This invention relates to a pump jack means and, more particularly, to a hydraulically operated pump jack means used to pump oil wells and the like having a walking beam actuated by a dual acting piston and cylinder means. Still more specifically, this invention relates to a hydraulic pump jack means having a new and novel control means operable to uniquely regulate the oscillatory movement of an interconnected walking beam. Additionally, this invention relates to a hydraulic pump jack means; a frame means; a walking beam connected to the frame means; a power means connected to the beam to impart oscillatory movement thereto; and a control means connected to the power means operable to provide rapid control deceleration of the walking beam under a force of fluid compression prior to movement of the walking beam in an opposite direction thereby prolonging the life of the equipment and providing shock absorbing, quiet operation.

Various types of pump jack means are known to the art and include hydraulically actuated walking beams used to impart reciprocating movement to, for example, a pump polish rod in an oil well. The prior art devices present pump mechanisms requiring a large amount of repair and maintenance due to the large loads carried thereon in combination with the use of an oscillatory movement in order to reciprocate the pump polish rod. Therefore, the prior art devices cannot be used satisfactorily in marginal wells due to the high cost of utilizing a pump jack means that will operate continuously and economically with a minimum of initial investment. Additionally, the prior art hydraulically actuated pump jack means are subject to fluid lock in the piston-cylinder assemblies resulting in a stopping of the oscillatory movement of the walking beams at the extreme positions where reverse movement is to take place. Such a stoppage results in large losses of production and, therefore, requires frequent inspection of the pump jack means. Consequently, there is a great demand for hydraulic pump jack means to be used in the oil field business which are low in initial cost, economical to operate, substantially maintenance free, and readily portable from one location to another.

In preferred specific embodiments of the invention, a pump jack means is provided including a frame means having a pair of spaced upright support members known as a Samson post to which at the upper adjacent ends is pivotally connected a walking beam. A horseshoe assembly is connected to one end of the walking beam having means thereon for connection to a cable to reciprocate a pump polish rod on oscillatory movement of the walking beam. At the opposite end of the walking beam is a counter weight movable to control the speed and operation of the pump jack means in conjunction with a hydraulic power source means therefor. Mounted on the frame means is a hydraulic actuator means having an upright cylinder with a piston rod slidably mounted therein and pivotally connected to the walking beam adjacent the upright support members. The actuator means further includes an upwardly inclined control cylinder having one end pivotally connected to the frame means and containing a slidably movable control piston. The outer end of the control piston is connected to a cam plate which in turn is pivotally connected to the frame means and the lower end of the lift cylinder. A pump and motor assembly is used to provide high pressure operating fluid and has a fluid supply line connected therewith through first and second control valves to the lift cylinder and the control cylinder, respectively. The first and second control valves are connected to the respective cylinders by a linkage means and operable to control pivotal movement of the cam plate on approaching extreme positions of travel of the piston rod in the lift cylinder to effectively regulate reversing movement of the walking beam. The first and second control valve operate to effectively maintain a continuously fluid flow within the system so as to provide for a smooth and continuous operation of the walking beam through directional reversing stages for an effective and efficient pumping operation.

Accordingly, it is an object of this invention to provide a pump jack means that overcomes the above-mentioned disadvantages of the prior art devices.

Another object of this invention is to provide a pump jack means for producing new and novel reciprocating movement.

A further object of this invention is to provide a new and novel pump jack means having a walking beam, a lift cylinder assembly connected to the walking beam for imparting oscillatory movement thereto, and a control means operable to effectively control changes in direction of the walking beam in a shock absorbing manner to reduce wear and increase the life thereof.

Still another object of this invention is to provide a pump jack means having a walking beam movable in an oscillatory path and a control means to assure smooth, efficient movement of the walking beam.

Another object of this invention is to provide a pump jack means operated by fluid pressure having control means operable to maintain a continuous flow of the fluid pressure in the system thereby achieving a shock absorbing operation throughout the entire pumping movement.

One further object of this invention is to provide a pump jack means having a walking beam imparted with oscillatory movement by a hydraulic piston-cylinder assembly and a control means for regulating the supply of hydraulic fluid to the piston-cylinder assembly so as to provide for a smooth, shock absorbing continuous movement of the walking beam.

