Dec. 28, 1937. R. H. CARR 2,103,742

MOTOR APPARATUS FOR PUMPING AND OTHER PURPOSES

Filed June 30, 1932 2 Sheets-Sheet 1

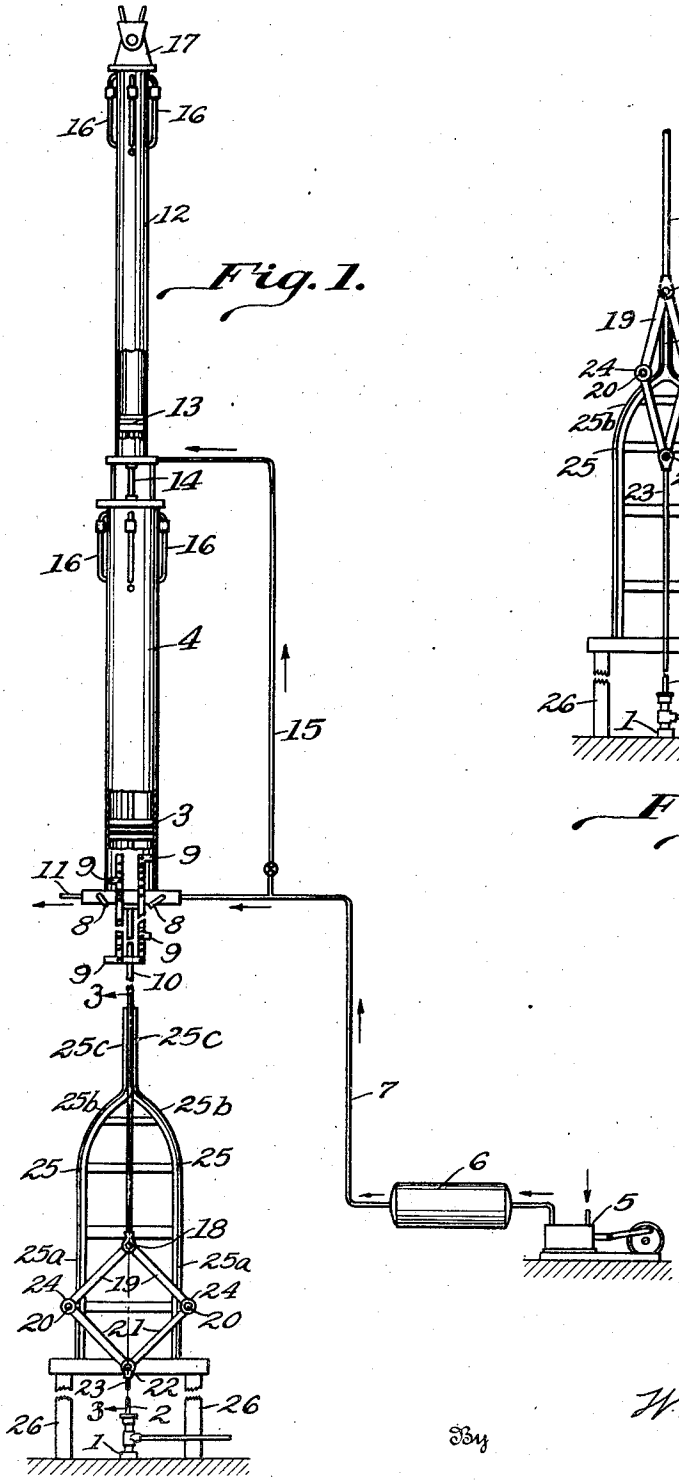


Fig. 1.

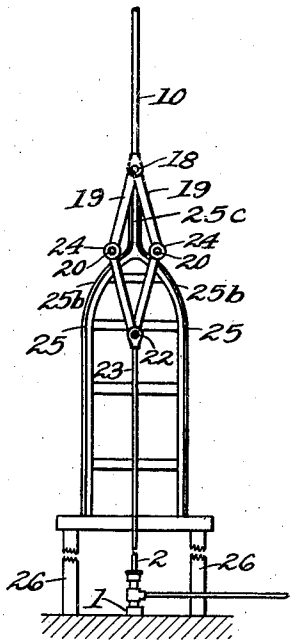


Fig. 2.

