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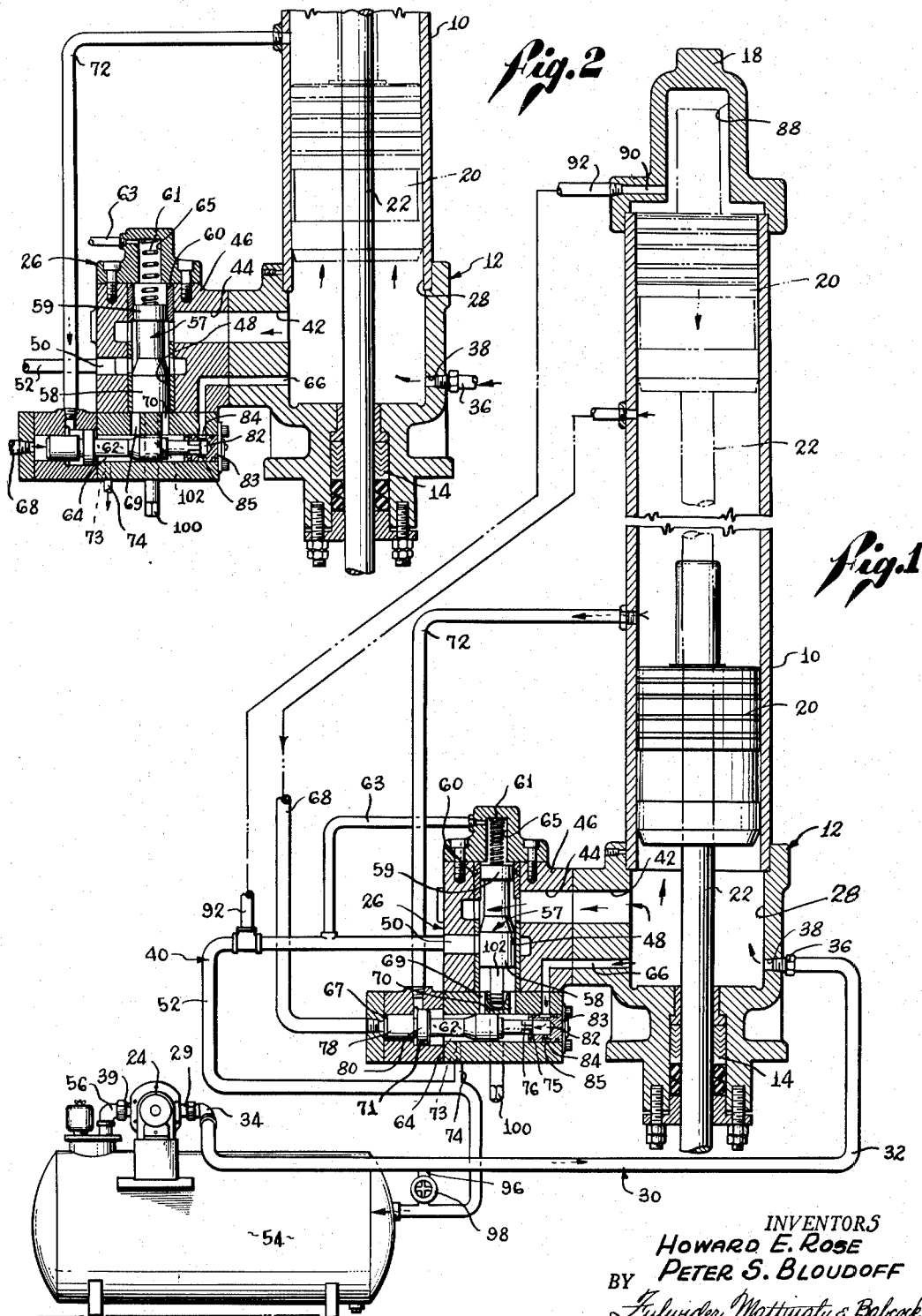
H. E. ROSE ET AL

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FLUID ACTUATING PUMPING JACK

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3 Sheets-Sheet 1



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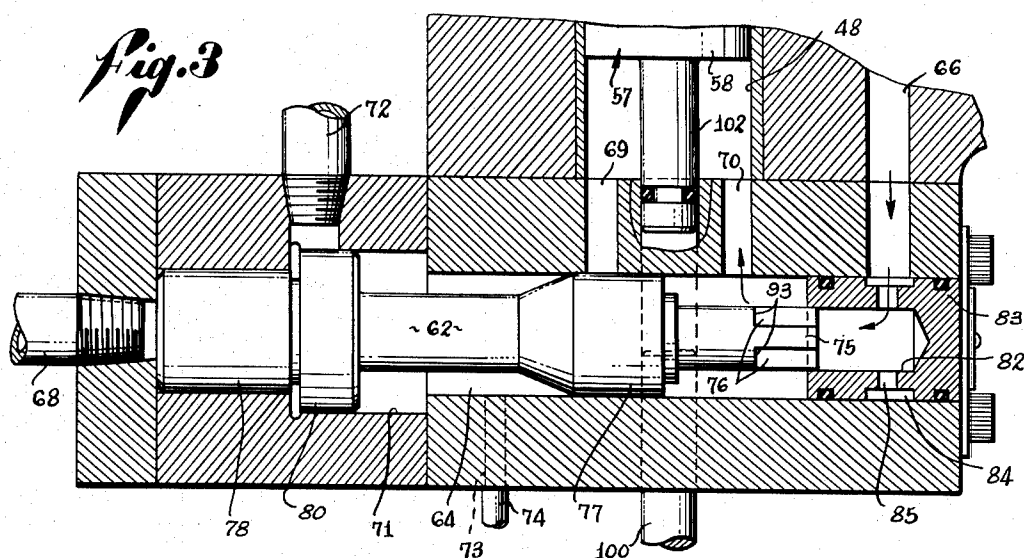
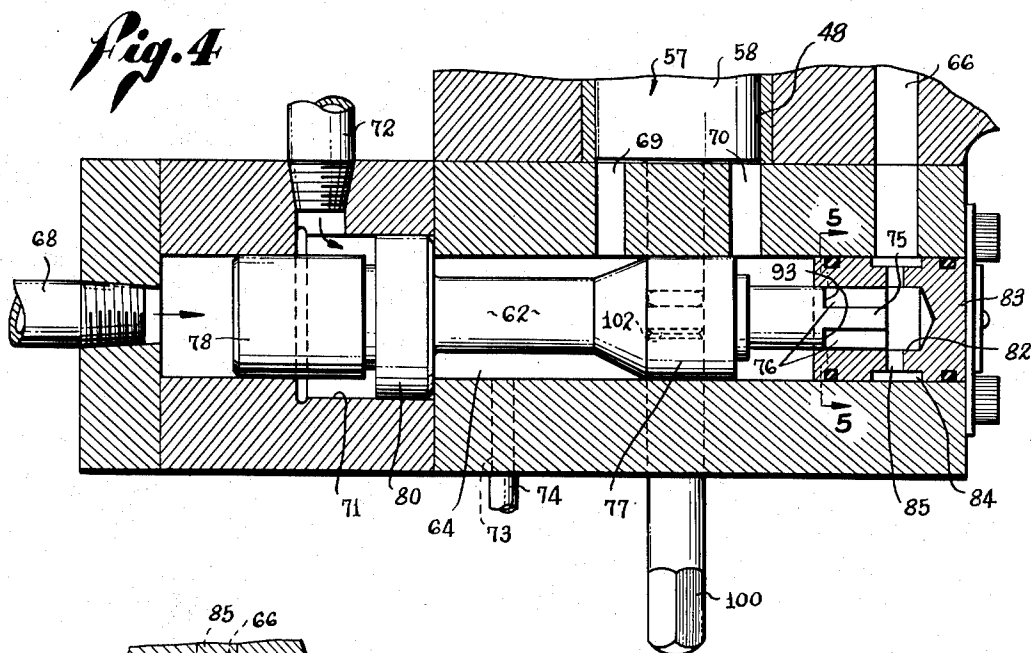
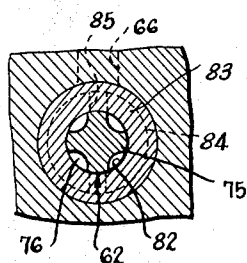
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3 Sheets-Sheet 2



