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S. C. CARTER

PUMPING APPARATUS

Filed April 27, 1926

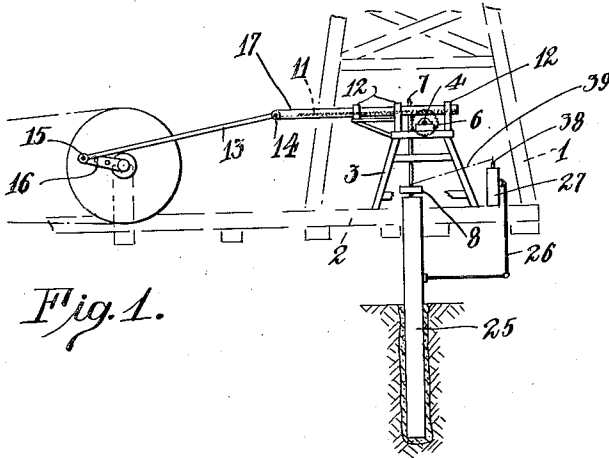


Fig. 1.

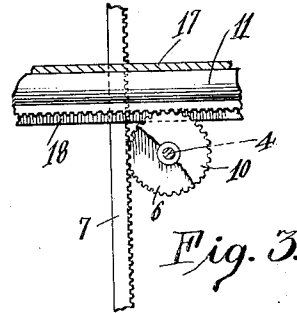


Fig. 3.

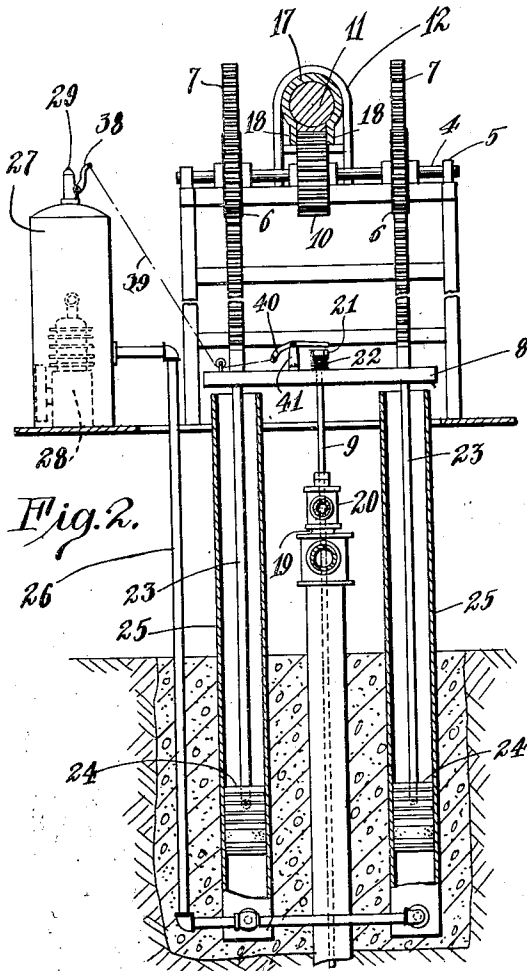


Fig. 2.

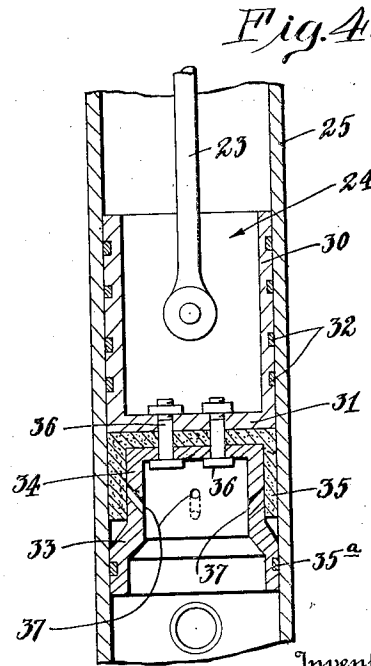


Fig. 4.

Inventor

Samuel Clark Carter

By

Lyon & Lyon

Attorneys

UNITED STATES PATENT OFFICE.

SAMUEL CLARK CARTER, OF LOS ANGELES, CALIFORNIA, ASSIGNOR OF ONE-THIRD TO ANSON ROBINSON AND ONE-THIRD TO J. H. CARSON, BOTH OF LOS ANGELES, CALIFORNIA.

PUMPING APPARATUS.

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This invention relates to pumping apparatus and is more particularly directed to deep well pumps for the recovery of oil or the like from the ground.

5 In the recovery of oil from oil wells, the inequality of the effort required for the pumping strokes causes great difficulties in the maintenance of pumping apparatus. The weight of the pump assembly, presence of gas pockets, sand difficulties, and the like, cause
10 such unequal pumping conditions that maintenance of the pumping equipment frequently is extremely difficult and expensive. This is particularly true in the case of long stroke
15 pumps in deep wells, where reciprocation of the pump plunger is rendered exceptionally difficult because of the unequal power requirements for the up and down strokes. Many means have been provided and suggested for
20 equalizing the power required for the opposite strokes of such pumping apparatus, including systems for counter-balancing the weight of the reciprocating parts, but such means have been only partially successful and
25 do not permit much flexibility of operation. For the most part they also are both cumbersome and unwieldy.

