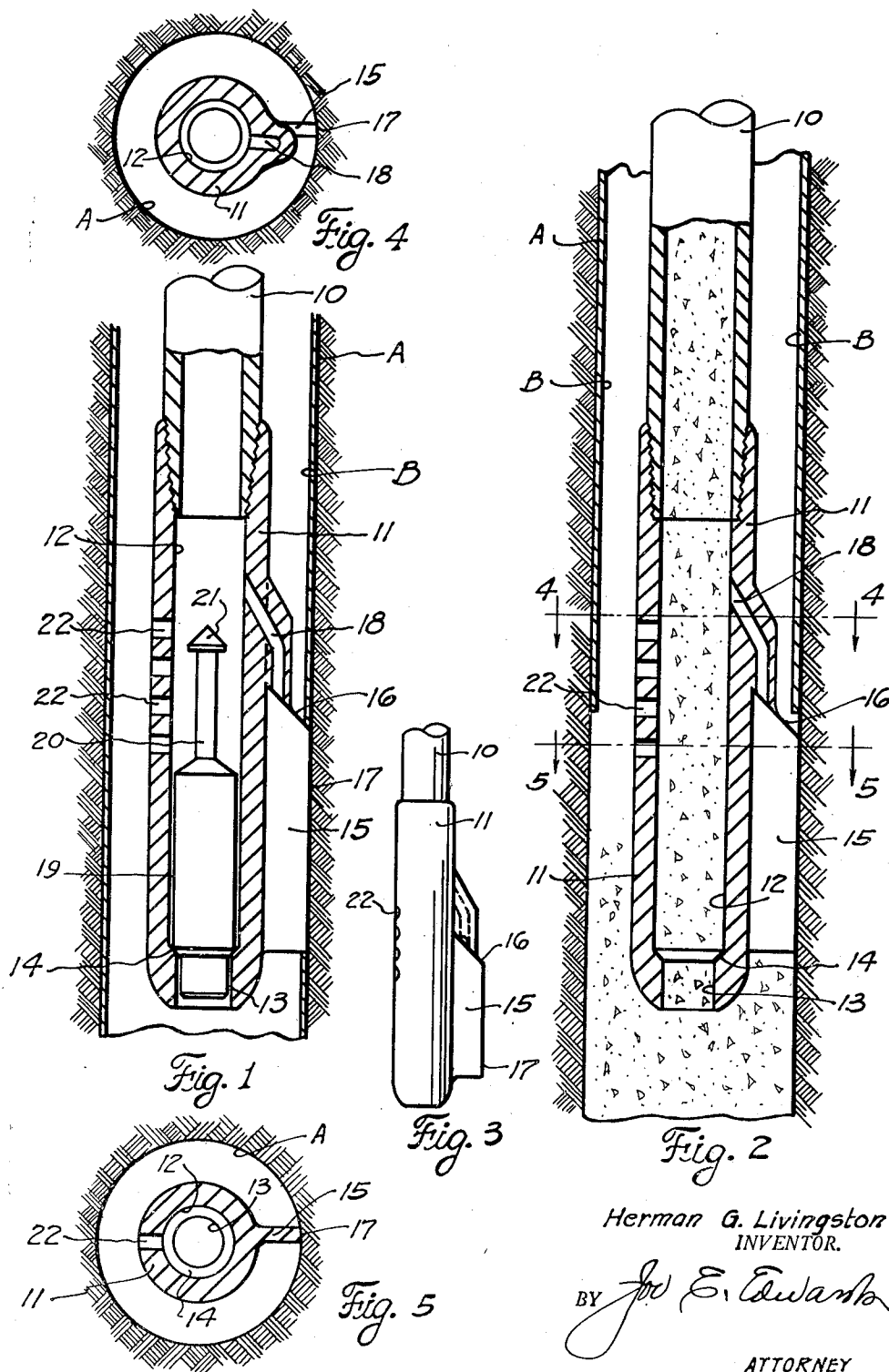


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COMBINATION REAMING AND CEMENTING APPARATUS AND METHOD
OF FORMING CEMENT PLUGS WITHIN WELL BORES
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COMBINATION REAMING AND CEMENTING
APPARATUS AND METHOD OF FORMING
CEMENT PLUGS WITHIN WELL BORES

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This invention relates to new and useful improvements in combination reaming and cementing apparatus and methods of forming cement plugs within well bores.

