

Dec. 9, 1969

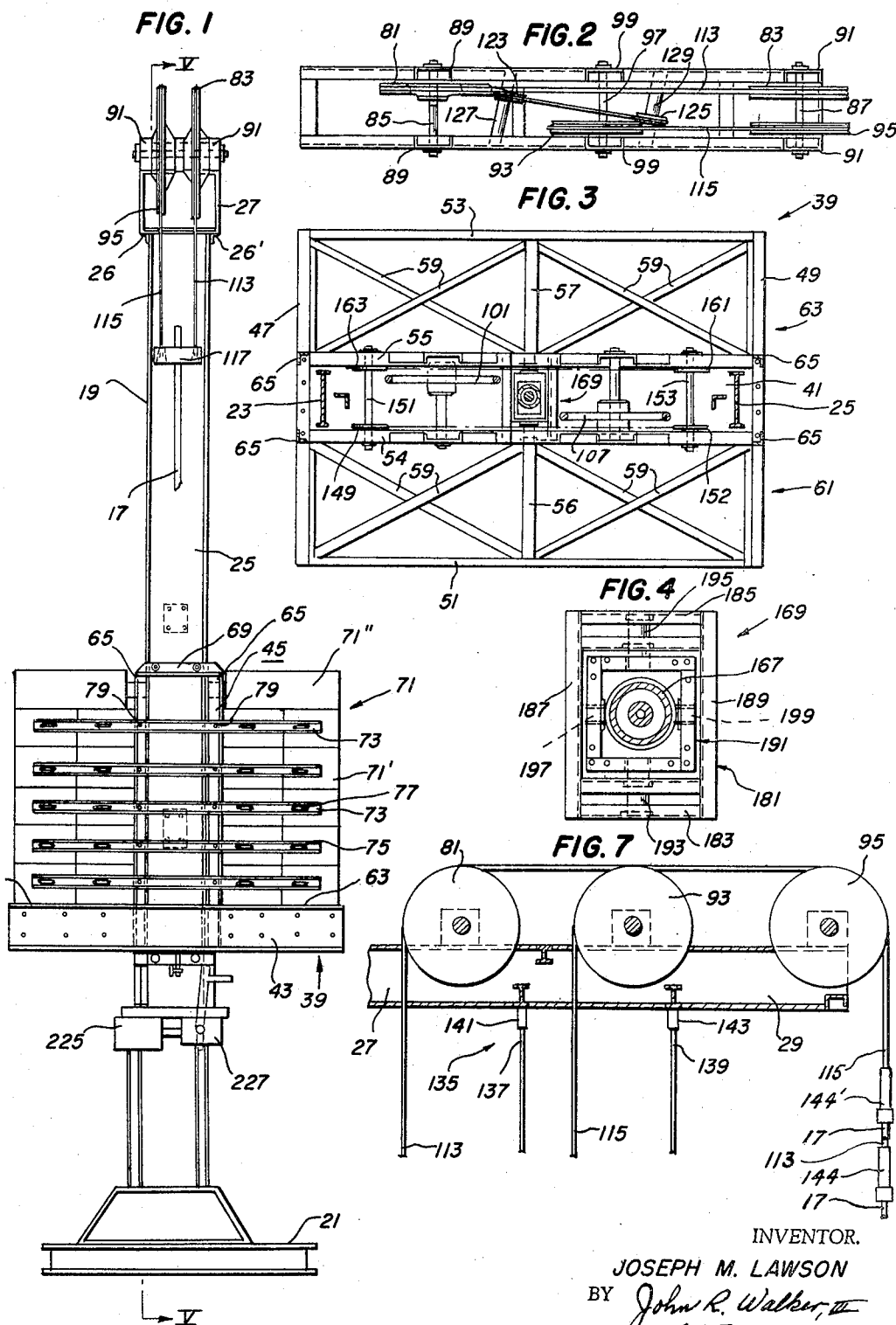
J. M. LAWSON

3,482,399

PUMP OPERATING UNIT

Filed Feb. 27, 1968

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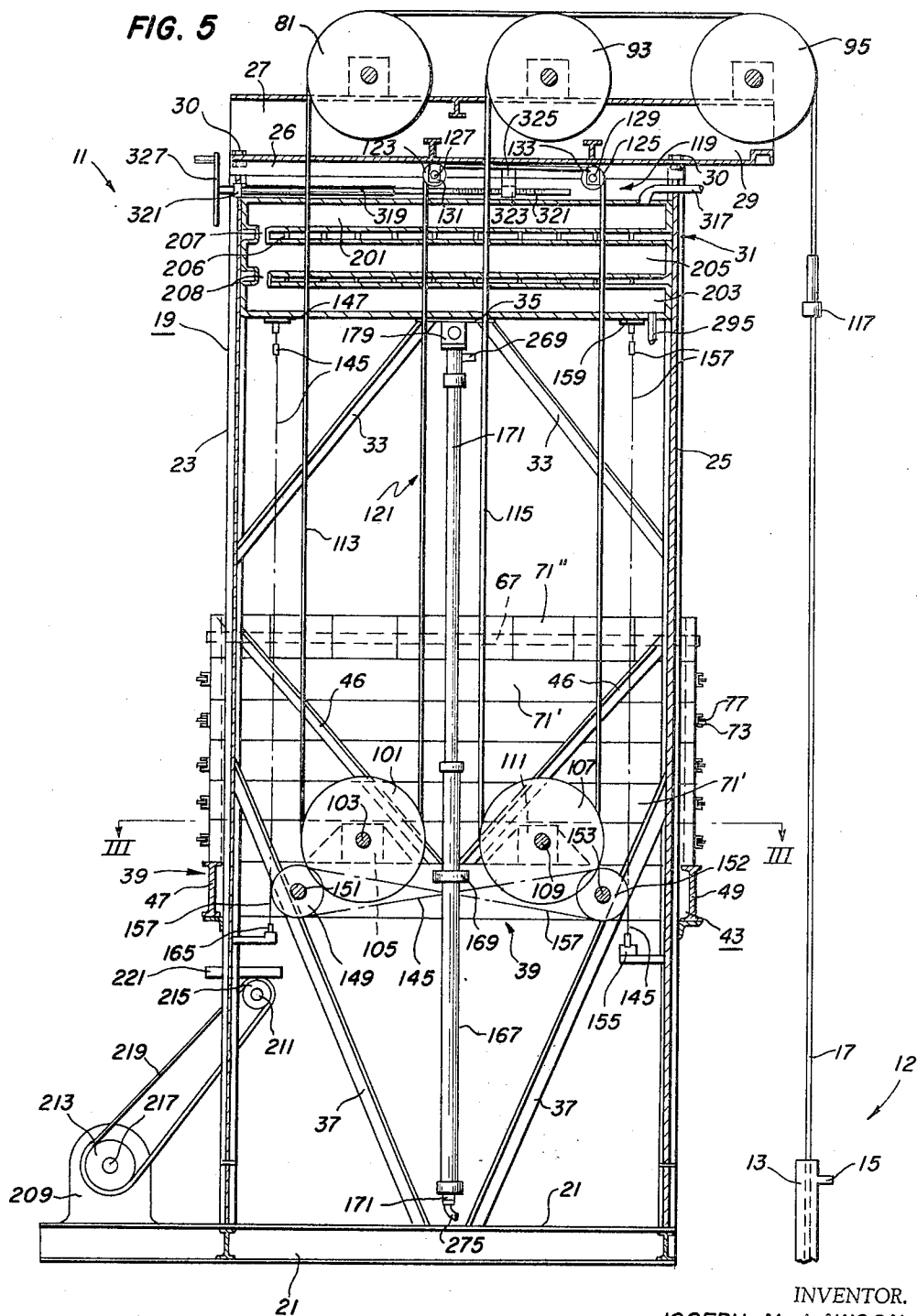