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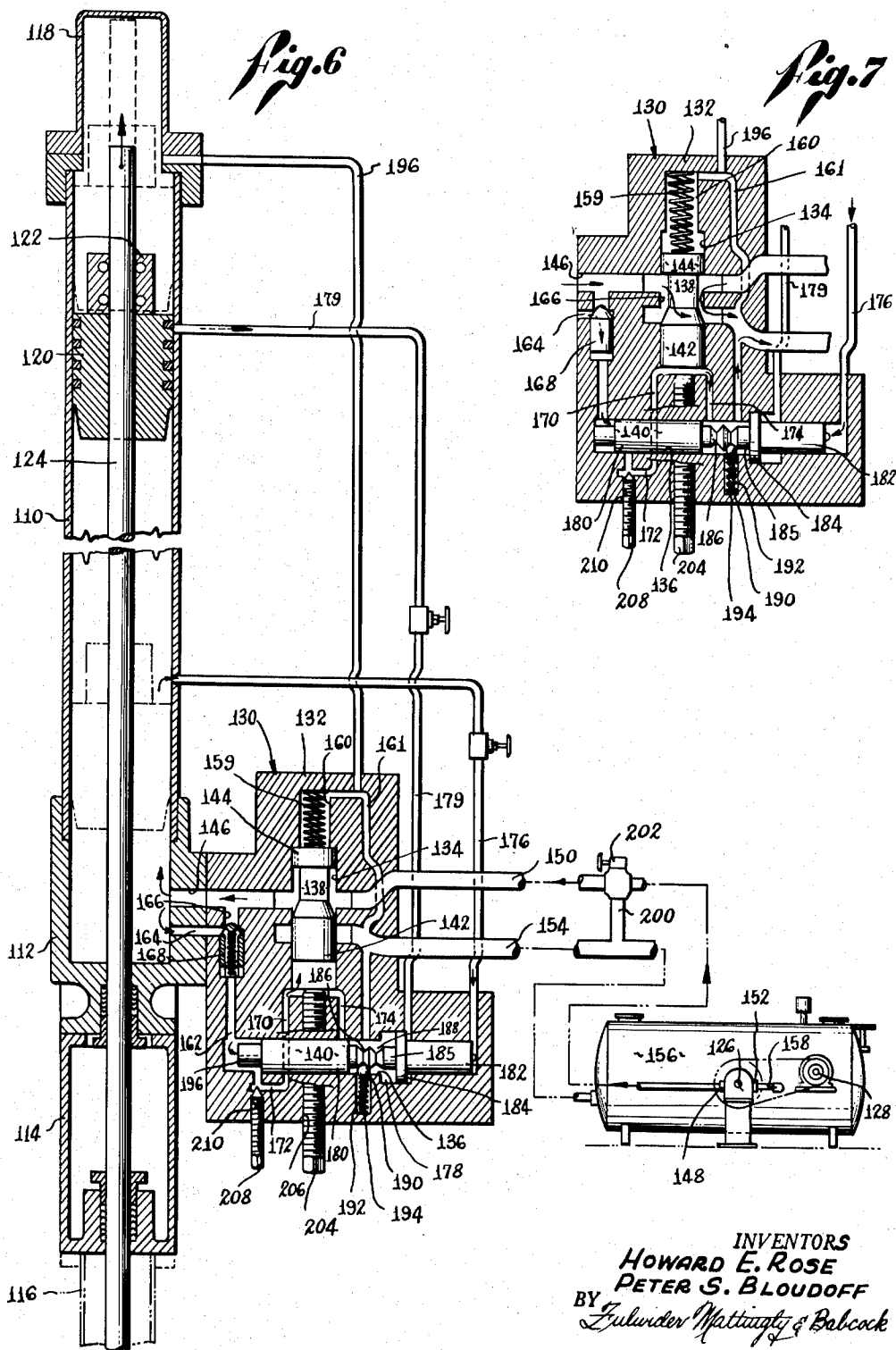
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FLUID ACTUATING PUMPING JACK

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3 Sheets-Sheet 3



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2,729,941

FLUID ACTUATED PUMPING JACK

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29 Claims. (Cl. 60—52)

The present invention relates generally to fluid actuated pumping jacks and more particularly to a novel fluid actuated pumping jack especially adapted for use in pumping oil from an oil well.

In the production of oil from an oil well a reciprocating pump is most commonly used. Such pump is mounted at the bottom of a string of surface-connected tubing within the production zone of the well bore. Reciprocation of the pump is effected by means of a string of sucker rods. These rods are in turn reciprocated by a suitable power operated device located at the surface of the earth. The most common device utilized to effect reciprocation of the sucker rod string is the so-called "walking beam" actuator. These walking beam actuators impose great mechanical stress upon the sucker rods because of the speed and frequency with which the direction of rod movement is changed. Such mechanical stress is productive of progressive fatigue of the metal from which the sucker rods and the joints therebetween are formed often causing the rod string to part. An expensive fishing job is then required before the well can again be placed on production. A further disadvantage of the walking beam type of actuator results from the comparatively short stroke it is capable of imparting to the sucker rod string. This disadvantage is especially serious in the case of deeper wells. Yet another disadvantage is that the pump is reciprocated at the same speed during its upstroke and its downstroke, and in many cases in order to obtain maximum pumping efficiency it is desirable to have the upstroke take place at one speed and the downstroke at another speed.