Still a further object of this invention is to provide a pump jack means which is economical to manufacture, durable in construction, simple to operate, substantially maintenance free, and of low cost operation.

Various other objects, advantages and features of the invention will become apparent to those skilled in the art from the foregoing discussion, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a top plan view of a preferred specific embodiment of the pump jack means of this invention;
FIG. 2 is a side elevation view of the pump jack means of this invention;
FIG. 3 is an enlarged fragmentary sectional view of a preferred specific embodiment of an actuator means of the pump jack means of this invention illustrating a control valve therefor in dotted lines for the purpose of clarity;
FIG. 4 is a side elevation view taken along lines 4-4 in FIG. 3;
FIG. 5 is an enlarged fragmentary sectional view of a preferred specific embodiment of a control valve of the pump jack means of this invention;
FIG. 6 is an enlarged fragmentary elevation view of a preferred specific embodiment of a control valve actuator mechanism of the pump jack means of this invention; and
FIGS. 7-10, inclusive, are schematic diagrams illustrating the operation of the pump jack of this invention in various stages of pumping movement.

The following is a discussion and description of preferred specific embodiments of the new pump jack means of this invention, such being made with reference to the drawings, whereupon the same reference numerals are used to indicate the same or similar parts and/or structure. It is to be understood that such discussion and description is not to unduly limit the scope of the invention.

Referring to the drawings in detail, and in particular to FIGS. 1 and 2, a pump jack means of this invention, indicated generally at 15, includes a basic supporting frame means 16, a walking beam assembly 18 pivotally connected to the frame means 16, a horsehead assembly 19 connected to one end of the walking beam assembly 18, and a hydraulic power actuator means 21 mounted on the frame means 16 operably connected to the walking beam assembly 18 to impart oscillatory movement thereto.

The frame means 16 has a pair of spaced parallel beams 23 interconnected at one end by a tubular member 25 welded thereto and at the opposite end by a pair of parallel adjacent plate members 27 and 28. Intermediate the tubular member 25 and the plate members 27 and 28, the beams 23 are interconnected by heavy base plate 30 thereby presenting a rigid, stable horizontal support section of the frame means 16. A pair of parallel upright beams or channels 32 and 33, collectively known as a Samson post, are spaced and welded to angle members 35 which are attached to the plate members 27 and 28. The channels 32 and 33 are given lateral stability by the angle members 35 secured thereto and interconnected as by bolts to each of the plate members 27 and 28, respectively. The upper open ends of the channels 32 and 33 are covered, respectively, by mounting plate 37.

The walking beam assembly 18 has a main body or walking beam 38 of 1-piece in transverse cross section having support brackets 39 at one end and a weight support 41 at the opposite end. Intermediate these ends is secured a pair of opposed shaft mounts 43 connected to a shaft 44 having its opposite ends carried in bearing mounts 46 secured to the mounting plates 37, respectively. It is seen that the shaft 44 extends above the upper surface of the walking beam 38 providing for depending pivotal movement thereof about the axis of the shaft 44. The weight support 41 consists of a channel member adapted to receive a plurality of weight members 48 as required to serve as a counter balance for the front end load including the horsehead assembly 19 connected to the opposite end of the walking beam 38.

The horsehead assembly 19 includes a horsehead 50 having a housing and main shaft assembly 52 pivotally mounted in the support brackets 39 secured to a pair of rearwardly projecting sections 54 which, in turn, are pivotally connected to downwardly extended rocker rods 55. The lower ends of the rocker rods 55 are pivotally connected to bearing connectors 57 secured to the angle member 35 of the frame means 16. The structure of the horsehead assembly 19 is substantially identical to that disclosed in the applicant's Patent No. 3,006,201 and further discussion thereof is not deemed necessary. It is seen that the walking beam 38 is pivotable about the shaft 44 in an oscillatory movement to reciprocate a cable or rod connected to a pumping plunger 62 with the pumpjack means 63 slidably mounted therein. The piston 63 is connected to a rod 65 having the upper end thereof pivotally connected to a pair of parallel, spaced support yokes 66 which are secured as by bolts to the walking beam 38 and positioned between the Samson post and the weight support 41. The lower end of the lift cylinder 62 is pivotally connected by a bolt 67 to a pair of spaced rocker or cam plates 69 (FIG. 4). The rocker plates 69 in turn are pivotally connected by a pin 71 to a pair of spaced angle members 73 secured as by bolts 74 to the base plate 30 of the frame means 16. It is seen, therefore, that the lower end of the lift cylinder 62 is movable in an arc about the pin 71 similar to a linkage movement and lateral movement of the upper end of the lift cylinder 62 is controlled by the connection of the piston rod 67 to the walking beam 38.

