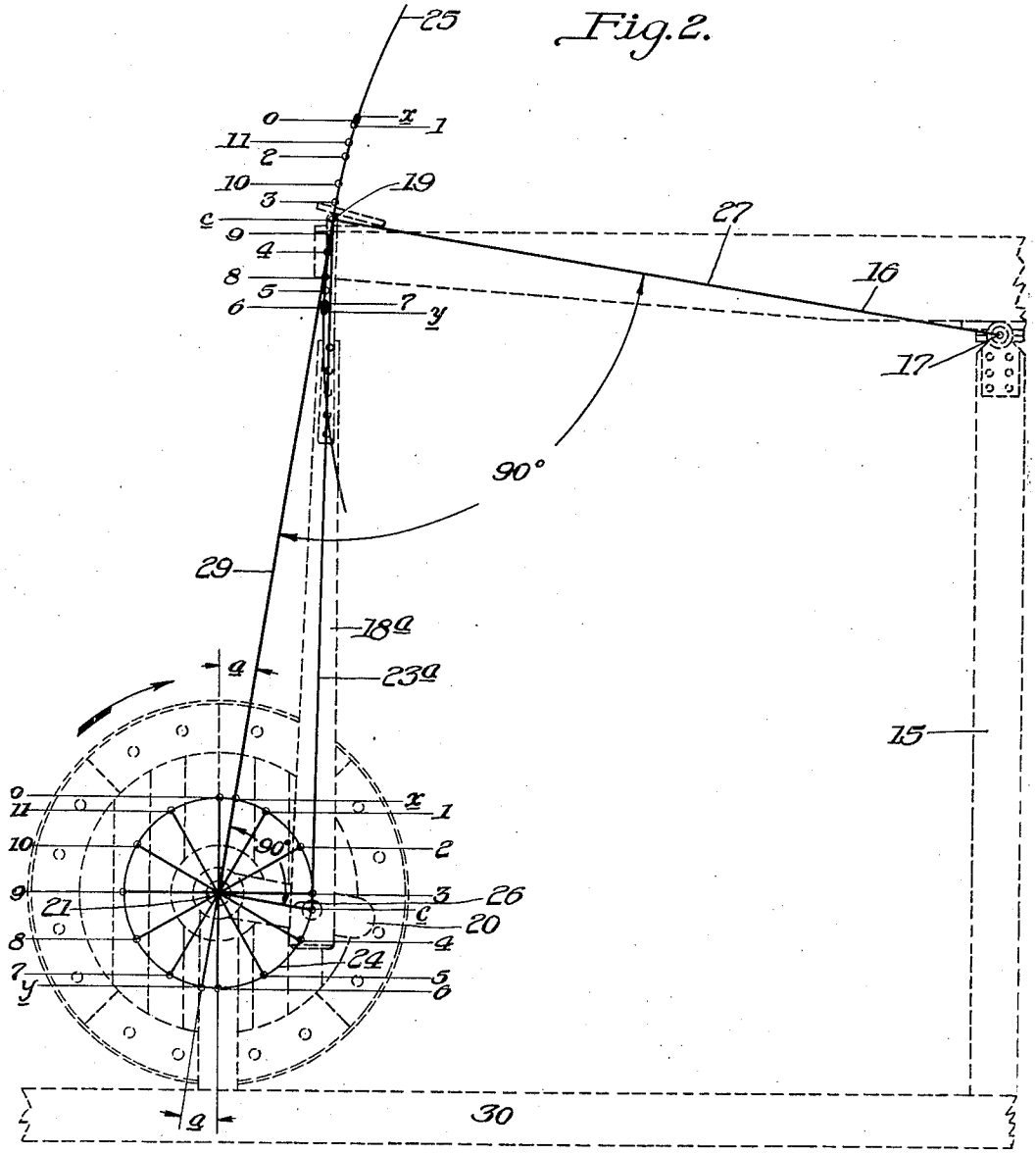
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METHOD OF AND APPARATUS FOR PUMPING WELLS

Filed Dec. 31, 1930 3 Sheets-Sheet 2

Fig. 2.



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Dec. 13, 1932. A. L. FABER 1,890,807