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3 Sheets--Sheet 2



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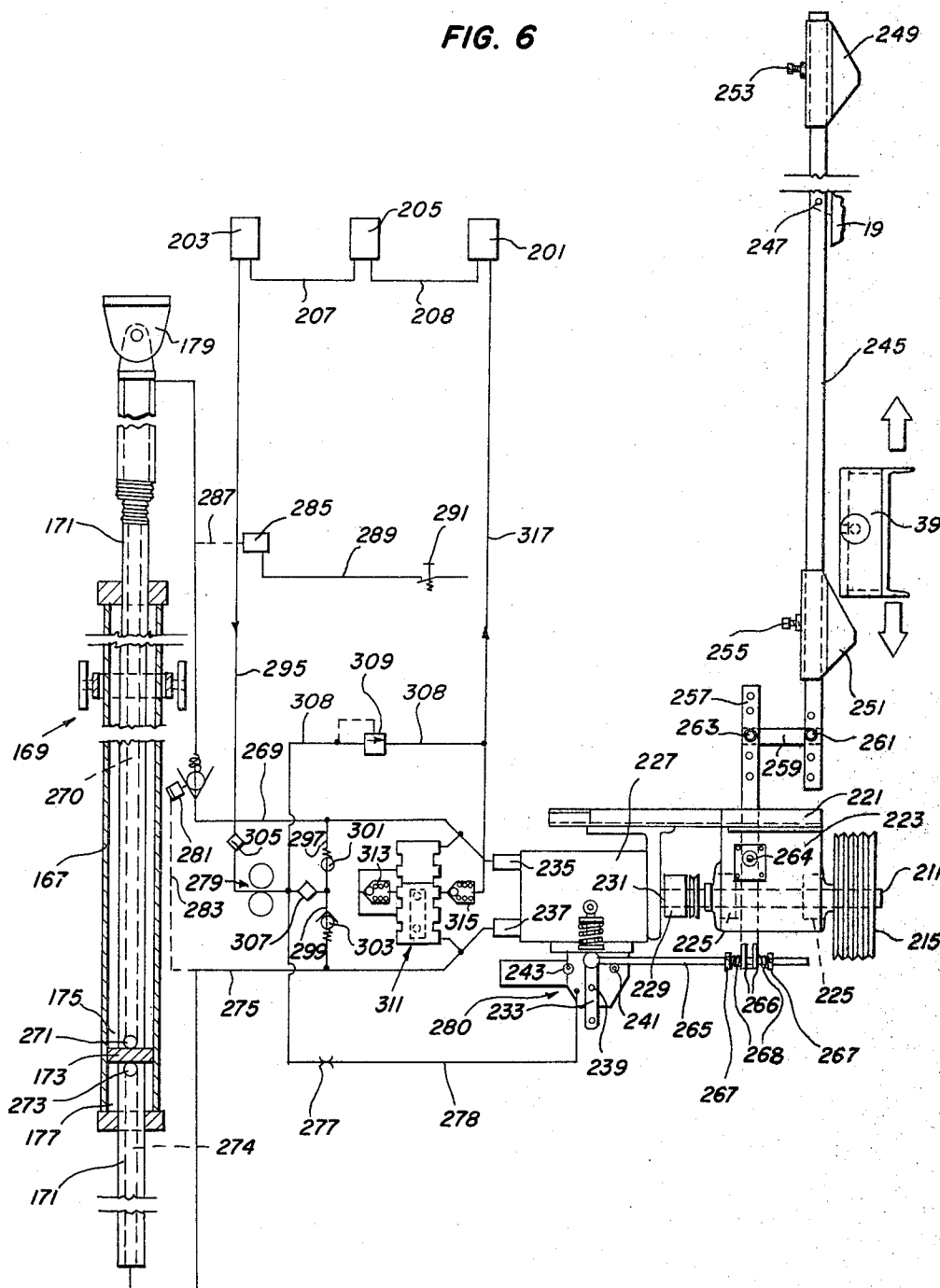
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FIG. 6



