APPARATUS FOR SERVICING AND OPERATING A RECIPROCAL WELL PUMP OR THE LIKE

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ABSTRACT
The apparatus includes a frame arranged for mounting adjacent a well bore and it may support a pulley generally above the well bore. A motor is mounted on the frame for providing a source of power and a reel having a supply of cable wound thereon is also mounted on the frame. A selectively attachable first drive connection is provided between the motor and the reel for rotating the reel to thereby pay out and take up the cable over the pulley at predetermined times to thereby lower and raise the pump in the well bore. There is also provided a selectively attachable second drive connection between the motor and the reel for imparting oscillating rotational motion to the reel at predetermined times. Line means, such as a wire line or cable, is connected to the reel and cooperative with the second drive connection for imparting reciprocal motion to the pump suspended in the well incident to the oscillation of the reel, thus eliminating the old walking beams which are conventional in the art with respect to well pumping, and at the same time, providing a simple, compact and economic unit for both servicing and operating the well pump.

11 Claims, 6 Drawing Figures
APPARATUS FOR SERVICING AND OPERATING A RECIPROCAL WELL PUMP OR THE LIKE

BACKGROUND OF THE INVENTION

a. Field of the Invention
This invention generally relates to an apparatus which is designed for both servicing and operating a reciprocal well pump, or the like, suspended in a well bore. More particularly, it is an apparatus which is designed to perform both the function of running a reciprocal well pump into the bore and removing the same from the well bore as well as operating the pump during the pumping stage.

b. Description of the Prior Art
Conventionally, downhole reciprocal well pumps have been operated by pumping units utilizing a Samson post, which in turn supports the traditional walking beam, which is oscillated at one end and supports the well cable or rod on the other end. When it becomes necessary to remove the pump from the well bore, usually a workover derrick or the like must be placed over the well bore for this purpose. The result is that there is usually a prime mover for both the pumping unit and the workover unit, and this entails considerable expense in servicing and pumping certain wells, particularly those operating on a marginal basis. A typical well workover unit is quite massive and expensive to move to the well site when servicing is required. Moreover, the servicing cannot be performed until the workover unit is placed in position, which may be delayed several hours, or days in some instances.

It is therefore an object of this invention to provide an improved apparatus which is useful for both servicing the well pump and thereafter running the same back into the well, as well as for effecting the pumping operation when the pump is in position. During operation as a pumping unit, the apparatus imparts a vertical motion to a flexible cable which actuates a conventional plunger type pump used to elevate fluid from the bottom of the well to the surface. The arrangement of the apparatus is such that there is eliminated the conventional Samson post and walking beam, which are traditional with respect to the pumping units of the prior art.

SUMMARY OF THE INVENTION

The apparatus of this invention is for servicing and operating a reciprocal pump, or the like, suspended in a well bore, and includes a frame arranged for mounting adjacent a well bore. This frame may support a pulley mounted generally over the well bore. Power means such as a reversible motor is mounted on the frame for providing a source of power. In addition, a reel is mounted on the frame and is provided with a supply of flexible cable wound thereon. The unit is also provided with a selectively attachable first drive means between the motor and the reel for rotating the reel to thereby pay out and take up cable at predetermined times to thereby lower and raise the pump in said well during servicing of the pump. The apparatus also includes a selectively attachable second drive means between the motor and the reel for imparting oscillating rotational motion to the reel at predetermined times. Line means are connected to the reel and cooperative with the second drive means for imparting reciprocal motion to the pump suspended in the well bore, incident to the oscillation of the reel. In those embodiments wherein a frame supports a pulley over the well bore, the cable or line means may be trained over such pulley.

Preferably, the second drive means includes a first annular drive member such as a sprocket for rotation by the motor through speed reduction means and a second annular drive member such as a sprocket connected to the wheel for rotation therewith. In addition, an endless drive member such as a chain is trained over the annular drive members, whereby the reel may be rotated for paying out or taking in flexible cable.

The first drive means may include a crank connected through speed reduction means to the motor for rotation thereby in one direction, with a pitman arm connected at one end to the crank and with the other end being operationally connected to the reel at a point spaced apart from the axis of rotation thereof, for imparting oscillating rotational motion to the reel incident to rotation of the crank in the one direction. The crank may be provided with a counterbalance arm connected thereto for rotation therewith, having a counterweight adjustably mounted thereon for the purpose of evening the work load.