METHOD OF AND APPARATUS FOR PUMPING WELLS

Filed Dec. 31, 1930 3 Sheets-Sheet 3

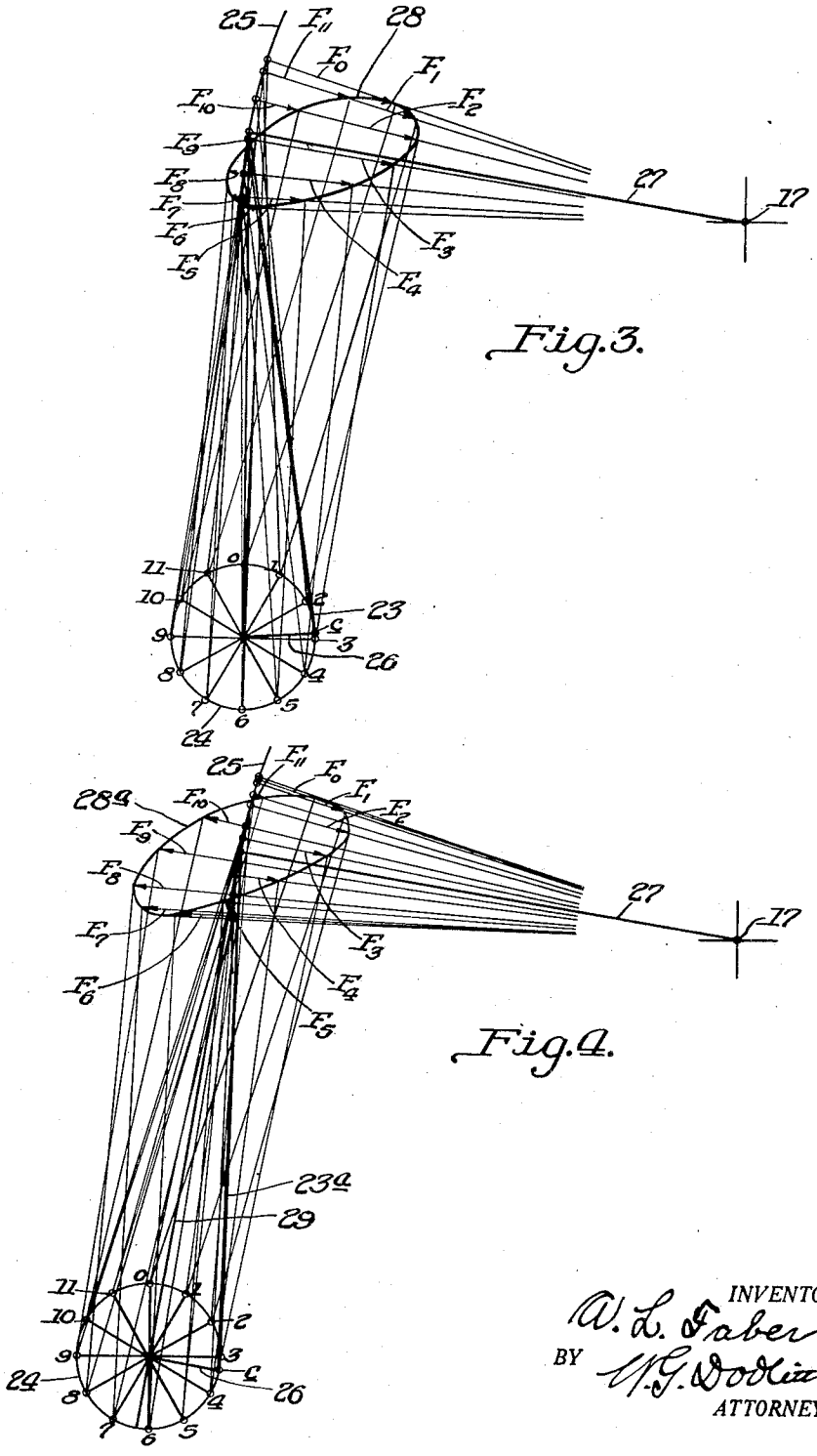


Fig. 3.

Fig. 4.

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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR PUMPING WELLS

Application filed December 31, 1930. Serial No. 505,765.

My invention relates to the art of pumping wells, and more particularly to the provision of and disposition of means embodied in pumping rigs, with especial reference to the rig set-up and its effect on power and stress.

The present invention is particularly applicable for use with the rotating or pitman type of rig, comprising a walking beam, a crank shaft, a crank, and a pitman connecting the crank and beam, said beam being adapted to be connected with and operate the polish rod, etc., of a pumping apparatus.

In pumping rigs of the character specified, it has been, prior to my invention, the usual practice to set or position the crank or jack shaft with respect to the walking beam in the following manner. The said beam was placed in an approximately horizontal position, and the distance between the center of the crank or jack shaft and the center of the Samson post was made equal to the distance between the center of the Samson post and the center line of the polish rod, i. e., the said shaft was positioned approximately directly under the pitman pivot support located at one end of the walking beam.

Due to the fact that the pitman pivot support, the polish rod connection, and the beam bearing or fulcrum are not on the same straight line in the usual type of walking beam rigs, the application of power is at an angle which varies with the length of the working centers and the size of the beam. Therefore, in setting up the parts in the relation stated, a considerable portion of the applied power is lost in forces which set up stresses against the Samson post, resulting in excessive vibration and shock to the pumping rig.

After considerable investigation and research work, I discovered that, in order to obviate the serious objections above pointed out, and other disadvantages known to those skilled in this art, the assembling or set-up of the rig should be radically changed and definitely determined by a positive and efficient method of procedure.

My invention contemplates setting the crank or jack shaft of the rig with respect to the line of rotation of the walking beam, instead of locating the same with respect to the walking beam, as heretofore. In other words, the said shaft is set back so as to produce a lead angle, whereby the upper and lower limits of the pitman and walking beam motion takes place after the crank has passed upper and lower dead center positions respectively.

Under my invention, the amount of setback is determined definitely by means of a vector diagram, and it has been discovered that the most efficient position is attained by setting the crank or jack shaft below and outwardly beyond an end of the walking beam on a line drawn approximately perpendicular to the beam lever arm. That is to say, the amount of lead angle obtained in this manner is the correct value thereof for a condition of maximum efficiency and uniformity of motion of the walking beam.

Further, by means of my invention, the upper and lower travel of the walking beam and pitman pivot point from the horizontal position of the beam is increased, thereby providing a longer stroke of the polish rod than has been accomplished heretofore.

Additional objects and advantages will become apparent from the following specification taken in connection with the accompanying drawings, wherein:

Fig. 1 is an elevational view of a portion of a pumping rig, showing the parts thereof in dotted lines and assembled in the usual and customary manner, with a diagrammatic view superimposed thereon for the purpose of illustrating the paths of motion of said parts;

Fig. 2, a view similar to Fig. 1, illustrating the pumping rig positioned in accordance with my invention; and

Figs. 3 and 4 are diagrammatic views illustrating the distribution of applied forces when the rigs are set as in Figs. 1 and 2 respectively.

Referring to the drawings, the pumping rig illustrated includes a Samson post 15 and a walking beam 16, said beam being fulcrumed at its mid-point to the post by means of a bearing 17. Said rig also includes a pitman 18, pivoted to an end of the walking

beam, as at 19, by means of a stirrup connection, and pivotally connected to a crank 20 rotatable with a crank or jack shaft 21. The remaining end of the walking beam 16 is connected to a polish rod (not shown) for reciprocation in a well for pumping fluid therefrom in the usual and well known manner.

In present practice, it has been customary to assemble or set up the above parts of the pumping rig in the manner of Fig. 1, i. e., by positioning the crank or jack shaft 21 on a vertical line 22 drawn through the walking beam-pitman pivot 19 when said beam is in the horizontal position shown. The effective length of the pitman 18 was determined by the vertical distance from the pivot 19 to the center of the shaft 21, said distance being represented by the line 23 in Fig. 1.

For the purpose of more clearly illustrating the end accomplished by my invention, I have shown in the drawings a diagrammatic analysis of the motions of the parts of the pumping rig. The path of the crank or the crank circle 24 has been divided into equal numbered divisions, and the movement of the pitman-beam pivot 19 is traced along its arc or path of motion 25 by locating the respective positions of the pitman 18 by means of the line 23.

Thus, in the customary set-up of Fig. 1, it will be seen that the upper and lower limits of the walking beam stroke are reached when the crank 20, as represented by the line 26, is at its positions of upper and lower dead center, designated 0 and 6 respectively. The movement of the beam 16 in either direction from its horizontal position c is effected at considerable velocity, until when the dead center positions are approached, the beam becomes practically stationary for an appreciable length of time, resulting in loss of motion and power. In addition to the power losses, when the motion of the crank 20 again takes effect and the beam suffers a change in direction, the parts will become subjected to a severe shock which often causes crystallization of the sucker rods, or other metallic parts of the pumping mechanism.

Since the working centers of the beam fulcrum, polish rod and pitman pivot point are not on the same straight line, the forces applied to the parts of the mechanism have an angular application, i. e., along the walking beam lever arm 27, which is the line drawn through the beam fulcrum 17 and the pitman pivot point 19. The forces set up in this direction are excessive in the construction just described, as illustrated in Fig. 3, wherein the forces have been designated F_0, F_1, F_2, etc., corresponding to the angular position of the crank 20 on the crank circle 24.

Said forces have been determined by a series of vector diagrams, and are those force vectors in the direction of the beam lever arm 27 perpendicular to the moment force vectors acting on the beam. From the curve 28 enclosing said vectors F_0, F_1, F_2, etc., it will be seen that they are practically all applied toward the beam bearing 17 and the Samson post 15 to produce a non-uniform distribution and cause substantial wear and vibration of said post and bearing.

It is, therefore, the principal aim of my invention to obviate the aforesaid disadvantages and power losses by changing and altering the set-up of a well pumping rig of the character set forth. To this end, I propose to set back the crank or jack shaft 21 to some point outwardly beyond the pitman end of the walking beam in order to provide a lead angle a for the crank 20. By a lead angle is meant the angular distance of the crank past dead center when the beam has attained its upper or lower limit of travel, and it provides for the continued application of power from dead center until said angle is traversed by the crank.

The provision of a lead angle a, as indicated in Fig. 2, introduces a stabilizing element into the motion of the walking beam. Thus, employing the same notation as in Fig. 1 with the added lead angle positions x and y of the crank past the dead center positions, it is seen that the maximum velocities of said beam, and more particularly of the pitman pivot point along the path 25, occur when the beam is approximately in mid-position. As the change of direction points x and y are approached, the velocity gradually decreases until when the change of direction takes place, it is effected gradually with no undue shock or strain on the parts of the mechanism, thereby providing for uniformity of motion.

I have found that this more uniform operation increases with the increase of the amount of lead angle employed, and therefore with the amount of set-back of the crank or jack shaft 21, until a certain limiting value of lead angle is reached, at which value the most economical and desirable condition is obtained. This correct value of lead angle may be produced according to the method of my invention in the following manner.

Employing the same pumping rig as in Fig. 1, and having the walking beam 16 in approximately horizontal position, a line 29 is drawn through the center of the pitman pivot point 19 perpendicular to the lever arm 27 of said beam. Since the same rig is employed as before, the height of the shaft 21 from the rigging floor or base members 30 is determined. Hence, where the perpendicular 29 intersects a horizontal line drawn through the center of said shaft, will locate approximately the correct position of the shaft to provide the desired value of the lead angle a.

However, in applying my invention to the design of a pumping rig, the shaft 21 may

be located at different points along the perpendicular 29, depending on the sizes and proportions of the parts.

By reason of the radical change in the position of the crank shaft 21 when employing the usual parts of such rigging, the length of the pitman 18*a* must necessarily be increased, and the correct length thereof is obtained as follows. Having located the shaft 21 in the manner just described, the crank 20 is placed so that the line 26 joining its centers is perpendicular to the line 29. The line 23*a* drawn from the pitman pivot point 17 with the beam 16 in horizontal position to the pitman connection center at the outer end of the crank 20, will determine the correct length of the pitman 18*a* to be used in practicing my invention.

In a pumping rig constructed in this manner, the pumping stroke will be produced with a substantially uniform motion, as hereinbefore stated. Thus, when pumping with the usual type of counterbalance, the amount of counterbalancing employed may be materially decreased, thereby decreasing the amount of power input necessary for the same operation accomplished with the usual rig set-up.

In addition, it is to be noticed that the use of a lead angle effects an increase in the pumping stroke of the walking beam, due to the additional travel of the same after the crank has passed through its dead center positions, thereby increasing the pumping efficiency of the rig. It has been found that the increase in length of stroke amounts to several percent in a comparison of the method of my invention with the usual rig set-up now employed in practice.

Referring now to Fig. 4, which has been drawn to the same scale as Fig. 3, and wherein the forces F_0, F_1, F_2, etc. have again been determined by means of vector diagrams for the same numbered angular positions of the crank 20, but with the pumping rig assembled in accordance with my invention as shown in Fig. 2, it will be seen that the said forces, being those which do not work but are directed along the beam 16 in the direction of its lever arm 27, are generally of lesser magnitude than those occasioned by the usual operation shown in Fig. 3. Also, as indicated by the curve 28*a* enclosing the force vectors F_0, F_1, F_2, etc. it is noted that these forces are equally distributed toward and away from the beam fulcrum 17 and the Samson post 15, thereby materially decreasing the destructive vibration and shock produced in present constructions, and providing an increased smoothness of operation.

Since the magnitude of the forces F_0, F_1, F_2, etc. is materially reduced by the method of my invention, it follows that there is a material reduction in the power losses resulting in more efficient operation. It has been proven that this saving will amount to a considerable percentage of the required power input.

I claim:

1. In a pumping rig, the combination with a Samson post, of a walking beam fulcrumed thereon, a transverse crank shaft rotatably mounted below and outwardly beyond an end of said beam on a line perpendicular to the beam lever arm, a crank rotatable with said shaft, and a pitman pivotally connected to the beam and the crank, whereby the parts produce substantially even acceleration.

2. In a pumping rig, a walking beam, a crank shaft, a crank rotatable with said shaft, a pitman pivotally connected to said beam and crank, said crank shaft being located on a line below and approximately perpendicular to the lever arm of the walking beam to provide a lead angle for the crank, whereby the parts produce substantially even acceleration.

3. In a pumping rig, a walking beam, a crank shaft, a crank rotatable with said shaft, a pitman pivotally connected to said beam and crank, said crank shaft being set outwardly from the end of the effective lever arm of the walking beam to provide a lead angle for the crank, whereby the parts produce substantially even acceleration.

In testimony whereof I affix my signature.

ARTHUR L. FABER.