Aug. 1, 1950 A. C. NESTLE 2,517,017

EROSION-ABRASION CLEANING DEVICE

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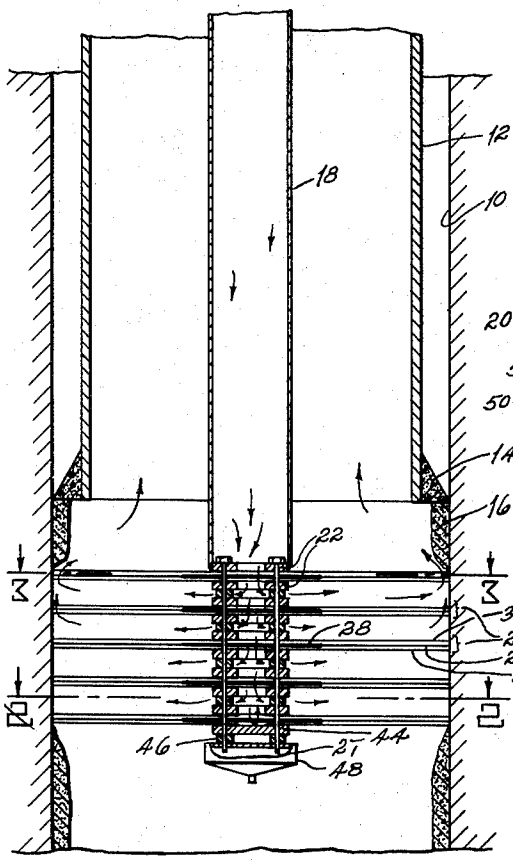


Fig. 1.

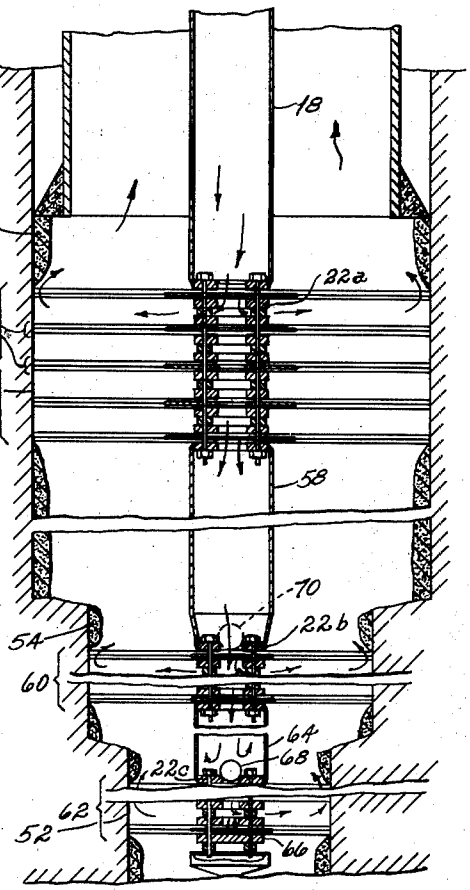


Fig. 6.

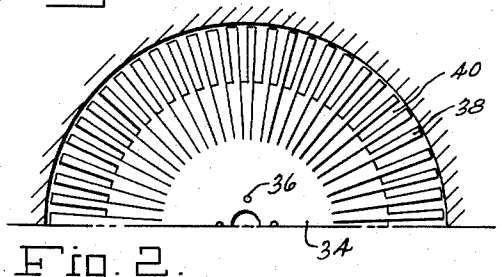


Fig. 2.

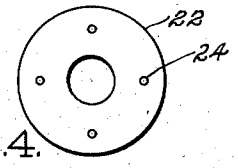


Fig. 4.

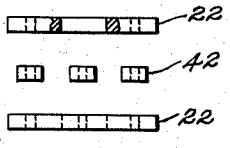


Fig. 5.

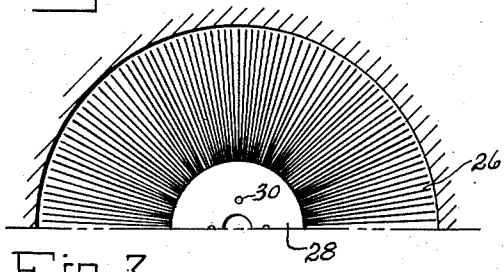


Fig. 3.

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EROSION-ABRASION CLEANING DEVICE

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4 Claims. (Cl. 166—18)

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This invention relates to devices for cleaning the walls of a bore hole or well and more particularly to a device for abrading and washing away the layer of drilling mud which usually adheres to the hole walls after the drilling operation.

In the drilling of a well by the rotary method it is customary to circulate a fluid such as mud downwardly through the rotating drill pipe, the mud passing outwardly through holes in the bit and then upwardly to the surface between the drill pipe and the walls of the hole. The mud serves to carry upwardly to the surface the cuttings made by the bit and to plaster the walls of the hole to prevent sloughing as well as to prevent, at least to some extent, water from filtering into the hole from water-bearing formations traversed by the drill. When the hole has been drilled into and to the proper depth in the producing formation the layer of mud naturally adheres to the walls of that formation also and should be removed prior to placing the well on production. Many efforts have been made to remove this mud cake or layer, such as by flowing a stream of water or other liquid at fairly high velocity through the hole, scraping the walls of the hole with wire brushes and the like but none of these methods has proven really successful.

When gravel is placed in the producing cavity of a well by the reverse circulation method, the gravel particles are usually circulated into the cavity in a carrier fluid such as drilling mud, the fluid passing into the screen or perforated liner and then upwardly to the surface through the tubing while the gravel accumulates in the cavity around the screen or liner. After the gravel has been placed the pores or interstices between the gravel particles are often left full of the mud and the gravel pack must be cleaned before efficient production can take place. Experimental results have shown that when the gravel pack is subjected to the rapid flow of a stream of water the gravel particles are agitated to some extent and the tiny streams of water produced by the breaking up of the water flow by the gravel particles, together with the agitation of the particles causes the mud to be washed from and substantially completely removed from the gravel pack. The cleaning device or tool about to be described combines the abrading or scratching of the mud cake with the impingement thereupon of the small streams of a washing liquid, the action in removing the mud from the walls of the hole being somewhat similar to the action of the small streams and agitation of the gravel

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particles in the process of cleaning a gravel pack.

In carrying out the invention a device is provided which is essentially a bore hole wall scratcher having hollow scratching elements. The scratching elements may comprise a plurality of spaced substantially parallel units, each unit consisting of a wire brush element, the wires of which project radially toward the hole walls, and a pair of fabric elements covering the top and bottom surfaces of the brush. The units are disposed in slightly separated relation and a liquid such as water is ejected from the tubing or drill pipe outwardly through the spaces between adjacent units. When the device is moved up or down in the hole the wire elements scratch and abrade the layer of mud adhering to the hole walls while at the same time the washing liquid strikes the mud layer in a direction substantially perpendicular thereto and this combined abrading and washing action quickly removes the mud from the holes of the well. Due to the presence of the fabric elements covering the top and bottom sides of the wire brushes, the washing liquid in being confined to the space between adjacent brushes tends to stiffen these brushes and thereby to increase their effectiveness in abrading the mud cake.

In a modification a plurality of sets of the scraping units are provided, those of each set being of progressively smaller or larger diameter so that one section of the device will remove the mud cake from a portion of the hole having say a large diameter, another section will engage and remove the mud from a portion of the hole of smaller diameter while an intermediate section may engage and remove the mud cake from the portion of the hole of intermediate size.

For a better understanding of the invention reference may be had to the accompanying drawing in which:

Fig. 1 is a vertical sectional elevation through a portion of a bore hole showing one of the cleaning devices in position to remove the mud cake from the hole walls;

Fig. 2 is a plan view taken on the line 2—2 of Fig. 1 showing a portion of one of the fabric or cover elements;

Fig. 3 is a view similar to Fig. 2 and taken on the line 3—3 of Fig. 1 showing a portion of one of the wire brush members;

Fig. 4 is a plan view of one of the circulation discs or rings;

Fig. 5 is an exploded view showing two of the circulation rings with spacer elements therebetween; and

Fig. 6 is a view similar to Fig. 1 but showing a mud washing assembly having three sets of the erosion-abrasion units of different diameters.

Referring to the drawing a section of a bore hole 10 is shown, the upper portion having a casing 12 cemented in place at 14 and the portion below the casing i. e. within the producing formation or zone being covered with a layer or cake of drilling mud 16. A string of tubing or drill pipe 18 extending downwardly through the hole has affixed to its lower end a mud cleaning assembly made up of a plurality of separated washing units 20. A circulation ring member 22 shown enlarged in Fig. 4 fits within, and after the device has been assembled as will be described hereinafter, can be attached to the bottom end of the tubing 18 in any suitable manner such as by welding. A plurality of these ring members are used in the assembly, the members being provided with holes 24 for accommodating bolts 27 which serve to hold the assembly together. Each of the units 20 includes a wire brush scraping or scratcher element 26 the wires of which extend radially outward from an annular ring member or center portion 28. The wires of the brushes 26 may be attached to the rings 28 in any suitable manner or the entire member comprising the solid portion 28 and the wire brush 26 may be stamped or cut from a unitary sheet. The solid center portion 28 of each wire brush is also provided with holes 30 for accommodating the bolts 27.

Adjacent the top and bottom of each brush element 26 is a disc-like flexible member 32 preferably of a water and oil resistant fabric and coextensive with the wire brush disposed therebetween. The center portion 34 of each fabric disc as is shown in Fig. 2 is preferably solid and provided with holes 36 to accommodate the bolts 27. The outer portion of each fabric disc is cut into tongues 38 and a portion of each tongue as at 40 is removed to permit some flow of the cleaning fluid upwardly through the assembly as will be explained hereinafter. A ring member 22 is disposed above and below each of the units 20 and between each adjacent pair of the ring members 22 is a plurality of small spacer elements 42 shown more clearly in Fig. 5. The assembly as shown in Fig. 1 is built up on the bolts 27, a solid disc or plate 44 being disposed directly below the lowest unit 20 and nuts 46 being threaded upon the bolts to hold the parts in the position shown. A cap member 48 may be attached in any suitable manner to the lower ends of the bolts 27 to protect those members, or if desired, instead of the nuts 46, spacers 42 may be used and the bolts 27 screwed into the cap member 48.

The cleaning device will, of course, be assembled at the surface and attached to the lower end of a section of the tubing or drill pipe 18. Due to the flexibility of the units 20 the device can be lowered through the casing 12, the units 20 bending upwardly somewhat until the device passes out of the lower end of the casing as is shown in Fig. 1. Cleaning fluid such as water pumped downwardly through the pipe string 18 will follow the direction of the arrows, some of the liquid passing radially outwardly between adjacent pairs of the rings 22, i. e., between adjacent units 20. This liquid will flow radially or laterally outward to contact the mud cake 16 which mud cake is at the same time being scratched or abraded by the wire brush elements 26. Assuming that there is already liquid in the cavity below the cleaning fluid the particles of mud cake removed from the wall of the hole will pass upwardly through the brush elements 26 and the slotted fabric members 32 and finally upwardly to the surface through the annular space between the casing 12 and the pipe string 18. The pipe string 18 with the cleaning device can be lowered gradually through the cavity during the above-mentioned cleaning operation or if desired it can be moved back and forth vertically through any desired distance until the mud cake has been abraded and washed from the wall of the formation.

Frequently the diameter of a bore hole varies from the top to the bottom as is illustrated in Figure 6. Thus a hole may comprise a large portion 50, a small portion 52, and an intermediate portion 54. It is contemplated that the cleaning device may be made up in sections having diameters substantially the same as the portions of the hole. As is shown in Fig. 6 the upper section 56 of the cleaning device is substantially the same as that shown in Figure 1 but instead of the plate 44 at the lower end of the device, a tubing section 58 is attached below the lowest cleaning unit 20 and extends downwardly to an intermediate cleaning section 60, the cleaning units of which are of a diameter to fit the intermediate hole portion 54. Below the section 60 is a still smaller section 62 spaced from the section 60 by another piece of tubing 64. At the bottom of the cleaning section 62 is a plate or disc 66 corresponding to the plate 44 of Fig. 1. It should be noted that the holes through the ring members 22a of the upper cleaning section 56 and also the holes through upper wire brush elements and the fabric cover discs are larger than those in the intermediate section 60, while the holes through the intermediate section are larger than those in the smallest section 62.

Assuming that it is desired to remove the mud cake from the walls of a bore hole having portions of different diameter as shown in Fig. 6 the cleaning device is assembled as illustrated in that figure with the pipe portions 58 and 64 of such lengths that each of the cleaning sections 56, 60 and 62 will be within its corresponding bore hole portion. If cleaning liquid is then forced downwardly through pipe string 18 some of this liquid will pass outwardly between adjacent cleaning units 20 of each of the cleaning sections and the action of this liquid together with the scraping or scratching action of the wire brush elements will remove the mud cake from the hole walls as has been described in connection with Fig. 1.

Instead of separating the sections 56, 60 and 62 as is shown in Fig. 6 these sections may be placed rather close together vertically, the device then being lowered into the hole portion 52 of smallest diameter. The larger cleaning units forming the sections 56 and 60 will then be flexed or bent upwardly in such manner that the lateral flow of cleaning liquid through these sections will be substantially shut off. The cleaning liquid will therefore pass downwardly through the tubing 18, 58 and 64 to the cleaning section 62 where it will pass outwardly to contact the mud cake as has been described above. Assuming that the lower or smaller portion 52 of the hole has been cleaned of the mud cake a ball 68 may then be dropped through the tubing string 18 and if of the proper size it will engage the uppermost ring member 22c of the cleaning section 62 so as to seal the opening therein and prevent liquid from thereafter passing into the section 62. The de-

vice can then be pulled upwardly into the intermediate hole portion 54 and the cleaning liquid again passed downwardly through the tubing 18 and 58. This liquid will then pass laterally outwardly between the units of the cleaning section 60 to engage the mud cake while it will be prevented from passing outwardly between the units of the section 56 since those units will be bent so as to be accommodated within the hole portion 54. The device will then be moved throughout the length of the hole portion 54 until the walls thereof are cleaned of the mud cake. A second ball shown by the dotted lines 70 is then dropped through the tubing string, this ball being small enough to pass through the center hole in the cleaner section 56 but large enough to engage the uppermost ring member 22b of the intermediate section 60 in the manner described above with reference to the ball 68. Further circulation of the cleaning liquid through the intermediate section 60 will thereby be prevented and when the device is pulled upwardly into the largest hole portion 50 the liquid will pass laterally outwardly between the units 20 of the section 56, thus stiffening these units and causing the ends of the wire brushes to engage the mud cake 16. The action in cleaning the mud cake from the hole portion 50 will then be the same as that described previously in connection with the embodiment shown in Fig. 1.

If desired, a mud cleaning device similar to that which has been described can be used as an aid in removing mud cake from the walls of a hole prior to a cementing operation in order to provide a better bond between the formation and the cement. In this application the cleaning device would be used as an integral part of the well known cementing "shoe" and cleaning liquid would be forced through it as the pipe to be cemented is run in past that part of the hole which it is desired to cement off.

If desired, the cleaning device can also be run on the lower end of a string of casing or temporarily blanked perforated liner. Combined circulating and vertical motion would effect the mud cake removal from that portion of the hole through which the device is run as has been described hereinbefore.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A bore hole washing device comprising a string of tubing adapted to be moved vertically within said hole, an assembly secured to the lower end of said string for eroding and abrading the walls of the hole, said assembly comprising a plurality of abrading units disposed in spaced relation perpendicularly to the axis of the tubing,

each of said units consisting of a thin, disc-like, wire brush element the wires of which project radially to engage the hole walls and a pair of flexible fabric elements covering and coextensive with the top and bottom surfaces of the brush element, and separating elements between said units, said separating elements being provided with openings whereby fluid passing downwardly through the tubing string will be ejected radially outwardly toward the hole walls between the fabric elements of each adjacent pair of abrading units, the flow of the fluid serving to erode the hole walls and to maintain stiffness in the units to increase the abrading action of the wire brush elements against the walls of the hole as the device is moved along the hole.

2. A bore hole washing device comprising a string of tubing adapted to be moved vertically within said hole, an assembly secured to the lower end of said string for eroding and abrading the walls of the hole, said assembly comprising a plurality of sandwich-like abrading units disposed in spaced relation perpendicularly to the axis of the tubing, each of said units consisting of a thin, disc-like wire brush element the wires of which project radially to engage the hole walls and a pair of thin flexible fabric elements covering and substantially coextensive with the top and bottom surfaces of the brush element, and a pair of slightly spaced separator rings between said units, the arrangement being such that fluid passing downwardly through the tubing string will be ejected radially outwardly through the spaces between the rings and between the fabric elements of each adjacent pair of abrading units to strike and erode the walls of the hole, the flow of the fluid also serving to maintain stiffness in the units to increase the abrading action of the wire brush elements against the walls of the hole as the device is moved along the hole.

3. A device according to claim 1 in which the assembly is divided into sections having different diameters, each section being of substantially the same diameter as a portion of the bore hole.

4. A device according to claim 1 in which the assembly is divided into sections having different diameters, each section being of substantially the same diameter as a portion of the bore hole, and means for rendering inoperative the washing fluid ejecting means of one or more of said sections.

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