Oct. 30, 1934. E. D. NOTHSTINE 1,978,595

WELL PUMPING APPARATUS

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FIG.1.

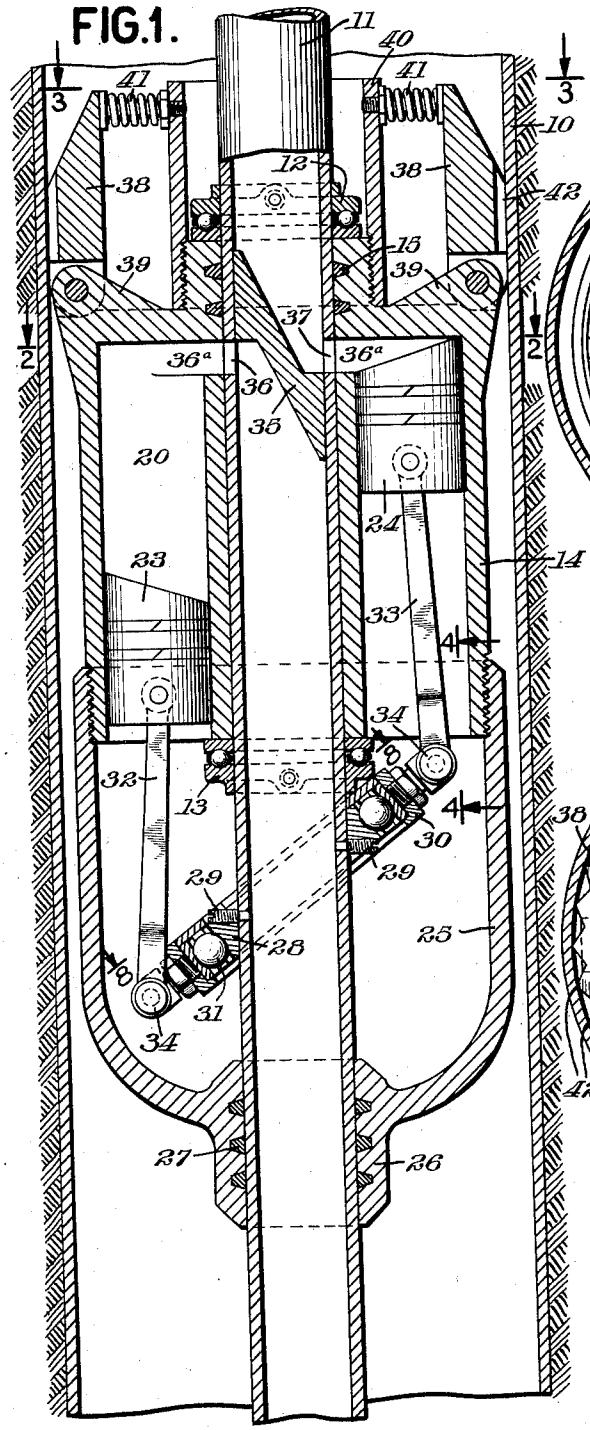


FIG.2.

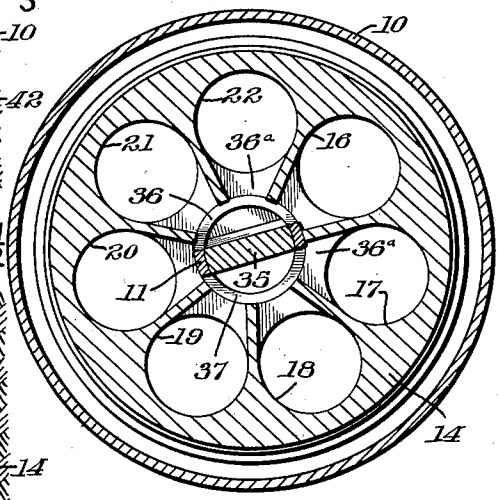
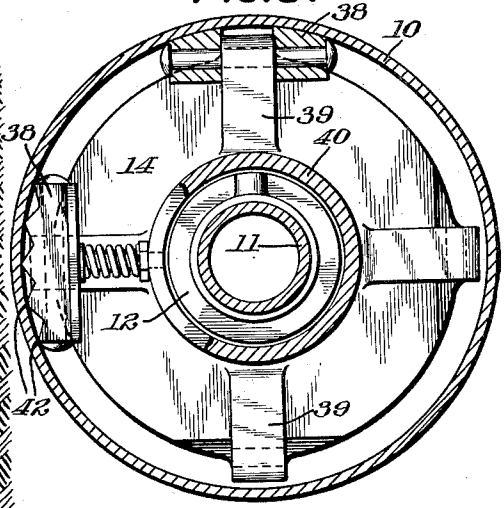


FIG.3.