The aforesaid line means may simply be an end portion of the cable paid out from the reel and connected to the pump plunger. Alternatively, and preferably, the line means is in the form of a wireline assembly having one end connected to the periphery of the reel and the other end trained over the pulley and connected to the pump plunger or cable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of the apparatus of this invention shown with the second drive means and the line means connected for oscillating the reel and effecting the pumping operation.

FIG. 2 is a somewhat enlarged partial sectional view taken generally along line 2—2 of FIG. 1.

FIG. 3 is a partial end elevation view taken generally along line 3—3 of FIG. 1.

FIG. 4 is a partial end elevation view taken generally along line 4—4 of FIG. 1.

FIG. 5 is a partial end elevation view taken generally along line 5—5 of FIG. 1.

FIG. 6 is a side elevation view generally similar to FIG. 1, but showing the apparatus connected in the mode for servicing the well pump and with the selectively attachable first drive means connected for that purpose, and with the second drive means disconnected.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, a frame arranged for mounting adjacent a well bore is generally designated by the numeral 11 and is comprised of a skid base 12, a pair of vertical front posts 13 mounted on base 12, and a pair of inclined support braces 14 mounted at an angle and connecting the top of post 13 with base 12. In addition, a pair of short braces 15 are connected to skid base 12 and to inclined braces 14 near the lower end thereof, as shown. A pulley 18 having three cable grooves is mounted on the top of post 13 by a shaft journaled in bearings 19.

A power means is mounted on the frame for providing a source of rotary power and this conveniently takes the form of a reversible electric motor 21, which is arranged to drive sheave 22 having belts 23 trained
thereover, which in turn are trained over sheave 24 mounted on high speed shaft 25, which in turn is connected to a conventional type gear reducer box 26. Gear reducer box 26 contains a train of gears which are arranged to rotate slow speed shaft 28 to effect the desired pumping speed. Shaft 28 also has mounted thereon a chain drive sprocket 29, as best shown in FIG. 3, which forms a part of the second drive means, which will be described hereinafter.

Shaft 28 forms a part of the first drive means and has crank 31 mounted thereon for rotation therewith. Crank 31 also has attached therewith a counterbalance arm 32 which has mounted thereon an adjustable or moveable counterweight 33. As shown in FIG. 1, crank 31 is selectively connected by wrist pin 35 to one end of pitman arm 36, with the other end being selectively connected by wrist pin 37 to the end of crank arm 38, which is mounted for rotation on shaft 39 journalled in a pair of block bearings 40 mounted on braces 14 near the upper end of braces 15. Alternatively, wrist pin 37 may be attached directly to reel 50 in certain embodiments, with such connection being of such radial distance from the axis of rotation of reel 50 to provide the desired length of pumping stroke.

Shaft 39 is of somewhat larger diameter between braces 14 as shown and has mounted thereon for rotation thereon a righthand (as viewed in FIG. 2) reel hub 42 having a flange 43 thereabout. Shaft 39 also has mounted thereon a lefthand (as viewed in FIG. 2) reel hub 45 to which is attached by welding or the like a hub flange 46 for rotation therewith. Hub flange 46 has a plurality of screw or bolt holes therethrough, the purpose of which will be explained hereinafter. Reel hub 45 also has mounted thereon for rotation therewith drive sprocket 48, the purpose of which will be explained hereinafter also.

Reel hubs 42 and 45 have mounted thereon a spool or reel generally designated by the numeral 50 having a supply of flexible cable 51 wound thereon and arranged for paying out and taking up thereon during rotation of reel 50. Reel 50 is comprised of a righthand flange 53 and a lefthand flange 54 as viewed in FIG. 2. Flange 54 is in the form of a drum flange for the purpose of applying brake shoes (not shown) so as to effect braking of rotation of the flange 54, which brake shoes are arranged for operation by brake lever 57 attached to base 12. In certain instances, it is desirable to change the relative position of reel 50 with respect to crank arm 38 and this is accomplished by a plurality of cap screws 55 which are passed through the holes in hub flange 46 and frictionally engage drum flange 54 or holes provided in flange 54.

It will thus be apparent that motor 21 causes crank 31 to rotate in a counterclockwise direction, as shown in FIG. 1, which in turn imparts an oscillating rotational motion to reel 50. This mode of operation is selected when it is desirable to conduct the pumping operation. In this operation, line means is connected to the reel and cooperative with the aforereferred second drive means for imparting reciprocal motion to the pump suspended in the well bore incident to said oscillation of the reel. As previously stated, this line means may either be the paid out end section 56 of flexible cable 51 or, alternatively and preferably, a wireline assembly generally designated by the number 59, as shown in FIGS. 1, 4 and 5, and which is comprised of a pair of wirelines 59 connected at the lower end to an arc plate 60, which is selectively attachable by bolts between flanges 53 and 54 of reel 50 about the periphery thereof.