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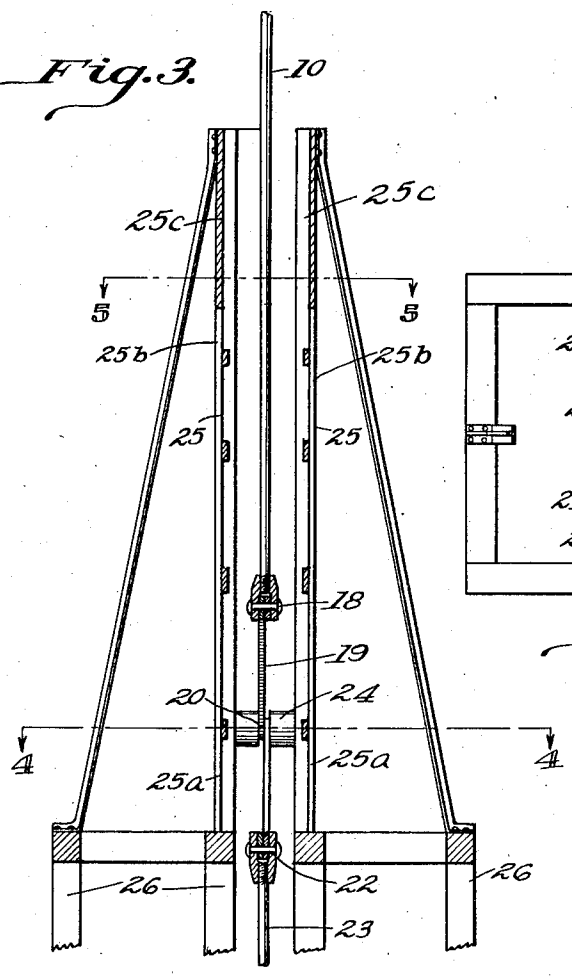
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Fig. 3.



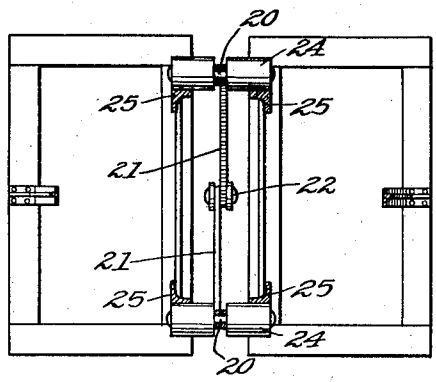
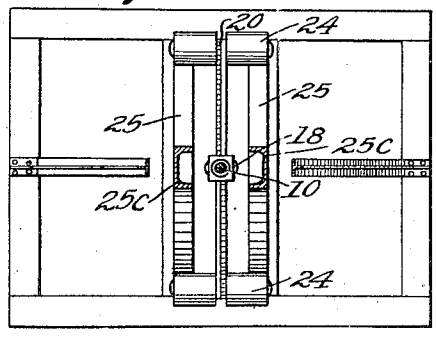


Fig. 4.

Fig. 5.



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UNITED STATES PATENT OFFICE

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MOTOR APPARATUS FOR PUMPING AND OTHER PURPOSES

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Application June 30, 1932, Serial No. 620,178

10 Claims. (Cl. 121—118)

This invention relates broadly to motor apparatus and particularly to an improved pumping mechanism of the fluid actuated type which has been especially designed for use in the removal of liquid from underground wells. More specifically, the present invention has to do with apparatus of the type disclosed in my prior Patent No. 1,860,137 issued May 24, 1932, which sets forth the provision of apparatus for pumping oil wells by means of a reciprocatory piston arranged in a pumping cylinder into which an elastic pumping fluid is admitted under pressure, the admittance and exhaust of the fluid being controlled by an automatic valve mechanism whereby upon the admission of fluid into the cylinder, the said piston will be elevated, effecting the operation of a submerged well pump and the elevation of a column of liquid from the well bore, and upon the opening of the exhaust valve and the closing of the inlet valve, the said piston will descend in a regulated manner, under the weight of the load suspended therefrom.