As is well known, many occasions arise where it becomes necessary to "plug back" within a well bore or to form a cement plug at a desired elevation within said bore. Because the drilling fluid or mud which is circulated through the bore during the drilling operation forms an annular cake or "mud ring" on the wall of said well bore, it is essential that a reaming operation be performed to remove this cake or mud ring before any cementing operation can be carried out. It has been the usual practice to lower a suitable reamer on the drill pipe and through the usual rotation, ream out the well bore to effect removal of the annular mud ring from the wall of said bore. After the wall is cleaned, the reamer and pipe are withdrawn from the bore and a cementing pipe or conductor is lowered, the cement being pumped subsequently downwardly through the pipe or conductor in the usual manner. Obviously, this practice involves the running of the drill pipe which has the reamer mounted thereon, removal of said pipe after the reaming operation, and then a second run of the cementing conductor, all of which requires excessive time and labor.

It is one object of this invention to provide an improved apparatus which may be employed as a reamer to remove the "mud ring" or annular cake of drilling fluid from the well bore and which may be subsequently utilized as a cementing sub through which the cement may be introduced into the well bore, whereby only a single run of the pipe or conductor is required to perform both operations.

An important object of the invention is to provide a combined reaming and cementing sub which is so constructed that the pressure of the fluid circulated during the reaming operation is utilized to urge and maintain the cutting blade of said reamer in positive contact with the wall of the well bore, whereby efficient reaming of the wall to assure removal of the mud ring on said wall may be accomplished.

Another object of the invention is to provide an improved reaming and cementing device having its bore normally closed by a removable closure which closure causes said sub to function as a reaming device; removal of said closure, either by a wire line removing tool or by fluid pressure, opening said bore to provide an un-

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restricted outlet for the passage of cement into the well bore.

A particular object of the invention is to provide an improved device, of the character described, wherein an elongate radially extending reaming blade is formed exteriorly of the body of said device, with fluid outlet ports located in said body substantially diametrically opposite said blade, said ports being of a reduced area whereby fluid under pressure may be jetted out through said ports at a relatively high velocity so that the force of said fluid jets urges and maintains the blade in contact or engagement with the wall of the well bore to assure efficient reaming when said device is rotated.

Still another object of the invention is to provide an improved method of forming a cementing plug within a well bore including, lowering a drill pipe having a reaming sub with a closed bore on its lower end into the bore, rotating the pipe to remove the "mud ring" from the wall of the bore, then opening the bore of said sub, and finally pumping cement into the well bore below said sub through said open bore, whereby the reaming and cementing operations may be carried out without removal of the drill pipe and sub from the well bore.

The construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, wherein an example of the invention is shown, and wherein:

Figure 1 is a view, partly in section and partly in elevation, of a combined reaming and cementing apparatus, constructed in accordance with the invention, and showing the removable closure within the bore of the sub to cause the apparatus to function as a reamer,

Figure 2 is a similar view with the closure removed and illustrating the cement being introduced through the bore of the sub,

Figure 3 is an elevation of the improved sub,

Figure 4 is an enlarged horizontal cross-sectional view, taken on the line 4—4 of Figure 2, and,

Figure 5 is an enlarged, horizontal cross-sectional view, taken on the line 5—5 of Figure 2.

In the drawings the numeral 10 designates a tubular conductor or drill pipe which is adapted to be lowered within a well bore A. An elongate sub 11 is connected to the lower end of the pipe 10 and is provided with an axial bore 12 which

extends entirely therethrough. The extreme lower end of the bore is reduced as shown at 13, whereby an internal annular shoulder or seat 14 is provided within the lower portion of said bore.