As shown in FIG. 4, the rocker plates 69 are of a substantially V-shape having the divergent outer end portions pivotally connected to the lift cylinder 62 and a connector head 76 of a piston rod 77, respectively. The other end of the piston rod 77 is connected to a piston or plunger 79 that is slidably mounted within a control cylinder 80. The lower or rearward end of the control cylinder 80 is pivotally connected to a bolt 82 carried in the angle members 73 of the frame means 16. The lift cylinder 62 and the control cylinder 80 with their respective pistons are substantially identical in structure and operation except, first, the shorter control cylinder 80 and plunger 79 are operable to pivot the rocker plates 69 about the pin 71 and, secondly, the lift cylinder 62 and its corresponding piston 63 are operable to raise and lower the walking beam 38 as will become obvious.

The control means 61 includes a motor 81 connected by multiple drive belts 83 to a fluid pump 84 all secured as by bolts to the frame means 16. The pump 84 can be of any type resulting in a constant pressure fluid output through a line 86 from a fluid supply through an inlet line 87. A reservoir tank 89 mounted between the channels 32 and 33 on the support section of the frame means 16 is connected through a cut-off valve 91 to regulate flow of the operating fluid through the control means 61 and into the reservoir 89. A pressure by-pass valve 92 connected to the outlet line 86 is operable to control the operating pressure of the entire system and to by-pass fluid flow to a bypass flow circuitry of the cut-off valve 91. The control means 61 includes first and second control valves 93 and 94 secured to the lift cylinder 62 and the control cylinder 80, respectively, for movement therewith.

As the first and second control valves 93 and 94 are substantially identical, the first control valve 93, as shown in FIG. 5, is a channel member control valve 93 having a cylindrical housing 95 having a valve piston 96 connected to a control rod 98 slidably mounted therein. The fluid under pressure enters the valve 93 through the line 86 and is connected through a conduit 101 to the control cylinder 80 operating to extend the plunger 79. Concurrently, the first control valve 93 is connected by another conduit 103 to the control cylinder 80 to convey exhaust fluid through a passageway 105 of the valve 93 into a line 107 for recirculating fluid into the reservoir tank 89. The cut-off valve 91 is connected to the line 107 to control the speed of movement of the control cylinder 80. The valve plunger 79 and integral control rod 98 are axially movable to a second position, as shown in dotted lines in FIG. 5, whereupon the conduit 103 now conveys high pressure fluid to the control cylinder 80 and the conduit 101 carries the exhaust fluid to the reservoir tank 89 thereby resulting in movement of the plunger 79 and interconnected rocker plates 69. It is obvious that the various conduits and lines are operable to convey either pressure or exhaust fluid depending on the positions of the first and second control valves 93 and 94.

As shown in FIGS. 2 and 6, the control rod 98 is of a substantial length having a first stop 106 adjacent the housing 95 and a second stop 109 operatively secured to the outer end thereof. A second control rod 109 has one end secured to an upper piston rod head 110 extending through an opening 111 in the second stop 108 and has a laterally extended projection 113 similarly mounted about the first control rod 98. Compression springs 115...
are mounted about the first control rod 98 between the second step 108 and the projection 113 and the first step 106 and the other hand on the opposite sides of a laterally extended actuating pin 121 secured to the head 107 of the piston rod 77. The second control valve 94 is similarly connected to the pressure fluid supply and the reservoir tank 89 by the lines 86 and 87, respectively, and housing lines 124 and 125 connected to the upper and lower ends of the lifter cylinder 62 for actuating the rod 89.

Additionally, a conduit 126 connects the valve 94 through the cut-off valve 91 to the reservoir tank 89 in order to control the speed of movement of the lift cylinder 62. It is seen, therefore, that the first and second control valves 93 and 94 are operated through a control linkage means to control direction of fluid flow and resultant movement of the plunger 79 and piston 63, respectively, at the extreme ends of their travel.