In accordance with the present invention, I have provided means which may be applied to well pumping systems of this type and result in reducing the consumption of air or other elastic working fluid used in the operation of the system by effectively expanding the same.

It is another object of the invention to provide an improved link motion between the piston rod of the well pumping piston and the sucker rod line leading to the submerged well pump, whereby through the provision of said link motion, a mechanism is provided permitting of the lifting of the sucker rod and associated column of liquid with less gas pressure under the working piston at the upper part of its stroke than it will on the lower part of the stroke, the operation thus giving the piston in the motor cylinder a mechanical advantage by which the gas or other elastic fluid employed to operate the motor cylinder may be used expansively.

With these and other objects in view, which will appear as the description proceeds, the invention consists in the novel features of construction, combination of elements and arrangements of parts hereinafter fully described and pointed out in the appended claims.

In the accompanying drawings:

Fig. 1 is a view in side elevation and partly in vertical section of well pumping apparatus constructed in accordance with the present invention;

Fig. 2 is a similar detailed view disclosing the positions of the link members when the piston is near the end of its up stroke; Fig. 3 is a vertical transverse sectional view on the line 3—3 of Fig. 1; Fig. 4 is a horizontal sectional view taken on the plane disclosed by the line 4—4 of Fig. 3; Fig. 5 is a similar view on the line 5—5 of Fig. 3.

Referring more particularly to the drawings when my improved motor apparatus is used for pumping oil wells, the numeral 1 designates the head portion of the casing of an oil well or other well of any suitable depth. Arranged in the bottom of this casing in the liquid producing region of the well is a submerged pump mechanism (not shown) which is operated to effect the lifting of the liquid from the well by a string of pump rods 2. The latter extend above the casing, and in this instance, are connected for vertical movement with a reciprocatory piston 3, the latter being mounted for sliding movement in a motor cylinder 4, suitably supported above the well bore but in vertical registration therewith.

In order to operate the piston 3 whereby to reciprocate the pump rods 2, use is made of a compressor 5 which delivers an elastic working fluid under pressure to a container 6. Leading from the container 6 is a pressure line 7 which enters the bottom of the cylinder 4 subject to the regulation of inlet valve means. When the piston is at the bottom of the cylinder 4, the inlet valve means may be opened automatically to admit air, gas or other elastic fluid into the cylinder 4 to effect the raising of the piston 3 and the load suspended therefrom. When the piston begins its down stroke, the inlet valve means closes to arrest further inflow of the elastic fluid under pressure into the cylinder 4, and an exhaust valve means opens whereby to provide for the expulsion of the gaseous fluid from the cylinder 4 and, in the form of the invention depicted, to the atmosphere, or may be restricted by a valve or regulating means (not shown) for holding desired back pressure on the exhaust. The inlet and outlet valve means may be of any suitable character and for the purposes of the present invention, the said valve means are shown as provided with cranks 8 which are engageable with adjustable stops 9 provided on the piston rod 10 which is rigidly connected with the piston 3 and extends through a stuffing box in the bottom of the cylinder 4. The opening and closing, therefore, of the valve means will be automatically effected.

To permit of the direct discharge of the elastic working fluid to the atmosphere through the vent 11, provision must be made for sustaining the load of the submerged pump and the column of liquid above the same during the descent of

the piston 3. To permit of this, there is arranged above the cylinder 4, a counterbalancing cylinder 12 in which is mounted for reciprocation a piston 13, which is directly connected with the piston 3 in the cylinder 4 by a rigid piston rod 14, the latter passing through stuffing boxes provided in the upper head of the cylinder 4 and the lower head of the cylinder 12. The piston in the counterbalancing cylinder ordinarily possesses a smaller effective area than the piston in the motor cylinder 4, and the high pressure line 7 is provided with a branch 15 which leads directly to the lower part of the counterbalancing cylinder. Thus the area of the piston 13 and the pressures employed thereon are so balanced with relation to the load suspended from the pistons 3 and 13 that the piston 13 will serve to provide for a regulated and controlled descent of the pumping mechanism even though the exhaust valve means of the cylinder 4 opens direct to the atmosphere, or at relatively low back pressure.

