April 7, 1953 J. I. SLOAN 2,634,101

APPARATUS FOR ACCELERATING THE REMOVAL OF CUTTINGS FROM THE BOTTOM OF WELLS

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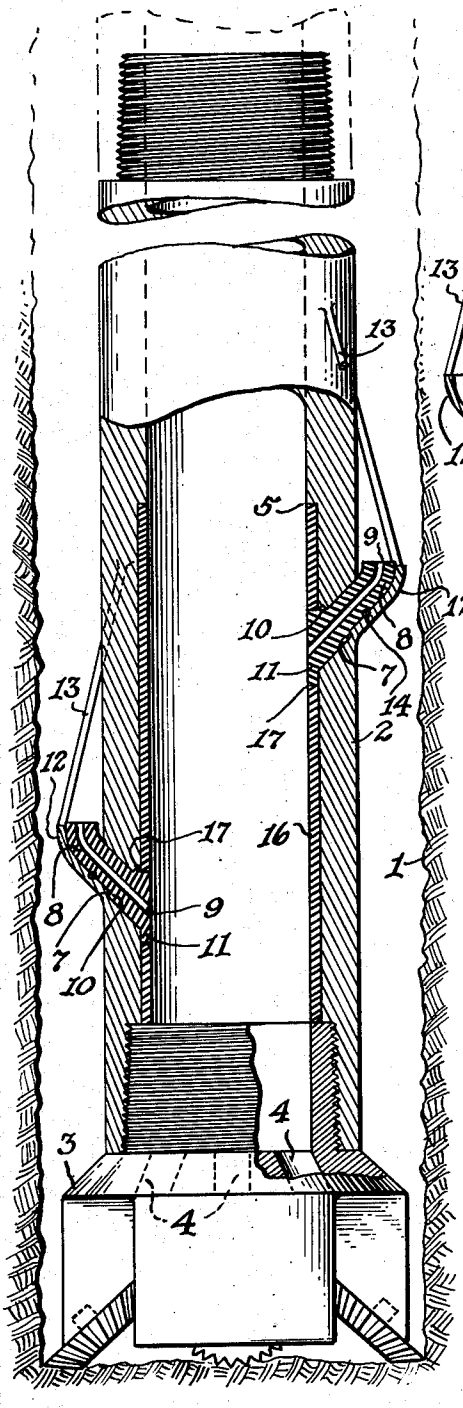

Fig. 1.

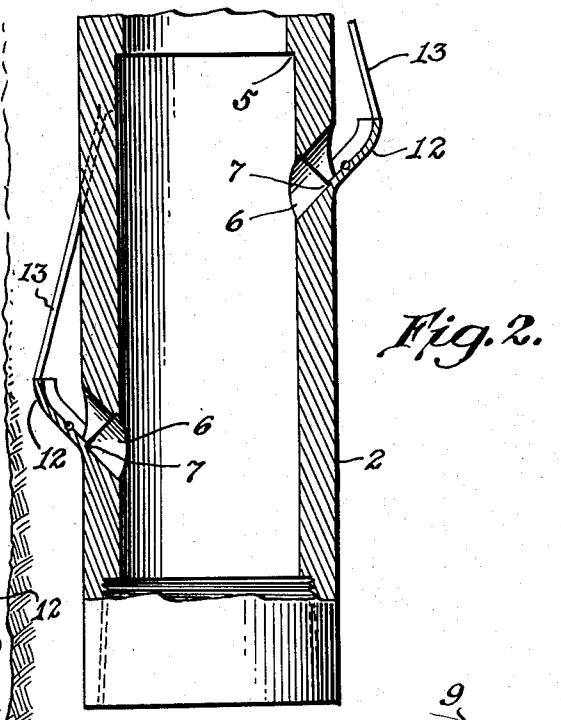

Fig. 2.

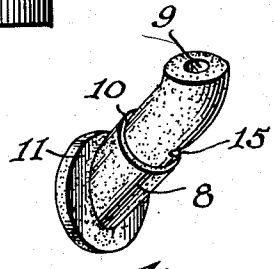

Fig. 3.

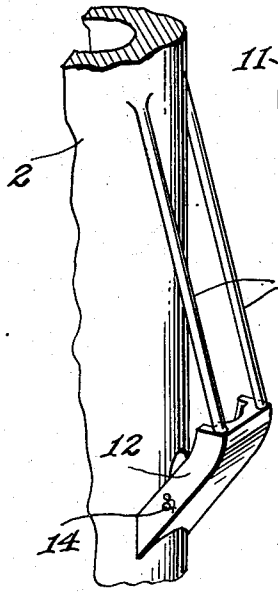

Fig. 4.