A longitudinally extending reamer blade 15 is preferably made integral with the body of the sub 11 and is located exteriorly thereof. The lower end of the blade is disposed in a plane above the extreme lower end of the sub, while the upper end of said blade extends to a point above the mid-height of the sub, said upper end being inclined or bevelled as shown at 16. The blade is relatively flat and projects radially outwardly from the body of said sub and the longitudinal outer edge 17 of said blade forms the cutting edge thereof.

When the tubular conductor or pipe 10 and the sub 11 are rotated, the blade 15 will be rotated within the well bore 10 and the cutting edge 17 of said blade will ream the wall of the well bore to remove any accumulation on said wall and thereby effect cleaning thereof. Fluid which is circulated downwardly through the bore of the pipe and into the bore 12 of the sub is directed outwardly into contact with the blade 15 through an inclined passage 18 which has its inner end communicating with the bore 12 and its outer end located adjacent the upper surface of the blade 15. Thus, during the reaming operation the downwardly circulated fluid flowing through the passage 18 washes the blade 15 to lubricate said blade and to maintain the blade clean and free from the cuttings which said blade removes from the wall of the well bore.

In order to assure the engagement of the cutting edge 17 of the blade with the wall of the well bore, a removable plug 19 is adapted to seat upon the bevelled shoulder 14 within the lower portion of the bore 12 of the sub and when this plug is in position, as shown in Figure 1, the lower end of the sub bore is closed. The plug 19 has an upwardly extending, integral shank 20 provided with an enlarged conical head 21 at its upper end for engagement with the usual fishing or retrieving tool. The provision of the head 21 permits a retrieving tool to be lowered through the pipe or conductor 10 on a wire line or cable for the purpose of removing the plug 19 from the sub bore.

During the reaming operation, the plug 19 is in position closing the bore of the sub and as fluid is circulated downwardly through the conductor, a portion of this fluid flows outwardly through the passage 18 to wash the reaming blade 15. The remainder of this circulating fluid is jetted or forced outwardly through a plurality of reduced openings or velocity ports 22 which extend radially through the wall of the sub 11. These ports are disposed in substantially a single vertical plane and are located diametrically opposite the reamer blade 15 whereby the escaping fluid is directed into contact with the wall of the well bore at a point diametrically opposite the reamer blade 15. The force of the fluid jets flowing through the velocity ports 22 is sufficient to urge the sub 11 in a direction which will maintain the cutting edge 17 of the blade 15 in positive contact with the wall of the well bore during rotation of the sub. Thus, the fluid is utilized to assure efficient reaming action by the blade 15 and so long as the fluid circulation is maintained, positive contact of the blade with the well bore will be had.

After the reaming operation is completed, a retrieving tool (not shown) may be lowered

through the conductor and into the bore 12 of the sub and engaged with the head 21 on the shank 20 of the plug 19. Lifting of the retrieving tool will, of course, remove the plug 19 from within the bore and said plug may be brought to the surface to allow flow through the sub. The bore of the sub is substantially full-gauge so that cement may be subsequently pumped downwardly through the conductor and sub into the well bore A below the device. Thus, the reaming and cementing operations may be carried out without removing the conductor or sub from the well. If desired, the plug 19 may be pumped upwardly to the surface by reversing the circulation of the fluid, that is, by pumping said fluid downwardly through bore A and upwardly through the conductor.

The operation of the apparatus and in practicing the method the plug is placed within the sub 11 and said sub is connected to the conductor or pipe 10. The apparatus is then lowered into the well bore A with the sub located at the point at which the cementing is to be done within the bore.

It is pointed out that during the drilling of a well bore, drilling fluid or mud is circulated through the drill pipe and bit and through the well bore and it has been found that this drilling mud will accumulate on the wall of the well bore A to form an annular accumulation which is generally known as a "mud ring." This mud ring is indicated at B in Figures 1 and 2. In order to form a proper cement plug or to carry out an efficient cementing operation it is first necessary that this accumulation or mud ring be removed from the wall of the well bore.

