United States Patent [19]

Oliver

[11] **3,795,282**

[45] **Mar. 5, 1974**

[54] **WELL FLUSHING METHOD**

[75] Inventor: **Don L. Oliver,** Houston, Tex.

[73] Assignee: **Cities Service Oil Company,** Tulsa, Okla.

[22] Filed: **Aug. 31, 1972**

[21] Appl. No.: **285,142**

[52] **U.S. Cl.** **175/65,** 175/237, 175/317

[51] **Int. Cl.** **E21b 7/00**

[58] **Field of Search** 166/99, 222, 223, 311, 312; 175/25, 38, 60, 65, 72, 237, 243, 308, 320, 324

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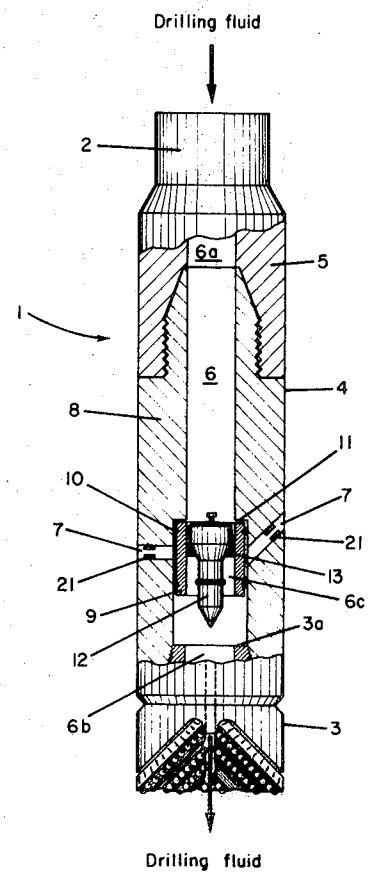
Primary Examiner—David H. Brown

Attorney, Agent, or Firm—Elton F. Gunn

[57] **ABSTRACT**

Method of flushing debris from a well wherein an upper section of the well hole has a significantly larger diameter than the lower end. Drilling fluid is normally supplied through a drilling bit, but additional fluid can also be supplied from another source so that the total amount of fluid being pumped to the hole is substantially in excess of that which can be supplied through the bit alone. Upward thrust of drilling fluid in the larger, upper section of the hole is significantly increased, thus overcoming the settling rate of debris therein so that it becomes entrained in the circulated drilling fluid and is hence discharged from the top of the hole while suspended in the fluid.

4 Claims, 4 Drawing Figures



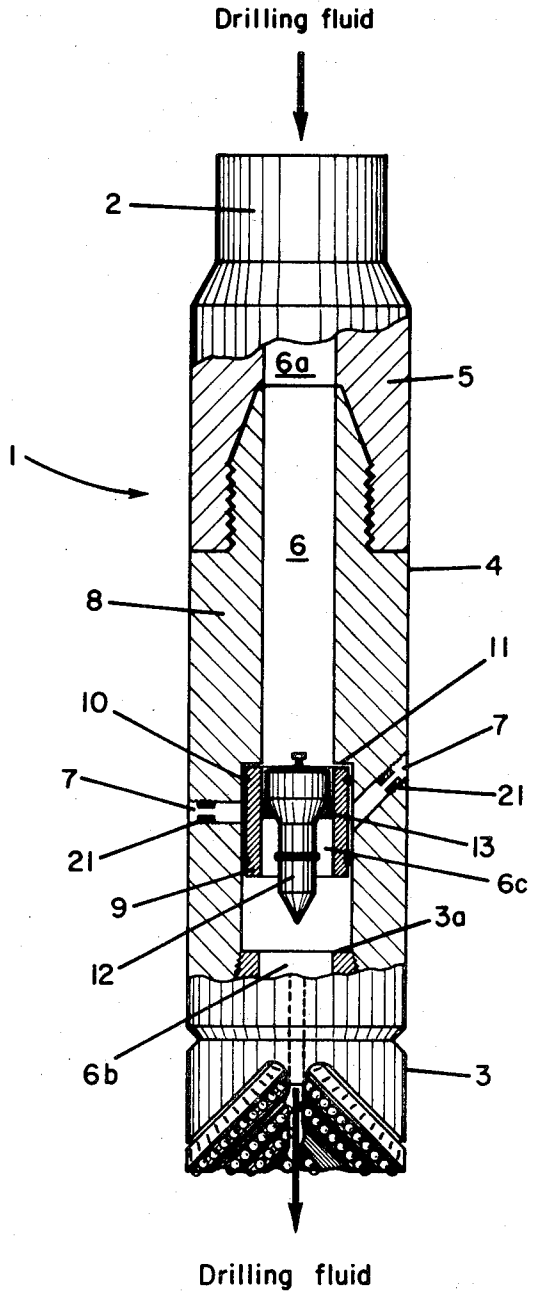

Drilling fluid
2
6a
5
1
6
4
8
11
10
7
7
21
21
13
6c
9
3a
12
6b
3
Drilling fluid

FIG. 1

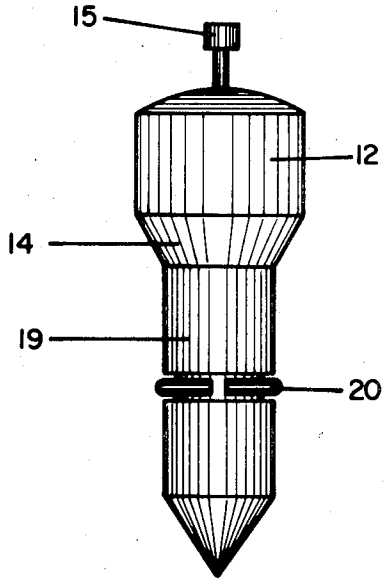


Fig. 2

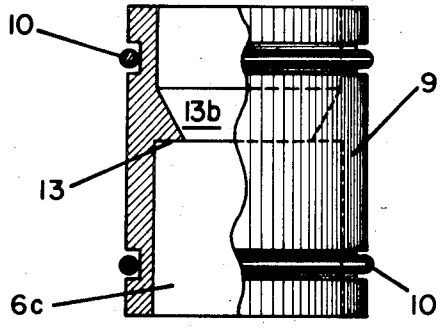


Fig. 3

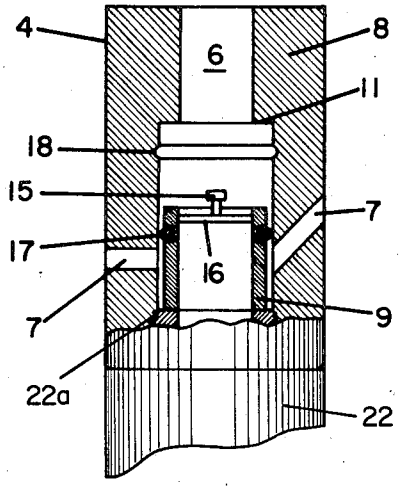


Fig. 4

WELL FLUSHING METHOD

BACKGROUND OF THE INVENTION

This invention pertains to the drilling of wells wherein a drilling fluid is pumped into the well hole from a drilling bit and is then circulated up through the hole and out at the top. More particularly, this invention pertains to the flushing of rubble, debris, small pieces of junk, etc. from a well hole having a diameter in an upper section which is significantly larger than the diameter of a shallower portion.

In the drilling of some wells the hole is first put down at one diameter and is then drilled to one or more smaller diameters until a desired total depth is reached. For instance, a casing program might comprise 30 inch casing to 100–200 feet, 10½ inch casing to 900–1,000 feet, and 7 inch casing to several thousand feet. Open hole drilling can also be carried out below a casing to provide an open hole having a diameter smaller than the casing.

It has now been observed that difficulty can sometimes be en-countered with build up in the larger, upper part of the well hole of large drill cuttings, rubble, small pieces of cement, junk, etc.—hereinafter referred to as debris—which cannot be flushed from the hole because of inadequate fluid velocity in the larger, upper section.

More specifically, the volume of drilling fluid which is provided to a well hole by the drilling bit is generally sufficient to provide a fluid velocity which effectively suspends the debris so that it can be entrained and flushed from the section of hole then being drilled. It has been observed, however, that the resulting drop in velocity which occurs upon entry of the fluid into an upper section of larger diameter can be so severe as to result in precipitation and accumulation of at least some of the entrained objects therein, i.e., the velocity is no longer sufficient to overcome the settling rate of the debris. Accumulation of these undesirable materials in the upper section does not necessarily have any detrimental effects on the drilling operation during the time that the buildup occurs, but upon stopping mud circulation to trip the drill pipe out of the hole, the debris can settle around the pipe and stick to it. On the otherhand, if the pipe is successfully pulled from the hole, settling of the accumulated debris can result in formation of a bridge across the hole that can require drilling through to get the drill pipe back to the bottom. Such bridging of debris is particularly detrimental when the drilling string is pulled from the hole so that casing can be run back, or when open hole logging is to take place. Besides sticking and bridging, raising the drilling bit into the upper section can cause debris to drop into the lower end of the hole and fall to the bottom since there is no longer any upward fluid velocity or pipe in the hole to prevent such an occurrence. Once on the bottom, the objects which have fallen in can seriously interfere with drilling when the bit is again lowered, and fishing may be required before drilling can be safely resumed.

SUMMARY OF THE INVENTION

Therefore, the principle object of this invention is to substantially preclude or even obviate the aforementioned problems associated with accumulation of debris, rubble and the like during the drilling of a well

hole which has an upper section of larger diameter than the lower end.

Other objects and advantages of the invention will become apparent from the following description and the appended claims.

When drilling a well wherein an upper section of the hole has a significantly larger diameter than the lower end, and a drilling fluid is circulated from the bottom to the top of the hole to lubricate the drilling string and flush drill cuttings and debris out of the well hole at the top, additional drilling fluid is introduced into the lower end of the hole from still another source other than the drilling bit. As a consequence of this increased flow to the lower end of the hole, fluid velocity in the upper section of larger diameter is raised to a level in excess of that which can be effected by pumping through the bit alone, for the rate at which fluid can be pumped through the bit is limited by the size of the discharge orifices therein, the pressure at the point being drilled, and the pressure at which the fluid can be made available to the bit.

Because of frictional drag with the interior wall of the drilling string, much if not most of the pressure supplied to the drilling fluid at the upper end is lost by the time it reaches the bit. Thus, by using still another opening in the drilling string so that fluid can be introduced to the well hole from another source as well as the drilling bit, the aforementioned difficulties are avoided. To advantage, this additional fluid can be introduced higher up in the string where more pumping pressure and, hence, more fluid flow is available for getting the fluid into the well hole. The increased upward thrust made available by supply of additional fluid thus overcomes the settling rate of debris in the upper section of the hole having a larger diameter, thus maintaining the debris suspended in the drilling mud after it has passed from the lower end of small cross section, so that flushing of debris out of the hole without accumulation can be carried out either continuously or at will.

The present invention can be practiced by use of a special circulating tool located in the drilling string above the bit. The tool can comprise a tubular body section coupled at each end to other members of the drilling string, a passageway through the body section which interconnects with the central passageway for fluid which extends through the side wall of the body section from the fluid passageway therein to the outside. The tool can further comprise a previously set operable member inside the section which covers the channel through the wall of the body section when set, and which uncovers the channel when operated.

The circulating tool, along with a bit, can thus be made up with the drilling string when it is lowered into the smaller, lower end of a hole. Because of the channel for fluid in the wall of the tool, more drilling fluid can be injected into the bottom of the hole, thus raising the velocity and hence the upward thrust of the fluid in the upper section having a larger diameter.

Using an operable member inside of the tool for covering and uncovering the fluid channels at will, drilling fluid can be circulated only to the bit until such time as a need is recognized for injecting a greater volume of fluid than can be passed through the bit, e.g., when raising the bit in the hole to a level above the lower section of smaller diameter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view, partly in section, of one embodiment of the tool of the present invention.

FIG. 2 is a side view of a weighted dart, or plunger, which can be used to operate a slidable sleeve which covers the channels in the wall of the body section of the tool, and also to obstruct flow of fluid beyond the tool.

FIG. 3 is a side view, partly in section, of a slidable sleeve which can be used as the preset operable member in the tool of FIG. 1 for covering and uncovering the channels in the wall of the body section of the tool.

FIG. 4 is a partially fragmentary and partially sectional side view of another embodiment of the invention wherein the sleeve arrangements and the method of operating the sleeve are different from that shown in FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. 1, the tool is generally represented at 1, and is connected by threads to a drill pipe 2 and a drill bit 3. The tool is thus made up with the drilling string at the time the bit is to be lowered in he hole, and does not necessarily perform any special function until there is need to pump drilling fluid into the hole at a greater rate than can be supplied through the bit. The body section 4 of the tool is attached at the upper end to a coupling 5 on the drill pipe 2. A passageway 6 for drilling fluid runs through the body section 4 and interconnects at the upper and lower ends with fluid passageway 6a and 6b which lead, respectively, from the drill string 2 and into the drilling bit 3.

Channels 7 are drilled ducts which extend through the wall 8 of the body section from the passageway 6 to the outside. When the string is lowered into the bore hole these channels can be covered over by an impervious axially slidable sleeve 9 frictionally held in place in the passageway 6 by means of O-rings 10 attached to the sleeve in recessed grooves. As drilling proceeds, drilling fluid passes through the central passageway 6c of the sleeve which is aligned with the other passageways 6, 6a and 6b, thus maintaining a flow of all drilling fluid to the bit, since the channels 7 are blocked off by the sleeve which is preset in position over the openings of the channels before the tool and bit are lowered into the well hole.

In FIG. 1, the sleeve 9 is thus shown in the preset position whereby the channels 7 are covered over. The passageway 6 in the vicinity of the sleeve is recessed for a distance in excess of the sleeve length to permit the sliding thereof when operated and to provide a chamber which accommodates the thickness of the sleeve wall, the latter feature tending to preserve the diameter of the fluid passageway 6 while also forming a shoulder 11 at the top of the chamber which serves as an upper stop for the sleeve. The upper edge 3a of the drill bit 3 serves as a lower stop for the sleeve.

When it is desirable to increase the rate at which drilling fluid is pumped into the well hole, channels 7 are then uncovered in order to divert flow from the bit and into the hole through the wall 8 of the body section. This can be accomplished in various ways, and two apparatus arrangements intended for this purpose are shown in the drawings. FIGS. 1–3 illustrate use of a weighted dart, or plunger, which is dropped into the drilling string for displacing the sleeve downwardly to uncover the channels 7, and FIG. 4 illustrates use of a sleeve which normally covers the channels 7 when the sleeve is bottomed, and which can be lifted by wire line to uncover the channels.

Referring to FIGS. 1–3, the dart 12 is dropped into the drilling string from the surface when it is desirable to increase the rate at which fluid is pumped to the hole so that flushing of debris can be continuously carried out. As soon as the dart is dropped, pressurization of the drilling fluid can be resumed. The momentum of the falling dart may in itself be sufficient to drive the sleeve downward below the channels 7, but in any event both dart and sleeve are constructed so as to form a piston which can be driven downward by pumping pressure when engaged as shown in the drawing.

More specifically, the sleeve 9 comprises an attached or integral ring 13 which projects into the central passageway and is axially aligned therewith. With the sleeve shown, the ring is machine beveled to provide an upper tapered sealing surface 13b. The upper part of the dart 12 is provided with a matched bevel 14, so that when the dart and the sleeve are engaged as in FIG. 1, flow of fluid past the sleeve is effectively obstructed. Therefore, elevation of pumping pressure on the drilling fluid will displace the dart and sleeve down-wardly and thus uncover the channels 7 when dart and sleeve are mated as in FIG. 1.

FIG. 4 illustrates a different arrangement wherein the sleeve is normally bottomed against the lower stop 22a for covering of the channels 7. When there is a need to increase the rate at which drilling fluid is pumped to the well hole, a wire line tool is lowered which engages a latch 15 on a rod 16 which extends inside the sleeve from one side to the other. The sleeve is then raised against the upper stop 11 by means of a wire line tool. A snap ring 17 which extends around the sleeve and is attached thereto in a groove engages a latching groove 18 in the wall of the passageway and thus holds the sleeve in an elevated position. The wire line is then pulled loose from the sleeve and the latter remains in place by engagement of the snap ring with the latching groove.