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PUMP OPERATING UNIT

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14 Claims

ABSTRACT OF THE DISCLOSURE

A pump operating unit particularly adapted to be used for pumping fluid from a deep oil well and the like using conventional sucker rods and a bottom hole pump. The pump operating unit comprises a tower and a counterweighted carriage movably mounted on the tower for upward and downward movement. A system of cables and pulleys interconnect the carriage to the pump rod. Pulley and cable means are provided for equilibrating the carriage. A vertically disposed piston-cylinder assembly is provided with the piston being attached adjacent the upper end thereof to the tower and the cylinder attached to the carriage by gimbal means. A hydraulic system is disclosed for selectively supplying fluid under pressure to the upper or lower chambers of the cylinder to cause the carriage to raise and lower, which in turn moves the pump rod upwardly and downwardly.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to a pumping unit, particularly adapted to be used for pumping crude oil from wells.

Description of the prior art

The prior devices and developments for pumping crude oil have been numerous but none have been effective enough to displace the old "walking beam" type of pumps from the field. The lack of success in these prior developments and attempts is apparent by the prevalence of said "walking beam" type of pump still in the oil fields in spite of known limitations and ineffectiveness. A major problem involves the transmission of force from the surface to the bottom hole pump. Because of simplicity and effectiveness, the sucker or pump rod has been almost universally adopted by the industry for this purpose. The weight of the rod string plus the weight of the fluid column and accompanying friction imposes an extremely heavy load on the upstroke and a negative load on the downstroke due to the weight of the descending rod. A solution to the rod string weight and fluid load problem is to counterbalance the rod weight and one-half the fluid weight so the total power requirement would be lifting the fluid plus the friction and would therefore be divided equally between the upstroke and downstroke. Except in a limited way, this solution has been theoretical and has not been reduced to practice in an economical and effective manner.

In Patent No. 3,248,958 a wire line deep well pumping apparatus is shown which has a pair of counterbalance mounted on cables which are wound about helical grooved drums that are driven by a rotary prime mover such as an electric or hydraulic motor through reduction gears. The cables and counterbalancing means are suspended over pulleys from a tall derrick. There are certain disadvantages with this pumping apparatus, such as requirement for the heavy gear reduction unit and the wear on the gears. Also, tall derricks or towers are needed.

Other prior systems have offered various solutions with emphasis on one or more of the problems but none has

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come up with a system effective and economical enough for general acceptance.

SUMMARY OF THE INVENTION

The present invention is directed toward solving the heretofore-mentioned and other problems in pumping units. The present invention solves these problems in general by eliminating the walking beam entirely and eliminating the need for any reduction gears and the like. Thus, the pump operating unit of the present invention comprises in general a relatively short tower, a counterweighted carriage movably mounted on the tower for upward and downward movement, and a system of cables and pulleys interconnecting the carriage to the pump rod. A vertically disposed piston-cylinder assembly is provided with the piston thereof being attached adjacent of the upper end thereof of the tower and the cylinder attached to the carriage by gimbal means so that the effect of or tendency of the carriage to cant, etc., is not felt in the cables, which would otherwise cause undue strain and wear on the cables and other related parts. A means which is independent of and separate from the cables is provided for equilibrating the carriage. In its preferred form, the pulley and cable system is so arranged that there is a 2:1 ratio of movement of the pump rod relatively to the carriage. Also, in the preferred embodiment of the invention a pair of the cables are joined together to provide a single cable extending through pulley means to establish an equalizing holding means for the cable so that the forces acting on the cables will be equalized. An effective hydraulic system which includes a variable flow hydraulic pump, in the preferred form, is provided for selectively introducing the hydraulic fluid to the upper and lower chambers of the piston-cylinder assembly for the lowering and raising of the carriage. It should be pointed out that the above-mentioned piston-cylinder assembly that utilizes linear motion is the preferred form for driving the carriage since it is more economical and efficient as compared with the rotary hydraulic motor and reduction gear as shown FIG. 5 of Patent No. 3,248,958, which converts hydraulic fluid flow into rotary motion and through a reduction gear, drum, and cable finally to linear motion. In the hydraulic system of the present invention means are provided for varying the acceleration and deceleration of the carriage. Also, means is provided in the hydraulic system which includes pilot check valve means for checking the flow of the hydraulic fluid from the upper chamber of the piston-cylinder assembly in the event of accidental loss of fluid in the hydraulic means which would otherwise cause the dropping of the carriage. Additionally, the hydraulic means includes reservoir means which not only provides for a cooling of the hydraulic fluid but also serves as a part of the upper portion of the structure of the tower.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an end elevational view of the pump operating unit of the present invention with parts removed for purposes of clarity.

FIG. 2 is a top view thereof, also with parts removed for purposes of clarity.

FIG. 3 is a sectional view taken as on the line III—III of FIG. 5.

FIG. 4 is an enlarged view of the gimbal means of the present invention shown connected with the cylinder.

FIG. 5 is a somewhat schematic sectional view of the pump operating unit of the present invention taken as on the line V—V of FIG. 1.

FIG. 6 is a somewhat schematic drawing of the hydraulic system of the present invention shown in connection with its related parts.

