

March 4, 1941.

R. B. BRYANT

2,233,692

DRILLING APPARATUS

Filed April 20, 1939

2 Sheets-Sheet 1

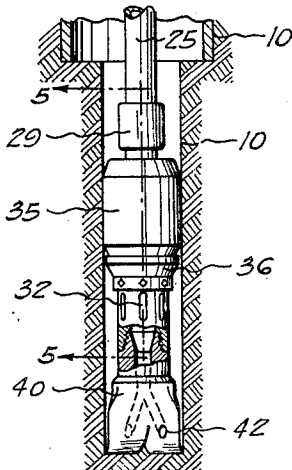
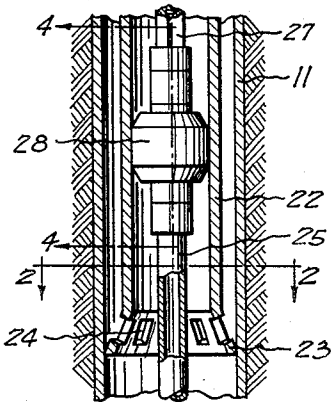
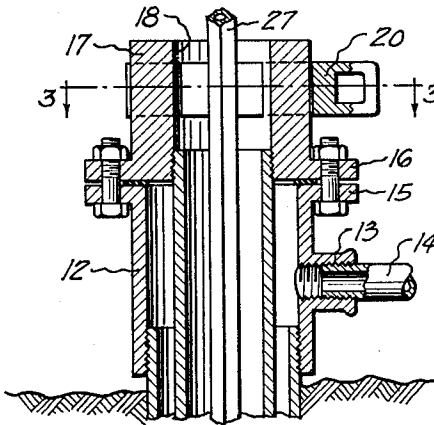


Fig. 1.

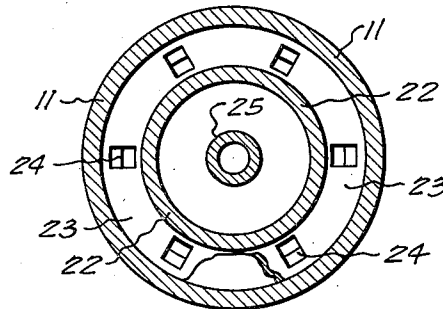


Fig. 2.

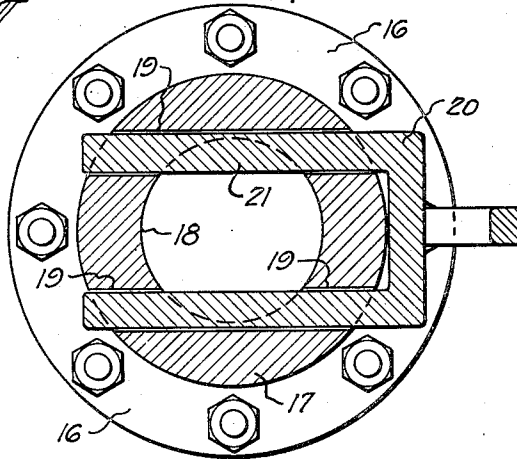


Fig. 3.

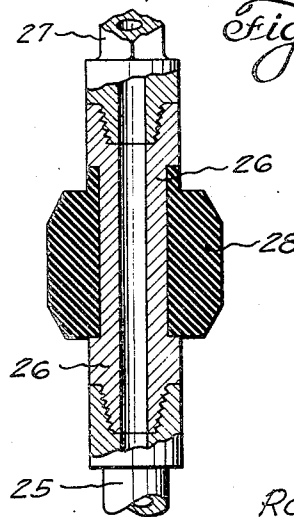


Fig. 4.