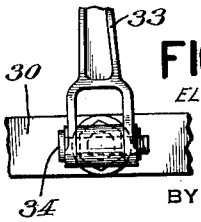


FIG.4.

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WELL PUMPING APPARATUS

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FIG.5.

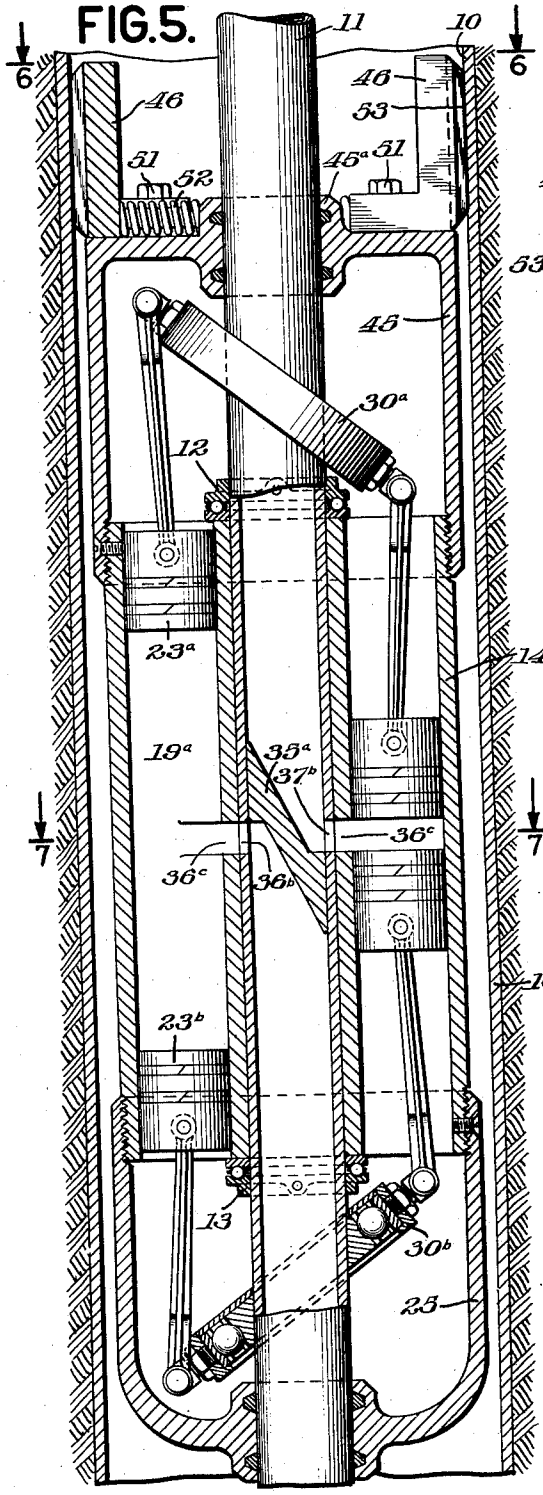

FIG.6.

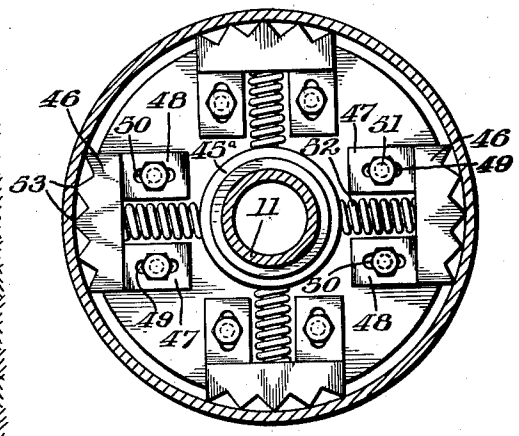

FIG.7.

