Nov. 6, 1962 J. K. BECKETT 3,062,290

APPARATUS FOR PERIODICALLY BACK FLUSHING A WELL

Filed Nov. 25, 1959 2 Sheets-Sheet 1

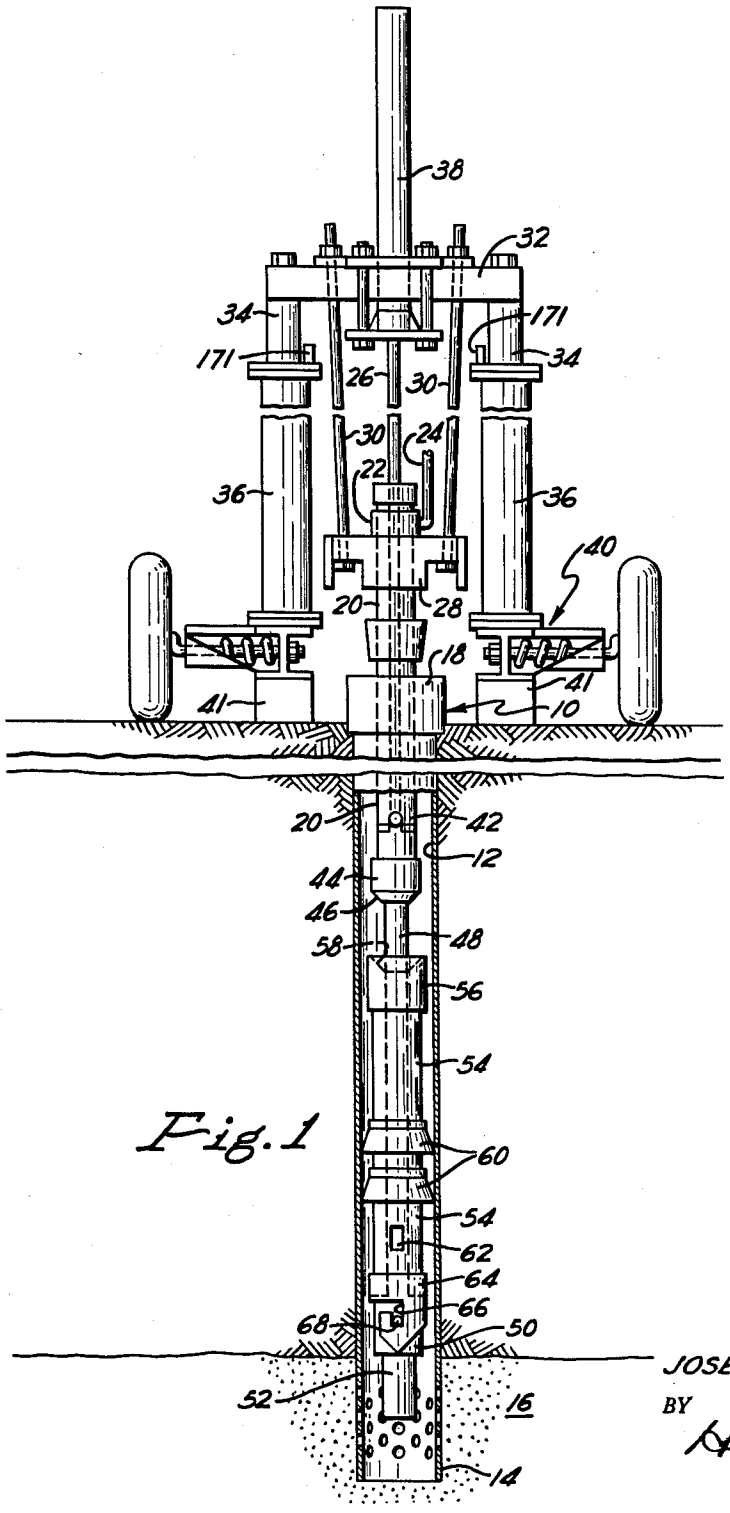


Fig. 1

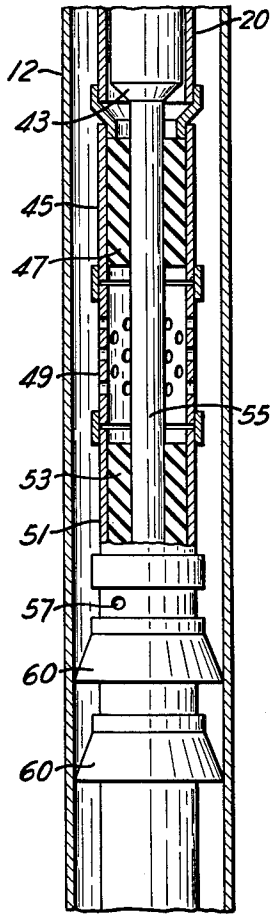


Fig. 3

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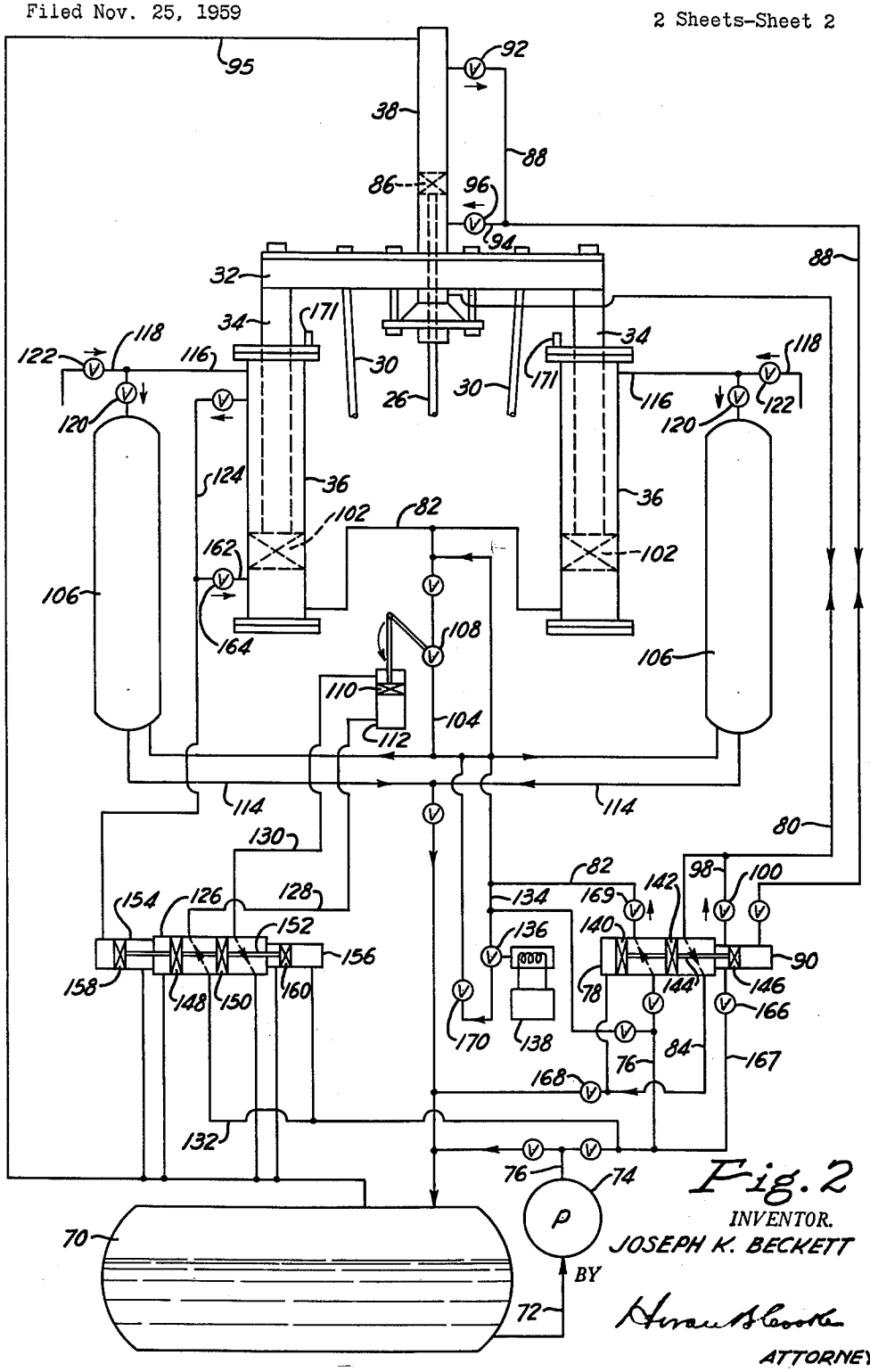


Fig. 2

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APPARATUS FOR PERIODICALLY BACK FLUSHING A WELL

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13 Claims. (Cl. 166—68)

This invention relates to a method of stimulating flow from oil wells and more particularly to a method of periodically reversing the direction of flow of liquids in an oil well to loosen and remove materials plugging passages in the producing formation.

During the production of oil, particularly from clayey, silty, or unconsolidated oil sands, frequently the formation around the well bore, or the perforated liner often used, becomes plugged and the rate of production decreases. The plugging may be caused by silt and sand packing in the formation or around the perforated liner. Another cause of the reduction in rate of production may be the deposition of waxy or asphaltic materials adjacent the borehole. In some instances swelling clays, water, silt or any combination of them may plug the capillary passages in the formation.