In order to overcome the disadvantages of the walking beam type of actuator there have heretofore been developed fluid actuated pumping jacks adapted to effect reciprocation of the sucker rod string. These fluid actuated pumping jacks offer smooth operation in both directions of travel whereby the mechanical stress imposed upon the sucker rod string is considerably reduced. Additionally, a longer stroke may be provided and the speed of this stroke in one direction may be adjusted at a different rate than the speed in the opposite direction. The heretofore-proposed fluid actuating pumping jacks are generally very expensive as compared to the conventional walking beam type of actuator. Such pumping jacks have further proven to be complex in design and heavy in weight. Because of their complexity, breakdowns are not infrequent and upon the occurrence of a breakdown a highly skilled technician is generally required in order to again place the pumping jack in operation.

A major object of the present invention is to provide a novel and improved type of fluid actuated pumping jack having a simple design and which is light in weight.

A further object is to provide a fluid actuated pumping jack which is capable of providing long periods of trouble-free service without requiring other than minor attention from an operator.

Yet another object of the present invention is to provide a pumping jack of extremely compact design which

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may be moved to and installed at a well site in a comparatively short period of time.

A more particular object is to provide a fluid actuated pumping jack having a unique control valve arrangement which affords positive control over the pumping unit.

An additional object of the invention is to provide a fluid actuated pumping jack which does not require a separate scavenging pump in order to return exhausted pressure fluid to the system.

These and other objects and advantages of the present invention will become apparent from the following detailed description, when taken in conjunction with the appended drawings wherein:

Figure 1 is a side view, taken partly in central vertical section, of a preferred form of fluid actuated pumping jack embodying the present invention;

Figure 2 is a vertical sectional view of the control valve mechanism of the pumping jack of Figure 1 with its parts disposed in a different position than in Figure 1;

Figure 3 is an enlarged central vertical sectional view of the pilot valve portion of Figure 1;

Figure 4 is an enlarged central vertical sectional view of the pilot valve portion of Figure 2;

Figure 5 is an enlarged vertical sectional view taken along line 5—5 of Figure 4;

Figure 6 is a side view, taken partly in central vertical section, of another form of fluid actuated pumping jack embodying the present invention; and

Figure 7 is a vertical sectional view of the control valve mechanism of the pumping jack of Figure 6 with its parts disposed in a different position than in Figure 6.

Referring to the drawings, and particularly Figure 1 thereof, the preferred form of fluid actuated pumping jack embodying the present invention broadly comprises a vertically extending cylinder 10 mounted at its lower end upon a base member generally designated 12 and incorporating a conventional stuffing box 14. The base member 12 may be affixed to the upper end of a string of well casing (not shown). The top of the cylinder 10 is closed by a cap member 18. A lifting piston 20 is slidably disposed within the cylinder 10 for vertical reciprocal movement relative thereto. The lifting piston 20 is clamped or otherwise rigidly secured to a polish rod 22 which extends through the stuffing box 14 and is attachable at its lower end to a string of sucker rods (not shown). The sucker rods are in turn connected to a reciprocating pump (not shown) disposed in the production zone of an oil well. A source of pressurized power fluid, such as a gear pump 24 is adapted to supply power fluid to the lower end of the cylinder so as to effect vertical reciprocation of the lifting piston 20. Such vertical reciprocation of the lifting piston 20 is controlled by a control valve mechanism, generally designated 26.

More particularly, the lower end of the cylinder 10 is rigidly secured within a circular cavity 28 formed in the base member 12. The lower right side of this cavity is connected to the discharge side 29 of the pump 24 by a supply passage, generally designated 30. The supply passage 30 is defined by a length of pipe 32 connected at one of its ends to an elbow 34 mounted by the pump 24, and having its other end secured by a fitting 36 within a bore 38 formed in the base member 12. The upper left side of the cavity 28 is in communication with the intake 39 of the pump 24 by means of a return passage, generally designated 40, and defined by a base member bore 42, an aligned bore 44 formed in the control valve block 46, a vertically extending cylindrical chamber 48 formed in the latter block 46, an outlet bore 50 also formed in the latter block, and a length of pipe 52 connecting outlet bore 50 with a reservoir tank 54, the tank 54 being in communication with the pump inlet 39 by an elbow 56.

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A piston-type control valve element 57 is slidably disposed within the chamber 48 of the control valve block 46 for vertical reciprocal movement therein. The control valve element 57 includes a lower head 58 and an upper collar 59 of somewhat smaller diameter than the head 58. The collar 59 reciprocates within a sleeve 60 having a smaller diameter than the major portion of the control valve chamber 48. Optionally, the control valve 57 may be constantly biased downwardly by spring means, such as the compression spring 61 shown. A length of tubing 63 may vent the spring cavity 65 to the pipe 52 of the return passage 40. With the control valve element 57 disposed in its raised position of Figure 1, pressurized power fluid entering the cavity 28 through the supply passage 30 will be directed against the bottom of the lifting piston 20 so as to effect its upstroke. When, however, the control valve 57 is disposed in its lowered position of Figure 2, the pressurized power fluid will be free to recirculate directly from the discharge of the pump 24 to its inlet by means of the return passage 40. Because of the resultant pressure drop within the cylinder 10, the weight of the sucker rod string will then cause the lifting piston 20 to drop within the cylinder 10, the fluid therebelow passing into the reservoir tank 54 through the return passage 40.

Vertical movement of the control valve element 57 is controlled by a piston-type pilot valve element 62 that is slidably disposed within a horizontally extending cylindrical chamber 64 formed in the lower portion of the control valve mechanism 26. The right end of the pilot valve chamber 64 is in communication with the lower portion of the base member cavity 28 by a passage 66. The left end of this chamber 64 is in communication with a point in the cylinder 10 below but adjacent to the highest elevation normally reached by the underside of the lifting piston 20 during its working stroke by means of a length of pipe 68. The intermediate portion of the pilot valve chamber 64 is connected to the lower end of the main valve chamber by a pair of horizontally-spaced vertical bores 69 and 70. An enlarged portion 71 of this chamber 64 located between the left end thereof and the bore 69 is in communication with a point in the cylinder 10 above but adjacent to the lowest point normally reached by the top of the lifting piston 20 during its working stroke by means of a length of pipe 72. A short vertical passage 73 and a conduit 74 connects the portion of the chamber 64 between the bore 69 and the enlarged portion 71 with the length of pipe 52 of the return passage 40.