FIG. 7 is a view somewhat similar to the upper portion

of FIG. 5 but showing an alternate embodiment of the holding means of the cables.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to the embodiment in FIGS. 1-6 and now in particular to FIG. 5 wherein it will be seen the pump operating unit 11 of the present invention is shown in connection with a typical oil well 12 (a part only of which is shown) which includes the well head 13, the outlet pipe 15, through which the oil flows that is pumped upwardly through the well head, and the vertically movable pump rod or so-called polish rod 17.

Pump unit 11 includes an upstanding substantially rectangular tower 19 which is preferably narrow in width as viewed in FIG. 1, and somewhat wider when viewed from the front, as in FIG. 5. Tower 19 is preferably mounted on a base 21 and upstands therefrom. Tower 19 is preferably of open framework construction and preferably includes a pair of upstanding vertical structural members 23, 25 which are spaced apart horizontally and are fixedly attached adjacent the lower ends thereof to the base 21. Members 23, 25 are interconnected adjacent the upper ends thereof by members 26, 26'. A box-like transverse member 27 is mounted across the upper ends of vertical members 23, 25 and extends beyond vertical member 25 to provide a cantilever portion 29. Transverse member 27 is preferably attached in place to the upper end of the other or remaining stationary portion of tower 19 by the removable bolt-nut fasteners 30, so that the fasteners 30 can be removed for sliding transverse member 27 endwise for a purpose and by means later to be described in the specification. A reservoir 31 in the upper portion of tower 19 forms a part of the structure of the tower, which will be described more in detail later in the specification. Suitable braces such as the angular braces 33 extend respectively between the vertical members 23, 25 and an anchoring plate 35 fixedly attached to the bottom of reservoir 31. In addition, suitable angular braces 37 are provided which extend respectively between vertical members 23, 25 and base 21.

A carriage 39 having a vertically extending opening 41 is somewhat loosely mounted on tower 19 and held by means later to be described for upward and downward movement with tower 19 extending through opening 41. The carriage 39 is shown in its lowermost position in FIGS. 1 and 5 and is adapted to be moved in upper positions in a manner later to be described. Carriage 39 includes a substantially horizontally extending base 43 and a vertical portion 45 fixedly attached to base 43 and extending transversely in upstanding relationship on top of base 43. Angular braces 46 preferably are attached at the respective ends thereof to base 43 and vertical portion 45. Base 43 is preferably of open framework construction and preferably includes the spaced I-beams 47, 49 interconnected adjacent the ends thereof by the members 51, 53. In addition, carriage 39 includes spaced transverse members 54, 55 which are attached respectively at the opposite ends thereof to I-beams 47, 49 and span the space therebetween in parallel relationship between members 51, 53. It will be understood that the lower part of opening 41 in carriage 39 is defined by members 54, 55 and the midportions of I-beams 47, 49. Carriage 39 also preferably includes intermediate members 56, 57 spaced between the beams 47, 49, with member 56 extending between members 51 and 54, and with member 57 extending between members 53 and 55. Suitable cross members 59 are provided respectively between intermediate members 56, 57 and I-beams 47, 49 so that open framework horizontal platforms 61, 63 are respectively provided by the base 43 of the carriage forwardly and rearwardly of vertical portion 45. Vertical portion 45 is also of open framework construction and includes four upstanding angle members 65 at the four corners of the vertical portion which are fixedly attached to base 43 by

suitable means adjacent the lower ends thereof and extend upwardly therefrom. In addition, vertical portion 45 includes spaced parallel members 67 and spaced parallel members 69 which interconnect the angle members 65 adjacent the upper ends thereof.

Carriage 39 is counterweighted by a plurality of block-like weights 71 which may be of any suitable material, as for example, concrete, and which rest on platforms 61 and 63. Weights 71 are preferably divided into a plurality of long weights 71' and shorter weights 71''. The plurality of long weights 71' extend across the width of carriage 39 and are stacked on platforms 61, 63 in a plurality of stacks, preferably two stacks on each of the platforms. The plurality of short weights 71'' are stacked on top of long weights 71' and extend perpendicularly relative thereto. Short weights 71'' make it possible to have smaller increments of weights so that the counterbalance may be made more precisely.

Long weights 71' are preferably secured together and to vertical portion 45 as by means of the horizontally extending and vertically spaced channel members 73 which extend across the opposite ends of the weights 71'. The channel members 73 are provided with slots 75 through which extend tongues 77 anchored in the weights 71', and which tongues are held in the slots 75 by suitable securing means, as for example, pins or bolts not shown. The channel members 73 are fixedly secured to the members 65 by suitable fastening means as at 79. Short weights 71'' are removably secured to members 67 by suitable means, not shown, similar to the securing of the long weights 71' to channel members 73.

A first pair of upper pulleys 81, 83 are rotatably mounted from transverse member 27 by suitable means as by the pulleys being respectively rotatably mounted on horizontal shafts 85, 87. Pulleys 81, 83 are in alignment with one another, with pulley 83 being supported on the cantilever portion 29 and pulley 81 being supported adjacent the opposite end of the transverse member 27 respectively supported by the supports 89, 91. A second pair of upper pulleys 93, 95 are rotatably supported from transverse member 27, as by pulley 93 being rotatably supported on a shaft 97 mounted in supports 99 and by pulley 95 being supported on shaft 87 alongside of pulley 83. Pulleys 93 and 95 are in alignment with pulley 95 being supported on cantilever portion 29 and pulley 93 being supported intermediate the ends of transverse member 27, as best seen in FIGS. 2 and 5.

A first lower pulley 101 is rotatably attached to carriage 39 by means of the pulley being rotatably mounted on a shaft 103 which in turn is attached to the base 43 of the carriage 39 by means of the supports 105. Lower pulley 101 is in line directly below pulley 81. A second lower pulley 107 is rotatably attached to carriage 39 by means of the pulley being rotatably mounted on a shaft 109 which in turn is attached to the base 43 of the carriage 39 by means of the supports 111. Lower pulley 107 is in line directly below upper pulley 93. The shafts 85, 87, 97, 103 and 109 are preferably parallel with one another.