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APPARATUS FOR ACCELERATING THE REMOVAL OF CUTTINGS FROM THE BOTTOM OF WELLS

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6 Claims. (Cl. 255—24)

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In the drilling of oil wells, particularly by rotary rigs, a continuous stream of mud is pumped down through the string of drill pipe, out through passages in the drill bit, and thence upwardly and out through the mouth of the well.

This use of drilling mud is essential and is the common practice. The drilling mud performs various well known functions such as counteracting pressures exerted by gas or oil, carrying off cuttings, sealing off porous strata, etc. But the main function of the drilling mud with which the present invention is concerned, is carrying off the cuttings. The flow of the mud stream is not sufficient to carry off the cuttings as they occur, and consequently the cuttings remain at the bottom of the well until they are ground down to such very small particles that they can be carried off by the mud stream.

This grinding action of the bit on the cuttings obviously slows down the drilling operation, and further, it causes heavy wear on the bit, and thus much time is lost because of the more frequent necessity of the long and expensive operation of removing bits.

Also, as the wells get deeper and deeper, back pressure increases in the drill stem, and to prevent overloading of the pump the volume of the mud fluid forced down into the well is decreased, although the volume of the mud fluid should be increased as the well becomes deeper. The result of this decrease in volume of the mud fluid is that the cuttings must be ground still finer before they are carried away from the bit, thereby further slowing the drilling and further increasing the wear on the bit.

One of the objects of the present invention is to provide an apparatus by which the cuttings will be carried off much more rapidly, to thereby increase the speed of the drilling operation and reduce the wear on the drilling bits.

Another object of the invention is to provide a booster action adjacent the bottom of the well so that the cuttings churning adjacent the bottom of the well will be caught in this booster action and be carried upwardly clear of the drilling bit.

A further and more specific object of the invention is to provide upwardly directed jet nipples, above the drilling bit, to direct upwardly moving streams of mud fluid, to thereby accelerate the upward flow of the drilling mud.

Still another object of the invention is to provide means by which the volume flow of the mud stream can be increased as the well becomes deeper.

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A further object of the invention is to provide means for preventing wear on the interior of the drill stem at the points where the course of the mud stream is changed to cause the booster action.

Various other objects and advantages of the invention will be apparent to those skilled in the art, from the following detailed description when taken in connection with the accompanying drawings, in which:

Figure 1 is a vertical sectional view of the lower end portion of the drill stem and associated parts; the drill bit being shown in elevation;

Figure 2 is a vertical sectional view of the lower end portion of the drill stem with parts removed;

Figure 3 is a detail perspective view of one of the booster jet nipples; and

Figure 4 is a detail perspective view of the nipple support.

Referring to the drawings in more detail, numeral 1 indicates the lower portion of the bore of a well being drilled by a rotary rig. Numeral 2 refers to the lower section of drill piping. As is well known, the drill string consists of numerous hollow sections connected together, the drill string being rotated by the rotary rig, and carrying at its lower end a drill bit. The drill bit is referred to herein by numeral 3, and while the particular bit illustrated herein is of the cone type, yet it will be understood that any desired type of drill bit may be employed.

As is also well known, drilling mud is forced down through the drill stem, out through passages in the bit, and then upwardly between the drill stem and the wall of the well, to the surface. This is such common practice that illustration is deemed unnecessary, except that the usual passages or channels, in the bit, for the discharge of the drilling mud are shown and are referred to by numeral 4.

During the drilling operation, the action of the bit and the mud passing through the passages 4 and onto the cones of the bit, create a churning action of the mud and cuttings, but the volume and pressure of the drilling mud is not sufficient to carry off the cuttings until by repeated grinding action by the bit the cuttings are finely reduced in size and weight. As previously mentioned, this slows the drilling process and causes heavy wear on the bit.

The present invention increases the volume of the mud flow and provides a booster action, by which the cuttings are more quickly carried away from the bit, thereby speeding up the drill-

ing operation, and decreasing the bit wear, as will now be described. And while only one form of the invention is shown and described, yet it will be understood that the highly desirable results can be obtained with various forms of the invention.

By reference to Figure 2 it will be noted that the lower portion of the drill stem section which carries the bit has its interior diameter increased somewhat to provide an annular pocket having an annular shoulder 5 at its upper end. It will also be noted that this portion of the drill stem section, between the shoulder and the bit, is provided with upwardly inclined holes 6, and that an annular shoulder 7 is provided in the wall of each hole.