Should it become desirable to again cover up channels 7 once the sleeve has been shifted to uncover them, e.g., when pumping of more fluid to the bit is needed, the sleeve can be relocated over the channels by an action taken at the surface. When using a sleeve and dart arrangement as shown in FIGS. 1–3, the lower spindle 19 of the dart is provided with a snap ring 20 attached thereto in a groove so that upon entry of the dart into the sleeve the snap ring is compressed by the ring 13 into its recess; thus permitting the bevel 14 on the dart to abut the ring bevel 13b. However, when the dart is pulled upward through the sleeve, sufficient resistance is provided by the flat under surface of the ring to effect upward sliding of the sleeve before the ring 20 is compressed. Once the sleeve is topped against the upper stop 11, the snap ring can then be compressed by upward tugging and the dart withdrawn from the sleeve. Using an arrangement as shown in FIG. 4, the sleeve can be lowered again to cover the channels by bumping it downward with a weight on a wire line.

It will be appreciated that when the dart 12 is emplaced within the sleeve 9 the sealing surfaces 13b and 14 become mated, and flow of fluid to the bit is shut off. Since it will usually be desirable to continue the

pumping of fluid through the bit as well as through the circulating tool, the snap ring on the plunger can be omitted. In such cases a dart, minus the snap ring, is dropped into the drill pipe for operation of the sleeve, and can then be raised back out of the pipe by wire line without pulling the sleeve upwards and over the channels. Should it be desirable to again recover the channels, this can be accomplished with use of still another dart having a snap ring, as previously described.

In any event the apparatus illustrated in FIGS. **1-4** can be employed for increasing and subsequently restoring to normal the amount of drilling fluid which can be pumped into a well hole. As previously indicated, the channels **7** can be kept covered over by the sleeve **9** until greater flow is needed; for example, until the bit is about to be lifted up into the upper section of the hole of larger diameter, and can subsequently be covered over again when the increased flow is no longer needed.

The number and size of the channels **7** in the wall of the body section is subject to variation, but at least one is required and should have sufficient diameter to permit pumping of a significantly additional amount of fluid into the well hole.

FIG. **1** illustrates placement of the circulating tool directly above the drilling bit for introducing additional drilling fluid at that point. It will be appreciated, however, that the tool can, to advantage, be located further up in the string for introduction of additional fluid at a higher point, e.g., nearer the bottom of the upper section of the hole having a larger diameter than the lower end, for thus located, more pressure is available from the string for introducing a greater quantity of fluid into the hole.

The present invention has been described with reference to particular conditions, techniques, materials, apparatus arrangements and the like, but it will be understood that still other embodiments will become apparent which are within the spirit and scope of the invention described in the following claims.

What is claimed is:

1. In the drilling of a well wherein an upper section of the well hole has a significantly larger diameter than the lower end and a drilling fluid is circulated from the bottom to the top of the well hole by injection through a drilling bit, the method of flushing debris out of the well hole which has a settling rate that overcomes the upward thrust of drilling fluid injected through the drilling bit and which passes through the upper section of the hole having a larger diameter, said method comprising introducing additional drilling fluid into the hole from a source other than the drilling bit and hence in a quantity greater than can be supplied through the bit alone, raising the upward thrust of fluid in the upper section of the hole having a larger diameter, overcoming the settling rate of debris therein, discharging debris from the upper section of the hole while entrained in the fluid introduced into the well hole, and preventing the falling of debris into the lower end of the well hole.

2. A method as in claim **1** wherein fluid is introduced from a fluid channel through the wall of the drilling string, said channel being located above the drilling bit.

3. A method as in claim **1** wherein the supply of additional fluid is shut off during drilling and is turned on prior to raising the drilling bit into the larger, upper portion of the hole.

4. A method as in claim **1** wherein fluid from the source other than the bit is introduced into the well hole near the bottom of the upper section having a larger diameter than the lower section.

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