The other ends of wirelines 59 pass over cable pulley 18 and are connected to carrier bar 62, which in turn is connected to pump cable 63, which passes downward through well head 65 to thereby suspend a reciprocal well pump (not shown) in the well bore at the determined height, and usually on support means provided in the well bore, such as a pump seat.

Slack end section 56 of flexible cable 51 terminates at cable clamp 67 which also is connected to carrier bar 62, as shown in FIG. 5 in particular. Thus, when wireline assembly 58 is being used as the line means, end section 56 of cable 51 is permitted to remain slack as shown in FIG. 1 such that the work load or pumping load is supported by wirelines 59 which are of generally somewhat sturdier construction and will therefore withstand greater wear than would end section 56.

It is thus apparent that during oscillation of reel 50 in the mode of operation shown in connection with FIG. 1, an oscillating motion is applied to wirelines 59 which in turn is applied to pump cable 63, which causes operation of the well pump to lift the fluids in the well bore. The distance which reel 50 is rotated is selected so as to oscillate the line means a distance equal to the pump stroke.

Referring now to FIGS. 6 and 3 in particular, construction and operation of the selectively attachable first drive means will now be explained. The first drive means includes an endless drive member in the form of drive chain 70 which is trained over sprocket 29 and drive sprocket 48. In this mode of operation, wireline assembly 58, including arc plate 66, will have been removed and flexible cable 51 paid out to lower the cable into the well bore or to suspend or lower the well pump in the well bore. This is accomplished by electric motor 21 which operates through drive belts 23 to turn sprocket 29, which in turn causes rotation of reel 50 in the direction shown in FIG. 6. It is to be understood that motor 21 is of the reversible type so that the cable 51 may be either paid out or taken up on reel 50 as desired. In this mode of operation, counterweight 33 is shifted to the null or balanced position as shown in FIG. 6.

In the mode of operation of the apparatus shown in FIG. 6, a hydraulic cylinder and piston assembly, generally designated by the numeral 71, may be employed for purposes of applying additional tension to flexible cable 51, as may be required, for example, when unseating a well pump. Assembly 71 is generally arranged for connection at one end to frame 11 and at the other end to flange 53 of reel 50 such that the working direction of the assembly is at a tangent to the periphery of reel 50, as will be explained hereinafter. As shown in FIG. 6, assembly 71 is comprised of a cylinder 72 pivotally attached at the end least to base 12 and is provided with a piston (not shown) to which is attached piston rod 73, which is connected to lug 74. Lug 74 is detachably secured to the periphery of flange 53, as shown in FIG. 6, by a bolt passing through one of the pluralities of holes in the periphery of flange 53. Hence, by operation of hydraulic cylinder and piston assembly 71, reel 50 may be rotated counterclockwise in short strokes to apply additional tension to flexible cable 51, as desired. During the sequencing of assembly 71, it is desirable to have means for holding reel 50 against rotation and this means is in the form of an adjustable locking means
which is selectively connectable between frame 11 and reel 50. This locking means conveniently takes the form of a turnbuckle assembly 76, the lower end of which is pivotally connected to base 12 and the upper end of which is connected by a lug 77 detachably connected to the periphery of flange 53, as shown.

The sequence of operations required to lower the bottomhole well pump into the well and put the pump into operation will now be described, it being first assumed that flexible cable 51 has been previously supplied on reel 50.

The wireline assembly 58, including wirelines 59 and arc plate 60, are removed from the apparatus, as is pitman arm 36. Counterweight 33 is shifted on counterbalance arm 32 such that crank 31 is statically balanced. Drive chain 70 is then installed on sprockets 29 and 48, such that the apparatus takes the configuration as shown in FIG. 6.

By operation of electric motor 21 in the desired direction, reel 50 is rotated in a clockwise direction as shown in FIG. 6, which causes flexible cable 51 to pay out over the center groove in cable pulley 18. The bottomhole pump is attached to the extreme end of flexible cable 51 and guided into well head 65. When the weight of the pump and flexible cable 51 in the well bore is sufficient to drive reel 50 by gravity, electric current to motor 21 may be terminated and the speed of the mechanical system can then be controlled by the application of braking pressure through brake level 57. When the well pump has been lowered and properly spaced and seated, the well is clamped off at the well head by well head clamp 64.

