

April 24, 1962

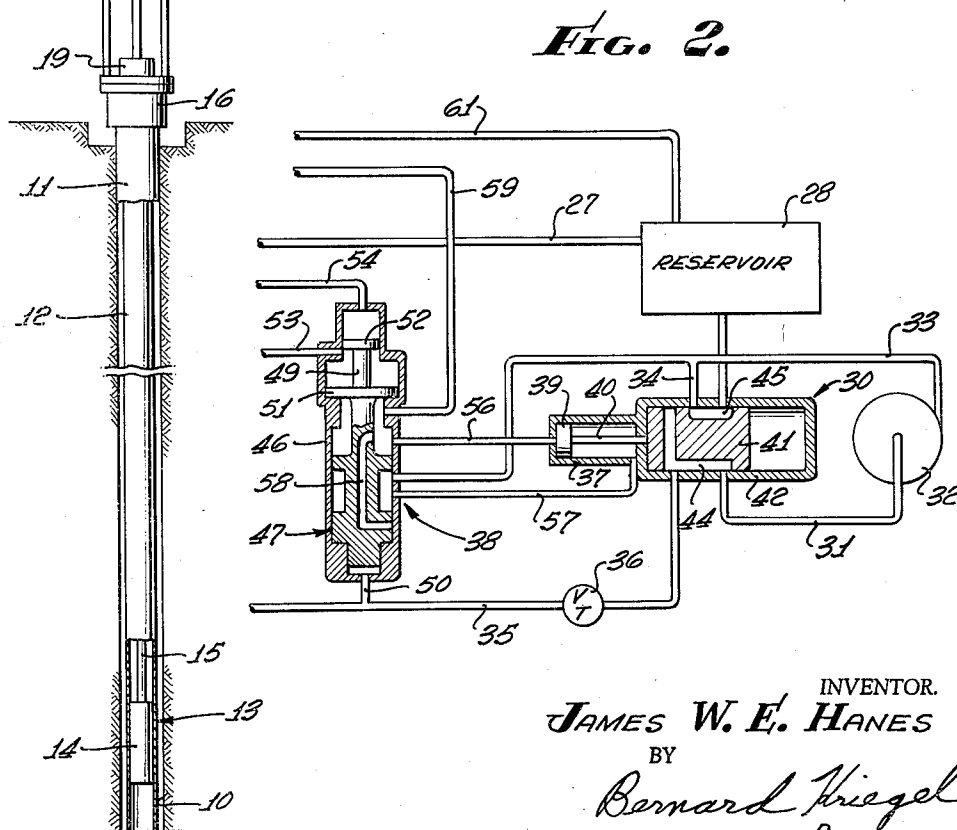
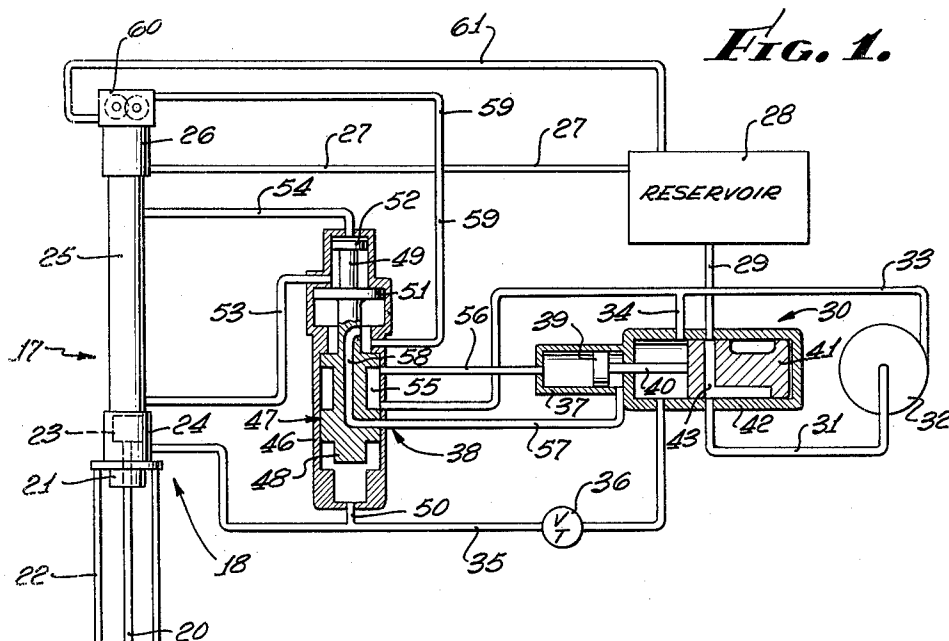
J. W. E. HANES