When the rate of production of oil from the well drops to an uneconomic level, it becomes necessary to treat the well to remove or overcome the cause of the plugging. The conventional methods of treating involve the washing of the producing formation with solvents or chemicals, back flushing the formation and liner gravel packs in the well, and fracturing the formation followed by packing sand in the resultant fractures. These procedures require moving a well work-over rig to the well to actuate bottom hole tools designed for the particular cleaning operation. The cost of moving a work-over rig to a well for the unplugging operation is substantial. When it becomes necessary to treat the well at frequent intervals to combat the plugging, the cost of the work-over equipment becomes excessive. Moreover, it has been found that when conventional back flushing procedures have been employed in geologically young, substantially unconsolidated oil sands, the producing formation is often disturbed to such an extent that it is more costly to repair the damage done during the back flushing than to perform the original back flushing operation.

This invention resides in apparatus for periodically producing gentle reversals of the direction of flow in an oil well to agitate silt and other materials plugging the formation to cause a redistribution of that material whereby some of it passes into the well bore and is pumped out of the well. In the apparatus of this invention, a tubing string through which production from the well is delivered, is supported by pistons adapted to move up and down periodically in a hydraulic ram cylinder. Downwardly acting swabs on the tubing string engage the casing and upon lowering of the tubing string cause flow from the borehole of the well out into the producing formation.

In the drawings:

FIGURE 1 is a diagrammatic view in elevation showing the well and hydraulic ram cylinders for supporting tubing within the well. The casing of the well is partially broken away for illustration of the mounting of the swabs on the tubing string.

FIGURE 2 is a diagrammatic view of the hydraulic ram cylinder which supports the tubing string and a hydraulic pump cylinder for driving an oil well pump with the hydraulic power oil lines and control valves for automatically and periodically causing reversal of flow in the well.

FIGURE 3 is a diagrammatic view, partly in vertical section, of a second arrangement for facilitating running the tubing string into the well.

Referring to FIGURE 1 of the drawings, a well indicated generally by reference numeral 10 is illustrated with casing 12 set in the well and provided at its lower end with a perforated casing liner 14 through which formation fluids flow into the well. The perforated casing liner 14 extends through the producing formation 16 which is to be back flushed with the apparatus of this invention. Casing 12 is closed at its upper end with a casing hanger 18 equipped with suitable seals to allow vertical movement of a tubing string 20 through the casing hanger while maintaining pressure, if desired, in the annulus between the tubing string 20 and casing 12. Casing hanger 18 is mounted on conventional fittings, not shown, at the well head.

The tubing string 20 is provided at its upper end with a tubing head 22 having a side outlet for connection with a production delivery line 24. Extending upwardly from the tubing head 22 is a sucker rod 26 for driving the plunger of a reciprocating oil well pump connected in the tubing string. The oil well pump is of conventional design and may be, for example, of the tubing liner type or the rod retrievable type. The tubing head 22 is supported on a tubing head hanger 28 which in turn is suspended by rods 30 from a beam 32. The ends of the beam 32 are supported by a pair of spaced piston rods 34 extending upwardly from spaced vertical hydraulic ram cylinders 36. Piston rods 34 are connected at their lower ends to pistons, not shown in FIGURE 1, which are movable vertically in the hydraulic ram cylinders 36.

Mounted on the beam 32 is a vertical hydraulic pump cylinder 38. The sucker rod 26 extends upwardly into the hydraulic pump cylinder 38 for connection with a piston, not shown in FIGURE 1, in that cylinder. The hydraulic pump cylinder 38, tubing head 22, and tubing head hanger 28 are all carried by the beam 32 mounted on the piston rods 34 and move vertically as a unit. For convenience in description of the invention, the apparatus supported by the piston rods 34 for suspending the tubing string 20 and mounting the pump cylinder 38 are referred to collectively as a tubing mounting. For convenience in moving the apparatus at the well head from one well to another, the hydraulic ram cylinders 36 and apparatus supported from them are mounted on a carriage, indicated generally by reference numeral 40. The carriage 40 is supported in place at the well on suitable blocks 41.

Connected in the tubing string 20, preferably a short distance above the producing formation 16, is the oil well pump, the lower standing valve of which is indicated by reference numeral 42. Directly below the standing valve 42 and connected in the tubing string is a tubing collar 44 having a beveled lower surface at 46. A tubular mandrel 48 in open communication with the tubing string 20 extends downwardly from the tubing collar 44. A lower mandrel collar 50 of larger outside diameter than the mandrel 48 is connected to the lower end of the mandrel 48 and is in turn connected to a tubing tail 52 through which production entering through the perforated liner 14 flows into the mandrel and then the tubing string.

Enclosing the mandrel 48 is a jacket 54 having an inner diameter larger than the outer diameter of the mandrel to provide an annular space between the jacket and the mandrel through which liquid can flow. An upper jacket collar 56 at the upper end of the jacket has an internally beveled surface 58 at its upper end adapted to engage the lower beveled surface 46 on the tubing collar 44 when the jacket 54 moves to its uppermost position on the mandrel 48. Mounted on the jacket 54 and extending outwardly therefrom to engage the casing 12 are downwardly acting swabs 60. In FIGURE 1, the swabs are

illustrated as downwardly opening cups which, on downward movement of the jacket 54, will force fluids in the annulus between the casing 12 and the jacket downwardly to cause the desired reversal of flow. Any desired number of swabs 60 may be used. Below the swabs is a port 62 extending through the jacket to allow flow from the annular space below the swabs between the jacket 54 and the casing 12 into the annular space between the jacket and the tubular mandrel 48 when the tubing string is run into the well.

A bottom jacket collar 64 having a J-slot 66 is connected to the lower end of the jacket. Bottom jacket collar 64 fits slidably over the lower mandrel collar, but is limited in its downward movement relative to the mandrel by a shoulder extending inwardly to bear against the upper end of collar 50. Prior to running the tubing string into the well, the jacket 54 is moved downward on the mandrel 48, and rotated to position a pin 68 extending from the lower surface of the lower mandrel collar in the J-slot 66 after which the jacket 54 is raised on the mandrel to the position illustrated in FIGURE 1. Engagement of the pin with the lower jacket collar 64 pulls the jacket downwardly as the tubing is lowered. Fluids in the well are able to by-pass the swabs 60 by entering port 62 and flowing upwardly through the annular space between the jacket 54 and the mandrel 58. The fluids are discharged into the annulus between the tubing string 20 and the casing 12 at the upper end of upper jacket collar 56. When the tubing string has been lowered to the desired depth, at which the swabs 60 are preferably positioned immediately above the perforated liner 14 at the end of the downstroke during the operation of the swabs, the tubing string is raised to raise the pin 68 to the horizontal portion of the J-slot and the tubing is then rotated a quarter turn to the right. The tubing string is then lowered to disengage the pin 68 from the J-slot 66 and bring the lower beveled surface 46 into contact with the beveled surface 58 to prevent flow between the jacket 54 and the mandrel 48. The pump is then run in the tubing and landed just above the tubing collar 44.

Another by-pass arrangement for running the swabs 60 into the well on the tubing string is illustrated in FIGURE 3 of the drawings. A pump shoe 43 at the lower end of a rod retrievable pump is held in tubing string 20 by a suitable pump hold down, not shown, which may be of either the top lock or bottom lock type. Connected in tubing string 20 directly below the level of the pump shoe 43 is an upper spool 45 having sealing means 47 positioned within it. Below the upper spool 45 in the tubing string is a perforated nipple 49. A lower spool 51 having internal sealing means 53 is connected in the tubing string 20 below the perforated nipple 49. The swabs 60 are connected in the tubing string 20 below the lower spool 51. A gas vent 57 may be provided below the sealing means 53 and above swabs 60 for release of gas liberated from well fluids below the sealing means.

Extending downwardly from the pump shoe 43 is a tubular stinger 55. Stinger 55 is long enough to extend past the perforated nipple 49 and into the lower spool 53. The outside diameter of stinger 55 is such that the stinger engages sealing elements 47 and 53 to prevent leakage into the tubing string 20 from the annular space between the tubing string and casing 12. Stinger 55 may be a section of an oil well pump plunger and sealing elements 47 and 53 sections of pump liners to provide the desired seal.

When the apparatus used in FIGURE 3 is used, the tubing string 20 is run into the hole before installation of the pump with the lower end of the tubing string 20 open. Fluids in the bore hole below the swabs 60 enter the lower end of the tubing string 20, flow up through it to the perforated nipple 49, and then flow outward through the perforated nipple. After landing the tubing string 20 at the desired depth, the rod retrievable pump, with the tubular stringer 55 attached to its lower end, is run into the tubing string.

Referring to FIGURE 2 of the drawings in which apparatus for driving the pistons in the several hydraulic cylinders and controlling the downswabbing operation is illustrated, a reservoir for a hydraulic power oil is indicated by reference numeral 70. A line 72 connects the bottom of the reservoir with a pump 74 which supplies pressure to the power oil to operate the other equipment. Pump 74 may be driven by an internal combustion engine, an electric motor, or any other energy source available at the well. A line 76 from the outlet of the pump is connected to a four-way control valve 78 which controls the flow of the power oil to deliver it alternately to the hydraulic pump cylinder 38 and hydraulic ram cylinder 36 and thereby cause the downswabbing operation.

Connected to the outlets of the four-way control valve 78 are a hydraulic pump power oil line 80, a hydraulic ram cylinder power oil line 82 and a drain line 84. The power oil line 80 is connected into the lower end of hydraulic pump cylinder 38 below a piston 86 therein from which sucker rod 26 is suspended. Extending from the hydraulic pump cylinder 38 near its upper end is a pilot line 88 which is connected into a control cylinder 90 in the four-way valve 78. A one-way valve 92 in pilot line 88 permits flow only in the direction from the upper end of the hydraulic pump cylinder 38 to the control cylinder 90. Connecting pilot line 88 with the hydraulic pump cylinder 38 to allow release of pressure in the pilot line at the end of the down stroke in cylinder 38 is a bleed line 94. A one-way valve 96 in line 94 allows flow only from line 88 into the hydraulic pump cylinder 38. Power oil collecting in cylinder 38 above piston 86 is returned to reservoir 70 through a vent line 95 from the top of cylinder 38.

A pressure relief line 98 connects the end of the control cylinder 90 opposite the connection with pilot line 88 to hydraulic pump power oil line 80. A valve 100 in line 98 permits free flow only from the control cylinder 90 to the line 80 but is provided with an internal needle valve which allows restricted flow in the reverse direction. Because the hydraulic pump cylinder 38 is mounted on the tubing mounting and moves up and down with the piston rods 34, the power oil line 80 and the pilot line 88, vent line 95, and the production line 24, are flexible lines of sufficient length to accommodate the changes in elevation of the equipment supported by the tubing mounting.

Hydraulic ram cylinder power oil line 82 extends from the control valve 78 to the lower end of the hydraulic ram cylinders 36 to supply the power oil for raising the pistons 102 in the cylinder. A power oil discharge line 104 is connected into line 82 and to dashpots 106 for draining power oil from the cylinders 36 at the end of the upward stroke. Flow through the discharge line 104 is controlled by a valve 108 actuated by a piston 110 in a valve control cylinder 112. Return lines 114 extend from the lower end of the dashpots 106 to the reservoir 70.

Connecting the upper end of each of the cylinders 36 with the corresponding dashpot 106 is a vent line 116, each of which is provided with an air inlet line 118. Check valves 120 and 122 permit flow from the upper end of the hydraulic ram cylinder 36 into its corresponding dashpot 106 during upward movement of the pistons 102 and allow air to flow into the upper end of the hydraulic ram cylinders 36 during the downstroke of the pistons 102.

A reversal line 124 extends from the upper end of one of the hydraulic ram cylinders 36 to a reversal control valve 126, which valve controls delivery of power oil to the cylinder 112 to control the operation of valve 108. Lines 128 and 130 from the reversal control valve 126 are provided for flow of power oil to and from cylinder 112. Power oil for operation of the cylinder 112 is supplied to the reversal control valve 126 from a line 132

leading from the power oil pump discharge line 76. The pressure release line 134 is connected into power line 82 between the control valve 78 and valve 108 and is tied into the discharge line 104 for release of power oil to reservoir 70 via dashpots 106. Flow through pressure release line 134 is controlled by a solenoid operated valve 136 which, in turn, is energized by a time switch 138. During the normal operation of the well, solenoid valve 136 is open to provide a by-pass to the reservoir 70 short-circuiting the hydraulic ram cylinders 36. Only when the solenoid valve 136 is closed is the power oil delivered to cylinders 36 under sufficient pressure to raise the pistons 102.

In the control valve 78 are a pair of pistons 140 and 142 mounted on a single piston rod 144 which extends through the end of the control valve into the control cylinder 90. A third piston 146 is mounted on the piston rod 144 in the control cylinder 90. A similar piston arrangement is provided in reversing control valve 126 to direct power fluid from the line 132 alternately to line 128 or line 130. Pistons 148 and 150 are mounted on a common piston rod 152 which extends into a control cylinder 154 at one end of the reversal control valve 126 and a return cylinder 156 at the other end of the valve. Pistons 158 and 160 are mounted on piston rod 152 in cylinders 154 and 156, respectively. Piston 158 has a larger effective diameter than piston 160 whereby the piston rod 152 is moved to the right when power oil is delivered through line 124 to valve 126. The several power lines are also preferably provided with manually operated valves as indicated in FIGURE 2 to allow manual downswabbing of the well.

Referring to FIGURE 2, in the operation of the apparatus illustrated, the tubing string 20 is suspended from rods 30 at the desired depth and prepared for operation by unlocking the J-slot locking device in the manner previously described and the rod retrievable reciprocating oil well pump run into and landed in the tubing. The pistons 102 are at the lower end of cylinders 36 during normal production from the well. The piston rod 144 in control valve 78 is manually moved to the right to start operation by opening a valve 166, in a line 167 connecting line 76 and control cylinder 90, and thereby putting line 76 in communication with hydraulic pump power oil line 80. Valve 166 is closed after the piston rod 144 has been moved to the right. Power oil is delivered from line 76 through valve 78 and line 80 into cylinder 38 to raise the piston in that cylinder and lift the plunger of the pump in the tubing string. When the piston rises above the outlet from cylinder 38 into pilot line 88, pressure is applied on the right-hand side of the piston 146 in control cylinder 90 to move the piston rod 144 to the left because of the larger effective diameter of right-hand face of piston 146 resulting from the piston rod extendinig from its left-hand face. Fluid to the left of piston 146 in control cylinder 90 is discharged through pressure relief line 98 as the piston rod 144 moves to the left to uncover the outlet to power oil line 82. Power oil drains from cylinder 38 through power oil line 80, the cylinder of the control valve 78, and drain line 84 into the reservoir 70. As the power oil drains from cylinder 38, the piston 86 moves downward for the downstroke of the oil well pump. The speed of the down stroke can be controlled by a valve 168 in drain line 84.

When piston 144 is at the position illustrated in FIGURE 2, the power oil is delivered from line 76 through pressure control valve 78 into hydraulic ram power oil line 82. At this stage of the cycle, valves 108 and 136 are closed and the power oil is forced into the lower portion of the hydraulic ram cylinders 36 to raise the pistons 102 in those cylinders and, hence, raise the entire tubing string 20 in the well. When the piston 102 moves above the outlet from the cylinder 36 to reversal line 124, power oil flows through reversal line 124 to apply pressure on the left end of the piston 158 in cylinder 154 of reversal control valve 126. The larger diameter of piston 158 compared to piston 160 causes the piston rod 152 to move to the right from its normal position biased to the left by the pressure on piston 160. Movement of the piston rod and pistons 148 and 150 to the right uncovers the opening to line 130 and thereby applies pressure to the top of piston 110 in cylinder 112, and at the same time uncovers ports so line 128 will drain oil from bottom side of piston 110.

Downward movement of piston 110 opens valve 108 and allows fluid to drain from the bottom of the cylinders 36 into the dashpots 106 under the pressure exerted by the weight of tubing string 20 and other equipment on the piston rods 34. Continued flow of the power oil into the dashpots 106 compresses air in the upper portion of the dashpots which decelerates the downward movement of the pistons 102 and thereby minimizes shock damage to the tubing string. Power oil flows from the lower end of the dashpots 106 into the reservoir 70 as drainage from the hydraulic ram cylinders 36 continues. When the pistons 102 drop below a pressure relief line 162 from the reversal line 124 to the cylinder 36, a check valve 164 in line 162 allows relief of the pressure in reversal line 124 whereupon the piston 152 again moves to the left to put line 132 in communication with line 128 and raise piston 110 in cylinder 112. Line 130 is thereby placed in communication through valve 126 with reservoir 70. The raising of piston 110 closes valve 108 to put the system in condition for another raising of the pistons 102 in the hydraulic ram cylinders 36.

During the period that power oil is delivered to the bottom of cylinders 36, power oil in cylinder 38 drains through line 80 and control valve 78 to drain line 84 and then into the reservoir 70. A valve 168 in drain line 84 controls the speed of the downstroke of the piston 86 and, therefore, the oil well pump. When the piston 86 drops below the opening of bleed line 94 into hydraulic pump cylinder 38, the pressure in pilot line 88 is relieved through the one-way valve 96 and the piston rod 144 in control valve 78 then moves to the right because of the higher pressure below piston 86 than above and again places line 80 in communication with line 76. Pistons 140 and 142 in the control valve 78 are then positioned to put power oil line 76 in communication with line 80 for another stroke of the oil well pump. At this time flow backward through line 82 to valve 78 is prevented by a check valve 169.

It may be necessary to downswab the well to reverse the flow of fluids in the well at frequencies ranging from 2 or 3 strokes per hour to one stroke a day or even less. Frequency of the downswabbing operation is controlled by suitable adjustment of the time switch 138 to close solenoid valve 136 at the desired intervals. Normally, during the period solenoid valve 136 is open and power oil is draining from the hydraulic pump cylinder 38, the power oil delivered by pump 74 merely circulates through power oil line 82, pressure release line 134, discharge line 104 and return line 114 to the reservoir 70. When the time switch 138 energizes the solenoid to close valve 136, power fluid is then directed to the hydraulic ram cylinders 36 to raise the pistons 102.

Damage to the equipment in the event that solenoid valve 136 should open when the pistons 102 are in the upper position is prevented by a valve 170 in pressure release line 134, and stops 171. The valve 170 controls the rate of flow through line 134 and thereby controls the speed of downward movement of the pistons 102. Stops 171 limit the extent of downward movement resulting from opening of valve 136.

Upon opening of valve 108 and flow of power oil into the dashpots 106, the weight of the tubing string 20 causes downward movement of the pistons 102, tubing hanger, and tubing string. Lower tubing collar 44 moves against upper jacket collar 56 to prevent flow therebetween and then forces the jacket 54 and swabs 60 downwardly to cause the desired downswabbing. In a typical installation, the length of cylinders 36 is such that a downstroke of

swabs 60 of the order of ten feet is obtained. The pressure increase resulting from the downswabbing causes a flow reversal through the perforations within the well and the capillarly passages in the reservoir sand. These surging flow reversals tend to disturb any plugging material which may have accumulated in the casing or liner perforations or in fill outside the perforations or in the pores of the formation. This disturbance results in a redistribution of the plugging material and causes some of it to pass through the perforations into the well bore where it is pumped out of the well and disposed of. After an adequate amount of such disturbance and removal of plugging material, the capillary passages and perforations will remain open, leaving a clear passage for fluid, which results in increased production rates. The gentle surges produced by the apparatus of this invention avoids damage to the formation and dislodgment of sands that may be caused by severe reversals.

The apparatus of this invention provides a method of periodically treating the well to move plugging material in a manner to permit flow from the producing formation. The invention has been described with swab cups mounted on the tubing string to produce a downswabbing action as the tubing string is moved downward. Other devices conventionally used to mechanically probe the perforations, for example, scratchers or knives to disturb the plugging material adjacent to the perforations in the liner can be used in combination with the apparatus of this invention to produce the desired unplugging operation at any desired frequency.

I claim:

1. Apparatus for producing oil from a well having casing set in the well, said casing having openings adjacent the producing formation to allow flow of oil into the casing, comprising a tubing string extending down the well within the casing, the lower end of the tubing string being positioned in liquids in the well, a pump in the tubing string for pumping oil from the well, a vertically movable tubing mounting suspending the tubing string in the well, a swab mounted on the tubing string and extending into the annular space between the tubing string and casing whereby upon downward movement of the tubing string fluids are displaced from the casing into the producing formation, driving means for actuating the pump, said driving means being mounted on the movable tubing mounting, and means for periodically moving the tubing mounting upward and downward independently of said driving means to cause periodic downward movement of the tubing string whereby the swab causes periodic reversal of flow from the well to the oil producing formation.

2. Apparatus for producing oil from a well having casing set in the well, said casing being open adjacent the producing formation to allow flow of oil into the casing, comprising a tubing string extending down the well within the casing, the lower end of the tubing string being positioned in liquids in the well, a pump on the tubing string for pumping oil from the well, a tubing mounting connected to the upper end of the tubing string and suspending the tubing string in the well, a downwardly acting swab on the outer surface of the tubing string adapted to move fluids in the annulus between the tubing string and the casing downwardly upon downward movement of the tubing string, driving means mounted on the tubing mounting for actuating the pump, a vertical hydraulic ram cylinder, a piston movable in the hydraulic ram cylinder extending upwardly to support the tubing mounting, a hydraulic power fluid pump connected to the reservoir and the hydraulic ram cylinder to supply hydraulic power fluid under pressure to the hydraulic ram cylinder, and means to control flow of hydraulic fluid into and out of the hydraulic ram cylinder below the piston whereby the piston moves upwardly and then downwardly to move the tubing string independently of the driving means and swab liquids from the well into the producing formation.

3. Apparatus for producing oil from a well having casing set in the well, said casing being open adjacent the producing formation to allow flow of oil into the casing, comprising a tubing string extending down the well within the casing, the lower end of the tubing string being positioned in liquids in the well, a reciprocating oil well pump for pumping oil from the well in the tubing string, a tubing mounting suspending the tubing string in the well, a downwardly acting swab on the outer surface of the tubing string adapted to move fluids in the annulus between the tubing string and the casing downwardly upon downward movement of the tubing string, a vertical hydraulic ram cylinder, a piston movable in the hydraulic ram cylinder and extending upwardly therefrom to support the tubing mounting, a vertical hydraulic pump cylinder mounted on the tubing mounting, a hydraulic piston movable in the hydraulic pump cylinder, a hydraulic power fluid reservoir, a hydraulic power fluid pump connected to the reservoir in the hydraulic ram cylinder and the hydraulic pump cylinder to supply hydraulic power fluid under pressure to the hydraulic ram cylinder and the hydraulic pump cylinder, a sucker rod connected to the hydraulic piston and extending down through the tubing for actuating the oil well pump, and valve means adapted to direct fluid selectively to the hydraulic pump cylinder and the hydraulic ram cylinder whereby the hydraulic pump piston moves vertically to pump fluid from the well and the hydraulic ram pistons move vertically to cause periodic swabbing of the annulus between the tubing string and casing.

4. Apparatus for producing oil from a well having casing set in the well, said casing being open adjacent the producing formation to allow flow of oil into the casing, comprising a tubing string within the casing extending down the well, the lower end of the tubing string being positioned in liquids in the well, a reciprocating oil well pump connected in the tubing string for pumping oil from the well, a tubing mounting connected to the upper end of the tubing string and suspending the tubing string in the well, a downwardly acting swab on the outer surface of the tubing string adapted to move fluids in the annulus between the tubing string and the casing downwardly upon downward movement of the tubing string, a hydraulic pump cylinder mounted on the tubing mounting, a hydraulic piston in the hydraulic pump cylinder, a sucker rod connected at its upper end to the hydraulic piston and at its lower end to the oil well pump for actuating the oil well pump, a vertical hydraulic ram cylinder, a piston movable in the hydraulic ram cylinder extending upwardly to support the tubing mounting, power fluid lines to the hydraulic pump cylinder and the hydraulic ram cylinder for moving the pistons in said cylinders, a discharge line connected to the hydraulic fluid line to the hydraulic ram cylinder, a valve in said discharge line, a time switch adapted to actuate the valve in the discharge line whereby flow through said discharge line is blocked and hydraulic fluid is delivered to the hydraulic ram cylinder, a hydraulic power fluid reservoir, a hydraulic power fluid pump connected to said reservoir and the hydraulic power fluid lines to supply hydraulic power fluid under pressure to the hydraulic ram cylinder and the hydraulic pump cylinder, and valve means in the hydraulic fluid lines adapted to direct fluids alternately to the hydraulic pump cylinder and to the hydraulic ram cylinder whereby fluid is pumped from the well and the hydraulic rams are actuated periodically to cause periodic down-swabbing of fluids in the well.

5. Apparatus as set forth in claim 1 in which the swab is positioned on the tubing string below the level of the pump.

6. Apparatus for producing oil from a well having casing set in the well, said casing being open adjacent the producing formation to allow flow of oil into the

casing, comprising a tubing string extending down the well within the casing, the lower end of the tubing string being positioned in liquids in the well, a pump connetced in the tubing string for pumping oil from the well, a tubing mounting connected to the upper end of the tubing string and suspending the tubing string in the well, a downwardly acting swab on the outer surface of the tubing string adapted to move fluids in the annulus between the tubing string and the casing downwardly upon downward movement of the tubing string, means for actuating the pump mounted on the tubing mounting, a vertical hydraulic ram cylinder, a piston movable in the hydraulic ram cylinder extending upwardly to support the tubing mounting, a hydraulic power fluid reservoir, a hydraulic power fluid pump connected to said reservoir and the hydraulic ram cylinder to supply hydraulic power fluid under pressure to the hydraulic ram cylinder, a dashpot, a discharge line connecting the dashpot with the hydraulic ram cylinder, valve means in the discharge line connecting the dashpot and the hydraulic ram cylinder actuated by the piston in the hydraulic ram cylinder when the piston is at the upper end of the stroke to discharge hydraulic power fluid from the hydraulic ram cylinder to the dashpot whereby the piston is lowered in the ram cylinder to move the tubing mounting downwardly.

7. Apparatus as set forth in claim 6 in which a vent line connects the upper end of the hydraulic ram cylinder with the upper end of the dashpot, an air inlet line is connected to the vent line, a first check valve is in the vent line between the connection of the vent line and air inlet line and the dashpot permitting flow from the hydraulic ram cylinder to the dashpot, a second check valve is in the air inlet line to allow flow into the upper end of the hydraulic ram cylinder.

8. In apparatus for producing oil from a well in which a pump is connected in tubing extending down the well and swabs on the tubing string engage casing in the well to downswab the well on lowering the tubing string in the well, the improvement comprising a hydraulic ram cylinder, a piston in the hydraulic ram cylinder movable vertically therein, a tubing mounting supported by the piston, said tubing mounting suspending the tubing in the well, a hydraulic pump cylinder mounted on the tubing mounting, a hydraulic piston movable in the hydraulic pump cylinder to actuate the pump in the well, a source of hydraulic power fluid under pressure, a control valve connected to the source of the hydraulic power fluid, a first hydraulic power fluid line from the control valve to the lower end of the hydraulic pump cylinder, a second hydraulic power fluid line extending from the control valve to the lower end of the hydraulic ram cylinder, a pilot line from the upper end of the hydraulic pump cylinder to the control valve adapted to actuate the control valve when the piston in the hydraulic pump moves above the pilot line to direct flow of power fluid to the second power fluid line, and valve means adapted to discharge hydraulic power fluid from the hydraulic ram cylinders when the piston therein reaches the upper end of the cylinder.