Reel 50 is then further rotated clockwise, as shown in FIG. 6, until crank arm 38 is pointing generally downwardly. At this point, reel 50 may be prevented from rotation by operation of the brake, at which point drive chain 70 is removed. Crank 31 is rotated so that counterbalance arm 32 is generally horizontal, as shown in FIG. 6, and pitman arm 36 is installed as shown in FIG. 1.

At this point, cap screws 55 are removed from reel hub flange 46 and reel 50 is rotated counterclockwise as shown in FIG. 1 until the end portion 56 of flexible cable 51 comes to a resting place within approximately a few inches of braces 14, as shown in FIG. 1, for example. It is to be understood that this slackening is accomplished if end portion 56 is not to be used as the line means as heretofore explained. At this point, cap screws 55 are reinstalled, thereby locking reel 50 to hub flange 46.

Wireline assembly 58 may then be installed by attaching arc plate 60 to the flanges of reel 50 as shown in FIGS. 1 and 4. It is to be noted that the upper end of arc plate 60 as shown in FIG. 1 is located at 180° opposite from crank arm 38 and wrist pin 37. Wirelines 59 are trained over the outside grooves of pulley 18 as shown in FIG. 5 and attached to carrier bar 62. Counterweight 33 is then adjusted on counterbalanced arm 32 for proper counterbalance.

At this point, well head clamp 64 may be removed and the pumping operation commenced. It will be observed that reel 50 is oscillated in a rotational direction at a distance which generally equals the pump stroke, while crank 31 and counterbalance arm 32 are continuously rotated in one direction.

When it becomes desirable or necessary to remove the pump from the well bore, the sequence of operations is basically reversed. The pumping operation is stopped by terminating current to motor 21 and well head clamp 64 is reinstalled at the well head.

The wireline assembly (including wirelines 59 and arc plate 60) and pitman arm 36 are removed. Drive chain 70 is reinstalled as shown in FIG. 6, and counterweight 33 is moved back to the static balance position on counterbalance arm 32. The electric motor is then operated to take up any slack in end section 56 of cable 51 by rotating reel 50 in a counterclockwise direction as shown in FIG. 6. Well head clamp 64 is then removed.

Hydraulic cylinder and piston assembly 71 is then installed and attached to the edge of flange 53 as shown in FIG. 6. By operation of assembly 71, additional tension can be imparted to flexible cable 51 by rotating reel 50 in a counterclockwise direction as shown in FIG. 6 to thereby unseat the bottom hole pump. Turnbuckle assembly 76 may be installed as shown to lock reel 50 in position while assembly 71 is repositioned for the next stroke or sequence. After the well pump has been unseated, the turnbuckle assembly 76 and hydraulic cylinder and piston assembly 71 are removed from reel flange 53.

At this point, by operation of motor 21, reel 50 is rotated in a counterclockwise direction as shown in FIG. 6 to thereby take in flexible cable 51, which lifts the well pump from the well bore.

It will thus be apparent that this invention provides an apparatus wherein the oscillation motion of the reel can be converted to full rotation by simple mechanical change for reeling in or pulling the flexible cable to which the well pump is attached. After the well pump has been repaired or serviced, the reel rotation is reversed to lower the pump to the bottom of the well. There are many advantages to the apparatus of this invention. It is a very compact and economical unit to manufacture and service. Only one prime mover is required for both the pumping operation and the well servicing operation. This invention eliminates the necessity of transporting a massive and expensive well servicing machine to each well when well pump servicing is required. Further, this apparatus provides well servicing capabilities which are readily available for use and can be effectively put into operation in a short period of time with a minimum crew. Stripper wells, for example, which are economically marginal producers can be serviced profitably with this apparatus. The standby expenses of conventional well pump servicing machines are eliminated while repairs are in process.