3,030,935

SUCKER ROD AND PUMP ROTATING APPARATUS

Filed April 29, 1958

4 Sheets-Sheet 1



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April 24, 1962

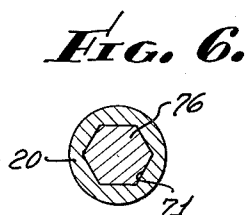
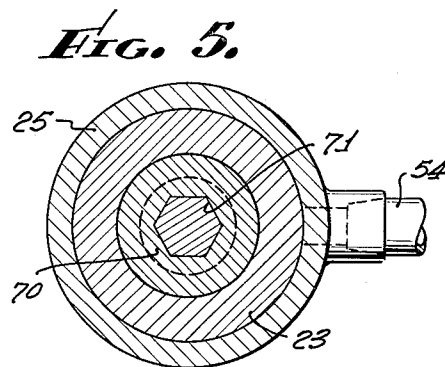
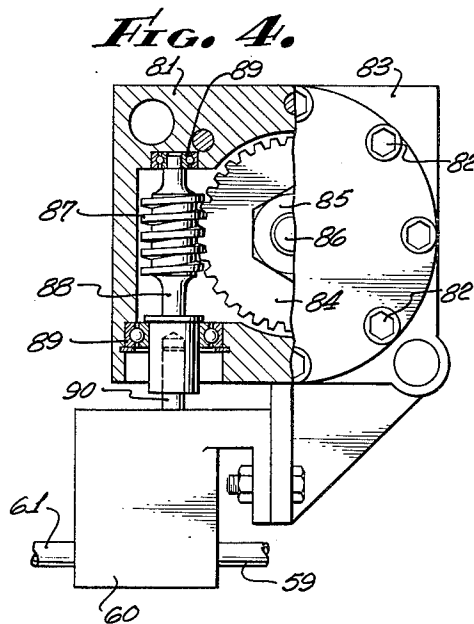
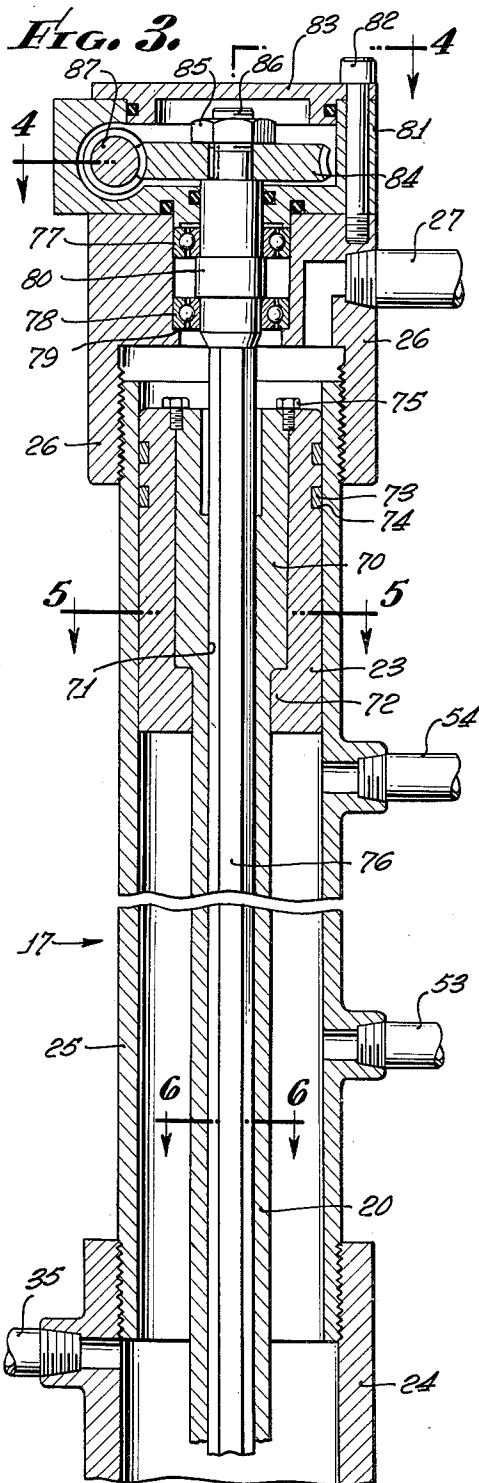
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SUCKER ROD AND PUMP ROTATING APPARATUS

Filed April 29, 1958

4 Sheets-Sheet 2



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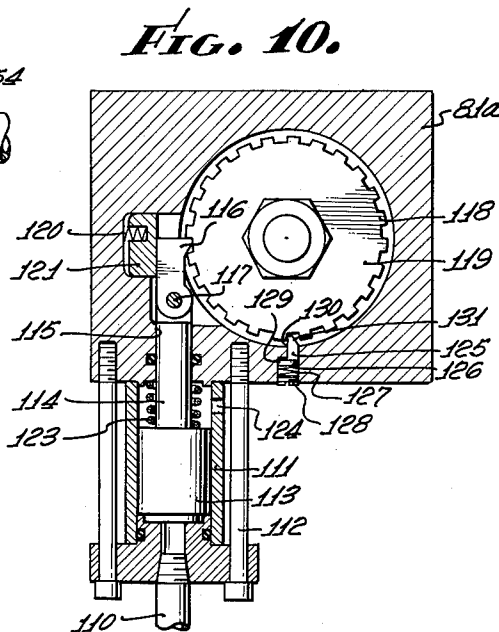
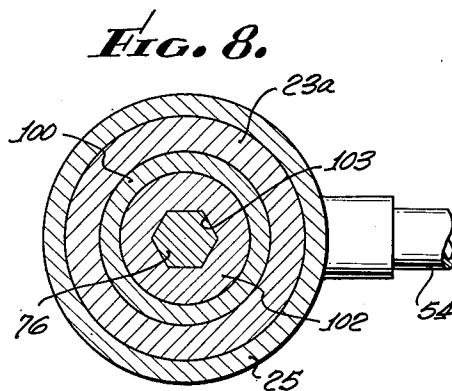
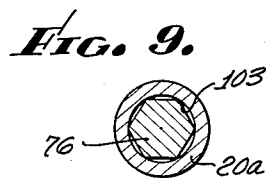
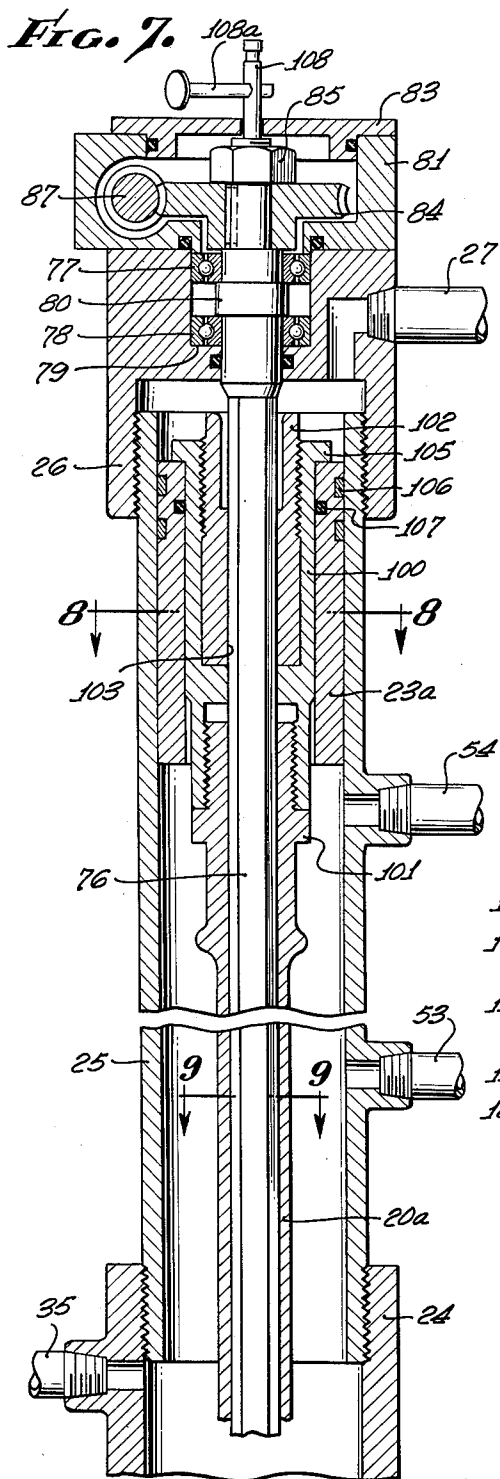
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SUCKER ROD AND PUMP ROTATING APPARATUS