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2 Sheets-Sheet 2

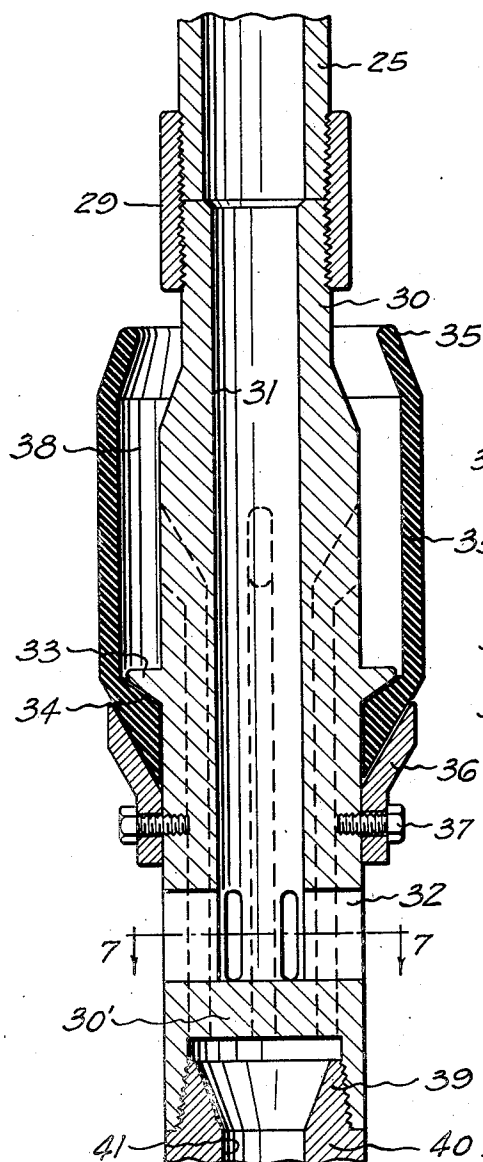


Fig. 5.

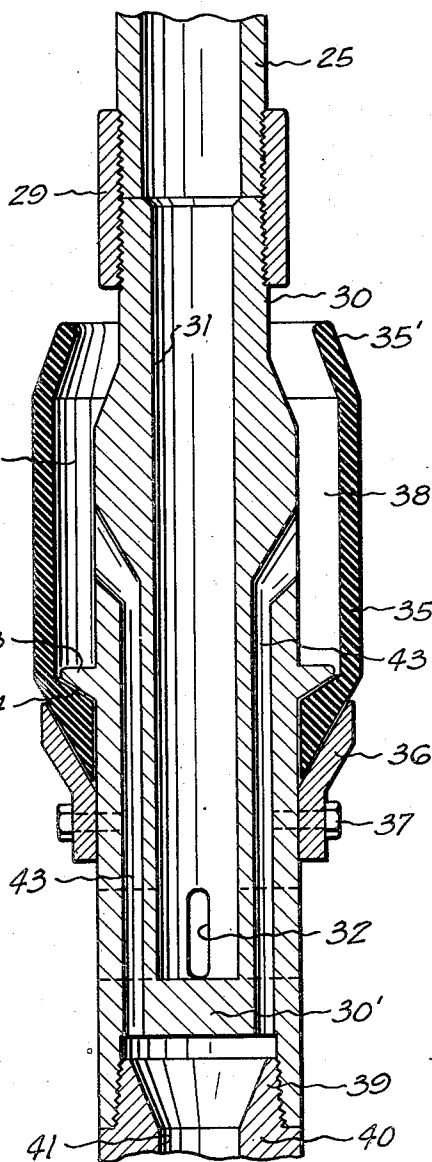


Fig. 6.

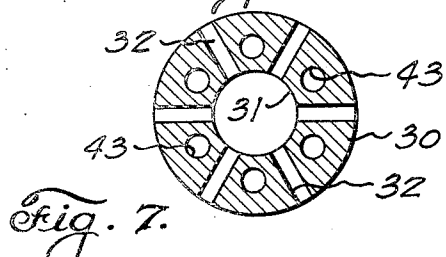


Fig. 7.

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UNITED STATES PATENT OFFICE

2,233,692

DRILLING APPARATUS

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11 Claims. (Cl. 255—1)

This invention relates to new and useful improvements in drilling apparatus.

In the drilling of wells, it is the general practice to circulate a drilling fluid, such as mud, downwardly through the drill stem or pipe and then upwardly through the well casing for the purpose of lubricating the rotating drill bit and also to carry the cuttings to the surface. Since the diameter of the casing is greater than the diameter of the drill stem, the velocity of the circulating fluid drops when it flows from said stem to said casing, with the result that a relatively high pump pressure must be maintained on the fluid entering the drill stem in order that sufficient pressure for circulation is had when the fluid flows into and enters the casing.