Referring now to Figures 3 and 4, pilot valve element 62 includes a pin element 75 at its right hand portion that is formed with flutes 76 at its right end, a land 77 formed at its generally intermediate portion, a solid head 78 formed at its left hand portion, and a collar 80 formed between the head 78 and the land 77. The pin element 75 is slidably disposed within the bore 82 of a plug element 83 rigidly secured within the right end of the pilot valve chamber 64. The bore 82 is in turn connected to the passage 66 and hence to base member cavity 28 by an annular groove 84 and radially extending passages 85. The bore 82 is likewise adapted to be placed in communication with the pilot valve chamber 64 by means of the flutes 76 of the pin 75 when the pilot valve is disposed in its position of Figures 2 and 4.

The cap member 18 is rigidly secured to the upper end of the cylinder 10 in a suitable manner and is formed with a vertically extending cavity 88 from one side of which extends a horizontal bore 90. The upper end of a scavenging pipe 92 is secured within the latter bore 90. The lower end of the scavenging pipe 92 is connected to the return passage 40, as by attachment to the length of pipe 52. During operation of the pumping jack, as the lifting piston 20 approaches the upper end of the cylinder 10 any power fluid which has leaked upwardly past this piston will be forced through the bore 90 and

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the scavenging pipe 92 back into the reservoir tank 54. Hence, a separate scavenging pump for returning such fluid is not required.

Referring now to Figure 1, the operation of the preferred form of the invention, power fluid will be forced under pressure from the pump 24 through the pipe 32 into the lower end of the cylinder 10. At this time the pilot valve element 64 will be disposed in its position of Figures 1 and 3 wherein the land 77 is disposed to the left of the lower end of the vertical bore 70. Thus, the lower portion of the main control valve chamber 48 will be in communication with the pressurized power fluid by means of passage 66, the annular groove 84 and radially extending passages 85 of the plug element 83, the bore 82 of the latter, the flutes 76 of the pin element 75, the pilot valve chamber 64 and the vertical bore 70. Accordingly, the pressurized power fluid will exert an upward force upon the underside of the control valve element's lower head 58. Simultaneously, the pressurized power fluid entering chamber 48 by means of bores 42 and 44 will exert an upward force upon the underside of the collar 59 of this element 57 and a downward force upon the exposed upper surface of the lower head 58 thereof. Inasmuch as the combined areas of the underside of the lower head 58 and the collar 59 are greater than that of the effective upper surface of the head 58, the control valve element will be retained in its raised position. If a compression spring 61 is utilized it will be held in a compressed condition at this time by the control valve element 57.

Inasmuch as the head 58 of the control valve element 57 blocks the outlet bore 50 when this element is in its raised position, the pressurized power fluid entering the base member cavity 28 will act upon the underside of the lifting piston 20 causing it to rise within the cylinder 10 and thereby lift the polish rod 22 and its attached string of sucker rods. During this time the force of the pressurized power fluid acting against the right side of the pilot valve element's plunger 74 and land 76 will retain this element in its position of Figures 1 and 3.

As the lifting piston 20 rises within the cylinder 10 it will unblock the opening to the pipe 72. Pressurized power fluid will then enter the enlarged portion 71 of the pilot valve chamber 64 and exert a force upon the left side of the collar 80 tending to urge the pilot valve element 64 to the right. Inasmuch, however, as the area of the left side of the collar is less than the combined areas of the right side of the pin element 75 and the right side of the land 77, the pilot valve element will remain in its original position. Eventually, as the lifting piston 20 continues its upward movement, it will unblock the opening to the pipe 68. Pressurized power fluid will then flow downwardly through the pipe 68 into the left side of the pilot valve chamber 64 and exert a force upon the left side of the left end of the head 78 of the pilot valve element. At this time the combined areas of the left side of this head 78 and the left side of the collar 80 will exceed that of the right side of the pin element 75 and the right side of the land 77. The pilot valve element 64 will then snap to the right to its position of Figures 2 and 4.

Referring to these figures, it will be seen that the land 77 has unblocked the vertical bore 69. The control valve element 57 is thus free to move downwardly under the downwardly-acting force of the pressurized power fluid against the upwardly-facing surface of the head 58, the diameter of the head 58 being greater than that of the collar 59. If a compression spring 61 is employed, it will also exert a downward force upon the control valve element 57. As the control valve element 57 moves downwardly, the power fluid in the lower portion of the chamber 48 will be vented from the latter to the return passage 40 by means of the passage 73 and the conduit 74. It will be observed that the vertical bore 70 is not blocked by the pilot valve land 77. Hence, any fluid leaking past the pin element 75 is free to flow below the head 58 into vertical bore 69

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and hence to the return passage 40. It will likewise be observed that the head 58 has now unblocked the outlet bore 50 whereby the pressurized power fluid entering the base member cavity 28 is free to recirculate through the return passage 40 directly to the reservoir tank 54. The resultant pressure drop within the cylinder 10 permits the weight of the sucker rod string to lower the lifting piston 20.

As the lifting piston drops within the cylinder 10 it will first block the entrance of pressurized power fluid to the upper end of the pipe 68. Referring to Figure 4, it will be seen that the entrance of power fluid into the pilot valve chamber 82 is blocked by the areas 93 of the pin element 75, which areas define the left ends of the flutes 76. Accordingly, even though the power fluid pressure acting against the left side of the pilot valve head 78 is now relieved, the pilot valve will not return to the left to its original position. This is true because the area of the left side of collar 80 that is still exposed to pressurized power fluid through conduit 72 is greater than pin element areas 93 and the right side of this element. When, however, the top of the lifting piston drops below the entrance to the pipe 72, as shown in Figure 2, the pressure acting on the left side of the collar 80 will be relieved and the pilot valve element 64 will snap to the left to its original position of Figures 1 and 3. The land 77 thereof will then block vertical passage 69 and pressurized power fluid will enter the lower end of control valve chamber 48 by means of vertical passage 70. The control valve element will thus be urged upwardly to its original position of Figures 1 and 3 so as to again block the outlet bore 50. Accordingly, the lifting piston 20 will reverse its direction of movement and commence another upstroke.

