PNEUMATIC-HYDRAULIC SYSTEM FOR WELL PUMPING OR DRILLING UNITS

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6 Claims. (Cl. 60—51)

1. This invention relates to a novel apparatus whereby a pump or drill rod may be readily reciprocated with respect to a pump casing utilizing the weight of the rod and the parts attached thereto for causing downward movement of the rod and providing a combination hydraulic and pneumatic means for elevating the pump or drill rod whereby a reciprocating up-and-down motion of the rod will be accomplished.

More particularly it is an aim of the present invention to provide a novel means for regulating the flow of a pressure medium for elevating the pump or drill rod and which is actuated in response to the movement of said rod.

Another object of the invention is to provide an apparatus capable of being utilized in conjunction with the pressure of a well whereby the well pressure may be readily substituted for the pneumatic means for accomplishing the elevation of the pump or drill rod.

Still a further object of the invention is to provide an apparatus of the aforesaid character of extremely simple construction which is readily portable and may be quickly and easily assembled over a well and quickly and easily attached to the pump or drill rod thereof.

Still a further object of the invention is to provide an apparatus wherein the pneumatic pressure medium will be secondarily utilized for cushioning the downward movement of the pump or drill rod and for checking its movement as it approaches a lowermost position.

Still a further object of the invention is to provide an apparatus employing a novel valve arrangement for regulating the flow of the pneumatic pressure medium forming a part of the combination hydraulic and pneumatic actuating means.

Numerous other objects and advantages of the invention will hereinafter become more fully apparent from the following description of the drawings, illustrating a presently preferred embodiment thereof, and wherein:

Figure 1 is an end elevational view of the apparatus;

Figure 2 is a side elevational view thereof;

Figure 3 is a top plan view of the apparatus;

Figure 4 is a vertical sectional view taken substantially along a plane as indicated by the line 4—4 of Figure 3;

Figure 5 is a vertical sectional view through another portion of the apparatus;

Figure 6 is a sectional view, partly in side elevation, showing the valve unit in one position, and

Figure 7 is a similar view showing the valve unit with the parts in another position.

Referring to the drawings wherein like characters of reference designate like or similar parts throughout the several views, 2 indicates a steel table which is supported by four or more downwardly and outwardly diverging legs 3 secured at their upper ends by bolts 4 or otherwise to the lower side of the table and resting with their lower ends upon the ground surrounding an oil or gas well (Figure 1).

A base plate 6 is secured to the top surface of the table by additional bolts 6 and is provided with a central thickened cylindrical portion 7 with threads for engagement with interior threads formed upon the lower portion of a main cylinder 9. The same is externally threaded at its upper marginal portion for engagement with the interior threads formed on the cylindrical flange 10 of a cap 11 having a central opening partly surrounded by a flange 13.

A piston 15 is slidably disposed in the opening of the cylinder and includes a hollow cylinder 16 having a reduced lower end portion surrounded by a ring 17. The ring is provided with a plurality of apertures parallel to the ring axis, each receiving a bolt 19 which is threaded with its upper end into the shoulder on the cylinder 16 above the reduced lower end portion. An upper inverted cup-like annular packing 20 surrounds the reduced lower end portion of the cylinder and is provided with a series of apertures for the bolts described and is clamped by the latter between the shoulder and the ring. A similar lower packing 21 surrounds the reduced cylinder portion and has apertures for the bolts the heads of which press it against the lower surface of the ring. The outer edges of the packings, preferably of leather, are in slidable engagement with the interior surface of the main cylinder 9.

The upper end portion of piston cylinder 15 is threaded into a cap 22 which is centrally apertured and has a flange 23 partly surrounding the aperture in which a pump rod 24 is secured. A bar 25 has a central opening for the flange 23 and is secured thereto by a collar 26 which bears on the upper side of bar 25 and is secured to the pump rod 24.

Cylinder 16 has a restricted bore portion 27 at its lower end to slidably receive a cylinder 28 which has exterior threads at its reduced lower end portion for engagement with the enlarged threaded upper end 29 of an opening 30 in the base plate 6 through which the piston rod 24...
loosely extends. Opening 30 registers with an opening 31 in table 2 through which pump rod 24 also extends. The guide sleeve 25 is interiorly threaded near its upper end to receive an exteriorly threaded plug 32 having a central opening through which the pump rod 24 reciprocally extends. The threads of the plug are formed on a lower reduced part which forms a shoulder with the remaining upper part of larger cross section. An annular leather packing 34 is clamped between the shoulder on the plug and the upper end of the guide sleeve 25 and engages with its peripheral edge against the inner surface of the cylinder 16.