Numeral 8 refers to booster jet nipples, a detail perspective view of one of which is shown in Figure 3. Two of these nipples are shown in operative position in Figure 1, and they make a snug fit in the previously described holes 6 in the lower portion of the drill stem section which carries the bit. While the drawings show two of these holes and consequently two nipples, and show these holes as differently spaced above the bit, yet of course the number of holes and their positions, and consequently the number of booster jet nipples and their positions, may be varied as desired.

These nipples are shown as made of rubber or rubber-like flexible material, though of course the nipples may be made of other material, such as metal. A passage 9 extends through the nipples, and the nipples when in position incline upwardly and their outer ends turn upwardly, so that the stream of drilling mud passing therethrough will be directed vertically upward. The nipples are of course removable and replaceable, and they are provided with passages of different sizes, so that as the well gets deeper and deeper nipples with passages of larger diameter may be substituted, for a purpose which will appear hereinafter.

In the specfic embodiment illustrated, the nipples have an annular shoulder 10 adjacent their inner ends, and at their inner ends a flange 11 is provided. The nipples are inserted in position in the holes 6 through the interior of the drill stem section and the annular shoulder 10 on the nipple will abut against the annular shoulder 7 in the holes 6, and the flange 11 of the nipples will abut against the interior face of the drill stem wall. The pressure of the drilling mud against the nipples is, of course, outwardly, and this pressure will hold the shoulder on the nipple tightly against the shoulder in the hole and likewise tightly hold the flange of the nipple tightly against the interior face of the drill stem wall.

Of course the invention is not limited to the specific form of nipple shown or to the particular manner in which the nipples are mounted in the drill stem section. Obviously wide variation is possible and, for example, if metal nipples are used they could be screwed or otherwise suitably mounted in the drill stem.

To support and shield the booster jet nipples 8, there is preferably provided a protecting shield 12 which is shaped transversely to receive and support that portion of the nipple which is exterior of the drill stem section. This protecting shield may be made of any suitable metal and preferably is welded to the drill stem. As additional support for the shield 12 two rods 13 may be provided; these rods having their lower ends welded to the upper end of the shield, and the upper ends of the rods being welded to the drill stem section. It will be apparent from the drawings that the jet nipples and the shields are considerably spaced from the wall of the well, as determined by the diameter of the drill bit, so that there is little danger of them striking the wall of the well.

As stated hereinbefore, when drilling mud is being pumped down the drill stem the pressure on the nipples is outwardly, but when the drill stem is being withdrawn the pressure of the drilling mud or other substances in the well bore, might tend to push the nipples back in the drill stem, and the same is true if the nipples should strike some obstacle. To prevent possible inward movement of the nipples while the drill stem is being pulled out of the well bore, I may provide a removable lock pin 14, which passes through holes in the sides of the shield and is seated in a groove 15 in the bottom of the nipple. Obviously other suitable means could be provided, if desired, to prevent unintentional inward movement of the nipples.

In order that a portion of the drilling mud flowing down the drill stem may be ejected through the nipples, it is necessary that part of the mud stream change its course, and this change of course adjacent the openings where the nipples are provided, might cause considerable wear on the drill stem. For this reason and to otherwise prevent wear of the drill stem, there is also preferably provided a cylindrical sleeve 16 which is preferably, though not necessarily made of rubber or rubber-like flexible material. This sleeve makes a neat fit in the annular pocket formed by the enlargement of the inner diameter of the lower portion of the drill stem section. And the upper end of the sleeve abuts against the annular shoulder 5 in the drill stem section, while the lower end of the sleeve abuts against the top of the stem of the drill bit when it is screwed into position, so that the sleeve is firmly held in place. The sleeve is provided with the proper number of openings 17, properly positioned, according to the number and position of the booster jet nipples. The sleeve is usually mounted in position first, and then the jet nipples are placed in position through the interior of the drill stem section, either by hand or by an appropriate tool, and these openings 17 permit the sleeve 16 to make a neat fit about the periphery of the flanges 11 on the nipples.

The operation will no doubt be clearly understood from what has been said hereinbefore. One of the functions of drilling mud is to carry away the cuttings. But heretofore the mud being pumped down the drill stem has been discharged only through the drilling bit. There are usually three or four holes in a bit for discharging the mud from the drill stem to the cones, and the size of these holes is necessarily limited; the largest being three quarters of an inch in diameter. Thus the volume flow of the mud stream is limited, and the cuttings must be ground very fine before this stream can carry them off. This grinding by the bit slows the drilling operation and subjects the bit to heavy wear.