Further modifications and alternative embodiments of the invention will be apparent to those skilled in the art in view of this description. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the manner of carrying out the invention. It is to be understood that the form of the invention herewith shown and described is to be taken as the presently preferred embodiment. Various changes may be made in the shape, size and arrangement of parts. For example, equivalent elements or materials may be substituted for those illustrated and described herein, parts may be reversed, and certain features of the invention may be utilized independently of the use of other features, all as would be apparent to one skilled in the art after having the benefit of this description of the invention.
What is claimed is:

1. In apparatus for servicing and operating a reciprocal pump or the like suspended in a well bore, the combination comprising:
a frame arranged for mounting adjacent a well bore; 5
power means mounted on said frame for providing a source of power;
a reel mounted on said frame and having a supply of cable wound thereon;
selectively attachable first drive means between said power means and said reel for rotating said reel to thereby pay out and take up said cable at predetermined times to thereby lower and raise said pump in said well bore;
selectively attachable second drive means between said power means and said reel for imparting oscillating rotational motion to said reel at predetermined times;
and, line means connected to said reel and cooperative with said second drive means for imparting reciprocal motion to said pump suspended in said well bore incident to said oscillation of said reel.

2. The invention as claimed in claim 1 wherein: said frame supports a pulley mounted generally over the well bore;
and, said cable and line means are trained over said pulley during operation thereof.

3. The invention as claimed in claim 2 wherein said line means includes:
a plate detachably connected to the reel flange for rotation therewith;
and, a line connected to said plate at one end and with the other end trained over said pulley and arranged for connection to said pump.

4. The invention as claimed in claim 2 wherein said line means includes:
an end portion of said cable trained over said pulley and arranged for connection to said pump.

5. The invention as claimed in claim 1 wherein said second drive means includes:
a first annular drive member arranged for rotation by said motor;
a second annular drive member connected to said reel for rotation therewith;
and, an endless drive member trained over said annular drive members.

6. The invention as claimed in claim 1 wherein said first drive means includes:
a crank connected to said power means for rotation thereby in one direction;
and, a pitman arm connected at one end to said crank, with the other end of said pitman arm being operationally connected to said reel at a point spaced apart from the axis of rotation thereof for imparting oscillating rotational motion to said reel incident to rotation of said crank in said one direction.

7. The invention as claimed in claim 6 wherein:
the effective length of said crank is less than the distance between said point of connection to said reel and said axis of rotation, whereby an oscillating rotary motion is imparted to said reel by rotation of said other crank in one direction.

8. The invention as claimed in claim 6 wherein:
said crank has a counterbalance arm connected thereto for rotation therewith; and, a counterweight adjustably mounted on said counterbalance arm for rotation therewith to even the work load during pumping operations.

9. In apparatus for servicing and operating a reciprocal pump or the like suspended in a well bore, the combination comprising:
a frame arranged for mounting adjacent a well bore; power means mounted on said frame for providing a source of power;
a reel mounted on said frame and having a supply of cable wound thereon;
selectively attachable first drive means between said power means and said reel for rotating said reel to thereby pay out and take up said cable at predetermined times to thereby lower and raise said pump in said well bore;
selectively attachable second drive means between said power means and said reel for imparting oscillating rotational motion to said reel at predetermined times, said second drive means including a first annular drive member arranged for rotation by said motor, a second annular drive member connected to said reel for rotation therewith, and an endless drive member trained over said annular drive members;
line means connected to said reel and cooperative with said second drive means for imparting reciprocal motion to said pump suspended in said well bore incident to said oscillation of said reel;
an hydraulic cylinder and piston assembly having one end connected to said frame and the other end selectively connectable to a flange of said reel at a tangent thereto, whereby said reel can be rotated by operation of said hydraulic cylinder and piston assembly to thereby impart additional tension to said cable to thereby unseat said pump during removal thereof from said well bore.

10. The invention as claimed in claim 9 including:
adjustable locking means selectively connectable between said frame and said reel for holding said reel from rotation while said cylinder and piston assembly is arranged for another operational sequence.

11. In apparatus for servicing and operating a reciprocal pump or the like suspended in a well bore, the combination comprising:
a frame arranged for mounting adjacent a well bore; a cable pulley supported generally above said well bore by said frame;
a motor mounted on said frame for providing a source of power;
a reel mounted on said frame and having a supply of cable wound thereon;
selectively attachable first drive means including an endless drive member operationally connected between said motor and said reel for rotating said reel to thereby pay out and take up said cable over said pulley at predetermined times to thereby lower and raise said pump in said well bore;
selectively attachable second drive means including a pitman arm operationally connected between said motor and said reel for imparting oscillating rotational motion to said reel at predetermined times; and, line means connected to said reel and trained over said pulley and cooperative with said second drive means for imparting reciprocal motion to said pump suspended in said well bore incident to said oscillation of said reel.

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