A first elongated member or cable 113 and a second elongated member or cable 115 are respectively attached adjacent their ends to the upper end of pump rod 17 by suitable connection means as a connector 117. From connector 117 first elongated member 113 extends upwardly and over first pulley 83 and thence horizontally and over pulley 81. First elongated member 113 then extends downwardly from pulley 81 under lower pulley 101 and thence upwardly to a holding means 119 adjacent the upper end of tower 19. From connector 117 second elongated member 115 extends upwardly and over pulley 95 and thence horizontally and over pulley 93. Second elongated member 115 then extends downwardly from pulley 93 under lower pulley 107 and thence upwardly to a holding means 119 adjacent the upper end of tower 19.

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In the preferred embodiment, after respectively passing upwardly from the lower pulleys 101, 107, first and second elongated members 113, 115 are integrally joined together adjacent the upper ends thereof to establish a single elongated member 121. When a single elongated member 121 is utilized, holding means 119 is preferably an equalizing holding means which includes a pair of pulleys 123, 125 rotatably supported from transverse member 27 respectively by the skewed shafts 127, 129, which shafts are in turn attached to the transverse member by the supports 131, 133. Shafts 127, 129 are parallel as best seen in FIG. 2 so that the pulleys 123, 125 are in alignment. The single elongated member 121 at the bight thereof extends over pulleys 123, 125 so that any differences in forces exerted on elongated members 113, 115 will be equalized.

An alternate or modified holding means 135 for the elongated members 113, 115 is shown in FIG. 7 wherein it will be seen the elongated members are not integrally joined to form a single elongated member but rather the respective upper ends 137, 139 of elongated members 113, 115 are fixedly anchored to transverse member 27 by suitable anchor means shown as at 141, 143. This embodiment is particularly useful with so called "multiple completion" arrangements in which case a pair of polish rods 17 are provided with the cables 113, 115 being respectively connected to the separate polish rods by suitable connection means, as the connectors 144, 144'. For smaller installations and if desired, one of the cables 113, 115 may be omitted and a single cable used which would be anchored at its end 141 or 143, as heretofore described. However, it will be understood that the pulleys for the single member would preferably be relocated to a more central position and the member 113 or 115 would be preferably relocated centrally of the connector 117.

Equilibrating means is provided for maintaining carriage 39 in a level position and said equilibrating means is preferably as follows: A first chain 145 is fixedly attached adjacent one end thereof to tower 19 adjacent an upper part thereof as by attaching the upper end of the chain to reservoir 31 as by suitable attachment means 147. From attachment 147 chain 145 leads downwardly and into engagement with the lower part of the sprocket 149 which is fixedly mounted on a shaft 151 rotatably supported horizontally on carriage 39 as by the ends of the shaft extending through suitable bearings, not shown, and apertures in the members 54, 55. The chain 145 leads from sprocket 149 into engagement with and over sprocket 152 which is in alignment with sprocket 149 and is fixedly mounted from a shaft 153 that in turn is rotatably supported from carriage 39 by the ends of the shaft extending through suitable bearings, not shown, and apertures in members 54, 55. After passing over sprocket 152 chain 145 extends downwardly to its lower end which is fixedly attached to tower 19 as by attachment means 155. A second chain 157 similar to chain 145 and having a similar sprocket system is attached adjacent the upper end thereof to tower 19 as by the attachment means 159 secured to the lower side of reservoir 31. From attachment 159 chain 157 leads downwardly into engagement with and below a sprocket 161 which is fixedly mounted on shaft 153 on the opposite side from sprocket 152. Chain 157 then leads from sprocket 161 into engagement with and over a sprocket 163 which is fixedly mounted on shaft 151 on the opposite end thereof from sprocket 149. It will be understood that sprockets 161, 163 are in alignment with one another. Then, from sprocket 163 the chain 157 leads downwardly where it is anchored adjacent the lower end thereof to tower 19 by suitable anchoring means as that shown as at 165. From the foregoing it will be understood that the carriage 39 will be kept level at all times, that is, the base 43 will remain substantially horizontal at all times while the carriage is being raised and lowered.

Hydraulic means is provided for moving carriage 39

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upwardly and downwardly which preferably is in the form of a vertically disposed cylinder 167, which is attached to the carriage 39 by a gimbal assembly 169 later to be described in more detail, and a piston rod 171 including an enlarged piston portion 173 that is slidably mounted in cylinder 167 to divide the cylinder into an upper chamber 175 and a lower chamber 177 respectively above and below the piston portion. Piston rod 171 extends upwardly and downwardly from enlarged piston portion 173 and through the upper and lower ends respectively of the cylinder 167 where suitable packing means, not shown, is provided for sealing the upper and lower ends of the cylinder between the cylinder and the piston rod. The upper end of piston rod 171 is fixedly attached to the tower 19 as by the anchor joint 179 being anchored to the anchoring plate 35. The anchoring joint 179 preferably permits universal pivoting movement of the piston rod 171 but the piston is held against vertical movement.

Gimbal assembly 169 preferably comprises a substantially rectangular rigid trunnion open frame assembly 181 which is fixedly attached to base 43 adjacent the middle thereof and spans the middle of opening 41. Frame assembly 181 preferably includes the end members 183, 185 rigidly interconnected at their ends by the side members 187, 189, by suitable means, as bolts or the like. In addition, gimbal assembly 169 includes a square open frame assembly 191 that is movably supported in frame assembly 181 by means of the forwardly and rearwardly extending pair of trunnion pins 193, 195. Frame assembly 191 extends around the upper end of cylinder 167 and is pivotally attached thereto by means of the transversely extending pair of trunnion pins 197, 199. From the foregoing it will be understood that the gimbal connection between cylinder 167 and carriage 39, above described, allows universal movement of the cylinder and carriage relative to one another so that none of the motion of the carriage is transmitted to the cylinder, thereby preventing any scoring or unwanted forces being transmitted to the cylinder by the carriage 39 or by the associated structure connected therewith, as the polish rod 17.