The upper ends of the cylinders 4 and 12 are provided with valved by-passes 16, whereby in the event of sudden release of load on said pistons, while the latter are advancing on their up strokes, a pneumatic cushioning or shock absorbing means will be provided in the upper end of each cylinder to arrest the shock of the reaction and prevent injury to the apparatus. The by-pass connection 16 is such that if the pistons 3 and 13 uncover the lower ends of the same, the elastic working fluid will travel through said connections and to the upper end of each cylinder, producing the aforesaid cushioning action. The upper end of the cylinder 12 may be provided with a clevis 17 by which the cylinder structure as a whole may be suspended from a derrick or other suitable overhead support.

The lower end of the piston or polish rod 10 is pivotally connected as at 18 with a pair of downwardly diverging links 19, and the lower ends of the links 19 are, in turn, pivotally connected as at 20 with a pair of upwardly diverging links 21, the lower adjoining ends of the links 21 being pivotally connected as at 22 with the upper end of a polish rod 23. The pivotal connections between the adjoining portions of the links 19 and 21 carry rollers 24 which engage with a fixed trackway 25 mounted upon an upstanding support 26. The trackway 25 possesses its greater width adjacent to its lower portion as at 25*a* and this width is sustained through a certain part of its height and then gradually decreases as represented by the inwardly curved regions 25*b* of the trackway.

It will be noted that at the beginning of the up stroke of the piston 3, the rollers 24 on the toggle arms or links 19 and 21 are in a position so that upward movement over the first part of the stroke will result in the links of the toggle remaining in substantially fixed relative positions, resulting in the movement of the sucker rods in the well and the well pump being practically equivalent to that of the piston 3 in the motor cylinder 4. As the stroke progresses upwardly, the rollers conform to the curvature 25*b* of the trackway, changing the position or length of the toggle so that the piston in the motor cylinder travels a greater distance than the corresponding travel of the submerged well pump, thus giving the piston in the motor cylinder a mechanical advantage which enables the system to use the elastic working fluid in the motor cylinder expansively; thereby performing more work with it.

Work equals force times distance. It is evident that if air under pressure is admitted to the motor cylinder during the initial part of the stroke only and is allowed to expand against the piston, the pressure or force which it exerts will gradually decrease until it is equal to the resistance offered by the string of tools. If no mechanical advantage were imparted to the motor cylinder at this point, movement of the well tools would cease. But, if the distance through which the motor cylinder is permitted to move is increased relative to the distance through which the string of tools moves, the value F D for the motor cylinder will exceed the resistance offered by the string of tools and useful work will be performed.

It is evident from the drawings that during the travel of the rollers 20 from the points 25 on the track to the position shown in Figure 2, the connection 22 and consequently the polish rod 23 will move upwardly. This is due to the fact that the curved sections 25*b* of the track meet at a higher point than the top of an arc having a radius equal to link 21 and having its center at the connection 22 when the rollers 24 are at the points 25. In order for the toggle connection to collapse without moving the polish rod, it is necessary to keep the connection 22 stationary and permit the rollers 24 to move over the circumference of a circle of radius equal to link 21. But these rollers are compelled to move to a higher point than any point on such a circumference and their upward movement necessarily pulls the links 21 and polish rod upwardly at a slower rate. Thus by gradually increasing the relative distance of travel between the motor piston and the polish rod, the force of the air pressure is able to do sufficient work to continue to lift the well tools.

It will be understood that mechanism of a considerable variety of design can be used to perform the same result as the toggle links set forth and the right is therefore reserved to employ various mechanical motions for attaining this result.

In summary, therefore, the apparatus disclosed will lift the sucker rods and the column of liquid oil with less pressure under the piston 3 during the upper part of the stroke than it will on the lower part of the stroke. It will be observed that on the lower part of the pumping stroke, there is considerable movement at the beginning of the stroke before any change takes place in the relative positioning of the toggle links. This enables me to admit a quantity of air or gas into the cylinder at the beginning of the up stroke and use it over the remainder of the stroke expansively. Above the curved portions 25*b* of the trackway, I provide track extensions 25*c* of parallel closely related order. The extensions 25*c* extend upwardly a sufficient distance to permit of the over stroke and cushioning of the piston in the event of sudden release of the load caused usually by the parting of rods.