And as the well is drilled deeper and deeper the pressure builds up in the drill stem, thereby overloading the pump, so that it is necessary to pump less mud down the well when it gets deeper, while in fact it is desirable that more mud should be pumped down as the well gets deeper.

In accordance with the apparatus of the present invention, the mud being pumped down the well is discharged not only through the drilling bit but also through appropriate discharge openings above the drill bit. Thus it is apparent that the volume and velocity of flow of the mud stream is increased, and this increase of course accelerates the carrying away of the cuttings in the region of the drilling bit. In other words, the mud stream, increased in volume and velocity, will carry away cuttings of much larger size and weight, and thus speed up the drilling operation and decrease the wear on the bit.

Further, the supplemental discharges above the bit, are directed upwardly by the nipples, and these upwardly discharged streams provide a booster action to pick up the cuttings which are swirling about near the bottom of the well and force them upwardly away from the bit. This booster action is, broadly speaking, in the nature of an injector action. Obviously the effect of these upwardly moving booster streams is to greatly accelerate the movement of the cuttings away from the drilling bit.

Also, these booster jet nipples are provided with discharge passages of different sizes, for example, varying from one quarter inch diameter to one half inch diameter. Thus as the well gets deeper nipples with larger discharge passages will be substituted, thereby preventing the building up of pressure in the drill stem resulting in overloading of the pumps.

Having fully described the invention, what I claim is:

1. Apparatus for the rotary drilling of oil wells, including the combination of a rotary drill stem, a drill bit carried by the drill stem, said drill bit having downwardly directed passages for discharging drilling mud downwardly from the drill stem through the drill bit, said drill stem having upwardly directed passages for upwardly discharging drilling mud from the drill stem above the drill bit, said upwardly directed passages in the drill stem arranged close enough to the bit to accelerate the removal of cuttings from the bit, and an annular sleeve fitted in said drill stem adjacent said upwardly directed passages.

2. Apparatus for the rotary drilling of oil wells, including the combination of a rotary drill stem, a drill bit carried by the drill stem, said drill bit having downwardly directed passages for discharging drilling mud downwardly from the drill stem through the drill bit, said drill stem having a lateral opening therein, an upwardly directed nipple of rubber or rubber-like material mounted in the opening in the drill stem above the drill bit and having a passage therethrough for discharging an upwardly directed booster stream of drilling mud from the drill stem, and a shield mounted on the drill stem to support the nipple exterior of the drill stem.

3. Apparatus for the rotary drilling of oil wells, including the combination of a rotary drill stem, a drill bit carried by the drill stem, said drill bit having downwardly directed passages for discharging drilling mud downwardly from the drill stem through the drill bit, said drill stem having a lateral opening therein, an upwardly directed nipple of rubber or rubber-like material mounted in the opening in the drill stem above the drill bit

and having a passage therethrough for discharging an upwardly directed booster stream of drilling mud from the drill stem, and a sleeve of rubber or rubber-like material mounted in the drill stem adjacent the nipple, said sleeve having an opening in its wall to permit the sleeve to fit snugly about the nipple.

4. Apparatus for the rotary drilling of oil wells, including a section of a rotary drill stem adapted to carry a drill bit, said drill stem section having a lateral opening in the wall thereof, an annular shoulder in said opening, a nipple mounted in said opening through the interior of the drill stem section, an annular shoulder on the nipple abutting against the annular shoulder in said opening, and said nipple having an upwardly directed passage therethrough for discharging an upwardly directed booster stream of drilling mud from the drill stem.

5. Apparatus for the rotary drilling of oil wells, including a section of a rotary drill stem adapted to carry a drill bit, said drill stem section having a lateral opening in the wall thereof, a nipple of rubber or rubber-like material mounted in said opening through the interior of the drill stem section, said nipple having an upwardly directed passage therethrough for discharging an upwardly directed booster stream of drilling mud from the drill stem, a flange on the inner end of said nipple abutting against the interior face of the drill stem section, and a sleeve of rubber or rubber-like material mounted in the drill stem section, said sleeve having an opening in the wall thereof to fit neatly about said flange.

6. Apparatus for the rotary drilling of oil wells, including a section of a rotary drill stem adapted to carry a drill bit, said drill stem section having a lateral opening in the wall thereof, a nipple of rubber or rubber-like material mounted in said opening, said nipple having an upwardly directed passage therethrough for discharging an upwardly directed booster stream of drilling mud from the drill stem, a shield mounted on the exterior of the drill stem section for supporting and protecting said nipple, and means cooperating with said shield and nipple for preventing accidental inward movement of the nipple.

JOHN I. SLOAN.

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