In the use and operation of the pump jack means of this invention as shown in FIGS. 7--10, inclusive, assume the pump jack is energized and presently operating to move the walking beam 38 counterclockwise, as viewed in FIG. 7, about the shaft 44 thereby moving the piston valve rod (not shown) counterclockwise. In this position, the piston 63 is moving upwardly under pressure fluid through the lines 86 and 125 with fluid exhaust through lines 124 and connected from the under side of the piston 63 to the reservoir tank 89. Concurrently, the rocker plates 69 have been pivoted clockwise, as viewed in FIG. 7 as far as possible under fluid pressure through conduits 103 and line 86. On approaching the uppermost travel of the second control rod 109, the projection 113 contacts the second step 106, and the resiliency of the spring 115, moves the first control rod 98 upwardly to reverse the direction of fluid flow in the first control valve 93 so as to move the plunger 79 counterclockwise and pivot the rocker plates 69.

On reaching the outermost travel of the plunger 79, as shown in FIG. 8, the actuator pin 121 contacts the stop 118 to actuate the piston rod 117 of the second control valve 94 and reverse fluid flow to the lift cylinder 63. More specifically, the rotation of the rocker plates 69 counterclockwise, as viewed in FIG. 8, results in a fluid compression above the lift piston 63 and a corresponding fluid expansion below the same resulting in a rapid and cushioned deceleration of the upper movement of the walking beam 38. After full rotation of the rocker plates 69 and resultant deceleration, the reversal of the second control valve 94 supplies fluid pressure through lines 86 and 124 to start movement of lift piston 63 downhill as shown in dotted lines in FIG. 8.

The walking beam 38 continues to rotate clockwise as viewed in FIG. 9, whereupon the projection 113 contacts the first step 106 through the spring 115 to axially move the first control rod 98 of the control valve 93 to reverse fluid flow to the control cylinder 88 to pivot the rocker 69 toward the position shown in dotted lines in FIG. 9. Similarly, this results in an expansion and contraction in the lift cylinder 62 above and below the piston 69, respectively, to rapidly decelerate the movement of the walking beam 38 as previously described.

On reaching the extreme of travel of the plunger 79 in the control cylinder 80, the actuator pin 121 contacts the stop 119 to return the second control valve 94 to the original position of FIG. 7. To supply fluid under pressure through line 125 to the lift cylinder 62 to elevate the rearward end of the walking beam 38. It is obvious that this cycle of operation will continue to repeat itself with the control means 61 of this invention operating to efficiently and effectively control the oscillatory movement of the walking beam 38 in a shock absorbing manner. Additionally, it is seen that the cut-off valve 91 and the pressure by-pass valve 92 are operable to control the speed of movement and the lifting force of the beam 38, respectively, and permit excess fluid to return to the reservoir 89.

The pump jack means of this invention presents a compact, portable structure that is efficient in use and operates to reduce shock and vibrations in a hydraulic piston-cylinder assembly resulting in longer life and decreased maintenance. The novel control means of this invention for reversing direction of movement of the walking beam operates under a continuous, uninterrupted fluid flow in the system thereby preventing any possibility of a fluid lock in the operating valves and piston-cylinder assemblies and such is an immense improvement over the prior art devices.

It is obvious that other types of control valves could be used resulting in reaction of the lift piston under the weight of the walking beam thereby eliminating the need for a fluid pressure supply to the upper end of the lift cylinder resulting in a power savings. Additionally, the pump means could be eliminated with the power assembly and control means operated by gas pressure found in the well being worked upon thereby resulting in a low-cost operation. Also, a control power source could be used to drive a plurality of spaced pumping units.

As will be apparent from the foregoing description of the preferred embodiment of applicant's pump jack means, relatively simple and inexpensive pumping means have been provided which is readily transportable to other locations and operable to achieve a highly efficient, low cost, and substantially maintenance-free structure readily usable, for example, in pumping oil wells whether of a marginal type or not.

While the invention has been described in connection with preferred specific embodiments thereof, it will be understood that this description is intended to illustrate and not to limit the scope of the invention, which is defined by the following claims.