Filed April 29, 1958

4 Sheets-Sheet 3



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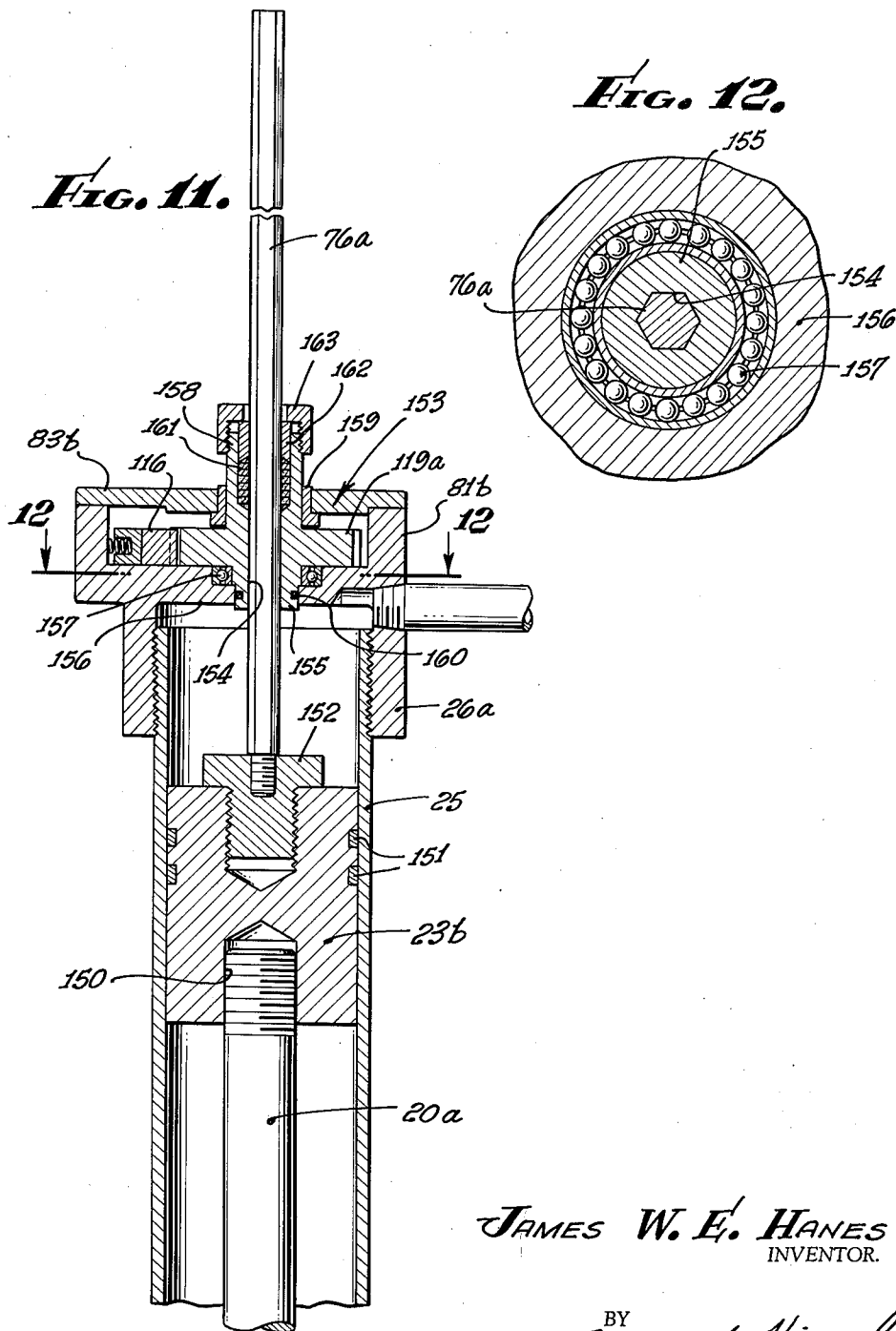
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SUCKER ROD AND PUMP ROTATING APPARATUS

Filed April 29, 1958

4 Sheets-Sheet 4



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3,030,935

SUCKER ROD AND PUMP ROTATING APPARATUS

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Filed Apr. 29, 1958, Ser. No. 731,692

23 Claims. (Cl. 121-150)

The present invention relates to well apparatus, and more particularly to apparatus for lifting production from a well bore through the agency of a string of sucker or pump rods extending into the well bore to a pump therewithin.

An object of the present invention is to provide an improved apparatus for turning or rotating a string of sucker or pump rods disposed in a well bore, in order to prevent localized wear on the rod coupling or couplings during reciprocation of the rod string in actuating the pump, particularly where the rods are operating in a crooked hole. Rotation of the rods distributes the wear around the periphery of the particular couplings involved.

Another object of the invention is to provide an improved apparatus for rotating a string of sucker or pump rods disposed in a well bore, to thereby rotate the pump in the well bore and prevent wear on the travelling or reciprocating portions of the pump at a single point. Rotation of the pump will also distribute the wear around its periphery.

A further object of the invention is to provide an apparatus for rotating a string of sucker or pump rods reciprocated by a hydraulic pumping unit at the top of the well bore, where the cylinder of the pumping unit is closely connected to the well head.

An additional object of the invention is to provide an apparatus for turning a string of sucker rods reciprocating in a well bore, which gives an easily visible indication that the rods are being turned.

Another object of the invention is to provide an apparatus for rotating a string of sucker rods in a well bore, in which back lash or reverse rotation of the sucker rods is prevented.

Yet a further object of the invention is to provide an apparatus for rotating a string of sucker rods being reciprocated in a well bore by a hydraulic pumping unit, rotation of the rods being effected by fluid pressure derived from the pumping unit itself.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a diagrammatic view of a hydraulic pumping unit for lifting well production in a well bore, the hydraulic piston being in its lower position;

FIG. 2 is a diagrammatic view of the hydraulic control portion of the apparatus shown in FIG. 1, shifted to a position in which the hydraulic piston will descend to lower the sucker rods in the well bore;

FIG. 3 is a longitudinal section through an upper portion of the hydraulic pumping unit and embodies one form of sucker rod rotation apparatus;

FIG. 4 is a section taken generally along the line 4-4 on FIG. 3;

FIG. 5 is a cross-section taken along the line 5-5 on FIG. 3;

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FIG. 6 is a cross-section taken along the line 6-6 on FIG. 3;

FIG. 7 is a view similar to FIG. 3 of a modified form of rod rotating apparatus;

FIG. 8 is an enlarged cross-section taken along the line 8-8 on FIG. 7;

FIG. 9 is an enlarged cross-section taken along the line 9-9 on FIG. 7;

FIG. 10 is a cross-section through another embodiment of rod rotating apparatus;

FIG. 11 is a view similar to FIG. 3 of yet another form of the invention;

FIG. 12 is an enlarged cross-section taken along the line 12-12 on FIG. 11.

As disclosed in the drawings, the production from a well bore 10 passes into a well casing 11 in the well bore extending to the top of the hole, in which is located a string of production tubing 12. At the lower portion of the tubing, a deep well pump 13 is installed, the travelling portion 14 of which is connected to a string of sucker or pump rods 15 extending to the top of the hole. The casing 11 terminates at its upper end in a well head 16, from which the cylinder 17 of the hydraulic pumping unit 18 is supported. Thus, a lower stuffing box 19 may be secured to the well head, through which the polish rod 20 of the sucker rod string extends. This polish rod also extends through an upper stuffing box 21, the two stuffing boxes being suitably secured in spaced relation by a plurality of rods or standards 22. A piston structure 23 is attached to the upper end of the polish rod 20 and is slidable within the cylinder 17, which includes a lower head 24 attached to the stuffing box 21 and threaded, or otherwise suitably, secured to a cylinder sleeve 25 of the desired length extending upwardly therefrom. This cylinder sleeve is threadedly secured within an upper cylinder head 26 that communicates with an upper inlet and outlet line 27 running to a reservoir 28 containing oil, or other fluid, for controlling the raising and lowering of the piston 23 in the hydraulic cylinder 17. Fluid from the reservoir 28 can pass through a suitable line 29 to a reversing valve 30, a suction line 31 being connected to this reversing valve and running to a pump 32 having a discharge line 33 provided with a branch 34 which also runs to the reversing valve 30. Another line 35 runs from the reversing valve 30 to the lower portion of the cylinder 17, such as the cylinder head 24 below the lowermost position of the piston 23.

The reversing valve 30 may be in a position so that the fluid under pressure being discharged from the pump 32 will pass through the line 35 to the lower end of the cylinder 17, acting on the underside of the piston 23 and raising it in the hydraulic cylinder to elevate the polish rod 20 connected thereto and the entire string of sucker rods 15. During the elevation of the piston 23 in the cylinder, the liquid thereabove is forced out through the upper inlet and outlet line 27 back to the reservoir 28. When the piston 23 reaches the upper end of its stroke, it effects automatic actuation of the reversing valve 30, so that the fluid under pressure is no longer directed into the lower end 24 of the cylinder, but, instead, is permitted to discharge therefrom through the lower inlet and outlet line 35. The descent of the piston can be retarded by providing a suitable choke 36 in the line 35. At this time, the reversing valve 30 is in a position to permit flow of fluid from such line back to the reservoir 28.

The position of the reversing valve 30 is determined by the passage of fluid to either end of a reversing valve actuating cylinder 37, determined by the position of a pilot valve 38. A valve actuating piston 39 is reciprocable in the actuator cylinder 37, and is connected through a rod 40 to a reversing valve piston 41 slidable in the body or cylinder 42 of the reversing valve. As disclosed in FIG.

1, when the valve actuating piston 39 is disposed to the right, the suction line 29 from the reservoir and the suction line of the pump 31 are both in communication with the passage 43 through the piston 41; whereas, the high pressure discharge line 33, 34 of the pump 32 and the lower line 35 leading to the lower end 24 of the cylinder 17 are in communication with each other. Thus, fluid can be drawn by the pump 32 from the reservoir 28 and forced under pressure into the lower end 24 of the cylinder 17 to elevate the piston 23.

If the valve actuating piston 39 is shifted to the left, such as disclosed in FIG. 2, the reversing valve piston 41 is also carried to the left. Such action will place the lower line 35 in communication with a passage 44 in the reversing valve piston 41 communicating with the suction line 31 of the pump, the discharge line 33, 34 of the pump then being in communication with another passage 45 in the piston which communicates with the line 29 leading to the reservoir 28. Thus, fluid can flow from the cylinder 17 through the lines 35, 31, 33, 34, 29 back to the reservoir 28, as the power piston 23 descends in the cylinder 17.

The position of the valve actuating piston 39 is determined by the pilot valve 38, and this pilot valve is actuated in response to the position of the power piston 23 in the vertical cylinder 17. As shown in FIG. 1, the pilot valve consists of a body 46 having a piston 47 reciprocable therein. This piston includes a lower valve head portion 48 and an upper head 49 portion. The lower end of the body 46 communicates with the lower inlet-outlet line 35 through the branch line 50, so that the lower end of the pilot valve body 46 is subject to the same pressure as exists in the lower line 35. The upper part of the pilot valve piston 47 has an enlarged piston portion 51 slidable in the body 46 and an upper piston portion 52 of a much smaller diameter than the piston portion 51 therebelow which is slidable in a cylinder part of the body 46 of correspondingly smaller diameter. A lower pilot valve line 53 leads from the lower portion of the cylinder 17 above the lower inlet-outlet line 35 to the valve body 46 between the larger and smaller piston portions 51, 52. Another pilot valve line 54 is connected to the upper portion of the cylinder 17 below the upper inlet-outlet line 27 and runs to the upper end of the pilot valve body 46.

When the valve head 47 in the pilot body is disposed in the upper position, as shown in FIG. 1, the discharge line 33 from the high pressure pump will enter an intermediate portion of the body 46 and will communicate with a passage 55 formed around the valve head 47, which is also in communication with a line 56 running to the head end of the reversing valve actuating cylinder 37. Thus, fluid under pressure from the pump 32 will be directed into the reversing valve actuating cylinder 37 to force the valve actuating piston 39 and the reversing valve piston 41 connected thereto to the right, placing it in the position illustrated in FIG. 1. As the valve actuating piston 39 moves to the right, the fluid in the valve actuating cylinder 37 on the rod side thereof is forced through a line 57 into the valve body 46 communicating with a passage 58 through the valve head 47, which communicates with an inlet line 59 running to a fluid motor 60, of any suitable type, which will effect rotation of the string of sucker rods 15, in the manner described hereinbelow. The fluid motor 60 may be of the gear type, the fluid discharging from such motor through an exhaust line 61 that runs back to the reservoir 28.

With the parts in the position illustrated in FIG. 1, the pump 32 is being driven from a suitable source of power (not shown), the fluid being drawn from the reservoir 28 and being directed through the discharge line 33, 34 into the lower inlet-outlet line 35 and to the lower end of the cylinder 17. At this time, the power piston 23 is at

the lower end of its stroke. Fluid under pressure enters the cylinder 17 and moves the piston 23 upwardly, carrying the polish rod 20 attached thereto and the string of sucker rods 15 upwardly, to lift the pump 14 in the production tubing 12. As the piston 23 passes the lower pilot valve line 53, the fluid under pressure can then pass through that line into the pilot valve body 46 above the large piston portion 51. However, the pressure acting downwardly over this large piston portion and upwardly over the small piston portion 52, coupled with the fluid pressure acting through the branch line 50 over the lower area of the valve head 47, is incapable of shifting the pilot valve head 47 downwardly from the position shown in FIG. 1. Accordingly, the pilot and reversing valve devices 38, 30 remain in the position shown in FIG. 1, and the piston 23 continues its ascent in the cylinder 17. When the piston reaches the upper end of its stroke, it moves above the upper pilot valve line 54, allowing the fluid under pressure supplied by the pump to then pass through the upper pilot valve line 54 into the upper end of the pilot valve body 46. This fluid under pressure then acts downwardly over the area of the smaller piston portion 52 and this pressure, coupled with the fluid pressure flowing through the lower pilot valve line 53 and acting downwardly on the upper valve portion 51 creates a force sufficient to shift the pilot valve head 47 downwardly, or to the position shown in FIG. 2. When in this position, the discharge line 33 of the pump is then connected to the valve head passage 55, which is now in communication with the line 57 leading to the rod end of the actuating cylinder 37. The fluid under pressure then enters such end of the cylinder 37 and moves the piston 39 to the left, carrying the reversing valve piston 41 to the left, or to the position shown in FIG. 2. During movement of the valve actuating piston 39 to the left, the fluid in the head end of the cylinder 37 is discharged through the line 56 into the valve body 46 and thence into the inlet line 59 leading to the fluid motor 60, again effecting rotation of the motor and discharging through the exhaust line 61 back to the reservoir 28.

With the valve mechanism arranged as shown in FIG. 2, the lower inlet-outlet line 35 is connected to the reservoir 28 and the weight of the sucker rods 15, upper polish rod 20 and piston 23 will cause the piston to descend, the fluid being forced out through the lower outlet line 35 back to the reservoir. The pressure of this fluid is also acting through the lower pilot line 53 and through the lower inlet-outlet line 35, 50, but not through the upper pilot valve line 54 since the piston moves below this line. The various areas of the valve head 47 are such that the valve head will remain in its lower position until the piston 23 has moved below the lower pilot valve line 53, whereupon the pressure of the fluid being forced through the lower inlet-outlet line is acting only on the lower end of the valve head 47, which will then be shifted upwardly to the position shown in FIG. 1. When this occurs, the power piston 23 has reached the lower end of its stroke and the lower end 24 of the cylinder 17 has again been connected to the high pressure line 33, 34. The foregoing cycle of operation will now be repeated, the piston 23 and sucker rod string 15 being elevated to elevate the travelling portion 14 of the deep well pump 13 and the well production, until the piston 23 reaches the upper limit of its travel, whereupon the pilot valve 38 will effect a reversal of the reversing valve 30, allowing the sucker rod string 15 to descend. At each reversal of the valve actuating piston 39, a charge of fluid under pressure is forced through the inlet line 59 to the fluid motor 60 to actuate the same and partially rotate the rod and pump rotating apparatus, which will now be described.

In the rotating apparatus illustrated in FIGS. 3 to 6, inclusive, the polish rod 20 is hollow, with its upper portion or head 70 upset and formed with a non-circular or poly-

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onal bore 71, such as a bore of hexagonal shape. Surrounding the head 70 is a piston member 23, the lower portion of which has an inwardly directed flange 72 to engage the underside of the head 70, the upper end of the piston 23 terminating substantially at the upper end of the head 70. Leakage of fluid between the piston 23, which slidably engages the cylinder 17, and the wall of the latter may be prevented by one or more piston or seal rings 73 fitting in ring grooves 74 in the piston and engaging the wall of the latter. The piston 23 may make a press fit on the head 70, or, if desired, the two parts may be secured together against rotation by one or more cap screws 75.

Slidably splined to the hollow polish rod 20 is a drive shaft 76 which has a non-circular cross-sectional shape companion to the shape of the bore 71 through the head. This shaft 76 has a length somewhat greater than the length of stroke of the polish rod 20, so that the slidable spline connection between the drive shaft 76 and the head 70 is maintained at all times during reciprocation or up and down movement of the piston 23 and polish rod 20 within the cylinder 17. Maintenance of such slidable coupling or connection is desired so that the rotation of the drive shaft 76 will be transmitted to the polish rod 20 and to the sucker rod or pump rod string 15 connected thereto, as well as to the travelling portion 14 of the pump 13 secured to the lower end of the string of sucker or pump rods.

The drive shaft 76 is supported against vertical movement by spaced bearings 77, 78, such as the ball bearings illustrated in FIG. 3. The lower bearing 78 rests upon an inwardly directed shoulder 79 on the upper cylinder head 26, whereas the inner portion of this bearing supports an enlarged flange or boss 80 on the drive shaft 76, the other end of such flange bearing upon the lower surface of the upper bearing structure 77, the outer race portion of which bears against a gear case 81 which is suitably secured to the cylinder head, as through use of the cap screws 82 that not only secure the gear case to the cylinder head but an upper cover 83 to the gear case as well, which closes the upper end of the latter. The fact that the shaft flange 80 engages the upper and lower bearings 77, 78 prevents the drive shaft 76 from partaking of longitudinal movement in both directions, whereas the bearings support the shaft for rotation within the cylinder head 26 and the gear case 81.

To the upper portion of the shaft 76 is secured a worm wheel 84 that may be suitably keyed to this shaft, and which is clamped against movement on the shaft by a clamp nut 85 threaded onto the upper threaded end 86 of the drive shaft. Meshing with this worm wheel is a worm 87 integral with a shaft 88 which is rotatably mounted in spaced bearings 89 in the gear case. This shaft 88 may extend outwardly of the gear case 81 and is coupled to the driven shaft 90 of the fluid motor 60, which may be of the gear type. Thus, as fluid under pressure enters the fluid motor 60 through the inlet line 59, it will rotate the gears therewithin and then exhaust through the discharge line 61 back to the reservoir 28. One of the gears is coupled to the driven shaft 90 which is, in turn, coupled to the drive shaft 88 of the worm 87, the motion being transferred to the worm and from the latter to the worm wheel or gear 84 to rotate the drive shaft 76. The rotation of the drive shaft is transmitted through the slidable spline connection 71 to the polish rod 20, the sucker rods 15, and the deep well pump 13, turning the latter.

As described above, each stroke of the piston 23 in the hydraulic cylinder 17 is accompanied by the forcing of fluid under pressure through the inlet line 59 into the fluid motor 60. The fluid motor 60 will only be rotated a slight amount, and may, in fact, only move a partial revolution, this motion, in turn, being further reduced because of the relatively large transmission ratio between the worm 87 and the worm wheel 84, so that the hexagonal drive shaft

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76 and the polish and sucker rods 15 are only rotated a relatively small arcuate extent as a result of each stroke of the piston 23 in the hydraulic cylinder 17. The rotation of the drive shaft and of the string of sucker rods and the deep well pump can be relatively slow, since the primary purpose of effecting such rotation is to prevent wear of the rod couplings or of the deep well pump at a single point, particularly in a crooked hole where the couplings would otherwise engage the wall of the production tubing at the same point or side, concentrating the wear at such point or side. By the relatively slow turning of the string of sucker rods 15 and the pump 13, the wear will be distributed around the periphery of the couplings, minimizing failure of the parts and enhancing the life of the deep well apparatus to a considerable extent. By way of example, the intermittent application of fluid pressure to the fluid motor 60 might result in rotation of the polygonally shaped drive shaft 76, the polish rod 20, sucker rods 15 connected thereto, and pump 13 connected to the sucker rods anywhere from one-sixth of a revolution per hour to about one-half of a revolution per hour.

The slidable spline connection 71 is maintained between the drive shaft 76 and the head 70 of the piston or polish rod structure at all times, so that it is immaterial when the fluid under pressure is applied to the fluid motor 60. The rotation of the latter will still be transferred through the reduction gearing to the drive shaft 76 and the rod string 15 extending into the well bore. It is also to be noted that the drive shaft extends into the upper end of the hydraulic pump unit 18 and that the power mechanism 60, 81-90 for driving this shaft is also disposed at the upper end of the unit. Accordingly, the cylinder 17 could be connected to the well or casing head 16 fairly closely thereto. In fact, it could be mounted directly on the casing head itself without interfering with the rod rotating apparatus, or its installation in the apparatus.

In the form of invention disclosed in FIGS. 7 to 9, the hollow polish rod 20a has its upper end threadedly secured within a sleeve 100, a flange 101 on the polish rod engaging the lower end of the sleeve. This sleeve 100 contains a drive bushing 102 threadedly attached thereto, that has a hexagonal or non-circular bore 103 receiving the correspondingly shaped drive shaft 76, which will extend down through the polish rod 20a to a slightly greater extent than the lowermost position of travel of the bushing 102. Surrounding the sleeve 100 is an annular piston member 23a engaging an external flange 105 at the upper end of the sleeve 100 and having packing or piston rings 106 for preventing leakage past the periphery of the piston, as well as an internal packing ring 107 engaging the exterior of the sleeve 100 to prevent leakage around the latter. The piston 23a need not be affixed to the sleeve 100, since the pressure is always acting in an upward direction on the lower portion of the piston to hold it against the flange 105. During the upstroke of the piston, fluid under pressure is being exerted thereon from below to elevate the piston 23a, the sleeve 100, the drive bushing 102, and the hollow polish rod 20a, as well as the sucker rod string 15 and deep well pump 14. During descent of the apparatus, a pressure differential is still present below the piston 23a tending to hold it upwardly against the flange 105.

Since the rotation of the drive shaft 76 and the entire rod string 15 may be relatively slow, it is desirable to provide an indicator that is readily visible to the operator that rotation is actually being effected. For that reason, a rod 108 may be secured to the upper end of the drive shaft 76, which projects through the gear case cover 83, this rod having a radial indicator pin 108a secured thereto. By noting the change in position of the indicator pin 108a over a particular period, the operator is assured of the fact that the drive shaft 76 and the mechanism slidably coupled thereto is rotating.

In the form of invention disclosed in FIG. 10, rotation

to the hexagonal drive shaft 76 is imparted through a reciprocating fluid motor and a pawl and ratchet drive, in lieu of the gear type of fluid motor 60 and the worm and worm wheel drive. In FIG. 10, a branch line 110 may extend from the upper pilot valve line 54 to a cylinder 111 suitably secured to a gear case 81a, as by means of the long screws 112. A piston 113 is reciprocable in the cylinder, this piston having a rod 114 integral therewith extending through a bore 115 in the gear case to its interior, where a power pawl 116 is connected to the inner portion of the piston rod by a pin 117. This power pawl is engageable with the ratchet teeth 118 of a ratchet wheel 119 affixed to the drive shaft 76. The power pawl 116 is yieldably urged into engagement with the ratchet teeth 118 by a helical compression spring 120 engaging the case 81a and a slidable pressure block 121 bearing against the outer face of the power pawl.

When the power piston 23 in the hydraulic pumping unit moves upwardly past the upper pilot valve line 54, fluid pressure will not only pass into the pilot valve line to actuate the pilot valve head 47 to a downward position, so as to secure reversal of the reversing valve 30, but such fluid under pressure will also pass through the branch line 110 into the cylinder 111, urging the piston 113 in a driving direction to cause the pawl 116 to engage the ratchet wheel 119 and turn the wheel a distance corresponding to the stroke of the piston 113. The piston moves inwardly on its power stroke against the force of a helical compression spring 123 surrounding its rod 114 and bearing against the inner end of the piston 113 and against the gear case 81a. When the pressure in the hydraulic cylinder 17 is relieved, the spring 123 can force the piston 113 back to its original position, the pawl 116 ratcheting freely against the force of the pressure block 121 and spring 120 in a reverse direction. To prevent air and the like from being entrapped in the cylinder 111 on the low pressure side of the piston 113, a suitable vent port 124 is provided in the cylinder on its low pressure side.

For the purpose of preventing reverse rotation of the ratchet wheel 119 and of the drive shaft 76, a holding pawl 125 is engageable with the ratchet teeth 118. This holding pawl is slidably mounted in a bore 126 in the gear case 81a, being urged in an inward direction by a helical spring 127 engaging a set screw 128 threaded into the case, the inward motion of the pawl 125 being limited by engagement of an arm 129 integral therewith with the gear case. One side 130 of the holding pawl is radial of the ratchet wheel 119, whereas the other side 131 is inclined, so that rotation of the ratchet wheel by the power pawl 116 will cause the ratchet teeth 118 to engage the inclined portion 131 of the holding pawl and urge it outwardly from engagement with the ratchet teeth. However, on the return or non-power stroke of the power pawl 116, the holding pawl 125 is shifted by the spring 127 back between adjacent ratchet teeth 118 so that one of the ratchet teeth will engage the radial face 130 of the holding pawl and prevent the ratchet wheel from partaking of retrograde movement.

The holding pawl 125 thereby prevents return movement of the ratchet wheel 119, as well as of the drive shaft 76, sucker rod string 15 and pump 13 connected thereto. Accordingly, backlash that might be developed in the entire sucker rod string 15 is incapable of creating any unwinding or reverse rotation of the sucker rod string, insuring rotation of the string throughout its entire length and of the pump device 13 connected thereto. The worm and worm wheel drive 87, 84 also is self-locking. When pressure is not being applied to the fluid motor 60, reverse rotation of such gearing is prevented, thereby preventing any backlash from occurring in the entire chain of drive mechanism from the fluid motor 60 to the deep well pump 13.

The embodiment of the invention shown in FIG. 11

permits the string of sucker rods to be rotated with the cylinder device 17 coupled closely to the cylinder head 16. However, it avoids the requirement for a hollow polish rod, as in the other forms of the invention, which are relatively costly. Instead, a standard polish rod 20a can be used.

As illustrated, the piston 23b has a lower threaded bore 150 for threadedly receiving the upper end of the polish rod 20a. The piston may be solid and carry suitable piston rings 151 for sealingly engaging the wall of the cylinder 25 to which the upper cylinder head 26a is secured. A drive shaft 76a has its lower end threadedly connected to a coupling 152, which is, in turn, threadedly attached to the upper portion of the piston 23b. This drive shaft 76a extends upwardly from the piston and has a slidable spline connection with the rotating mechanism 153, which may be of any suitable form. As illustrated, it is of the pawl and ratchet type 116, 119a, as in the form of invention illustrated in FIG. 10. The drive shaft 76a extends through the ratchet wheel 119a and makes a slidable spline connection therewith. Thus, the drive shaft 76a may be of non-circular or hexagonal cross-section, extending slidably through a companion non-circular or hexagonal bore 154 in the central or hub portion of the ratchet wheel 119a. The drive shaft 76a extends upwardly from the apparatus and is of a length in excess of the stroke of the piston 23b, to always maintain a proper driving connection with the ratchet wheel 119a as it slides upwardly and downwardly therewithin in response to up and down movement of the piston 23b within the cylinder 25.

As shown, the ratchet wheel 119a has a lower hub portion 155 rotatably mounted within the lower wall 156 of the gear case portion 81b of the apparatus, a suitable bearing 157 being interposed between the ratchet wheel and the gear case to resist radial and axial forces. The upper portion 158 of the ratchet wheel 119a is also constituted as a hub extending through the casing cover 83b and rotatable in a suitable bearing 159 mounted in the cover. Leakage of fluid between the gear case 86b and the ratchet wheel 119a is prevented by a suitable side seal ring 160, such as a rubber or rubber-like O ring, mounted on the lower hub 155 and engaging an opposed cylindrical wall or surface of the gear case wall 156. Leakage of fluid along the drive shaft 76a is prevented by mounting packing 161 in the upper hub 158, which will have an inner bore conforming to the cross-sectional shape of the drive shaft 76a, such as the hexagonal shape. This packing is compressed into sealing engagement with the drive shaft by a compression ring 162 engaging its upper end, the ring being forced downwardly by a suitable packing nut 163 threadedly mounted on the upper hub 158.

During the operation of the apparatus, the piston 23b is reciprocated in the cylinder 25 to correspondingly reciprocate the polish rod 20a and the string of sucker rods attached thereto. During such reciprocating movement, the drive shaft 76a slides downwardly and upwardly within the ratchet wheel 119a, but always maintains its driving connection therewith, because of the splined interconnection therebetween. The ratchet wheel 119a is rotated in intermittent fashion in the same manner as described in connection with the FIG. 10 embodiment of the invention, to rotate the drive shaft 76a, preferably in a right-hand or clockwise direction, such rotary motion being transmitted through the coupling 152 and piston 23b to the polish rod 20a, and from the latter to the string of sucker rods and pump.