Reservoir 31, which not only is a part of the structure of the tower 19 but is a part of the hydraulic means, includes an upper intake tank 201 that extends horizontally and is attached adjacent the opposite ends thereof to vertical members 23, 25 below transverse member 27 and parallel therewith. In addition, reservoir 31 includes a lower output tank 203 and an intermediate tank 205 which is between upper and lower tanks 201, 203 and in spaced parallel relationship thereto. A plurality of fins 206, which extend between and are attached to adjacent ones of tanks 201, 203 and 205, provide cooling for the tanks. A first conduit 207 communicates upper intake tank 201 with intermediate tank 205 and a second conduit 208 communicates intermediate tank 205 with lower output tank 203.

The hydraulic means for selectively introducing hydraulic fluid at selective rates of flow into one of chambers 175, 177 and exhausting the fluid from the other chamber to cause carriage 39 to move upwardly and downwardly at selected rates of speed, is described as follows: A prime mover, as an electric motor 209 is mounted on base 21 and rotatably drives a jack shaft 211 by means of the pulleys 213, 215 which are respectively fixed on the motor shaft 217 and jack shaft 211 and which are engaged by the series of continuous belts 219. Jack shaft 211 is rotatably mounted on tower 19 by means of a horizontal plate 221 fixedly attached to the tower and a housing 223 fixedly attached to plate 221 in which are provided bearings 225 through which the jack shaft 211 rotatably extends. A hydraulic pump 227 is coupled to jack shaft 211 by suitable means as the coupler 229 so that the shaft 231 of pump 227 is rotated by jack shaft 211. Pump 227 is of the well known variable displacement type of pumps which is controlled by the position of a

control or crank arm 233. As is known, the crank arm 233 is a part of the usual manually operated operating control mechanism which controls the usual cam, not shown, of pump 227 so that the volume of the hydraulic fluid passing through the connections 235 and 237 is determined. Thus, when the crank arm 233 is in the vertical neutral position shown in FIG. 6, there is no flow of hydraulic fluid through either connection 235 or 237. The crank arm 233 is pivotable about pivot axis 239 so that when the crank arm 233 is pivoted clockwise against the stop 241, the hydraulic fluid is caused to flow from the pump so that connection 235 is the outlet or high pressure side and connection 237 is the inlet, and when the crank arm 233 is moved counterclockwise against the stop 243, the connection 237 becomes the outlet and connection 235 the inlet of the pump. It will be understood that positions of crank arm 233 between the extreme positions when the crank arm is against the stops 241, 243 and the vertical position shown in FIG. 6, represent various degrees of flow of hydraulic fluid. In other words, as the crank arm 233 is moved towards the vertical position from either of the extreme positions the volume of hydraulic fluid decreases. As heretofore stated, the pump 227 is of well known construction and such a pump construction and related parts is shown in Hydreco Application Engineering Manual, 9-002.13, the manual of Hydreco Division, the New York Air Brake Company, Kalamazoo, Mich., printed April 1966. It will be understood that, if desired, reservoir 31 may be located with the hydraulic pump 227 and its related parts, as a unit, rather than being located adjacent the upper part of tower 19 as a part thereof.

The movement of crank arm 233 is controlled by the movement of carriage 39, and preferably in the following manner: An elongated rod 245 is pivoted from tower 19 by suitable means as the pivot pin 247 for pivot about a horizontal axis. Respectively above and below pivot axis 247 are provided upper and lower cams 249, 251 which are respectively adjustably and clampingly mounted on rod 245 by the set screws 253, 255. Rod 245 is coupled to a lever 257 by means of a coupler 259 that is pivotally attached as at 261 by suitable means to rod 245 adjacent the lower end thereof and is pivotally attached as at 263 adjacent the opposite end thereof to lever 257 by suitable means. Lever 257 is pivotally attached to housing 223 as at pivot point 264, by suitable means for pivot about a horizontal axis. The lower end of lever 257 is coupled to crank arm 233 by suitable means as the coupling rod 265. The connection between lever 257 and coupling rod 265 is preferably a yieldable or resilient one, and preferably as follows: A pair of out turned portions 266 are fixedly attached to the lower end of lever 257 and extend perpendicularly therefrom. Aligned openings, not shown, are provided in portions 266 through which rod 265 slidably extends. A pair of collars 267 are adjustably mounted on rod 265 on the remote sides of portions 266, and a pair of compression springs 268 are interposed respectively between portions 266 and collars 267 so that the motion of the lower end of lever 257 is transmitted to rod 265 through one of the springs 268, depending upon the direction of movement of the lever 257. It will be understood from the foregoing that carriage 39, in moving from an upper position into the lower position shown in FIG. 1, will strike cam 251 to cause rotation of rod 245 clockwise, which in turn through coupler 259, lever 257 and coupling rod 265 will cause crank arm 233 to pivot clockwise against a stop 241 which in turn causes hydraulic fluid to flow out connection 235, through conduit 269, which communicates the connection with an upper axial passage 270 in interior of piston rod 171, and through the opening 271 at the lower end of passage 270 adjacent the upper side of enlarged piston portion 173 and into the chamber 175. The hydraulic fluid in lower chamber 177 flows out piston portions 173 and through the lower axial passage