1. A pump jack means comprising:
   (a) a frame means,
   (b) a walking beam pivotally connected to said frame means,
   (c) power means connected to said walking beam in operation imparting oscillating movement thereto,
   (d) control means connected to said power means operable at each extreme position of the oscillatory movement for rapid, controlled deceleration of said walking beam prior to movement thereof in an opposite direction,
   (e) said power means has a lift cylinder with a piston slidably mounted therein,
   (f) said piston having one end connected to said walking beam,
   (g) said cylinder has one end pivotally connected to a cam plate, and
   (h) said cam plate is pivotally connected to said frame means and pivotal to move said lift cylinder relative to said piston to decelerate movement of said walking beam on actuation of said control means.

2. A pump jack as described in claim 1, wherein
   (a) said power means has a control cylinder pivotally connected to said frame means and a piston member is slidably mounted within said control cylinder,
   (b) said piston member is pivotally connected to said cam plate, and
   (c) said control means operable to move said piston member and pivot said cam plate with resultant movement of said lift cylinder relative to said piston to decelerate movement of said beam.

3. A pump jack as described in claim 2, wherein
   (a) said control means operable to pivot said cam plate on approaching one extreme travel position
of said walking beam for controlled deceleration thereof.

4. A pump jack as described in claim 3, wherein
(a) said control means has a second control valve operably connected to said lift cylinder to pivot said cam plate on approaching the other extreme travel position of said walking beam for controlled deceleration thereof.

5. A pump jack as described in claim 1, wherein:
(a) said power means has a horizontal piston-cylinder assembly pivotally connected to said cam plate and said frame means, and
(b) said cam plate movable by said horizontal piston-cylinder assembly to move said cylinder for deceleration of the oscillatory movement at the extreme limits of movement.

6. A pump jack as described in claim 5, wherein:
(a) said control means has first and second valve members operably connected to said cylinder and said horizontal piston-cylinder assembly, respectively, and is operable on approaching extreme positions of the oscillatory movement of said walking beam to pivot said cam plate to decelerate movement thereof.

7. A pump jack described in claim 1, wherein:
(a) said power means includes a control cylinder having a plunger slidably mounted therein, and fluid supply means connected to said lift cylinder and said control cylinder,
(b) said piston has a shaft pivotally connected to said walking beam,
(c) said control cylinder has one end pivotally connected to said frame means,
(d) said cam plate is pivotally connected to said lift cylinder, said frame means, and said plunger is movable to move said lift cylinder relative to said piston, and
(e) said control means is operable to pivot said cam plate at extreme limits of oscillatory movement of said walking beam to compress fluid in said lift cylinder to achieve a rapid, smooth deceleration of said walking beam.

8. A pump jack means as described in claim 8, wherein:
(a) said control means has a first control valve secured to said lift cylinder and a second control valve secured to said control cylinder,
(b) said fluid supply means interconnects said first control valve and said second control valve to said control cylinder and said lift cylinder, respectively, and
(c) linkage means connects said first control valve to said shaft and said second control valve to said plunger operable to reverse direction of fluid flow into said lift cylinder and said control cylinder whereby movement of said piston to one extreme of said lift cylinder operates said first control valve to actuate said control cylinder and pivot said cam plate to decelerate said walking beam movement.

9. A pump jack means as described in claim 8, wherein:
(a) said linkage means is operable on extension of said plunger to actuate said second control valve and reverse fluid flow into said lift cylinder to move the same in the opposite direction.

10. A pump jack means comprising:
(a) a frame means,
(b) a walking beam pivotally connected to said frame means,
(c) power means connected to said walking beam in operation imparting oscillating movement thereto, said power means having a lift cylinder and a piston slidably mounted therein connected to said walking beam,
(d) control means connected to said power means, 
(e) a control cylinder and piston means connected to said power means and operable at each extreme position of the oscillatory movement of said walking beam for rapid, controlled deceleration of said walking beam by movement of said lift cylinder relative said lift piston prior to movement thereof in an opposite direction.

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PAUL E. MASLOUSKY, Primary Examiner.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,405,605

October 15, 1968

Milburn M. Ross

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 29, after "the" insert -- prior --. Column 7, line 42, claim reference numeral "8" should read -- 7 --. Column 8, line 15, "flund" should read -- fluid --.

Signed and sealed this 3rd day of March 1970.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents