Aug. 15, 1939 J. W. PIPPIN 2,169,283

DRILLING APPARATUS

Filed Oct. 25, 1937 3 Sheets-Sheet 1

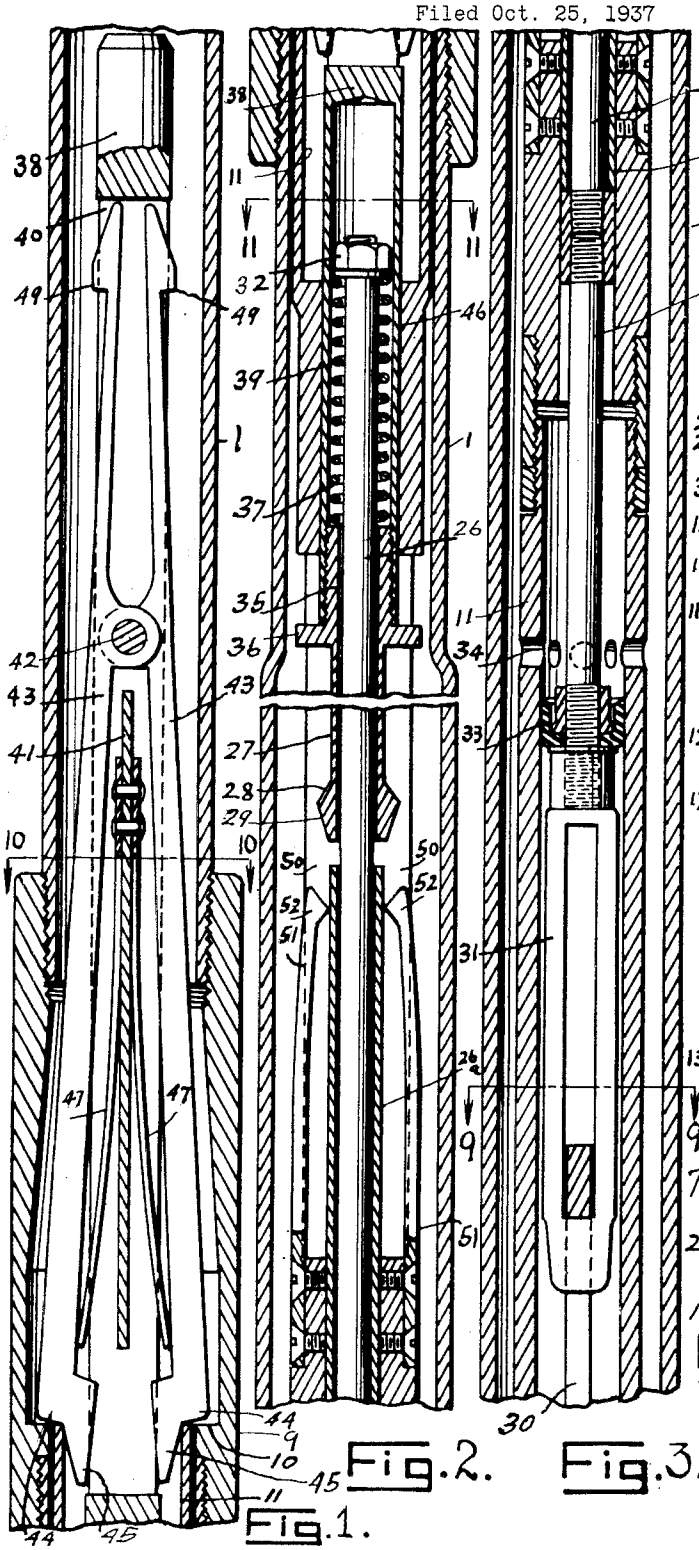


Fig. 1.

Fig. 2.

Fig. 3.

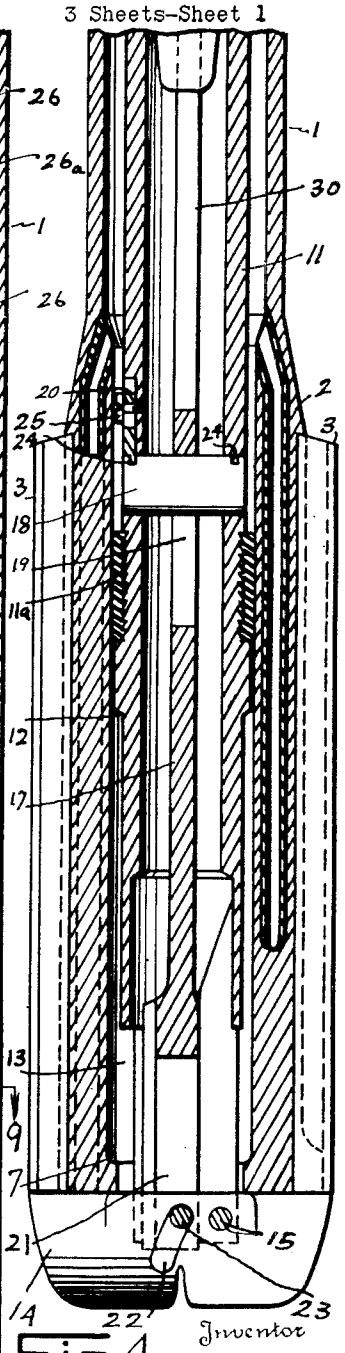


Fig. 4.