It has been found that by circulating the drilling in a reverse direction, that is, flowing the same downwardly through the casing and upwardly through the drill stem or pipe, much less pump pressure is necessary to maintain sufficient velocity for proper circulation. In employing reverse circulation, the fluid flows downwardly through the casing to the bottom of the hole and then upwardly through ports in the drill bit into the stem. With this method, the fluid is not directed against the cutting edges of the bit, as is the case when conventional circulation is employed, and this detracts from the use of reverse circulation because the bit is not properly lubricated, particularly when the bit is rotating in soft or sticky formations. Further, in using reverse circulation, the drill stem must be packed off from the well casing at the upper end thereof and the present pack-off devices, now in general use, are rather complicated and expensive, which also discourages the use of a circulation method other than the conventional.

It is one object of the invention to provide an improved apparatus whereby reverse circulation of the drilling fluid may be employed during the drilling operation without the disadvantages outlined above, and also without the other disadvantages which have heretofore been encountered by the use of such method of circulation.

An important object of the invention is to provide an improved apparatus which is arranged so that the drilling fluid may be circulated through the well in a direction reverse to the conventional method, and which has means for positively directing the fluid against the cutting edges of the drill bit to properly lubricate and clean said bit and also to assure carrying the removed cuttings to the surface.

Another object of the invention is to provide

an apparatus for practicing the reverse circulation of drilling fluid through the well bore which includes an improved means of packing off between the drill stem and casing, said means being simple in construction and being substituted for the usual complicated swivel and pack-off heads and devices now in general use.

A further object of the invention is to provide an improved apparatus, of the character described, having a sub or collar connected above the drill bit for diverting the drilling fluid from the well casing downwardly through the bit and thence upwardly around the bit and to the drill stem, whereby the action of the fluid on the bit is substantially the same as when the conventional method of circulating the drilling fluid is employed.

Still another object of the invention is to provide an improved apparatus for permitting reverse circulation of drilling fluid which includes a flexible sealing member arranged to seal off between the well bore and drill stem above the drill bit, whereby the fluid flowing downwardly through the casing cannot pass to the outside of the bit; said collar being adapted to be distorted and held in sealing position by the circulating drilling fluid and also being removably mounted so as to be readily replaceable when worn or for any other reason.

A 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 drawings, in which an example of the invention is shown, and wherein:

Figure 1 is a view, partly in section and partly in elevation, of an apparatus, constructed in accordance with the invention and showing the same within a well bore,

Figure 2 is an enlarged, horizontal, cross-sectional view, taken on the line 2—2 of Figure 1,

Figure 3 is an enlarged, horizontal, cross-sectional view, taken on the line 3—3 of Figure 1,

Figure 4 is an enlarged, transverse, vertical, sectional view, taken on the line 4—4 of Figure 1,

Figure 5 is an enlarged, transverse, vertical, sectional view, taken on the line 5—5 of Figure 1,

Figure 6 is a view similar to Figure 5, and taken at substantially a right angle thereto, and

Figure 7 is a horizontal, cross-sectional view, taken on the line 7—7 of Figure 5.

In the drawings, the numeral 10 designates a well bore through which the well casing 11 ex-

tends. The upper end of the well casing is externally screw-threaded to receive a casing head 12 which is provided with a lateral port 13. A suitable inlet pipe 14 is threaded into the port 13, whereby a drilling fluid may be conducted into the bore of the well casing. The head 12 is provided with an external, annular flange 15 at its upper end and this flange is bolted to the flange 16 of a suitable blowout preventer 17. The blowout preventer 17 may be of any suitable construction and, as shown, includes a body having an axial bore 18 extending therethrough. A pair of laterally directed openings or passages 19 are formed within the body of the blowout preventer, as is clearly shown in Figure 3, and these openings intersect the bore 18. A U-shaped member 20 has its arms slidable within the passages 19 and when said member is moved inwardly the arms 21 of said member overlie a portion of the bore. When the member 20 is removed from the port, the bore 18 is unrestricted to permit the passage of tools, or other elements therethrough.

An elongate cylinder 22, which is open at its ends, has its upper end screw-threaded into the lower end of the bore 18 of the blowout preventer 17, whereby said cylinder is suspended axially within the well casing 11. The lower end of the cylinder is flared outwardly, as shown at 23, whereby tools which are pulled upwardly through the cylinder are guided into the bore thereof by the flared portion. A plurality of ports or openings 24 are formed in this flared portion, whereby an unrestricted flow of fluid, which is passing downwardly through the well casing 11, may flow through said ports.

The tubular drill pipe or stem 25 extends axially through the well casing and through the well bore and has its upper end connected to the lower end of a tubular mandrel 26, as is shown in Figure 4. The upper end of the mandrel 26 is coupled to the lower end of an angular drive member or kelly 27, whereby said mandrel couples the kelly to the upper end of the drill stem. A suitable annular packing sleeve 28 is mounted on the mandrel and is constructed of an elastic material, such as rubber, duprene, or the like. The outer diameter of the packing sleeve 28 is substantially equal to the diameter of the bore of the cylinder 22, whereby the outer surface of the packing sleeve frictionally engages the wall of said bore. The packing sleeve is arranged to move downwardly through the cylinder 22, as the drilling operation progresses and, manifestly, said sleeve will serve to pack off around the drill stem, whereby fluid within the lower end of the cylinder and within the casing cannot pass upwardly around the drill stem. The sleeve will, of course, serve to hold the pressure and prevent it from leaking upwardly past the drill stem and kelly.

The lower end of the drill stem 25 is connected by a suitable coupling collar 29 with the upper end of a tubular mandrel or sub 30. As is clearly shown in Figures 5 and 6, the sub is provided with an axial bore 31 which extends from its upper end to a point just above its lower end. A plurality of radial ports or openings 32 extend from the lower end of the bore 31 to the outer surface of the sub, whereby fluid may enter the lower end of the bore.

An external, annular flange 33, which is preferably made integral with the sub or mandrel 30, is formed thereon and is located intermediate the ends thereof. The underside of the

flange 33 is bevelled or inclined, as shown at 34. An annular, elastic packing sleeve 35 surrounds the sub or mandrel and has its lower end tapered inwardly so as to rotatably engage around the sub immediately below the shoulder 33. A retaining thimble 36 surrounds the sub and has its upper end overlying the lower end of the packing sleeve 35, whereby said packing sleeve is rotatably confined on the sub between said thimble and the shoulder 33. The thimble is removably fastened to the sub by means of tap screws 37 which are threaded into the exterior surface of said sub. The upper end of the packing sleeve 35 is bevelled or inclined inwardly as shown at 35'. By observing Figures 5 and 6, it will be seen that the upper portion of the bore of the sleeve 35 is of a larger diameter than the external diameter of the sub or mandrel 30, whereby an annular space 38 is formed between the sleeve and said hub.

The lower end of the sub 30 is threaded onto the usual upwardly extending pin 39 of an ordinary drill bit 40. As is clearly shown in Figure 1, the bit is provided with an axial bore 41, which has its lower end communicating with the usual inclined ports or fluid passages 42. The upper end of the pin or the drill bit 40 is spaced from the underside of the transverse partition 30', which partition extends transversely across the interior of the sub or mandrel and serves to close the lower end of the bore 31.

For establishing communication between the well bore or casing above the packing sleeve 35 and the axial bore 41 of the drill bit, a plurality of vertical passages 43 are formed in the sub or mandrel 30 (Figure 6). Each passage has its upper end inclined outwardly and communicates with the annular space 38 which is formed between the mandrel and the packing sleeve 35. The lower end of the passage extends downwardly through the partition 30', whereby fluid from the annular space 38 may flow downwardly and to the axial bore 41 of the drill bit.

In the operation of the device, the parts are assembled as shown in Figure 1, with the lower packing sleeve 35 contacting the wall of the well bore 10. The upper packer 28 is located within the cylinder 22 and it is noted that said packer remains within said cylinder at all times. The kelly joint 27 has its upper end extending through the usual rotary table (not shown), whereby said joint is rotated. As said joint rotates, the packing sleeve 28 is rotated within the cylinder 22 and the drill pipe 25 is also rotated to impart a rotation to the drill bit 40. It is pointed out that the particular mounting of the lower packing sleeve 35 is such that said sleeve contacts the wall of the bore 10 frictionally and the mandrel or sub 30 is rotatable therein. In other words, the sleeve 35 is merely confined on the sub and is capable of being held stationary, while said sub is rotating therein.