The inventor claims:

1. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to such rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; said piston and rod device being hollow;

a drive shaft extending into said piston and rod device and slidably splined thereto; and means comprising a motor operatively connected to said shaft for rotating said drive shaft to rotate said piston and rod device and rods.

2. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to such rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; said piston and rod device being hollow; a drive shaft extending downwardly into said piston and rod device and slidably splined thereto; and means comprising a motor operatively connected to said shaft above said device for rotating said drive shaft to rotate said piston and rod device and rods.

3. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; and means responsive to operation of the hydraulic pumping unit and comprising a motor operatively connected to said drive shaft for rotating said drive shaft to rotate said piston and rod device and rods.

4. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a fluid motor; means operatively connecting said motor to said drive shaft; and means responsive to operation of said hydraulic pumping unit for directing fluid under pressure to said motor to actuate the same and produce rotation of said drive shaft and of said piston and rod device and rods.

5. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a fluid motor; reduction gearing operatively connecting said motor to said drive shaft; and means responsive to operation of the hydraulic pumping unit for directing fluid under pressure to said motor to actuate the same and produce rotation of said drive shaft and of said piston and rod device and rods.

6. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a fluid motor; means including meshing worm and worm wheel gearing operatively connecting said motor to said drive shaft; and means responsive to operation of said hydraulic pumping unit for directing fluid under pressure to said motor to actuate the same and produce rotation of said drive shaft, said piston and rod device and said rods.

7. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a fluid motor; means including a power pawl engageable with a ratchet operatively connecting said motor to said

drive shaft; and means responsive to operation of the hydraulic pumping unit for directing fluid under pressure to said motor to actuate the same and produce rotation of said drive shaft, said piston and rod device and said rods.

8. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a fluid motor; means including a power pawl engageable with a ratchet operatively connecting said motor to said drive shaft; means responsive to operation of the hydraulic pumping unit for directing fluid under pressure to said motor to actuate the same and produce rotation of said drive shaft, said piston and rod device and said rods; and a holding pawl for preventing reverse rotation of said ratchet and drive shaft.

9. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to such rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a motor; and reduction gearing operatively connecting said motor to said drive shaft to rotate said shaft and said piston and rod device and rods.

10. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to such rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a motor; a worm connected to said motor; and a worm wheel meshing with said worm and connected to said drive shaft to rotate said shaft, device and rods.

11. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to such rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a reciprocating motor; a power pawl connected to said motor; and a ratchet wheel connected to said drive shaft and engageable by said power pawl to rotate said shaft, device and rods.

12. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to such rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; a reciprocating motor; a power pawl connected to said motor; a ratchet wheel connected to said drive shaft and engageable by said power pawl to rotate said shaft, device and rods; and a holding pawl for preventing reverse rotation of said ratchet wheel and drive shaft.

13. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to said rods to effect their elevation and descent in the well bore; said piston and rod device being hollow and having a non-circular bore at its upper portion; a drive shaft having a non-circular cross-section fitting in and companion to said non-circular bore to provide a slidable spline connection between said shaft and device; means rotatably mounting said drive shaft and preventing its axial movement; said shaft being of a length sufficient to remain in said non-circular bore during the entire length of stroke of said piston and rod

device in said cylinder; and means for rotating said shaft to rotate said piston and rod device and rods.

14. In a combination as defined in claim 13, in which said non-circular bore and non-circular cross-section are polygonal.

15. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; a drive shaft operatively connected to said piston and rod device; and means responsive to operation of the hydraulic pumping unit and comprising a motor connected to said drive shaft for rotating said drive shaft to rotate said piston and rod device and rods.

16. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; a drive shaft operatively connected to said piston and rod device and extending thereabove; and means drivably comprising a motor connected to said drive shaft for rotating the same, the rotation of said drive shaft being transmitted to the piston and rod device and rods to rotate the same.

17. In combination with a string of sucker or pump rods in a well bore, in which a pumping unit is operatively connected to such rods to effect their elevation and descent in the well bore; a drive device connected to the sucker or pump rods; and means responsive to operation of the pumping unit and comprising a motor connected to said drive shaft for rotating said drive device to rotate the rods.

18. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to such rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; a drive shaft operatively connected to said piston and rod device and extending upwardly therefrom; and means comprising a motor connected to said drive shaft above said piston for rotating said drive shaft to rotate said piston and rod device and rods.

19. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to such rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; a drive shaft operatively connected to said piston and rod device and extending upwardly therefrom; a motor; reduction gearing operatively connected to said motor above said piston, said drive shaft extending upwardly through said gearing and having a slidable spline connection therewith, whereby said shaft is rotated to rotate said piston and rod device and rods.

20. In combination with a string of sucker or pump rods in a well bore, in which a pumping unit is operatively connected to such rods to effect their elevation and descent in the well bore; a drive shaft connected to the sucker or pump rods and extending upwardly from said pumping unit; and means responsive to operation of the pumping unit and comprising a motor connected to said shaft for rotating said drive shaft to rotate the rods.

21. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to said rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; means mounting said shaft for rotation and preventing substantial axial movement of said shaft; and means for rotating said drive shaft to rotate said piston and rod device and rods.

22. In combination with a string of sucker or pump rods in a well bore, in which a hydraulically actuated piston and rod device is connected to said rods and is movable in a cylinder to effect raising and lowering of the rods in the well bore; said piston and rod device being hollow; a drive shaft extending downwardly into said piston and rod device and slidably splined thereto; means mounting said shaft for rotation and preventing substantial axial movement of said shaft; and means operatively connected to said shaft above said device for rotating said drive shaft to rotate said piston and rod device and rods.

23. In combination with a string of sucker or pump rods in a well bore, in which a hydraulic pumping unit includes a cylinder and a piston and rod device in said cylinder operatively connected to such rods to effect their elevation and descent in the well bore; said piston and rod device being hollow; a drive shaft extending into said piston and rod device and slidably splined thereto; means supporting said shaft for rotation and preventing substantial axial movement of said shaft; and means responsive to operation of the hydraulic pumping unit for rotating said drive shaft to rotate said piston and rod device and rods.

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