Dec. 7, 1954 W. D. POWERS 2,696,262

APPARATUS FOR REMOVING LOOSE SAND OR THE LIKE FROM WELL BORES

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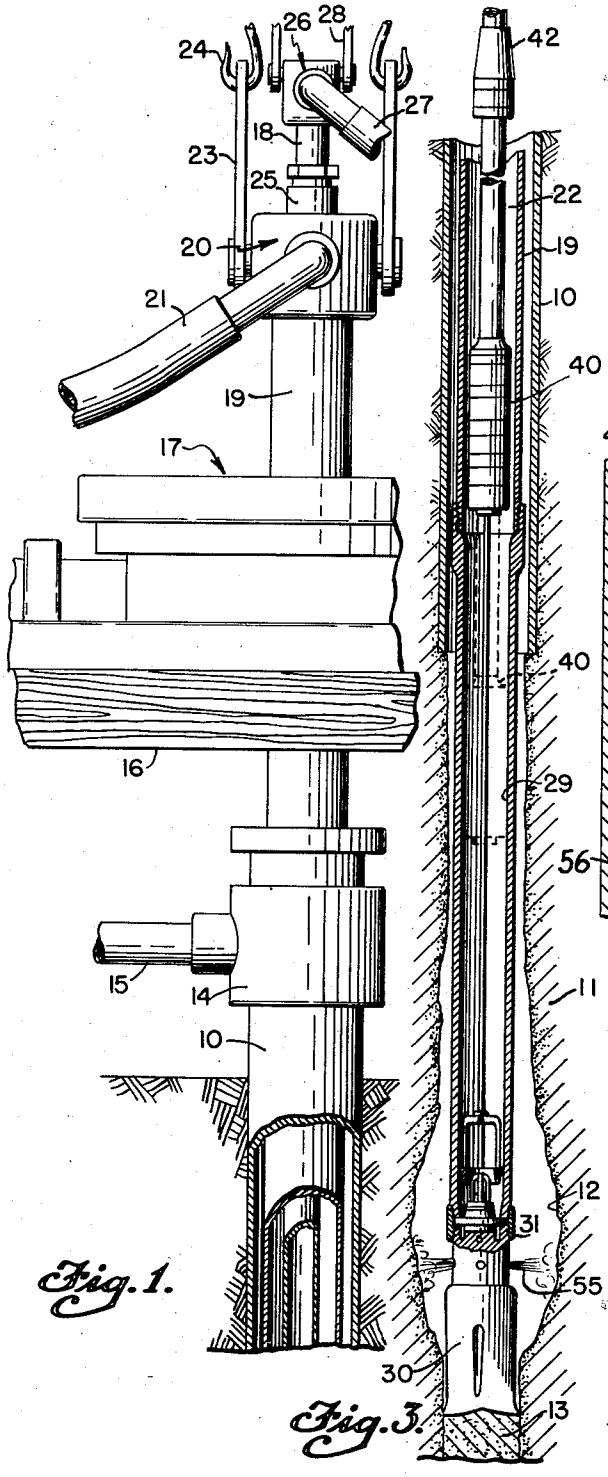


Fig. 1.

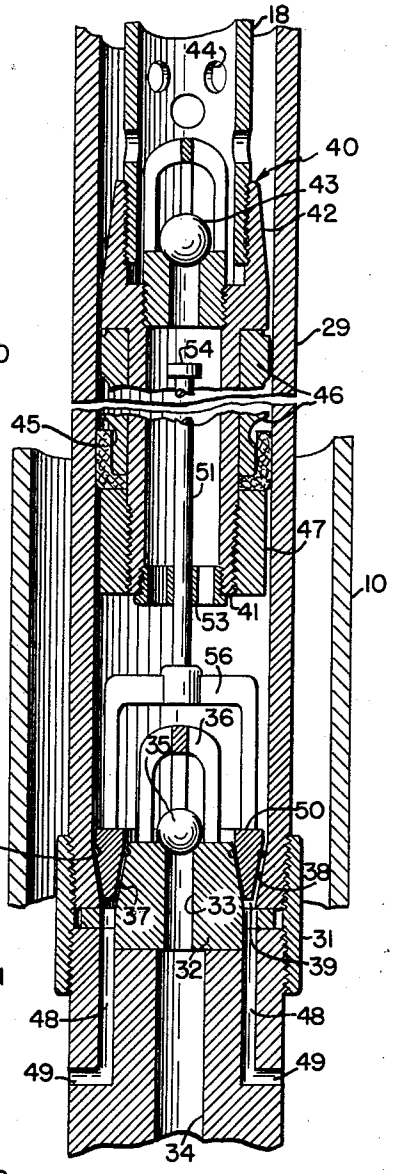


Fig. 2.

Fig. 3.

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APPARATUS FOR REMOVING LOOSE SAND OR THE LIKE FROM WELL BORES

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5 Claims. (Cl. 166—103)

This invention relates to equipment for removing cavings and other debris from oil wells, and has particular reference to washing loose sand and the like from the uncased production zones. Most low production wells are in formations which are relatively unconsolidated and tend to cave and fill the well bore. The caving tendency is further increased by the fact that most of these wells are subjected to an explosive for loosening the formation and thereby increasing the flow of oil into the well bore or cavity. As these wells become older the bottom hole pressure is reduced by reason of removing the oil therefrom, and artificial lift equipment is installed in order that production may be continued until the economic limit is reached. The artificial means referred to is usually in the form of a pump which tends to draw the formation inwardly, thus further increasing the tendency toward cave-ins. Ordinarily the weight of the oil or other liquid in the well tends to retard such cave-ins, but when the cave-ins occur it is necessary to remove the loose sand from around the pumping unit in order that production may be continued. So far, the most successful means of cleaning sand and the like from wells has been by means of cable tools. The cavings or the like are agitated by the reciprocating movement of the cable tool bit, and when in a semi-liquid state they are removed from the well by a bailer or the like. The cable tool method is objectionable because of the length of time required. Frequently several weeks are required to clean out a well by the cable tool method; thus, the cost of equipment and labor, together with the loss of production while the well is undergoing the operation, make the cable tool operation expensive and in many cases unprofitable.

Another method used for removing loose sand or the like from wells is by the circulation of liquid downwardly through a tube into the well cavity and upwardly through the well casing. This method has been found unsatisfactory because of the pressure differentials applied to the cavity wall. After the washing operation, the pressure against the wall is necessarily reduced, thereby causing additional cave-ins.

An object of the invention is to provide equipment whereby the uncased wall of a partially depleted well formation of sand or unconsolidated shale may be washed for removing sand or the like without applying hydrostatic pressure against the formation.

Another object of the invention is to provide, in combination with equipment of the described class, means whereby liquid within the well tubing may be released into the well when required.

A further object of the invention is to provide circulating means for removing sands from the uncased portion of an oil well without materially affecting the formation and liquid pressures within the well cavity.

A further object of the invention is to provide combined liquid circulating and pumping equipment for removing sand from a well and in which sand cannot accumulate during the operation thereof.

These and other objects of the invention will become apparent from the following description and the accompanying drawing, wherein:

Figure 1 is an elevation and broken sectional view of the upper end of an oil well, and showing the upper portion of a preferred form of the invention installed therein.

Figure 2 is a broken sectional view of a preferred embodiment of the pumping and valve mechanism of the invention, and

Figure 3 is a vertical sectional view of the lower end of an oil well, and showing the lower portion of an exemplary form of the invention installed therein.

In the drawings, the numeral 10 designates a well casing in the earth and above a production formation 11 of sand, loose shale or the like. The lower part of the well cavity 12 is shown as being filled with loose sand 13, loose shale or other unconsolidated material which is the result of a cave-in. The end of the casing 10 above the earth's surface is provided with a casing head 14 having a pipe 15 connected therewith. Above the casing head 14 there is a rig floor 16 for supporting a rotary table, generally designated by the numeral 17. The invention includes inner and outer tubes 18 and 19, one within the other, extending downwardly through the casing 10 to the well cavity 12. The outer tube 19 is rotated by the rotary table 17 during certain phases of the hereinafter described operation. As shown in Figure 1, the outer tube 19 is provided with a swivel connection 20 having a swivel hose 21 connected therewith for introducing a washing liquid, such as water, into the annulus 22 between the inner and outer tubes 18 and 19. The swivel assembly 20 is supported by hangers 23 and hooks 24 supported by cables, not shown, for raising and lowering the hereinafter described pumping and circulating equipment. The inner tube 18 is slidably received through a stuffing box 25 on the upper end of the outer tube swivel assembly 20, and said inner tubing is similarly provided with a swivel assembly 26 including a swivel hose 27 connected therewith for discharging the circulated liquid and sand. The last referred swivel assembly 26 is also supported on hangers 28 which in turn are connected with a pump jack or the like, not shown, for imparting reciprocating movement to the inner tube 18.

A working barrel 29, having a smaller inside diameter than the inside diameter of the outer tube 19, is connected with the lower end of the latter, and a rotary bit 30 is connected with the lower end of the working barrel by means of a collar 31. A valve seat element 32 is secured, as by welding, on the upper end of the bit 30 and the opening 33 thereof is in axial alignment with the bit's axial circulating port 34. As will become apparent, the last referred to port is for pumping liquid from the cavity 12, upwardly to the earth's surface. A ball valve element 35 normally closes the upper end of the valve seat element 32, and is loosely retained in place by means of a cage 36 secured to the upper surface of said seat element. The circumferential surface of the upper end of the valve seat element 32 is downwardly and outwardly tapered, as at 37, whereas the inner lower end of the working barrel 29 is downwardly and inwardly tapered, as at 38, so as to form a circular tapered valve seat 39.

A plunger assembly 40 is connected with the lower end of the inner tube 18 and includes a tubular mandrel 41 having an enlarged upper end 42 for threadedly receiving the lower end of said inner tube. A traveling valve assembly 43 is threadedly engaged in the upper end of the mandrel 41 and extends upwardly into the inner tube 18 and adjacent ports 44 in the lower end of the latter. The mandrel 41 supports cups 45 and guide rings 46 for co-action with the working barrel 29, and which cups and rings are retained by means of a nut 47 on the lower end of the mandrel. Guide rings 55 are provided around the mandrel 41 beneath the enlarged upper end 42.

Downwardly and outwardly directed ports 48 are provided in the upper end of the bit 30 as shown in Figure 2, and which ports communicate with the circular valve seat 39, whereas the lower ends 49 of said ports project laterally through the side wall of the bit 30 and are directed toward the wall of the cavity 12. A circular valve element 50 is arranged for co-action with the circular valve seat 39, and is operated by means of a rod 51 extending upwardly from a bracket 52 secured to the upper end of said circular element and through a spider 53 threadedly engaged in the lower end of the mandrel 41. The rod 51 has an enlarged head

54 for engaging the upper end of the spider 53 for raising the circular valve element 50 when the inner tube 18 is raised higher than the length of a normal pumping stroke. Ring seals 56 may be provided between the tapered surfaces of the circular valve element 50 and their coacting tapered surfaces 37 and 38 in the lower end of the working barrel 29.

The described construction may be used for pumping oil to the earth surface when the plunger 40 is reciprocally operated within the working barrel, but it is the intention of the present invention to remove the usual pumping mechanism from the well and to temporarily install the described construction in its place for the purpose of removing accumulated loose sand 13 and for washing down and removing sand from the wall of the well cavity 12. The equipment is installed in the manner illustrated in Figures 1 and 3 and circulation, using oil or water, is started through the outer tube swivel 20 and thence downwardly through the annulus formed by the outer tube 18 and the inner tube 19. The liquid then enters the ports 44 in the lower end of the inner tube 18, and thence moves upwardly through the inner tube 18. After circulation has been established the inner tube 18 is actuated by the pump jack, not shown, imparting a reciprocating movement to the plunger 40 while the latter is within the working barrel 29. The rotary table 17 is then placed in operation, turning the outer tube 19, the working barrel 29 and the bit 30 on the lower end thereof, causing the rotary bit 30 to agitate the loose sand 13 and to grind any cuttings, shale or the like in the bottom of the cavity 12. The operation of the plunger 40 moves the liquid containing the sand from the well cavity 12 upwardly through the working barrel 29, the plunger 40 and the inner tube 18, thence outwardly through the upper swivel 26. It is to be noted that by reason of the relatively small diameter of the inner tube 18, the flow upwardly therethrough is rapid so as to prevent the sand in the liquid from settling out. By reason of the downward circulation within the outer tube 19, sand or the like is prevented from settling in the lower end of said outer tube.