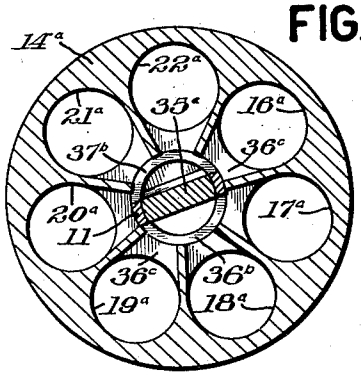

FIG.8.

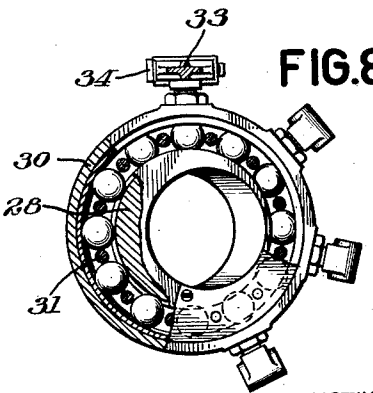

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FIG.9.

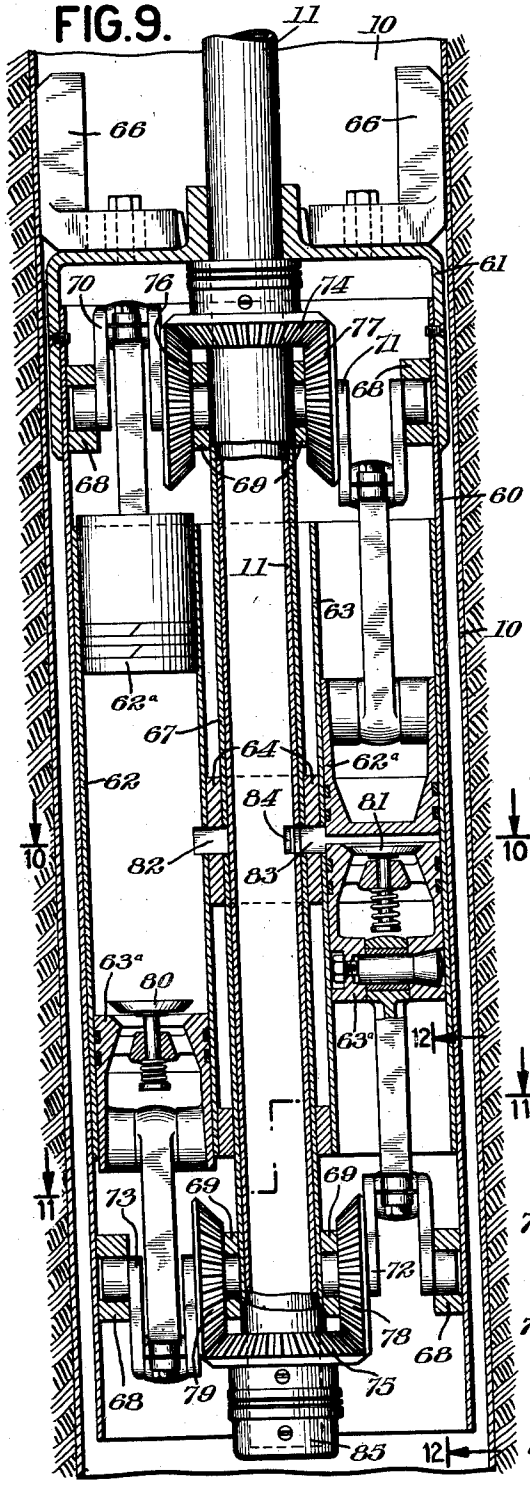


FIG.10.