through the opening 273 in piston rod 171 below enlarged 274 in the interior of the piston rod and then through the conduit 275 in communication with the lower end of the piston which is communicated with connection 237. With the above-mentioned flow of the hydraulic fluid, the carriage 39 is moved upwardly and continues to move upwardly until the carriage comes into contact with cam 249, which causes rod 245 to be pivoted counterclockwise which through the linkage heretofore described causes crank arm 233 to be pivoted counterclockwise and move against the stop 243. This causes the flow of fluid in the pump 227 to be reversed so that the high pressure side is at connection 237 and the low pressure side is at connection 235. Thus, the fluid will flow through conduit 275 into passage 274, through opening 273 and into lower chamber 177, and will flow from upper chamber 175, through opening 271, passage 270 and conduit 269 so that the carriage 39 is caused to lower, until the carriage hits the cam 251 and the cycle is continued, as above described. It will be understood that during the cycle, the rod 245 will remain in one of the two positions in which left, until caused to move into the other position by contact of carriage 39 with cam 249 or 251.

An adjustable restriction 277 is provided in the line 278 which leads from the charge pump 279 into the usual control mechanism 280 of pump 227. Such a control mechanism is shown in said Hydreco Application Engineering Manual, on page 35 thereof. The line labeled "oil from charge pump" on said page 35 corresponds to line 278 in which restriction 277 is placed. Changing restriction 277 varies the acceleration and deceleration of the oil flow through connections 235 and 237, and thus the acceleration and deceleration of carriage 39.

Safety features are provided as follows: A pilot check valve 281 is preferably provided in conduit 269 and is actuated through the conduit 283 responsive to the pressure in conduit 275. The pilot check valve 281 is for the purpose of preventing carriage 39 from dropping in the event of the breakage of a cable such as cables 113, 115 or breakage of the polish rod 17. Assuming that carriage 39 is in its upper position and the high pressure oil is in conduit 269 with chamber 175 being filled, normally when the pressure shifts from connection 235 to connection 237, as heretofore described, the pressure will build up in conduit 275 which will cause release of pilot check valve 281 to allow the fluid to flow from upper chamber 175 through conduit 269 towards connection 235. In other words, pilot check valve 281 is arranged so that it blocks flow of hydraulic fluid through conduit 269 in the direction of flow from chamber 175 towards connection 235 unless the pressure in conduit 283 and 275 is above a given amount. If the pressure in conduit 275 drops suddenly, as for example, if a cable or rod parted, then the pilot check valve 281 would close to seal off the oil in upper chamber 175. If the pump 227 were running, it would build up pressure in conduit 275 which would cause the pilot check valve 281 to open slightly and the carriage 39 to inch downwardly. However, means is preferably provided to cut off the pump in the event that the cable or rod parts or the pressure in upper chamber 175 is beyond a normal working pressure. This is preferably done by means of pressure switch 285 which is connected to the conduit 269 as by the line 287 so that it is responsive to the pressure therein to open the circuit 289 to the motor 209 in a manner well known. Also, provided in this circuit 289 there is preferably a normally closed pushbutton switch 291 which can be opened manually to cut off the motor, if desired.

Charging pump 279, shown schematically in FIG. 6, maintains the pressure on the intake of pump 227 equal to the setting on the charging pump and thereby replaces any loss in oil. The charging pump 293 is preferably placed in conduit 295 which leads from output tank 203 and branches as at 297 and 299 into conduits 269, 275, respectively. Also, as heretofore explained, the output of

the charging pump 279 is connected to the control mechanism 280 through line 278. In the branches 297, 299 are respectively provided check valves 301, 303. Also, filters 305, 307 are preferably provided in conduit 295. Conduit 295 is preferably tied into conduit 308 to provide a bypass through a pressure release valve 309, provided in conduit 308, in the event that the shuttle valve 311 is stuck. Shuttle valve 311 is provided in a well known manner to selectively connect high pressure release valve 313 and low pressure release valve 315 to conduits 269 or 275 depending upon whether the conduits are carrying high or low pressure. Low pressure relief valve 315 is connected to upper intake tank 201 by the conduit 317 which also is preferably connected into conduit 308. Such an arrangement of the shuttle valve is shown on pages 46 and 47 of the heretofore-mentioned Hydreco Application Engineering Manual.

Another feature of the present invention is the provision for moving transverse member 27 endwise to the left as viewed in FIG. 5, instead of having to move the whole tower 19, when it is necessary to get equipment into vertical alignment with and above the well, as when the well is reworked, pumps pulled, etc. A horizontally extending rod 319 is rotatably mounted in a bearing 321 in the upper portion of tower 19 beneath transverse member 27. Rod 319 extends parallel with member 27 and is threaded as at 321 adjacent the end thereof. Threaded portion 321 extends through an internally threaded member as a nut-like member 323 fixedly attached to transverse member 27 as by bracket 325. A hand wheel 327 is fixedly attached to rod 319 at the end opposite threaded portion 321 so that with fasteners 30 removed, the wheel 327 may be turned to cause rod 319 to rotate which will cause nut-like member 323, bracket 325 and transverse member 27 to move to the left as viewed in FIG. 5, whereby pulleys 83, 95 and cantilever portion 29 can be moved out of the way for the above described purpose and thence back into place after the reworking, etc., has been done.

Although preferred embodiments of the invention have been illustrated and described, it will be understood that various changes and modifications in structure may be made without departing from the spirit and scope of the invention as defined in the claims.