It should be particularly noted that very close control over the movement of the lifting piston 20 may be effected with the aforescribed arrangement. Thus, a by-pass pipe 96 may be interposed between the supply passage 30 and the return passage 40, which by-pass pipe may mount a safety valve 98. Likewise, it should be observed that a set screw 100 may be mounted by the control valve block 46 in vertical alignment with a rod 102 depending from the underside of the control valve element 57. Adjustment of the set screw 100 controls the extent to which the latter's head 58 will unblock the outlet bore 50 when the control valve element 57 is in its lowered position. In this manner the rate at which the lifting piston drops within the cylinder 10 may be adjusted. Such adjustment of the rate of lifting piston drop is independent of the rate at which it rises. Hence, the ratio of lifting piston rise to lifting piston drop may be adjusted to meet the optimum production requirements of an oil well. This is often a very important consideration.

Referring now to Figures 6 and 7, the second form of fluid actuated pumping jack embodying the present invention broadly comprises a vertically extending cylinder 110 mounted at its lower end upon a base member 112 incorporating a stuffing box 114. The base member 112 may be affixed to the upper end of a string of well casing 116. The top of the cylinder 110 is closed by a cap member 118. A lifting piston 120 is slidably disposed within the cylinder 110 for vertical reciprocal movement relative thereto. The lifting piston 120 is rigidly secured by a clamp 122 to a polish rod 124. A suitable pump 126 driven by an electric motor 128 provides pressurized power fluid for actuating the lifting piston 120. The vertical reciprocation of the lifting piston is controlled by a control valve mechanism, generally designated 130. The primary difference between the preferred form of pumping jack disclosed in Figures 1 through 5 and the second form shown in Figures 6 and 7 lies in the construction of their control valve mechanisms 26 and 130, respectively.

The control valve mechanism 130 includes a block 132 wherein is formed a vertically extending cylindrical control valve chamber 134 and a horizontally extending

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cylindrical pilot valve chamber 136. A control valve element 138 is slidably disposed within the chamber 134 for vertical reciprocal movement. A pilot valve element 140 is slidably disposed within the chamber 136 for horizontal movement therein. The control valve element 138 includes a head 142 at its lower portion and a collar 144 formed at its upper portion. The head 142 and the collar 144 are substantially equal in diameter. The control valve chamber 134 is connected to the lower end of the cylinder 110 by a horizontal passage 146. This chamber 134 is connected to the discharge 148 of the pump 126 by a supply passage or pipe 150. This chamber 134 is likewise in communication with the intake 152 of the pump by a return passage or pipe 154, which pipe is connected to a reservoir tank 156. The reservoir tank is in turn connected to the pump's intake 152 by an elbow 158. The control valve element 138 is continually biased downwardly by helical compression spring 159. This spring 159 is disposed within a cavity 160 that is connected by a conduit 161 with the return passage 154.

The left end of the pilot valve chamber 136 is in communication with the lower end of the cylinder 110 by a vertical passage 162 and a connecting horizontal passage 164. The intersection of these two passages is connected to the horizontal passage 146 by a short vertical bore 166. This bore 166 is normally closed by an upwardly-acting spring-loaded, pressure relief valve 168. The left portion of the pilot valve chamber 136 is in communication with the lower end of the control valve chamber 134 by a passage 170. Another passage 172 connects the lower end of the control valve chamber 134 with the intermediate portion of the pilot valve chamber 136. A vertically extending bore 174 connects the pilot valve chamber 136 with the return passage 154 at a point located to the right of the passage 172. The right end of the pilot valve chamber 136 is connected by a pipe 176 with the interior of the cylinder 110 below but adjacent to the lowest point normally reached by the top of the lifting piston 120 during its working stroke. The pilot valve chamber 136 is formed with an enlarged portion 178 between the bore 174 and the right end of this chamber. This enlarged portion 178 is connected by a pipe 179 with the interior of the cylinder 110 below but adjacent to the highest elevation reached by the lifting piston 120 during its working stroke.

The pilot valve element 140 includes a main land 180, a second land 182 formed at its right hand portion, a collar 184 formed to the left of the second land 182, a stem 185 between the main land 180 and collar 184, and annular grooves 186 and 188 formed in the stem 185. The latter grooves are adapted to receive a ball detent 190 which is constantly biased upwardly by a helical compression spring 192. This spring 192 is disposed within a pocket 194 formed in the control valve block 132.

The cap member 118 is rigidly secured to the upper end of the cylinder 110 in a suitable manner. The interior of this cap member 118 is connected to the conduit 160 and hence to the return passage 154 by a scavenging pipe 196. In this manner spent power fluid finding its way past the lifting piston 120 may be returned to the reservoir tank 156.

In the operation of this form of the invention, pressurized power fluid will be forced from the pump 126 through the supply passage 150 into the lower end of the cylinder 110, the control valve element 138 being disposed in its raised position of Figure 6 at this time. The control valve element 138 will be maintained in its raised position so long as the pilot valve element 140 is in its position of Figure 6, in which position the lower portion of the control valve chamber 134 is in communication with the lower end of the cylinder 110 through passages 162 and 164. Hence, pressurized power fluid may enter the lower portion of the control valve chamber 134 so as to exert an upward force against the underside of the control valve

element 138. The main land 180 of the pilot valve element 140 meanwhile blocks the bore 174. The compression spring 159 will be held in a compressed condition by the raised control valve element. In the raised condition of the latter its head 142 blocks the entrance to the return passage 154. Accordingly, the pressurized power fluid entering the lower portion of the cylinder 110 will act upon the underside of the lifting piston 120 causing it to rise within the cylinder and thereby lift the polish rod 124 and its attached string of sucker rods.

During the initial upward movement of the lifting piston 120, pressurized power fluid entering the left side of the pilot valve chamber 136 through passages 162 and 164 will act against the left side of the main land 180 so as to retain it in its position of Figure 6. As the lifting piston continues to rise it will unblock the opening to the pipe 176, and pressurized power fluid will then enter the right end of the pilot valve chamber 136 and exert a force on the right side of the second land 182 tending to urge the pilot valve element 140 to the left. Inasmuch, however, as the combined areas of the left side of the main land 180 and a spacer 196 extending therefrom is equal to the area of the right side of the second land 182, the forces acting on the opposite sides of the pilot valve element will be balanced. Hence, the latter will remain stationary. Additionally, the ball detent 190 will tend to maintain the pilot valve element stationary by virtue of its engagement with the annular groove 186.