The use of counterweights introduces still other difficulties. Oil wells, for instance,
30 often are many thousands of feet in depth, and the combined weight of the suspended pump rods, plus the weight of the column of oil supported thereby, is very great. At the end of each pump stroke it is necessary to
35 overcome the inertia of these great moving masses. If then we should attempt to counter-balance these weights we must necessarily double the mass in motion, and must deal with enormous inertia effects that are twice as
40 great as before.

With these principles in view it is a primary object of my invention to provide means for equalizing the power required for the up and down strokes of the pump, without appreciably increasing the effects of inertia.

45 A further object of this invention is to provide a pumping apparatus particularly adapted for long stroke pumping operations, in which the power required for the pumping
50 strokes is approximately equalized by pneumatic means.

Another object of this invention is to provide a long stroke pumping apparatus which is of simple and relatively inexpensive construction, and in which a pair of cylinders

is provided, with pistons therein adapted to reciprocate with the pump plunger; gas under pressure being provided beneath the pistons to counter-balance the weight of the pump assembly for equalizing the power required for the pumping strokes. 60

Other objects and advantages of this invention will be apparent from the following detailed description of a preferred embodiment thereof, as illustrated in the accompanying drawings, in which— 65

Figure 1 is a side elevation of a pumping apparatus embodying this invention;

Figure 2 is a side elevation, partly in vertical section, of the pumping apparatus illustrated in Figure 1 when revolved 90 degrees about a vertical axis; 70

Figure 3 is a fragmental detailed view, partly in section, illustrating the driving means embodied in this invention; and 75

Figure 4 is an enlarged fragmental sectional view of a preferred type of piston employed in the cylinders, for compensating or equalizing the strokes of the pump.

In the embodiment of this invention illustrated in the accompanying drawings, 1 illustrates a fragment of a well derrick, on the floor 2 of which a frame 3 is mounted. The frame 3 supports a counter-shaft 4 in bearings 5. Rigidly secured to shaft 4 are pinion
80 gears 6, meshing with rack gears 7. The latter are secured at one end to the cross-head 8, which in turn is secured to the pump rod 9 in manner that will hereinafter be specifically described. 85

Mounted intermediate the pinion gears 6, and secured to the shaft 4, is a driving gear 10, which meshes with and is driven by a rack bar 11. The latter is adapted for being reciprocated by any suitable mechanism. One
90 such mechanism is illustrated in the drawings as comprising a connecting rod 13 which is pivotally secured at one end to rack 11 by a pin 14, and is pivotally engaged at its opposite end by a crank-pin 15 on a crank 16. 100
Crank 16 is driven from any suitable source of power. The crank may be that customarily provided on the band wheel shafts commonly used in oil well derrick constructions. The rack 11 is slidably mounted in
105 a tube 17 which is secured in position by means of clamps 12. The guide tube 17 has a longitudinal slot at the bottom through which the peripheral part of pinion 10 extends, and preferably also has downwardly 110

projecting flanges 18 which serve to stiffen and strengthen the guide tube at its slot edges, and also to protect the engagement between pinion 10 and rack 11.

5 The pump rod 9 extends into the well tubing 19 through a tubing head 20, as is well understood in the art, and is secured at its lower end to a pump plunger (not shown) of any suitable construction. The pump rod at 10 its upper end extends through the cross-head 8 and is provided with a head 21 between which and cross-head 8 a heavy compression spring 22 is provided to yieldingly support the pump rod upon the cross-head.

15 Secured to the cross-head 8 are piston rods 23, which carry pistons 24 at their lower ends. These pistons are reciprocated in cylinders 25, the latter being upright and oppositely spaced from the pump rod. The cylinders 20 preferably are installed in position below the derrick floor 2, and are supplied through a conduit 26 with gas or air under pressure from a storage tank 27. The pressure in this 25 tank is maintained above a pre-determined minimum pressure by means of a compression unit 28 of any suitable or desirable construction. The storage tank 27 is a closed tank and is provided with a blow-off valve 29 to 30 limit the maximum pressure therein. The gas pressure fluctuates with the movement of pistons 24. Gas from the tank flows to the cylinders on the up-stroke of pistons and is returned on the down-stroke.

35 In order to make up gas losses from tank 27, and possibly from around the pistons 24, the compression unit may be operated in any desired or preferred manner by automatic control in ways that are understood in the art.

40 The pistons 24 are preferably of the following construction. They comprise substantially cylindrical bodies 30, which are substantially closed at their lower ends 31, and which are fitted with metallic piston rings 32. Shoes 33 are provided having sections 45 of reduced diameter 34 over which non-metallic packing cups 35 are fitted, with the walls thereof extending over the reduced portions 34. The shoes 33 may also be provided with piston rings 35^a at their lower ends. 50 These shoes are secured to piston bodies 30 by means of bolts 36, so as to firmly hold the non-metallic packing cups 35 in position. A plurality of ports 37 are formed in the walls of reduced portions 34 of the shoes to admit gas 55 pressure against the inner surface of the non-metallic packing cups 35. This pressure tends to expand the skirts of the packing cups outwardly, and insures a fluid tight contact with the cylinders 25, so as to reduce or 60 prevent gas leakage from the cylinders.

Means are provided for warning the operator in case of the parting of the pump rod 9. These means preferably comprise an indicating device or whistle 38 mounted on stor- 65 age tank 27, the whistle being connected by

means of a cable 39 with a pivotally supported operating lever 40 mounted in a bracket 41 on cross-head 8 and extending over the head 21 of the piston rod 9. If the rod 9 should part the upper end would be forced upwardly by 70 means of the compression spring 22, due to the release of the weight supported by this spring, and the operating lever 40 would be actuated to open the whistle 38 to warn the operator of the parting of the pump rod. 75

From the foregoing description it will be apparent that I have provided a means for approximately equalizing the power requirements for the up and down strokes of a deep well pump, without appreciably increasing 80 the inertia effects. Only the relatively very small weights of pistons 24 and piston rods 23 have been added. The relatively insignificant inertia of these small masses is entirely negligible in ordinary pumping operations. 85

In my apparatus power is absorbed on the downstroke of the pump in overcoming the pressure of the compressible fluid below the pistons, and in further compressing it to the extent that it will considerably more than 90 overbalance the weight of the suspended parts and the column of oil supported thereby. This stored power is returned on the up stroke of the pump, and reduces the power that otherwise would be required from the prime 95 mover.

Obviously the volumes of the compression spaces at the bottoms of the pneumatic cylinders, plus the volume of tank 27, must be correctly 100 proportioned to the total piston displacement, to obtain the desired effects in operation. It can easily be shown mathematically that when the volume of the air space that is not swept by the pistons bears the same relation to the piston displacement 105 that the weight of the suspended parts bears to the weight of oil pumped per stroke, the gravitational forces will be counter-balanced by the air pressure under the pistons to exactly the same extent at all points of the 110 stroke. This method of air balancing may thus be made to fully and exactly overcome the gravitational forces, and if the proportion is correctly made, the power requirements for the up and down strokes of the 115 pump may be very closely equalized.

Having fully described a preferred embodiment of my invention, it is to be understood that I do not wish to be limited to the exact details herein set forth, which may obviously 120 be varied without departing from the spirit of my invention as set forth in the appended claims.

I claim:

1. In a long stroke pumping apparatus, the 125 combination of a cross-head, yieldable means for securing the cross-head to a pumping rod, means for reciprocating the cross-head vertically, a piston secured to the cross-head, a cylinder mounted in position below the cross- 130

head and in which the said piston is adapted to be reciprocated, means for supplying gas under pressure to the said cylinder, and signal actuating means secured to the cross-head and adapted to be actuated by the yieldable pump rod securing means in case of breaking of the pump rods.

2. Pumping apparatus comprising; a reciprocable pumping rod; a cylinder having a reciprocable piston therein; means for constraining said rod and said piston to reciprocate proportionally; a compression chamber of constant volume, communicating with one end of the cylinder; and compressible fluid under pressure within said cylinder-end and chamber; the pressure of said fluid being variable by the displacement of said piston, and greatest at the beginning of the pumping stroke of said rod.

3. Pumping apparatus comprising; a vertically reciprocable pumping rod; a cylinder having a reciprocable piston therein; means for constraining said rod and said piston to reciprocate proportionally; a compression chamber of constant volume, communicating with one end of the cylinder; and compressible fluid under pressure within said cylinder-end and chamber, opposing the gravitational force exerted upon the piston through the medium of said rod; the fluid pressure upon the piston being approximately equal to said force at the end of the pumping stroke of said rod; and the ratio of piston displacement to the maximum volume of said fluid being such that the fluid pressure upon the piston will approximate said force at the beginning of the pumping stroke of said rod

by virtue of the increased fluid pressure due to said displacement.

4. Pumping apparatus comprising; a pair of vertical cylinders having reciprocable pistons therein connected to a common cross-head; a pumping rod depending from said cross-head intermediate the cylinders; means for reciprocating said cross-head vertically; a compression chamber of constant volume, communicating with the lower ends of the cylinders; and compressible fluid under pressure within the chamber and cylinders beneath the pistons; the space within which said fluid is confined being variable in operation only by the displacement of said pistons.

5. Pumping apparatus comprising; a pair of vertical cylinders having reciprocable pistons therein connected to a common cross-head; a pumping rod depending from said cross-head intermediate the cylinders; rack and pinion means for reciprocating said cross-head vertically; and compressible fluid under pressure within the cylinders beneath the pistons; the total fluid pressure upon the pistons being approximately equal to the gravitational force exerted upon said cross-head at the end of the pumping stroke of said rod; and the ratio of total piston displacement to the total maximum volume of said fluid being such that the total fluid pressure upon the pistons will approximate said force at the beginning of the pumping stroke of said rod by virtue of the increased fluid pressure due to said displacement.

Signed at Los Angeles, California, this 17th day of April, 1926.

SAMUEL CLARK CARTER.