What is claimed is:

1. Motor apparatus comprising a cylinder, a piston slidably mounted in said cylinder, said piston having a gravity load suspended therefrom, means for admitting an elastic working fluid under pressure into said cylinder to effect the elevation of said piston and its suspended load, and compensating means between said piston and the suspended load, said compensating

means serving to effect substantially uniform linear travel of the piston and its load in the lower part of the up stroke of said piston and increased linear travel of said piston with respect to the suspended load during the upper portion of the up stroke of said piston.

2. Motor apparatus comprising a cylinder, a piston slidably mounted in said cylinder, and having a gravity load suspended therefrom, means for admitting an elastic working fluid into said cylinder during the up stroke of the piston therein and discharging said fluid from said cylinder during the down stroke of the piston, and a variable length connection between said piston and its suspended load, said connection providing for substantially uniform linear rates of travel of the piston in said cylinder and the suspended load during a considerable portion of the length of the up stroke of said piston and for an increased rate of linear travel of said piston in proportion to that of the suspended load during the upper portion of the up stroke of said piston, whereby to provide for the expansion of the working fluid in said cylinder.

3. Apparatus of the character described comprising a motor cylinder, a piston mounted for reciprocation in said cylinder, a piston rod extending from said piston, a toggle connection uniting the lower end of said piston rod with a gravity load, a guide frame for controlling and changing the effective length of said toggle connection, valve means for admitting a gaseous working fluid under pressure into said cylinder beneath said piston, and means for closing said valve means prior to the end of the up stroke of said piston.

4. Apparatus of the character described comprising a motor cylinder, a piston slidably mounted in said cylinder, valve means for admitting an elastic working fluid under pressure into said cylinder during the power stroke of said piston, valve means operative to discharge fluid from said cylinder during the return stroke of said piston, and a connection, adapted to vary in length during each stroke of the piston, uniting said piston with a gravity load.

5. Apparatus of the character described comprising a motor cylinder, a piston operable in said cylinder, automatic fluid inlet and discharge valves associated with said cylinder, and means adapted to vary in length during each stroke of said piston, connecting said piston to a gravity load.

6. Apparatus of the character described comprising a motor cylinder, a piston operable in said cylinder, fluid inlet and discharge valves associated with said cylinder, means to close said inlet valve prior to the end of the power stroke of said piston and means adapted to vary in length during the time when said inlet valve is closed, connecting said piston with a gravity load.

7. Apparatus of the character described comprising a motor cylinder, a piston operable in said cylinder, fluid inlet and discharge valves associated with said cylinder, means to close said inlet valve prior to the end of the power stroke of said piston, and means connecting said piston with a gravity load adapted to gradually increase in length during a portion of the power stroke when said inlet valve is closed.

8. Apparatus of the character described comprising a reciprocating means, fluid means operable to drive said reciprocating means, a gravity load adapted to be lifted by said reciprocating means and a means connecting said reciprocating means to said load adapted to automatically impart a mechanical advantage to said reciprocating means during the latter part of the lifting stroke thereof only.

9. Apparatus of the character described comprising a reciprocating means, expansible fluid means operable to drive said reciprocating means, a gravity load adapted to be lifted by said reciprocating means, means for reducing the supply of said fluid means to said reciprocating means prior to the end of its lifting stroke, and a means connecting said reciprocating means to said load adapted to automatically impart a mechanical advantage to said reciprocating means during the latter part of the lifting stroke thereof only.

10. Apparatus of the character described comprising a motor cylinder, a piston slidably mounted therein, a load connected to said piston, means for admitting to and discharging an expansion fluid from said cylinder, means for cutting off the supply of fluid to said cylinder prior to the end of the piston stroke, and means for automatically imparting a mechanical advantage to said motor cylinder only during a portion of the stroke when the fluid supply is cut off.

RICHARD H. CARR.