I claim:

1. A pump operating unit for connecting to a vertically movable pump rod of a well comprising a tower, a counterweighted carriage movably mounted on said tower for upward and downward movement, upper pulley means mounted on said tower above said carriage, holding means mounted on said tower above said carriage, lower pulley means mounted on said carriage, connection means for attachment to the movable pump rod of the well; elongated member means attached to said connection means, extending upwardly and over said upper pulley means, then downward and under said lower pulley means, thence upward into engagement with said holding means whereby upward and downward movement of said carriage is effective to move said connection means upwardly and permit said connection means to move downwardly for respectively carrying the movable pump rod upwardly and permitting the rod to move downwardly; means operably coupled to said carriage for moving said carriage upwardly and downwardly, and means for equilibrating said carriage to maintain said carriage in a level position.

2. The pump operating unit of claim 1 in which said upper pulley means includes a pair of upper pulley means, in which said lower pulley means includes a pair of lower pulley means and in which said elongated member means includes first and second elongated members respectively attached to said connection means, extending upwardly and over said first and second upper pulley means, then downwardly and under said first and second lower pulley means, thence upwardly into engagement with said holding means.

3. The pump operating unit of claim 2 in which said

holding means comprises additional pulley means and in which said first and second elongated members are joined together to provide a single elongated member extending through said additional pulley means to establish an equalizing holding means.

4. The pump operating unit of claim 1 in which said holding means comprises anchoring means for fixedly anchoring said elongated member means.

5. The pump operating unit of claim 2 in which said holding means comprises a pair of anchoring means for respectively fixedly anchoring said first and second elongated members.

6. The pump operating unit of claim 1 for connecting to an additional vertically movable pump rod of a well, in which claim said upper pulley means includes a pair of upper pulley means, in which said lower pulley means includes a pair of lower pulley means, in which said connection means includes a pair of connectors respectively connected to said pump rods, in which said holding means includes a pair of anchoring means, in which said elongated member means includes first and second elongated members respectively attached to said connectors, extending upwardly and over said first and second upper pulley means, then downwardly and under said first and second lower pulley means, thence upwardly into engagement respectively with said anchoring means.

7. The pump operating unit of claim 1 in which said tower includes a transverse member movably attached to the upper end of the remaining stationary portion of said tower and normally projecting beyond the stationary portion of said tower to provide a cantilever portion, in which said upper pulley means is supported by said transverse member, and in which means is provided for withdrawing said cantilever portion inwardly towards the stationary portion of said tower.

8. The pump operating unit for claim 1 in which said means operably coupled to said carriage for moving said carriage upwardly and downwardly comprises a cylinder, a piston rod including an enlarged piston portion slidably mounted in said cylinder to divide said cylinder into upper and lower chambers, said piston rod being attached to said tower, gimbal means pivotally coupling said cylinder and said carriage, and hydraulic means for alternately introducing hydraulic fluid at selected rates of flow into one of said upper and lower chambers and exhausting the fluid from the other of said chambers to cause said carriage to move upwardly and downwardly at selective rates of speed.

9. The pump operating unit of claim 8 in which said hydraulic means comprises a variable flow hydraulic pump including control arm means movable through a neutral position to first or second positions to govern the flow of hydraulic fluid between zero and positive fluid flow under pressure to said lower or said upper chambers, a prime mover coupled to said hydraulic pump for the drive thereof, and means operably coupled to said control arm and operable responsive to movement of said carriage for moving said control arm.

10. The pump operating unit of claim 8 in which said hydraulic means includes means for checking flow of hydraulic fluid from said upper chamber in the event of accidental loss of fluid in said hydraulic means which would otherwise cause dropping of said carriage.

11. The pump operating unit of claim 9 in which is included means for stopping said prime mover responsive to an increase in pressure in said upper chamber beyond a normal working pressure.

12. The pump operating unit of claim 8 in which said hydraulic means includes reservoir means including an upper intake tank, a lower output tank and an intermediate tank between said upper and lower tanks, said tanks being in vertically spaced relationship, a plurality of fins extending between and attached to adjacent ones of said tanks, conduit means communicating said upper tank with said intermediate tank and said intermediate

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tank with said lower tank, and said reservoir means forming a part of the upper portion of the structure of said tower.

13. A pump operating unit for connecting to a vertically movable pump rod or rods of a well or wells comprising an upstanding tower, a carriage including a substantially horizontal extending base, said carriage being provided with a vertical opening in the middle thereof, said carriage being loosely mounted on said tower for upward and downward movement with said tower extending through said opening, a plurality of blocklike weights mounted in balanced condition on said carriage on opposite sides of said tower and substantially equally balancing the weight of the pump rod or rods and one-half the weight of the fluid column or columns from the well or wells, first and second upper pulley means mounted on said tower above said carriage, first and second lower pulley means mounted on said carriage, connection means for attachment to the movable pump rod or rods of a well or wells; first and second elongated members respectively attached to said connection means, extending upwardly and over said first and second upper pulley means, then downward and under said first and second lower pulley means, thence upward into engagement with said holding means whereby upward and downward movement of said carriage is effective to move said connection means upwardly and permit said connection means to move downwardly; a cylinder, a piston rod including an enlarged piston portion slidably mounted in said cylinder to divide said cylinder into upper and lower chambers, said piston rod being pivotally attached to said tower, gimbal means pivotally cou-

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pling said cylinder and said carriage, hydraulic means for alternately introducing hydraulic fluid at selected rates of flow into one of said upper and lower chambers and exhausting the fluid from the other of said chambers to cause said carriage to move upwardly and downwardly, said hydraulic means comprising a variable flow hydraulic pump including control arm means movable between first and second positions to govern the flow of hydraulic fluid to and from said lower and said upper chambers, a prime mover coupled to said hydraulic pump for the drive thereof, and means operably coupled to said control arm and operable responsive to movement of said carriage for moving said control arm.

14. The pump operating unit of claim 13 in which said holding means comprises additional pulley means and in which said first and second elongated members are joined together to provide a single elongated member extending through said additional pulley means to establish an equalizing holding means.

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