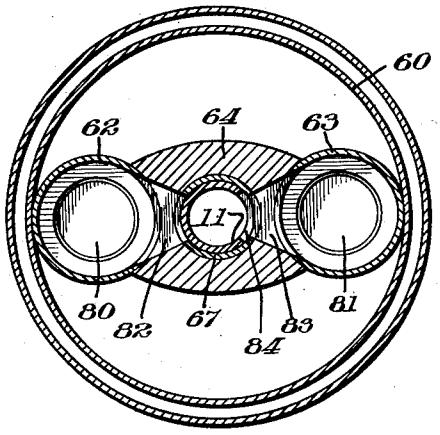
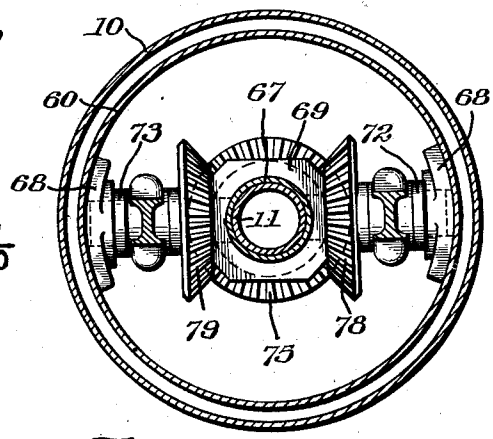


FIG.11.



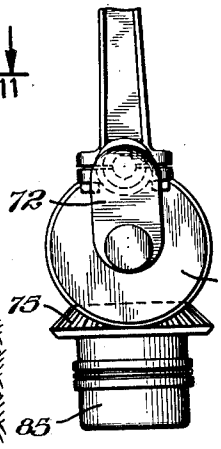


FIG.12.

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UNITED STATES PATENT OFFICE

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WELL PUMPING APPARATUS

Elmer Dewitt Nothstine, Pettus, Tex.

Application January 7, 1933, Serial No. 650,699

11 Claims. (Cl. 103—155)

My invention relates to improvements in well pumping methods and apparatus, more particularly to a pumping unit adapted to be mounted at the bottom of a well and actuated through rotary movement of the tubing such movement being imparted to the tubing at the surface of the ground. The principal object of my invention is the provision of a pump which will be compact so as to be operable within a small space, such as a well casing, which will be positive in operation and which will necessitate a minimum of moving parts such as valves and valve actuating structure.

A further object of my invention is the provision of means whereby the pump will be rotatably mounted upon the lower end of the tubing in such a way as to prevent longitudinal movement of the pump with respect to the tubing and also rotary movement with respect to the well casing. Through the use of my invention, heavy sucker rods with their associated disadvantages and also the cumbersome pumping equipment usually located at the surface at the top of the well will be eliminated.

In carrying out my invention I have provided a pump in which a plurality of pistons are mounted for reciprocation within cylinders which latter are located substantially in a circle about the tubing with their axes parallel to the tubing. Rotary motion of the tubing is translated into reciprocating motion of the pistons by means of a cam and a follower ring, the former being secured to the tubing while to the latter are attached the piston rods of the pistons. A partition within the tubing and a pair of slots associated therewith serve as inlet and outlet valves for the cylinders. A pair of thrust bearings prevent longitudinal movement of the pump with respect to the tubing while anchor members serve to hold the pumps stationary during rotary movement of the tubing.

For a further explanation of my invention reference may be had to the accompanying drawings, in which:

Figure 1 is a vertical sectional elevation of a pump embodying a preferred form of my invention,

Figure 2 is a sectional plan view taken on the line 2—2 of Figure 1,

Figure 3 is a sectional plan view taken on the line 3—3 of Figure 1,

Figure 4 is an elevation of a detail taken on the line 4—4 of Figure 1,

Figure 5 is a vertical sectional elevation showing a modification of my invention,

Figure 6 is a sectional plan view taken on the line 6—6 of Figure 5,

Figure 7 is a sectional plan view taken on the line 7—7 of Figure 5,

Figure 8 is a view partly in section taken on line 8—8 of Figure 1, showing the cam and ring connection,

Figure 9 is a vertical sectional elevation showing a still further modification of my invention,

Figure 10 is a sectional plan view taken on the line 10—10 of Figure 9,

Figure 11 is a sectional plan view taken on the broken line 11—11 of Figure 9, while

Figure 12 is an elevation of a detail taken on line 12—12 of Figure 9.