Eventually, as the lifting piston 120 continues its upward movement, it will unblock the opening to the pipe 179. Pressurized power fluid will then flow downwardly through the latter pipe into the right end of the enlarged portion 178 of the pilot valve chamber 136 and exert a force upon the right side of the collar 184. At this time the combined areas of the right end of the second land 182 and the right side of the collar 184 will exceed that of the left side of the main land 180 and its spacer 196. The pilot valve element will then snap to the left to its position of Figure 7, the ball detent 190 being retracted from the groove 186 and being engaged with the other groove 188.

Referring now to Figure 7, it will be seen that the main land has unblocked the bore 174 so as to permit the power fluid disposed below the control valve element 138 to be vented from the control valve chamber 134. Inasmuch as the upwardly-facing side of the control valve element's head 142 and the downwardly-facing side of the collar 144 are equal, the control valve element will be urged downwardly under the influence of the compression spring 159. The head will then unblock the return passage 154 whereby power fluid entering the chamber 134 through the supply passage 150 may directly recirculate to the reservoir tank 156 through the return passage 154. The resultant pressure drop within the cylinder 110 permits the weight of the sucker rod string to lower the lifting piston 120.

As the lifting piston drops it will first block the entrance of pressurized fluid to the upper end of the pipe 179. The pilot valve element will not be caused to move at this time, however, because the left and right sides thereof will still be exposed to an equal amount of pressure. Additionally, the ball detent 190 will yieldingly resist any movement of the pilot valve element. When, however, the top of the lifting piston falls below the entrance to the pipe 176, as indicated by dotted outline in Figure 6, the pressure acting on the right side of the pilot valve element 140 will be suddenly reduced and this element will snap to the right to its original position of Figure 6. The lifting piston will then be caused to reverse its direction of movement and commence another upstroke.

It should be noted that a by-pass pipe 200 may be interposed between the supply passage 150 and the return passage 154, which by-pass pipe mounts safety relief valve 202. Likewise, a set screw 204 may be threadedly mounted in a bore 206 formed in the control valve block 132 in

vertical alignment with the control valve element 138. Adjustment of this set screw 204 controls the extent to which the head 142 will unblock the opening to the return passage 154 when the control valve element is in its lowered position. In this manner the rate at which the power fluid is throttled through the control valve chamber 134 as the lifting piston 120 descends may be adjusted. This adjustment controls the speed of drop of the lifting piston. Another set screw 208 may be threadedly mounted in a bore 210 intersecting the lower portion of passage 170 for controlling the speed at which the control valve element 138 rises within its chamber 134. It should be further noted that the pressure relief valve 168 is designed to open when the lifting piston 120 is disposed with its underside resting upon the floor of the base member 112. With the lifting piston so disposed, its sidewalls will block the outlet of bore 146 to the entrance of pressurized power fluid. When the power fluid in passage 146 builds up sufficient pressure to open the pressure relief valve, it will flow into the lower end of the cylinder 110 through the passages 164 and 166 so as to cause the lifting piston to begin its upstroke. Once the sidewalls of the lifting piston have cleared the outlet to bore 146 the pressure relief valve 168 will again snap shut.

From the foregoing description it will be apparent that the preferred and alternate form of fluid actuated pumping jack embodying the present invention provide several advantages over heretofore-proposed devices of this nature. These embodiments are of extremely compact, light weight and simple design whereby they may provide trouble-free service. Additionally, they are very efficient in operation, offering a degree of control over their speed of reciprocation not generally possible in existing fluid actuated pumping jacks.

It will be apparent to those skilled in the art that various modifications and changes may be made with respect to the aforescribed embodiments of the invention without departing from the spirit of the invention or the scope of the following claims.

We claim:

1. Fluid actuated pumping jack apparatus for use with a source of pressurized power fluid, comprising: a vertical cylinder; a piston slidably disposed therein for axial reciprocal movement relative thereto; supply passage means for conducting fluid from said source to the lower portion of said cylinder; return passage means for conducting said fluid from the lower portion of said cylinder to said source; control valve means that includes a chamber disposed in said return passage means, and a control valve element slidably disposed in said chamber for at least partially blocking said return passage means when disposed in a first position, said element unblocking said return passage means when disposed in a second position; biasing means normally urging said valve element toward said second position whereby said supply and return passage means will be placed in communication through means which include said chamber; pilot valve means that include a chamber, a piston-type pilot valve element slidably disposed therein, and passage means cooperating with said pilot valve element for alternately connecting one end of said chamber with the high-pressure side of said source of fluid pressure whereby said control valve element will be urged toward said first position, and for venting said one end of said chamber whereby said biasing means may urge said control valve element to said second position; and, fluid conduit means connecting spaced points in said pilot valve chamber with vertically spaced points in said cylinder whereby movement of said pilot valve element shall be responsive to the position of said piston in said cylinder.

2. Fluid actuated pumping jack apparatus as set forth in claim 1 which includes means for adjusting the fluid-carrying capacity of said return passage.

3. Pumping jack apparatus as set forth in claim 1 where said control valve element is of the piston type

having a head and a collar axially spaced therefrom, the proximate ends of said head and collar being constantly exposed to the pressure existing in the lower portion of said cylinder, and the remote ends of said head and collar respectively being exposed to the pressure existing in said one end of said control valve chamber and to a pressure that is lower than the latter pressure.

4. Pumping jack apparatus as set forth in claim 3 where said biasing means includes spring means that constantly urges said control valve element toward said one end of said control valve chamber.

5. Pumping jack apparatus as set forth in claim 1 where said control valve element is of the piston type having a coaxial head and collar, said collar being of smaller diameter than said head and axially spaced therefrom, said collar also being disposed in a portion of said chamber that is of reduced diameter, the proximate ends of said head and collar being constantly exposed to the pressure existing in said cylinder below said piston, the remote end of said head being exposed to the pressure existing in said one end of said control valve chamber, and the remote end of said collar being exposed to the low-pressure side of said source of fluid pressure.

6. Pumping jack apparatus as set forth in claim 1 which includes means for controlling the extent of travel of said control valve element toward said one end of said control valve chamber so as to vary the fluid-carrying capacity of said return passage.