9. Apparatus as set forth in claim 8 in which a pressure release line is connected to the second hydraulic power fluid line, a normally open control valve is connected in the pressure release line to control the flow therethrough, and a time switch is operatively connected to the control valve in the pressure release line, said time switch being adapted to periodically close the control valve in the pressure relief line to cause the hydraulic power fluid to flow to the hydraulic ram cylinder.

10. In apparatus for periodically reversing the direction of flow in a well having casing set therein, a tubing string extending down the well through the casing, a reciprocating oil well pump in the tubing string adapted to pump liquids from the well, and a swab on the tubing string arranged to force liquids in the well downwardly upon lowering the tubing string, the improvement comprising a vertical hydraulic ram cylinder, a piston in the hydraulic ram cylinder adapted to move vertically therein, a tubing mounting supported by the piston for vertical movement therewith, said tubing mounting suspending the tubing string in the wall, a hydraulic pump cylinder mounted on the tubing mounting, a hydraulic power fluid reservoir, a hydraulic power fluid pump connected to the power fluid reservoir for delivery of hydraulic power fluid under pressure to the hydraulic ram cylinder and hydraulic pump cylinder, a first hydraulic power fluid line to the hydraulic pump cylinder, a second hydraulic power fluid line to the hydraulic ram cylinder, control valve means adapted to deliver hydraulic power fluid from the hydraulic power fluid pump alternately to the first hydraulic power fluid line and the second hydraulic power fluid line, a pressure release line extending from the second hydraulic power fluid line and the hydraulic power fluid reservoir, a normally open valve in the pressure release line, and timing means adapted to close said normally open valve periodically whereby hydraulic power fluid is periodically delivered to the hydraulic ram cylinder.

11. In apparatus for periodically reversing the direction of flow from a producing formation in an oil well having casing set therein to the producing formation, tubing extending down the well through the casing, a downwardly acting swab mounted on the tubing slightly above the producing formation, and an oil well pump in the tubing, the improvement comprising a vertical hydraulic ram cylinder, a piston in the hydraulic ram cylinder adapted to move vertically therein, a tubing mounting supported by the piston for vertical movement therewith, said tubing mounting suspending the tubing in the well, means mounted on said tubing mounting for actuating the pump in the tubing, a source of hydraulic power fluid under pressure, a hydraulic power fluid supply line connecting said source with the lower end of the hydraulic ram cylinder below the piston, a hydraulic power fluid discharge line connected to the hydraulic power fluid supply line, a discharge valve in said discharge line for control of flow therethrough, a reversal line extending from the upper end of the hydraulic ram cylinder, and a reversal control valve in said reversal line adapted to open the discharge valve when fluid in the hydraulic ram cylinder enters the reversal line, the opening of the discharge valve draining hydraulic power fluid from the hydraulic ram cylinder whereby the piston moves downwardly in the cylinder to lower the tubing and downswab the well.

12. In apparatus for periodically reversing the direction of flow in a well having casing set therein, a tubing string extending down the well through the casing, said tubing string being suspended from a vertically movable mounting whereby the tubing is movable downwardly in the well and a pump in the tubing string for delivery of liquids from the well, the improvement comprising a tubular mandrel connected in the tubing string, a jacket slidable on the mandrel, said jacket having an inside diameter larger than the outside diameter of the mandrel, a downwardly acting swab mounted on the jacket adapted to engage the casing in the well, an entrance port opening through the jacket below the swab, a collar secured to the upper end of the mandrel, said collar having a diameter larger than the inside diameter of the jacket, and means for detachably locking the jacket to the mandrel at a lower position where the collar is out of engagement with the upper end of the jacket.

13. Apparatus for producing liquids from a well and periodically removing plugging material from flow passages into the well, said well having casing set in the well and a tubing string extending downwardly through the casing, comprising a pump for lifting liquids from the well in said tubing string, a vertical hydraulic ram cylinder at the well head, a piston in said cylinder adapted to move vertically therein, a tubing mounting supported

by the piston, said tubing string being suspended from the tubing mounting, means for driving the pump mounted on the tubing mounting, means for controlling the flow of hydraulic fluid into the hydraulic ram cylinder to periodically raise and lower the piston whereby the tubing is periodically moved vertically in the well independently of the means for driving the pump, and means on the tubing string actuated by vertical movement of the tubing string to displace plugging material from the flow passages.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,062,290 November 6, 1962

Joseph K. Beckett

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 1, for "stringer" read -- stinger --; column 7, line 57, for "on" read -- in --; line 69, after "ing," insert -- a hydraulic power fluid reservoir, --; column 8, line 53, before "power" insert -- hydraulic --.

Signed and sealed this 2nd day of April 1963.

(SEAL)
Attest:

ESTON G. JOHNSON
Attesting Officer

DAVID L. LADD
Commissioner of Patents