Referring to Figures 1 thru 4 of the drawings, the well is provided with a casing 10 and a string of tubing 11. Where possible, the same ordinals will be applied to the figures showing the modifications of the invention. Secured to the exterior of the tubing 11 are anti-friction bearings 12 and 13 and between these bearings is mounted a cylinder block or housing 14, the latter being preferably provided with suitable packing 15 where it engages the tubing 11. Within the block 14 are located a plurality of cylindrical chambers or cylinders 16, 17, 18, 19, 20, 21 and 22, in this instance seven cylinders being shown. Mounted for reciprocation within the cylinders are a plurality of pistons, two of which are shown in Figure 1 by ordinals 23 and 24. A cup-shaped member 25 is secured to the lower outer edge of the cylinder block 14 and is provided at its center with a bearing 26 and suitable packing 27 so that the tubing 11 may rotate freely therein. The cup-shaped member 25 serves not only to enclose and lubricate the driving mechanism for the pistons but also as a receptacle to catch any broken parts and keep them from being lost in the well.

In order to translate rotary movement of the tubing 11 into reciprocating movement of the pistons I have provided a cam member 28 attached to the outside of the tubing by any suitable means, such as set screws 29. A follower ring 30 encircles the cam 28 and between the ring and the cam a ball race 31 is located. The pistons reciprocable in the chambers 16, 17, 18, 19, 20, 21 and 22 are provided with piston rods 32 and the lower ends of the piston rods are secured by pivot or pin connections 34 to the ring 30 as shown more clearly in Figure 8. The plane of the cam 28 is at an angle of substantially 45° with the longitudinal axis of the tubing and it will thus be seen that when the tubing is rotated

the cam 28 will also be rotated but due to the anti-friction bearing the ring 30 will not necessarily rotate. The ring will, however, follow the upward and downward movement of the cam 28 and the piston rods and pistons, which are secured to the ring member, will thus be reciprocated within their respective cylinders.

At a point substantially even with the tops of the chambers 16, 17, 18, 19, 19, 20, 21 and 22 the tubing 11 is provided with an internal partition 35 and is also provided on opposite sides of the partition with a pair of slots 36 and 37, the slot 36 forming an inlet port and the slot 37 forming an outlet port. At the upper end of each cylinder a port 36*a* is provided, leading to the tubing 11.

In order to prevent rotation of the pump, with respect to the casing 10, I have provided a plurality of anchor members 38, each of these anchor members being pivotally secured to an ear 39 projecting from the upper outer edge of the cylinder block 14. A short cylinder 40 is threadedly secured to the cylinder block 14 and extends upwardly as shown in Figure 1. Between each of the anchor members 38 and the cylinder 40 is mounted a compression spring 41 adapted to force the anchor member toward the casing well 10. Each of the anchor members 38 is provided at its outer surface with a plurality of longitudinally extending sharp edges 42, and it will thus be obvious that the edges 42 will tend to grip the casing 10 and prevent any rotary movement of the pump unit with respect thereto while not interfering with longitudinal movement of the pump as it is being lowered into or withdrawn from the well.

In the operation of this embodiment of my invention let us assume that the pump unit has been assembled and secured to a section of the tubing 11 between the bearings 12 and 13, as shown in Figure 1. The tubing may then be inserted in the well and lowered until the pump unit is in a desired position with the lower end of the tubing extending downwardly into the oil or other fluid to be pumped. When the tubing is then rotated, the cam 28 will cause the ring 30 to oscillate in a vertical direction and the pistons connected thereto to be reciprocated in orderly sequence. As the pistons are reciprocated within their respective cylinders, the fluid to be pumped will be drawn upwardly thru the lower portion of the tubing and will pass into certain of the cylinders thru the inlet port 36 in the tubing and the ports 36*a* in the cylinder block. At the same time oil, which has previously been drawn into the remaining cylinders, will be forced upwardly by their respective pistons and out thru the ports 36*a* and 37 into the tubing whereupon it will be forced to the surface of the ground. As the tubing 11 rotates the partition 35 will also rotate and, as shown in Figure 2, this partition and the ports 36 and 37 will serve as valves to admit oil to each cylinder when the piston in that cylinder is on its down stroke and to allow oil to be pumped from each cylinder the piston of which is on its up stroke. A continuous flow of oil will therefore take place from the lower portion of the tubing into and out of the cylinders and then up thru the remainder of the tubing to the surface.