The bar 28 has a tapped opening near both ends to receive the threaded upper end of a piston rod 36 which is further secured to the bar by upper and lower lock nuts 37. The lower end of each cushion piston rod 36 is reduced and threaded for insertion through the central aperture of an inverted cup-like leather packing 39 which is secured thereto by a nut 40 (Figure 4).

Each packing 39 engages with its peripheral inner surface of a cushioning cylinder 42 which is screwed into the lower end into a socket 43 formed in a bracket 44. Brackets 44 are attached by fastenings 45 to the main cylinder 9. Each cushion cylinder has an upper exteriorly threaded end engaged by a cap 46 which is centrally apertured for sliding engagement with the associated piston rod 36.

The upper ends of the main cylinder 9 and cushioning cylinders 42 are provided with vent openings 11a and 46a through which atmospheric air can enter during the down stroke and leave during the upward stroke.

The cushioning cylinders are further connected to the main cylinder by ties 48 (Figure 4). An electric motor 49 and a compressor 50 driven thereby are supported on the table 2 and connected by an air line 51 to the upper, air compartment 52 of a tank 53 which is supported by the table 2 and which also includes a lower compartment 54 separated from the air compartment 52 by a partition 55. The motor 49 is controlled by the pressure prevailing in the air chamber 52 by a switch 56 actuated by a conventional diaphragm-type pressure responsive switch actuator 57 which is connected to the pipe 51 and which is responsive to the pressure therein for causing the motor 49 to be energized when the pressure in the chamber 52 falls below a certain value.

As an alternative to the pressure creating means shown and described it is proposed to utilize the pressure of a gas well or the casing head pressure of an oil well to which the conduit 51 could be connected and the actuator 56a could then be utilized for regulating a shut-off valve (not shown) in the line 51.

A rod 57 is secured to and depends from one end of the cross head 26 and extends reciprocally through a guide 58, forming an outward extension of one of the brackets 44 and has a lower portion extending loosely through aligned openings 59 in the base 6 and table 2. The rod 57 has an upper collar 60 and a lower collar 61 adjustably secured thereto.

A valve, designated generally 62 is disposed adjacent said rod 57 and includes a housing 63 and a core 64 which is rotatably disposed in the housing 63. The core 64 has a stem projecting from one end thereof and extending from one end of the housing 63 and to which one end of a lever 65 is fixedly secured. The lever 65 has a bifurcated opposite, free end through which the rod 57 slidably extends and which is disposed on said rod between the collars 60 and 61.

As best illustrated in Figures 6 and 7, the valve housing 63 is provided with three circumferentially spaced bosses or ports 66, 67 and 68. A pipe 69 is connected at one end to the port 66 and opens at its opposite end into the tank chamber 52. A pipe 70 connects at one end to the port 67 and has its opposite end opening into the bottom of a cylindrical housing 71 of a valve 72. A pipe 73 connects the port 68 with the top of the cylindrical valve housing 71. The valve core 65 is provided with a substantially V-shaped passage 74 the legs of which communicate with the ports 66 and 67 when the lever 65 is in its lower position of Figure 6 and which legs communicate with the ports 67 and 68 when the lever 65 is in its other, raised position of Figure 7, for a purpose which will hereinafter become apparent.

The cylindrical valve housing 71 is provided with internal flanges 75 and 76 adjacent its upper and lower ends, respectively, and contains a valve body 77 in the form of a weighted piston which is reciprocally disposed therein between said flanges 75 and 76. The valve body 77 using 71 is provided with an exhaust port 78 which opens to the atmosphere and which is located between the flanges 75 and 76 and adjacent the upper flange 75. The valve housing 71 is also provided with an inlet port 79 35.

The upper ends of the main cylinder 9 and cushioning cylinders 42 are provided with vent openings 11a and 46a through which atmospheric air can enter during the down stroke and leave during the upward stroke.