7. Fluid actuated pumping jack apparatus for use with a source of pressurized power fluid, comprising: a vertical cylinder; a piston slidably disposed therein for axial reciprocal movement relative thereto; supply passage means for conducting fluid from said source to the lower portion of said cylinder; return passage means for conducting said fluid from the lower portion of said cylinder to said source; control valve means that includes a chamber disposed in said return passage means, and a control valve element movably disposed in said chamber for at least partially blocking said return passage means when disposed in a first position, said element unblocking said return passage means when disposed in a second position; biasing means normally urging said valve element toward said second position whereby said supply and return passage means will be placed in communication through means which include said chamber; pilot valve means that includes a chamber, a piston-type pilot valve element slidably disposed therein, and passage means cooperating with said pilot valve element for alternately connecting one end of said chamber with the high-pressure side of said source of fluid pressure whereby said control valve element will be urged toward said first position, and for venting said one end of said chamber whereby said biasing means may urge said control valve element to said second position; said pilot valve element having a first area facing in one direction and two separate areas facing in the opposite direction; first fluid conduit means connecting said pilot valve chamber with the pressure existing in the lower portion of said cylinder whereby it may be applied to said first area; and second and third fluid conduit means respectively connecting said pilot valve chamber with a point in said cylinder above but adjacent the lowest elevation reached by said piston and with a point in said cylinder below but adjacent the highest elevation reached by said piston whereby the pressure existing in said cylinder at these points may be applied to said separate areas, said first area being at least equal to the larger of said separate areas.

8. Fluid actuated pumping jack apparatus as set forth in claim 7 where said control valve element is of the piston type having a head and a collar axially spaced therefrom, the proximate ends of said head and collar being constantly exposed to the pressure existing in the lower portion of said cylinder, and the remote ends of said head and collar respectively being exposed to the

pressure existing in said one end of said control valve chamber and to a pressure that is lower than the latter pressure.

9. Fluid actuated pumping jack apparatus as set forth in claim 8 where said biasing means includes spring means that constantly urges said control valve element toward said one end of said control valve chamber.

10. Fluid actuated pumping jack apparatus as set forth in claim 8 where said control valve element is of the piston type having a coaxial head and collar, said collar being of smaller diameter than said head and axially spaced therefrom, said collar also being disposed in a portion of said chamber that is of reduced diameter, the proximate ends of said head and collar being constantly exposed to the pressure existing in the lower portion of said cylinder, the remote end of said head being exposed to the pressure existing in said one end of said control valve chamber, and the remote end of said collar being exposed to the low-pressure side of said source of fluid pressure.

11. Fluid actuated pumping jack apparatus for use with a source of pressurized power fluid, comprising: a vertical cylinder; a piston slidably disposed therein for axial reciprocal movement relative thereto; supply passage means for conducting fluid from said source to the lower portion of said cylinder; return passage means for conducting said fluid from the lower portion of said cylinder to said source; control valve means that includes a chamber disposed in said return passage means, and a control valve element movably disposed in said chamber for at least partially blocking said return passage means when disposed in a first position, said element unblocking said return passage means when disposed in a second position; biasing means normally urging said valve element toward said second position whereby said supply and return passage means will be placed in communication through means which include said chamber; a pilot valve chamber having an enlarged portion and connected to one end of said chamber by a pair of spaced passages, one side of said pilot valve chamber being in communication with the high-pressure side of said source of fluid pressure by first fluid conduit means; second and third fluid conduit means, one of said means being connected at one of its ends to a point in said cylinder above but adjacent the lowest elevation reached by said piston, and the other of said means being connected at one of its ends to a point in said cylinder below but adjacent the highest elevation reached by said piston, said fluid conduit means being connected at their opposite ends to the opposite side of said pilot valve chamber and to the enlarged portion of said pilot valve chamber; means connecting the opposite side of said pilot valve chamber with said return passage means; and, a pilot valve element of the piston-type slidably disposed in said pilot valve chamber, said element having a collar disposed in said enlarged portion thereof and a land adapted to cooperate with said spaced passages for alternately connecting said one end of said control valve chamber with the first-mentioned side of said pilot valve chamber so as to urge said control valve element toward said first position, and for venting said one end of said control valve chamber into the opposite side of said pilot valve chamber whereby said biasing means may urge said control valve element to said second position.

12. Fluid actuated pumping jack apparatus as set forth in claim 7 where the first-mentioned passage means of said pilot valve means is disposed below the connection of said supply passage to the lower portion of said cylinder, a by-pass connects said first-mentioned passage means and said supply passage, and a downwardly acting pressure relief valve is interposed between said by-pass and said first-mentioned passage means.

13. Fluid actuated pumping jack apparatus of the type set forth in claim 12 where said control valve element is of the piston type having a head and a collar axially

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spaced therefrom, the proximate ends of said head and collar being constantly exposed to the pressure existing in the lower portion of said cylinder, and the remote ends of said head and collar respectively being exposed to the pressure existing in said one end of said control valve chamber and to a pressure that is lower than the latter pressure.

14. Fluid actuated pumping jack apparatus of the type set forth in claim 13 where a spring-urged detent extends into said pilot valve chamber to releasably engage spaced depressions formed in said pilot valve element.

15. Fluid actuated pumping jack apparatus for use with a source of pressurized power fluid, comprising: a vertical cylinder; a piston slidably disposed therein for axial reciprocal movement relative thereto; supply passage means for conducting fluid from said source to the lower portion of said cylinder; return passage means for conducting said fluid from the lower portion of said cylinder to said source; control valve means that includes a chamber disposed in said return passage means, and a control valve element movably disposed in said chamber for at least partially blocking said return passage means when disposed in a first position, said element unblocking said return passage means when disposed in a second position; biasing means normally urging said valve element toward said second position whereby said supply and return passage means will be placed in communication through means which include said chamber; a pilot valve chamber having a plug element closing one of its ends, said plug element being formed with an axial bore that is in communication with the lower portion of said cylinder; a pair of axially spaced passages connecting the intermediate portion of said pilot valve chamber with one end of said control valve chamber; an enlarged portion formed in said pilot valve chamber between its end opposite said plug and said spaced passages; a piston-type pilot valve element slidably disposed in said pilot valve chamber, one end thereof being formed with a pin element that reciprocates within the axial bore of said plug, said pin having flutes; a collar formed on said pilot valve element and disposed within the enlarged portion of said pilot valve chamber; a land formed on the intermediate portion of said pilot valve element, said land covering the spaced passage proximate said enlarged portion when said pilot valve element is disposed in a first position and uncovering said passage when the latter is disposed in a second position, said other spaced passage constantly remaining open, and said flutes cooperating with said bore to block flow of fluid into said pilot valve chamber when the latter is disposed in said first position; means connecting the portion of said pilot valve chamber between its enlarged portion and said spaced passages with said return passage; fluid conduit means connecting said enlarged portion with a point in said cylinder above but adjacent the lowest elevation reached by said piston; and, fluid conduit means connecting said opposite end of said pilot valve chamber with a point in said cylinder below but adjacent the highest elevation reached by said piston.