In Figures 5 thru 7, I have illustrated a modification of my invention in which two pistons such as are shown at 23*a* and 23*b* in Figure 5 are used in each of the cylindrical chambers 16*a*, 17*a*, 18*a*, 19*a*, 20*a*, 21*a*, and 22*a* and are connected by means of piston rods to oppositely disposed cams and rings 30*a* and 30*b*, so that the pistons in each cylinder will move always in opposite directions. The principle of operation of this type of pump is substantially the same as that described with reference to Figures 1 thru 4, the main difference being that the capacity of the pump is doubled by lengthening the cylinders and the addition of a second set of pistons in the upper portions thereof. In this embodiment the cylinder block 14*a* is substantially twice as long as the block 14 of Figure 1, in order to accommodate the two pistons in each cylinder. To the top of cylinder block 14*a* is secured an inverted cup member 45 which serves as a housing for the upper cam and ring 30*a*. It will be understood that the two cam and ring connections 30*a* and 30*b* shown in Figure 5 are substantially the same as the connections 29 and 30 shown in Figures 1 and 8, and that the two cams are mounted upon the tubing 11 at right angles to each other so that the pistons in each cylinder will move in opposite directions when the tubing 11 is rotated. The cup-shaped member 45 is provided at its center with a bearing 45*a* and suitable packing so that the tubing 11 can rotate therein.

In the embodiment shown in Figures 5, 6 and 7, the anchor members take the form of L-shaped blocks 46, each of these blocks being provided with two legs 47 and 48, the legs 47 being provided with holes 49 while the legs 48 have arc-shaped slots 50 formed therein. A plurality of short bolts 51 are secured to the upper side of the cup-shaped member 45 and project through the holes 49 and slots 50, allowing the anchors limited movement around those pins 51 which project through the holes 49. A plurality of compression springs 52 are mounted between the anchors 46 and the bearing 45*a* of the upper cup-shaped member 45 and serve to normally hold the anchors in engagement with the casing 10. The outer surfaces of the anchors 46 are provided with sharp edges 53, and it will be observed that rotation of the pump in a clockwise direction, when viewing Figure 6, will be prevented through the engagement of the teeth 53 with the casing 10. The greater the tendency of the pump to turn, the greater will be the force exerted between the teeth of the anchor members and the casing. The anchor members 46 will, of course, not interfere with longitudinal movement of the pump with respect to the casing.

The tubing 11 is provided with an internal partition 35*a* similar to the member 35 shown in Figure 1 and also with inlet and outlet ports 36*b* and 37*b* at opposite sides of the partition 35*a*. In this embodiment the ports 36*c* of the cylindrical chambers 16*a*—22*a* are located at the mid-points of the chambers and cooperate with the tubing ports 36*b* and 37*b*.

The operation of this embodiment is substantially the same as that described with reference to Figures 1 through 4, the oil being drawn upwardly through the lower section of the tubing and into certain of the cylinders through ports 36*b* and 36*c* while at the same time oil is being forced out of the remaining cylinders through ports 37*b* and 36*c* and thence upwardly through the tubing 11 to the surface of the ground.

In Figures 9 through 12, I have illustrated a further modification of my invention wherein but two cylinders or chambers are used and gearing is employed to translate the rotary motion of the tubing 11 into reciprocating movement of the pistons. In this embodiment a cylinder 60 forms

a housing for the pump and to the upper end of this cylinder is attached a cup-shaped member 61, having a bearing at its center around the tubing 11. Within the housing 60 are arranged two smaller cylinders 62 and 63, provided in their upper portions with pistons 62*a* and in their lower portions with pistons 63*a*. The cylinders 62 and 63 are held in proper spaced relation, as shown in Figure 10, by means of a spacing member 64. The cup-shaped member 61 is provided with a plurality of anchor members 66, which serve to engage the casing 10 in a manner such as has been described with reference to the embodiment shown in Figures 5, 6 and 7.

Affixed to the spacing member 64 and surrounding the tubing 11 is a cylindrical sleeve 67, which serves as a bearing for the tubing 11. Secured, as by welding, to the inner surfaces of the housing 60 are a plurality of bearings 68 and in alignment with these bearings and secured to the sleeve 67 is another set of similar bearings 69. The bearings 68 and 69 serve to support four crank shafts 70, 71, 72 and 73, these crank shafts being arranged oppositely in pairs as will be observed with reference to Figure 9. Affixed to the tubing 11 are two bevel gears 74 and 75 and meshing with these gears and secured to the respective crank shafts 70, 71, 72 and 73 are four other bevel gears 76, 77, 78 and 79. It will thus be observed that when the tubing 11 is rotated the gears 74 and 75 secured thereto will cause rotation of the gears 76, 77, 78 and 79, which in turn being secured to the crank shafts 70, 71, 72 and 73 will cause reciprocation of the two sets of pistons 62*a* and 63*a* in opposite directions.

A pair of valves 80 and 81 are mounted in the upper surfaces of each of the lower pistons 63*a*, these valves comprising the intake valves for the chambers 62 and 63. A pair of ports 82 and 83 formed in the mid-portions of the cylindrical chambers 62 and 63 and extending through the spacer member 64 are adapted to cooperate with a port 84 formed in the tubing 11 to direct the fluid from the chambers into the tubing. A cap member 85 is secured to and closes the lower end of the tubing 11.

In the operation of this modification, when the tubing 11 is rotated, the two sets of pistons 62*a* and 62*b* will be reciprocated within the cylindrical chambers 62 and 63, the pistons in each chamber being moved in opposite directions due to the arrangement of the crank shafts 70, 71, 72 and 73 and the gearing which transmits the motion from the tubing to the crank shafts. When the pistons in cylinder 62 are moving away from each other the valve 80, in the piston 63*a* in that cylinder will open, thus allowing fluid to be drawn into cylinder 62. At this time the outlet port 82 will be closed. As the tubing 11 continues to rotate, the pistons in cylinder 62 which has been filled with fluid to be pumped will move toward each other and at that time the intake valve 80 will be closed and the outlet port 82 will communicate with the tubing port 84 and the fluid in the cylinder will be forced through the port 84 into the tubing 11 and upwardly to the surface of the ground. Since there are in effect two separate pumps within the housing 60, one pump being on its intake stroke while the other is on its discharge stroke, there will be a continuous passage of fluid upwardly through the tubing to the surface.

It will be understood that more than two cylinders may be used in the gear-type of pump illustrated in Figures 9–12 and also by using half as many teeth on the gears 76—79 as are used on the gears 74 and 75 and by providing an additional discharge opening 84 opposite the one shown in Figure 9, the volume of the pump will be doubled for the same rate of rotation of the tubing.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. In a well pump, in combination with a string of tubing extending downwardly from the surface of the ground, a housing surrounding a portion of said tubing, said housing being provided with a plurality of cylindrical chambers, ports connecting said chambers with said tubing, a piston slidably mounted in each of said chambers, means for translating rotary motion of said tubing into reciprocating motion of said pistons, and valve means associated with said tubing and cooperating with said ports for directing fluid into certain of said chambers and out of certain other of said chambers as said tubing is rotated from the surface of the ground.

2. In combination with a string of tubing in a well, a pump unit comprising a housing normally maintained in fixed position in said well and provided with a plurality of cylindrical chambers, pistons slidably mounted in said chambers, means for reciprocating said pistons comprising connections between said pistons and said tubing for translating rotary motion of said tubing into reciprocating motion of said pistons, a partition in said tubing, the portion of the tubing below said partition being in communication with the fluid in the well to be pumped while the upper portion of the tubing leads to the surface of the ground, and valve means associated with said partition for connecting said chambers to the lower and upper portions of said tubing in predetermined sequence as the tubing is rotated.

3. In combination with a string of tubing extending downwardly into a well from the surface of the ground, a pump unit comprising a housing normally maintained in fixed position in said well and provided with a plurality of cylindrical chambers, pistons slidably mounted in said chambers, means for reciprocating said pistons comprising connections between said pistons and said tubing for translating rotary motion of said tubing into reciprocating motion of said pistons, and valve means associated with said tubing for directing fluid into and out of said chambers in predetermined sequence.

4. In combination with a string of tubing adapted for rotation in a well, a housing mounted on said tubing, anti-friction bearings between said housing and said tubing so that the tubing will rotate freely with respect to said housing, means on said housing for engaging the inner surface of said well so as to hold said housing stationary when the tubing is rotated, said housing being provided with a plurality of cylindrical chambers arranged parallel to each other and to said tubing, pistons in said chambers, motion translating means connected to said tubing and said pistons so that said pistons will be reciprocated when the tubing is rotated, a partition dividing the interior of the tubing into a lower intake portion and an upper outlet portion, and cooperating ports in said tubing and chambers ar-

ranged to connect the chambers to said intake and outlet tubing portions in predetermined sequence.