A pair of branch conduits 84 lead from the conduit 69, adjacent the top of the tank 53 and are connected at their opposite ends to the cushioning cylinders 42 adjacent the bottom thereof and below the lowermost extremity of movement of the packing members 39 as seen in Figure 4. A pressure gauge 85B is mounted at the joint of the conduits 69 and 84 for indicating the air pressure in the chamber 52.

A conduit 86 (Figures 2 and 5) which communicates with the chamber 54, adjacent its bottom, connects with one end of a port 87 having an opposite end which opens into the bottom of the cylinder 8; said port 87 being formed in the thickened portion 71. The conduit 86 is provided with a manual shut-off valve 88. As seen in Figure 5, the tank chamber 54 is filled with an hydraulic medium such as oil as indicated at 99 to a level adjacent and below the connection of the pipe 82 with said chamber.

When the well pump or drill rod 24 is in its lowest position as seen in Figures 1, 2 and 4, the valve core 64 will be in its position of Figure 6 so that the compressed air in the tank chamber 52 can flow therefrom through the conduit 84 to the passage 74 and conduit 70 to the lower end of the valve housing 71. The air pressure in the lower end of the valve housing 71 will cause the valve body 71 to be moved to its uppermost position of Figure 6 uncovering the port 79 so that the compressed air from the tank chamber 52 can also flow to the lower end of the valve housing 71.
through the pipe 80. The compressed air from the pipes 10 and 80 will be discharged from the valve 72 through the pipe 82 into the hydraulic chamber 54 for producing a pressure on the hydraulic medium 55 contained therein, for forcing said medium through the pipe 86 and passage 87 into the master cylinder 9. The hydraulic medium 89 entering the lower end of the master cylinder 9 will exert an upward pressure on the packing members 21 and 26 for forcing the piston 22 upwardly carrying with said unit the rod 24 and piston rod 36 through the connection of the cross head 25 and collar 26. As these parts move upwardly the air will be vented from the cylinder 9 and cylinders 42 through the vent ports 11a and 46a, respectively. As the packing elements 39 move upwardly in the cushioning cylinders 42 compressed air will enter the lower ends of said cylinders from the tank chamber 52 through the conduits 84 for assisting the hydraulic medium in raising the piston or drill rod 24 and attached parts. As the parts previously referred to move upwardly, the rod 57, which is attached to the cross head 25 will likewise be carried upwardly so that as the pump rod 24 approaches the upper extremity of its movement the bottom collar 61 will engage the lever 65 for rocking said lever upwardly from its position as described in its position of Figure 7. When this occurs, the valve core 64 will be moved to its position of Figure 7 to shut off the flow of compressed air to the valve 72 from the conduit 69. The weight of the pump rod 24 and parts supported thereby will exert a pressure on the hydraulic medium 55 within the master cylinder 9 for forcing it back through the pipe 86 into the tank chamber 54 thereby expelling the air from said chamber 54 through the conduit 82 into the valve 72. This air from the conduit 82 will pass back through the pipe 70 and the passage 74 to the pipe 73 and into the upper end of the valve housing 71 for equalizing the pressure in the upper and lower ends of said valve housing so that the valve body 71 due to its weight will drop downwardly to its position of Figure 7 for shutting off the port 70 and so that the air can escape from the valve 72 through the exhaust port 78. As the pump rod 24 and connected parts move downwardly, the cushioning members 39 will be forced downwardly in the cylinder 42 for ejecting the compressed air therefrom back through the conduits 84 into the tank chamber 52 and the pressure of the air in the lower ends of the cushioning cylinders 42, due to the restricted size of the pipes 34, will check the downward movement of the pump rod 24 and connected parts. This downward movement will also be checked by the hydraulic medium 39 escaping back into the tank chamber 54 from the master cylinder 9. As the pump rod 24 approaches the lower extremity of its movement the upper collar 60 will engage the lever 65 and rock it downwardly back to its position of Figure 6 so that the operation, previously described, will be repeated. The cylinder 16 is guided in its reciprocating movement by its engagement on the guide sleeve 28 and in the flanged opening of the cap 11.

It will be readily obvious that the master cylinder 9 and associated parts may be of various lengths so that the lengths of the stroke of the pump rod 24 can thus be varied to any extent desired. As previously stated, when the air pressure in the tank chamber 52 falls below a predetermined value the switch actuator 56 will be operated due to a reduced pressure on the dia-

phragm, not shown, of said actuator 56 for actuating the switch 56 to energize the electric motor 49 so that the compressor 50 will be operated to supply compressed air to the tank chamber 52 to increase the air pressure therein.