16. Fluid actuated pumping jack apparatus as set forth in claim 15 where said control valve element is of the piston type having a head and a collar axially spaced therefrom, the proximate ends of said head and collar being constantly exposed to the pressure existing in the lower portion of said cylinder, and the remote ends of said head and collar respectively being exposed to the pressure existing in said one end of said control valve chamber and to a pressure that is lower than the latter pressure.

17. Fluid actuated pumping jack apparatus as set forth in claim 16 which includes adjustment means for controlling the extent of travel of said control valve element toward said one end of said control valve chamber so as to vary the fluid-carrying capacity of said return passage.

18. Fluid actuated pumping jack apparatus as set forth

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in claim 17 where said adjustment means includes a set screw that extends into said one end of said control valve chamber so as to abut the proximate end of said control valve element in its second position.

19. Fluid actuated pumping jack apparatus as set forth in claim 15 where said biasing means includes a helical compression spring that constantly urges said control valve element toward said one end of said control valve chamber.

20. Fluid actuated pumping jack apparatus as set forth in claim 15 where said control valve element is of the piston type having a coaxial head and collar, said collar being of smaller diameter than said head and axially spaced therefrom, said collar also being disposed in a portion of said chamber that is of reduced diameter, the proximate ends of said head and collar being constantly exposed to the pressure existing in the lower portion of said cylinder, the remote end of said head being exposed to the pressure existing in said one end of said control valve chamber, and the remote end of said collar being exposed to the pressure in said return passage.

21. Fluid actuated pumping jack apparatus for use with a source of pressurized power fluid, comprising: a vertical cylinder; a piston slidably disposed therein for axial reciprocal movement relative thereto; supply passage means for conducting fluid from said source to the lower portion of said cylinder; return passage means for conducting said fluid from the lower portion of said cylinder to said source; control valve means that includes a chamber disposed in said return passage means, and a control valve element slidably disposed in said chamber for movement therein between a first position and a second position, said control valve element at least partially blocking said return passage means when disposed in its first position whereby said pressurized power fluid will cause said piston to rise within said cylinder, and said control valve element unblocking said return passage means, when disposed in its second position whereby said supply and return passage means will be placed in communication through means that include said chamber and said piston may descend within said cylinder; pilot valve means that include a second chamber, a piston-type pilot valve element slidably disposed therein, and passage means cooperating with said pilot valve element for alternately connecting one end of said control valve chamber with the high-pressure side of said source of fluid pressure whereby said control valve element will be urged toward said first position, and for venting said one end of said control valve chamber whereby said control valve element may return to said second position; and, fluid conduit means connecting spaced points in said pilot valve chamber with vertically spaced points in said cylinder whereby movement of said pilot valve element shall be responsive to the position of said piston in said cylinder.

22. Fluid actuated pumping jack apparatus for use with a source of pressurized power fluid, comprising: a vertical cylinder; a piston slidably disposed therein for axial reciprocal movement relative thereto; supply passage means for conducting fluid from said source to the lower portion of said cylinder; return passage means for conducting said fluid from the lower portion of said cylinder to said source; control valve means that includes a chamber disposed in said return passage means, and a control valve element slidably disposed in said chamber for at least partially blocking said return passage means when disposed in a first position whereby said pressurized power fluid will cause said piston to rise within said cylinder, said element unblocking said return passage means when disposed in a second position; biasing means normally urging said control valve element toward said second position whereby said supply and return passage means will be placed in communication through means which include said chamber whereby said piston may descend within said cylinder; pilot valve means that include a chamber, a pilot valve element movably disposed therein,

and passage means cooperating with said pilot valve element for alternately connecting one end of said control valve chamber with the high-pressure side of said source of fluid pressure whereby said control valve element will be urged toward said first position, and for venting said one end of said control valve chamber whereby said biasing means may urge said control valve element to said second position; and, fluid conduit means connecting spaced points in said pilot valve chamber with vertically spaced points in said cylinder whereby movement of said pilot valve element shall be responsive to the position of said piston in said cylinder.

23. Fluid actuated pumping jack apparatus for use with a source of pressurized power fluid, comprising: a vertical cylinder; a piston slidably disposed therein for axial reciprocal movement relative thereto; supply passage means for conducting fluid from said source to the lower portion of said cylinder; return passage means for conducting said fluid from the lower portion of said cylinder to said source; control valve means that includes a chamber disposed in said return passage means, and a control valve element slidably disposed in said chamber for movement therein between a first position and a second position, said control valve element at least partially blocking said return passage means when disposed in its first position whereby said pressurized power fluid will cause said piston to rise within said cylinder, and said control valve element unblocking said return passage means when disposed in its second position whereby said supply and return passage means will be placed in communication through means that include said chamber and said piston may descend within said cylinder; pilot valve means that include a second chamber, a pilot valve element movably disposed therein, and passage means cooperating with said pilot valve element for alternately connecting one end of said control valve chamber with the high-pressure side of said source of fluid pressure whereby said control valve element will be urged toward said first position, and for venting said one end of said control valve chamber whereby said control valve element may return to said second position; and, fluid conduit means connecting spaced points in said pilot valve chamber with vertically spaced points in said cylinder whereby movement of said pilot valve element shall be responsive to the position of said piston in said cylinder.

24. Fluid actuated pumping jack apparatus as set forth in claim 23 which includes means for adjusting the fluid-carrying capacity of said return passage.

25. Pumping jack apparatus as set forth in claim 23 where said control valve element is of the piston type having a head and a collar axially spaced therefrom, the proximate ends of said head and collar being constantly exposed to the pressure existing in the lower portion of said cylinder, and the remote ends of said head and collar respectively being exposed to the pressure existing in said one end of said control valve chamber and to a pressure that is lower than the latter pressure.

26. Pumping jack apparatus as set forth in claim 23 where said biasing means includes spring means that constantly urges said control valve element toward said one end of said control valve chamber.

27. Pumping jack apparatus as set forth in claim 23 where said control valve element is of the piston type having a coaxial head and collar, said collar being of smaller diameter than said head and axially spaced therefrom, said collar also being disposed in a portion of said chamber that is of reduced diameter, the proximate ends of said head and collar being constantly exposed to the pressure existing in said cylinder below said piston, the remote end of said head being exposed to the pressure existing in said one end of said control valve chamber, and the remote end of said collar being exposed to the low-pressure side of said source of fluid pressure.

28. Pumping jack apparatus as set forth in claim 23 which includes means for controlling the extent of travel of said control valve element toward said one end of said control valve chamber so as to vary the fluid-carrying capacity of said return passage.

29. Fluid actuated pumping jack apparatus of the type set forth in claim 23 where a spring-urged detent extends into said pilot valve chamber to releasably engage spaced depressions formed in said pilot valve element.

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