As has been stated, the apparatus is lowered to locate the sub at the elevation at which cementing is to be carried out and a fluid is circulated downwardly through the conductor and into the bore 12 of the sub. The major portion of this fluid under pressure is ejected outwardly through the velocity ports 22 in the sub and the contact of this ejected fluid with the wall of the well bore is sufficient to urge the sub 11 toward a position opposite the point at which the ejected fluid contacts said wall, whereby the cutting edge 17 of the reamer blade 15 which is diametrically opposite the ports is engaged with the wall of the well bore A. The conductor and sub are then rotated and since the cutting edge 17 is engaged with the wall of the bore, a reaming action of said bore which will remove the mud ring B may be accomplished. The blade 15 is constantly washed and lubricated by the fluid flowing downwardly through the passage 18 and, of course, circulation of this fluid upwardly through the bore will carry the cuttings removed by the reaming blade to the surface.

The reaming operation is continued until a sufficient portion of the bore is cleaned of the mud ring B after which the conductor and sub are lifted to bring the sub back to its original or starting position or elevation within said bore. The plug 19 is then removed from the sub either by a wire line retrieving tool (not shown) or by reversing circulation and pumping the plug to the surface. The cement is then pumped downwardly through the conductor 10 and sub 11 and into the well bore A in the usual manner to carry out the cementing operation below said sub. It is pointed out that the sub has substantially a full opening therethrough whereby efficient cementing may be had. After the cementing is complete the entire assembly is removed.

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From the foregoing it will be seen that both the reaming and cementing operations may be accomplished without removing the tubular conductor and sub from the well bore. An important feature of the invention is the removable plug which permits the fluid pressure to be utilized to maintain the reaming blade in contact with the well bore and thereby assure efficient reaming. Removal of the plug allows the subsequent cementing to proceed in the usual manner.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. An apparatus, of the character described, including a tubular conductor adapted to be lowered into a well bore, a sub having an axial bore connected to said tubular conductor, the upper end of the bore of said sub communicating with the conductor and the lower end of said sub bore communicating with the well bore, means for closing the lower end of the bore of said sub, reaming means located on the exterior of said sub for reaming the wall of the well bore when the conductor and sub are rotated, said sub having reduced openings extending through its wall to establish communication between the sub bore above the closure and the well bore, said openings being located substantially diametrically opposite the reaming means, whereby fluid pumped downwardly through the conductor and into the sub bore is forced outwardly in relatively high velocity jets into contact with the well bore wall, the force of said jets resulting in urging and maintaining the reaming means in positive engagement with the wall of the well bore.

2. An apparatus as set forth in claim 1, together with means for diverting a portion of the pumped fluid over the reaming means to clean said means during the reaming operation.

3. An apparatus as set forth in claim 1, wherein the reduced openings are located in substantially the same longitudinal plane on the sub, and wherein the reaming means is a longitudinally

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extending blade, with the longitudinal plane of said blade being exactly one hundred eighty degrees opposite the plane in which the openings are disposed.

4. An apparatus as set forth in claim 1, wherein the closure for the sub bore is a removable plug element, and means for removing said plug after the reaming operation is completed whereby cement may be subsequently introduced into the well bore through said conductor and sub.

5. A reaming and cementing sub including, a body having a bore extending axially therethrough, a removable closure adapted to seat within the bore to close the lower end thereof, and reaming means on the exterior of the body, said body having velocity ports extending through its wall above the closure with said ports being located substantially diametrically opposite the reaming means.

6. A sub as set forth in claim 5, together with a passage extending from the bore of the sub to the reaming means for directing fluid from the bore to said means.

7. A sub as set forth in claim 5, wherein the reaming means is a single elongate blade extending longitudinally of the sub and projecting outwardly therefrom.

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