Various modifications and changes are contemplated and may obviously be resorted to, without departing from the spirit or scope of the invention as hereinafter defined by the appended claims.

I claim as my invention:

1. An apparatus for imparting reciprocating motion to a rod comprising, a main cylinder, a main piston reciprocally disposed therein, a pair of cushioning cylinders supported by said main cylinder, a cushioning piston in each of said cushioning cylinders, means connecting the main piston and cushioning pistons, a pneumatic pressure means, a pneumatic chamber supplied by said pressure means, a chamber for an hydraulic medium connecting with the lower end of the main cylinder, means connecting the lower end of each cushioning cylinder with the air chamber, conduit means connecting said chambers for admitting air under pressure to the hydraulic chamber, a first valve interposed in a portion of the conduit means, and means operatively connected to the main piston for actuating said first valve as the main piston approaches either extremity of its movement, a rod connected to said main piston and reciprocated thereby for elevating the rod in response to the pneumatic and hydraulic pressure medium on the under side of the main piston and cushioning pistons, a second valve interposed in another portion of said conduit means including a housing having opposite ends connected to different parts of the conduit means leading from the first valve, a valve body slidably disposed in the housing and held adjacent one end of the housing by the pressure of the pneumatic medium in one position of the first valve and during upward movement of the pistons whereby the pneumatic medium can pass freely between the pneumatic chamber and hydraulic chamber, and said first valve being moved to its other position by its actuating means as the reciprocating rod approaches the upper extremity of its movement for admitting the pneumatic pressure to the other end of the valve housing to displace the valve body to a position for shutting off passage between the hydraulic chamber and pneumatic chamber and for releasing the hydraulic pressure from the main piston whereby the reciprocating rod and pistons will be carried downwardly by the weight of said rod.

2. An apparatus as in claim 1, and said valve body being disposed during the downward stroke of the rod to vent the pneumatic pressure medium from the hydraulic chamber to the atmosphere whereby the hydraulic medium can be forced back from the main cylinder into said hydraulic chamber.

3. An apparatus for imparting reciprocating motion to a rod comprising, a main cylinder, a reservoir containing an hydraulic medium connected to the lower end of said main cylinder, a main piston reciprocally disposed in said cylinder and connected to a rod to be reciprocated for elevating said rod in response to the pressure of the hydraulic medium on the underside of said piston, a cushioning cylinder containing a reciprocating piston, means connecting said cushioning cylinder piston to said rod for movement therewith, a pneumatic chamber connected to the lower end of said cushioning cylinder by a restricted pas-
sage, a conduit connecting said pneumatic chamber and reservoir, a valve unit interposed in said conduit for admitting the pneumatic pressure medium from said chamber to the reservoir during the upward movement of the main piston and rod, and means operatively connected to said rod for actuating said valve unit as the rod approaches the upper extremity of its movement for closing said conduit and for actuating the valve unit as the rod approaches the lower extremity of its movement for opening the conduit, said valve unit having a vent port which is opened by movement of the valve unit to a closed position for venting the upper portion of the reservoir to the atmosphere.

4. An apparatus as in claim 3, said valve unit including a pressure responsive element actuated when the valve unit is in a closed position for opening said vent port for bleeding the hydraulic medium from the main cylinder to said reservoir to permit the rod and pistons to be carried downwardly by the weight of said rod.

5. An apparatus as in claim 3, said valve unit including a pressure responsive element actuated when the valve unit is in a closed position for opening said vent port for bleeding the hydraulic medium from the main cylinder to said reservoir to permit the rod and pistons to be carried downwardly by the weight of said rod, the pneumatic pressure medium in said cushioning cylinder being forced back into said chamber by the downward movement of the cushioning piston to provide a cushioning means for checking the downward movement of said rod.

6. An apparatus as in claim 3, said valve unit including a pressure responsive element actuated when the valve unit is in a closed position for opening said vent port for bleeding the hydraulic medium from the main cylinder to said reservoir to permit the rod and pistons to be carried downwardly by the weight of said rod, and pressure responsive means actuated in response to the pressure in said chamber for replenishing the pressure medium in said chamber.

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