5. In combination with a string of tubing in a well, a pump unit comprising a housing having a plurality of cylindrical chambers formed therein, pistons slidably mounted in said chambers, means for reciprocating said pistons comprising connections between said pistons and said tubing so that rotary motion of said tubing will be translated into reciprocating motion of said pistons, means for holding said housing stationary when the tubing is rotated, said means comprising a plurality of anchor members mounted upon said housing and compression springs for forcing the anchor members into engagement with the circumference of the well, ports connecting each of said chambers with said tubing and valve means associated with the tubing and cooperating with said ports for directing fluid into and out of said chambers as the tubing is rotated.

6. In combination with a string of tubing adapted for rotation in a well, a housing mounted on said tubing, said housing being mounted so that the tubing will rotate freely with respect thereto, means for holding the housing stationary when the tubing is rotated, said housing being provided with a plurality of cylindrical chambers arranged parallel to each other and to said tubing, pistons in said chambers, means for translating rotary motion of said tubing into reciprocating motion of said pistons, said translating means comprising a cam secured to said tubing, a ring member cooperating with said cam and connected to said pistons and an anti-friction bearing between said cam and said ring member, and valve means associated with said tubing for directing fluid into and out of said chambers in predetermined sequence.

7. In combination with a string of tubing adapted for rotation in a well, a housing mounted on said tubing, said housing being mounted so that the tubing will rotate freely with respect thereto, means for holding the housing stationary when the tubing is rotated, said housing being provided with a plurality of cylindrical chambers arranged parallel to each other and to said tubing, pistons in said chambers, means for translating rotary motion of said tubing into reciprocating motion of said pistons, said translating means including a gear secured to said tubing, crank shafts connected to said pistons and a second set of gears secured to said crank shafts and meshing with said first mentioned gear, and valve means associated with said tubing for directing fluid into and out of said chambers in predetermined sequence.

8. In combination with a string of tubing in a well, a pump unit comprising a housing having a plurality of cylindrical chambers formed therein, a pair of pistons oppositely disposed in each of said chambers, means for reciprocating said pistons in opposite directions comprising a pair of cams secured to said tubing, a ring member cooperating with each of said cams and connected to the pistons at adjacent ends of said chambers, anti-friction bearings between said cams and said ring members, said cams being oppositely arranged so that upon rotation of said tubing the pistons in each cylinder will move in opposite directions to each other, ports connecting the mid portion of each of said chambers with said tubing, and valve means associated with said tubing and cooperating with said ports for directing fluid into and out of said chambers in predetermined sequence as said tubing is rotated.

9. In combination with a string of tubing adapted for rotation in a well, a pump unit comprising a housing rotatably mounted on a portion of said tubing, a pair of cylinders longitudinally arranged within said housing, pistons in said cylinders, piston rods connected to said pistons, crank shafts for actuating said piston rods, gearing secured to said tubing and said crank shafts so that rotary motion of said tubing will be translated into reciprocating motion of said pistons, valve means for alternately admitting fluid to and discharging fluid from said cylinders, and means for holding said housing stationary while said tubing is being rotated.

10. In combination with a string of tubing adapted for rotation in a well, a pump unit comprising a housing rotatably mounted on a portion of said tubing a pair of cylinders longitudinally arranged within said housing, a pair of pistons oppositely disposed in each of said cylinders, means for translating rotary motion of said tubing into reciprocating motion of said pistons, intake valves mounted in the pistons at one end of said housing, ports connecting the mid portion of said cylinder to said tubing, discharge valves associated with said tubing for cooperating with said ports, the arrangement being such that on the intake stroke fluid will be drawn into said cylinders thru said intake valves and on the discharge stroke fluid will be pumped from said cylinders thru said ports and discharge valves into said tubing and means for holding said housing stationary while said tubing is being rotated.

11. In combination with a string of rotatable tubing extending into a well from the surface of the ground, a reciprocatory pump located near the bottom of and communicating with said well, means for converting rotary movement of said string of tubing into reciprocating movement of said pump, and means for conducting the discharge from said pump upwardly to the surface of the ground through said string of tubing on the pressure stroke of said pump.

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