By raising the plunger 40 upwardly above the working barrel 29 and thereby raising the circular valve element 50, liquid from the outer tube 19 may be released downwardly through the ports 48 in the bit 30 and outwardly through the projecting ends 49 thereof, thereby providing laterally projecting jets 55 for washing down the wall of the cavity 12. When desired, water may be introduced through the pipe 15 connected with the casing head 14 and allowed to fall downwardly through the casing 10 and around the outer tube 19 for washing loose sand from around the outer surface of the working barrel 29. The water and sand therein are subsequently pumped upwardly through the inner tubing 18 in the manner described.

The present invention is not limited to the construction herein shown and described, but may be made in many ways within the scope of the appended claims.

What is claimed is:

1. Apparatus for removing loose sand or the like from the bottom of a well bore, said apparatus comprising inner and outer tubes received one within and spaced from the other and adapted to extend downwardly into said well bore, a working barrel secured to the lower end of said outer tube, a bit having an opening through its axial center and secured to the lower end of said working barrel, a check valve carried by said bit and arranged to prevent downward flow of liquids through said bit opening, a plunger having an axial opening therethrouguh secured to the lower end of said inner tube and received within said working barrel, a traveling valve arranged to close said opening through said plunger and prevent downward flow of liquids therethrough, means

rotating said outer tube, means imparting reciprocating movement to said inner tube, and ports through said inner tube near the lower end thereof.

2. Apparatus for removing loose sand or the like from the bottom of a well bore, said apparatus comprising inner and outer tubes received one within and spaced from the other and adapted to extend downwardly into said well bore, a working barrel secured to the lower end of said outer tube, a bit having an opening through its axial center and secured to the lower end of said working barrel, a check valve carried by said bit and arranged to prevent downward flow of liquids through said bit opening, a plunger having an axial opening therethrough secured to the lower end of said inner tube and received within said working barrel, a traveling valve arranged to close said opening through said plunger and prevent downward flow of liquids therethrough, means rotating said outer tube, means imparting reciprocating movement to said inner tube, and ports through the side wall of said inner tube above the plunger.

3. Apparatus for removing loose sand or the like from the bottom of a well bore, said apparatus comprising inner and outer tubes received one within and spaced from the other and adapted to extend downwardly into said well bore, a working barrel secured to the lower end of said outer tube, a bit having an opening through its axial center and secured to the lower end of said working barrel, a check valve carried by said bit and arranged to prevent downward flow of liquids through said bit opening, a plunger having an axial opening therethrough secured to the lower end of said inner tube and received within said working barrel, a traveling valve arranged to close said opening through said plunger and prevent downward flow of liquid therethrough, means rotating said outer tube, means reciprocating said inner tube longitudinally, ports through the side wall of said inner tube near the lower end thereof and above said plunger, ports extending laterally through the outer wall of said bit and upwardly through the top of said bit for communication with said working barrel, valve seat means in the upper ends of the last said ports, valve element means received within said valve seat means, means connecting said valve element means with said plunger, the last said connecting means being of extensible construction so as to permit operation of said plunger within said working barrel without raising said valve element means, and yet permit raising said valve element means when said inner tube is raised a distance greater than the normal stroke of said plunger.

4. Apparatus for removing loose sand or the like from the bottom of a well bore, said apparatus comprising inner and outer tubes received one within and spaced from the other and adapted to extend downwardly from the earth's surface into said well bore, a working barrel secured to the lower end of said outer tube, a bit having an opening through its axial center secured to the lower end of said working barrel, a check valve carried by said bit and arranged to prevent downward flow of liquid through said bit opening, a plunger having an axial opening therethrough secured to the lower end of said inner tube and received within said working barrel, a traveling valve arranged to close said opening through said plunger and prevent downward flow of liquid therethrough, means rotating said outer tube, means reciprocating said inner tube longitudinally, ports through the side wall of said inner tube near the lower end thereof and above said plunger, ports extending laterally through the outer wall of said bit and upwardly through the top of said bit for communication with said working barrel, valve seat means in the upper ends of the last said ports, valve element means received within said valve seat means, means connecting said valve element means with said plunger, the last said connecting means being of extensible construction so as to permit operation of said plunger within said working barrel without raising said valve element means, and yet permit raising said valve element means when said inner tube is raised a distance greater than the normal stroke of said plunger.

5. In apparatus, as defined in claim 4, the construction wherein said means connecting said valve element means with said plunger is comprised of a spider secured within said opening through said plunger, a cage secured to said valve element means, a rod connected with said cage extending upwardly through said spider, an enlarged head on said rod above said spider.

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