The drilling fluid is introduced into the upper end of the well casing through the pipe 14 and passes downwardly through said casing. This drilling fluid flows through the ports 24 in the lower flared end of the cylinder 22 and then downwardly into the bore 10 above the lower packing sleeve 35. Manifestly, the fluid will enter the annular space 38 formed between the sleeve 35 and the sub 30 and the pressure of this fluid will tend to expand or distort the sleeve 35 into sealing engagement with the wall of the bore 10. The drilling fluid will then pass downwardly through the vertical passages 43 and will

flow to the bore 41 of the drill bit 40. From the bore 41, the drilling fluid will pass outwardly through the inclined port 42 and will be directed against the cutting edges of the bit to properly lubricate and wash said blades. The drilling fluid will then pass upwardly through the well bore and will flow through the radial ports 32 which are provided in the lower end of the sub. The drilling fluid cannot pass upwardly through the bore because of the lower packing sleeve 35 which is in sealing engagement with the wall of said bore. Upon entering the ports 32, the drilling fluid will pass upwardly through the bore 31 of the sub 30, then upwardly through the tubular drill stem 25, through the tubular mandrel 26 of the upper packer 28 and finally upwardly through the kelly joint 27 to the swivel (not shown), which is located at the upper end of said kelly joint. In this manner, the drilling fluid is circulated in a direction which is reverse to the conventional manner, yet said fluid is directed against the cutting edges of the drill bit blades and acts to keep said edges clean and free from accumulations. Also, by directing the drilling fluid against the blades in this manner at the bottom of the hole, it is assured that the cuttings which are removed by the rotating bit will be carried to the surface through the drill stem.

As the drilling progresses, the upper packing sleeve 28 moves downwardly through the elongate cylinder 22 so as to hold the pressure and prevent its escape upwardly around the drill stem and kelly joint. At the same time, the lower packing sleeve 35 moves downwardly through the well bore 10 and, since this lower sleeve does not rotate, it is not subjected to a great deal of wear.

After sufficient hole has been drilled to cause the packer 28 to have moved downwardly to the lower end of the cylinder 22, it is necessary to insert another section of the drill pipe 25 before drilling is continued. In such event, the drill stem is lifted to the surface so that the packer 28 is removed from the cylinder and also from the bore 18 of the blowout preventer 17 above said cylinder. The upper end of the drill pipe 25 is then disconnected from the lower end of the mandrel 26 and another section of drill pipe connected between these two parts. After this is done, the drill stem is again lowered so as to lower the packing sleeve 28 into its cylinder 22. The drilling operation is then continued.

In the event that an excessive pressure should occur below the packing sleeve 28, said pressure would tend to force the same upwardly through its cylinder 22, with the result that the drill stem might be blown from the well. In order to prevent such blowout, the preventer 17 has been provided. Manifestly, with the U-shaped member 60 or yoke 20 retracted from its passages 19, the bore 18 of the blowout preventer is unrestricted and the packing sleeve 28 may readily pass there-through. However, if an excessive pressure occurs and the kelly joint begins to move upwardly, the operator need only move the member or yoke 20 inwardly of the passages 19. Such movement will cause the yoke arms 21 to intersect the bore 18 of the blowout preventer and, as is clearly shown in Figure 3, such position of the arms will restrict the area of said bore. Therefore, as the packing sleeve 28 is moved upwardly by the excessive pressure, it will finally strike the arms 21 which are disposed within the bore 18 and further upward movement of the drill stem will be prevented. It is noted that the particular type

of blowout preventer forms no part of the present invention and, so long as some means for preventing excessive pressure lifting the drill stem from the well is provided, the purpose of the invention will be accomplished.

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. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, means for circulating a drilling fluid downwardly through the well bore outside of the stem, means for conducting the fluid from the bore to the fluid passages of the bit so as to direct said fluid into contact with the cutting blades thereof, and means for conducting the fluid upwardly through the drill stem to complete the circulation cycle.

2. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, and a connecting mandrel interposed between the bit and stem and having an axial bore which has its upper end communicating with the bore of the drill stem and its lower end communicating with the well bore immediately above the bit, said mandrel having vertical passages therein for conducting fluid from above the mandrel downwardly to the passages of the bit, whereby drilling fluid flowing downwardly through the well bore is conducted through the vertical passages of said mandrel to the bit and flows therethrough after which said fluid may pass upwardly through the bore of the mandrel and stem.

3. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, and a connecting member interposed between the stem and drill bit and having a fluid inlet in its upper end which communicates with the fluid passages of the bit and also having an outlet in its lower end which communicates with the drill stem, and means for sealing off the annular space between the drill stem and well bore, said sealing means being disposed between the inlet and outlet of the connecting member, whereby drilling fluid flowing downwardly through the well bore is conducted through the inlet and bit and then upwardly through the outlet and drill stem.

4. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, means surrounding the upper portion of the drill stem for packing off the annular space between said stem and the well bore, means for circulating a drilling fluid downwardly through the well bore outside of the stem, means for conducting the fluid from the bore to the fluid passages of the bit so as to direct said fluid into contact with the cutting blades thereof, and means for conducting the fluid upwardly through the drill stem to complete the circulation cycle.

5. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, a connecting member interposed between the stem and drill bit and having a fluid inlet in its upper end which communicates with the fluid passages of the bit and also having an outlet in its lower end which communicates with the drill stem, means for sealing off the annular space between the drill stem and well bore, said sealing means being disposed between the inlet and outlet of the connecting member, means secured to the upper end of the drill stem for packing off between said stem and the bore, and means for circulating a drilling fluid downwardly through the bore, whereby said fluid flows downwardly through the inlet of the connecting member and through the bit and then upwardly through the outlet and the drill stem.

6. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, a connecting mandrel interposed between the bit and stem and having an axial bore which has its upper end communicating with the bore of the drill stem and its lower end communicating with the well bore immediately above the bit, said mandrel having vertical passages therein for conducting fluid from above the mandrel downwardly to the passages of the bit, and an elastic packing sleeve surrounding the mandrel for packing off the annular space between the mandrel and well bore, whereby drilling fluid flowing downwardly through the well bore is conducted to the bit and flows therethrough after which said fluid may pass upwardly through the mandrel and stem.

7. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, a connecting member interposed between the stem and drill bit and having a fluid inlet in its upper end which communicates with the fluid passages of the bit and also having an outlet in its lower end which communicates with the drill stem, and an annular elastic packing element actuated by fluid pressure for sealing off the annular space between the drill stem and well bore, said sealing element being disposed between the inlet and outlet of the connecting member, whereby drilling fluid flowing downwardly through the well bore is conducted through the inlet and bit and then upwardly through the outlet and drill stem.

8. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, a connecting member interposed between the stem and drill bit and having a fluid inlet in its upper end which communicates with the fluid passages of the bit and also having an outlet in its lower end which communicates with the drill stem, and an annular elastic packing element actuated by fluid pressure for sealing off the annular space between the drill stem and well bore, said sealing element being disposed between the inlet and outlet of the connecting member, means secured

to the upper end of the drill stem for packing off between said stem and the bore, and means for circulating a drilling fluid downwardly through the bore, whereby said fluid flows downwardly through the inlet of the connecting member and through the bit and then upwardly through the outlet and the drill stem.

9. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, a connecting member interposed between the stem and drill bit and having a fluid inlet in its upper end which communicates with the fluid passages of the bit and also having an outlet in its lower end which communicates with the drill stem, means for sealing off the annular space between the drill stem and well bore, said sealing means being disposed between the inlet and outlet of the connecting member, an elongate cylinder surrounding the upper portion of the drill stem, a packing element mounted on the stem and having sealing engagement with the cylinder wall to pack off around the stem, and means for circulating a drilling fluid downwardly through the bore, whereby said fluid flows downwardly through the inlet of the connecting member and through the bit and then upwardly through the outlet and the drill stem.

10. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, a connecting member interposed between the stem and drill bit and having a fluid inlet in its upper end which communicates with the fluid passages of the bit and also having an outlet in its lower end which communicates with the drill stem, means for sealing off the annular space between the drill stem and well bore, said sealing means being disposed between the inlet and outlet of the connecting member, an elongate cylinder surrounding the upper portion of the drill stem, a packing element mounted on the stem and having sealing engagement with the cylinder wall to pack off around the stem, means for circulating a drilling fluid downwardly through the bore, whereby said fluid flows downwardly through the inlet of the connecting member and through the bit and then upwardly through the outlet and the drill stem, and a blowout preventer at the surface of the well bore arranged to be actuated to prevent the drill stem from being blown from the well by an excessive pressure.

11. A drilling apparatus including, a rotatable tubular drill stem, a drill bit having fluid passages therein secured to the lower end of said stem, whereby when the stem is rotated the bit performs the cutting operation, an elongate cylinder surrounding the upper portion of the drill stem, an elastic packing member surrounding the stem and having a sealing engagement with the cylinder wall to pack off around the stem, means for circulating a drilling fluid downwardly through the well bore outside of the stem and cylinder, means for conducting the fluid from the bore to the fluid passages of the bit so as to direct said fluid into contact with the cutting blades thereof, and means for conducting the fluid upwardly through the drill stem to complete the circulation cycle.