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DRILLING APPARATUS

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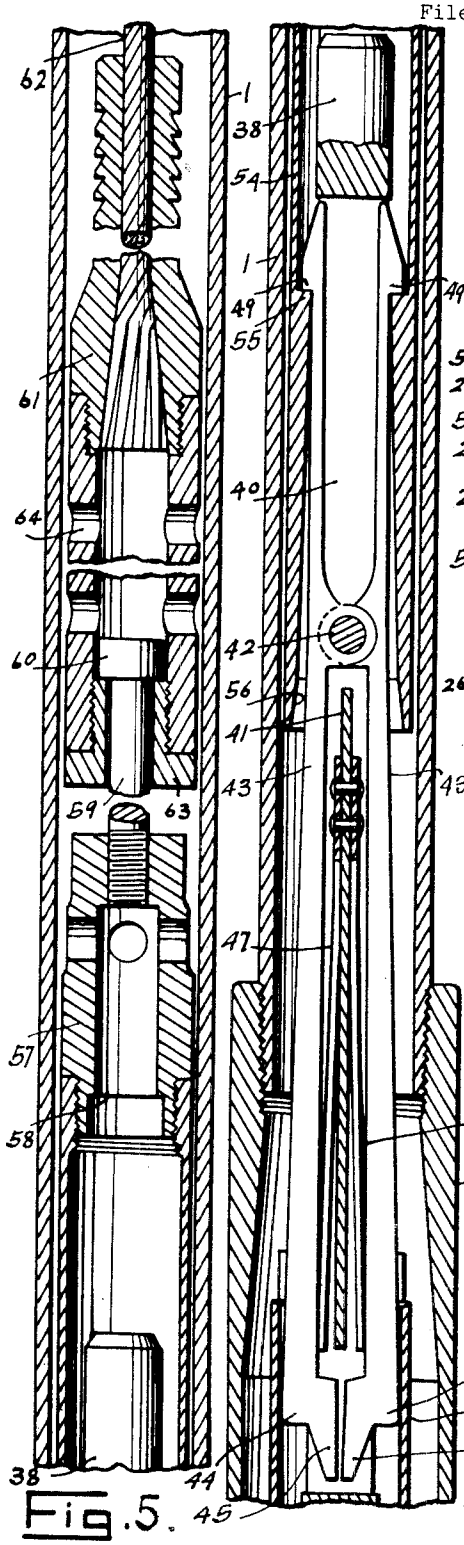


Fig. 5.

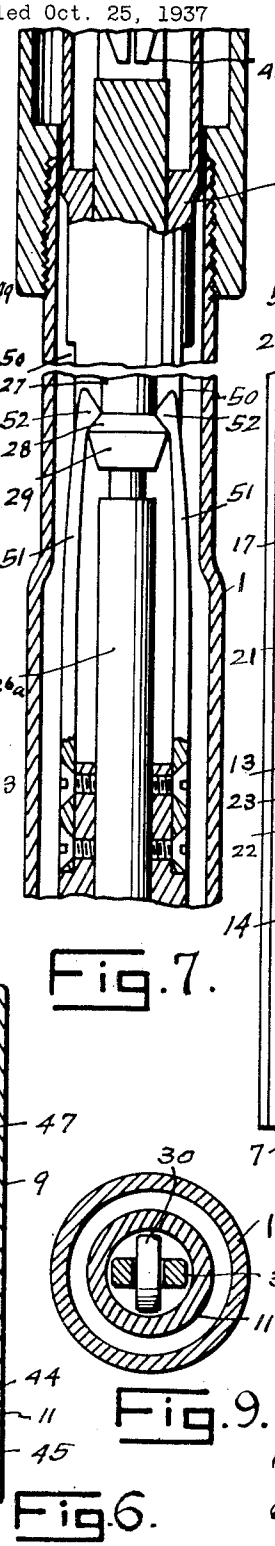


Fig. 6.

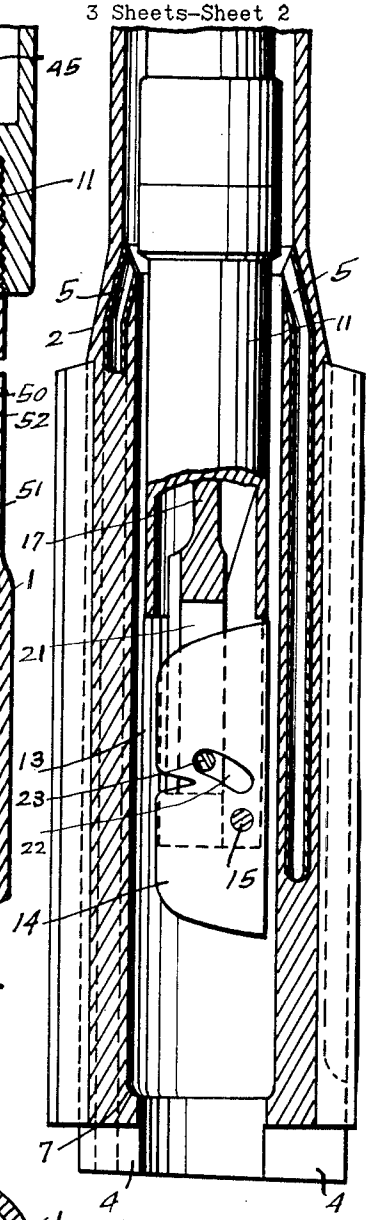


Fig. 8.

Fig. 9.

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DRILLING APPARATUS

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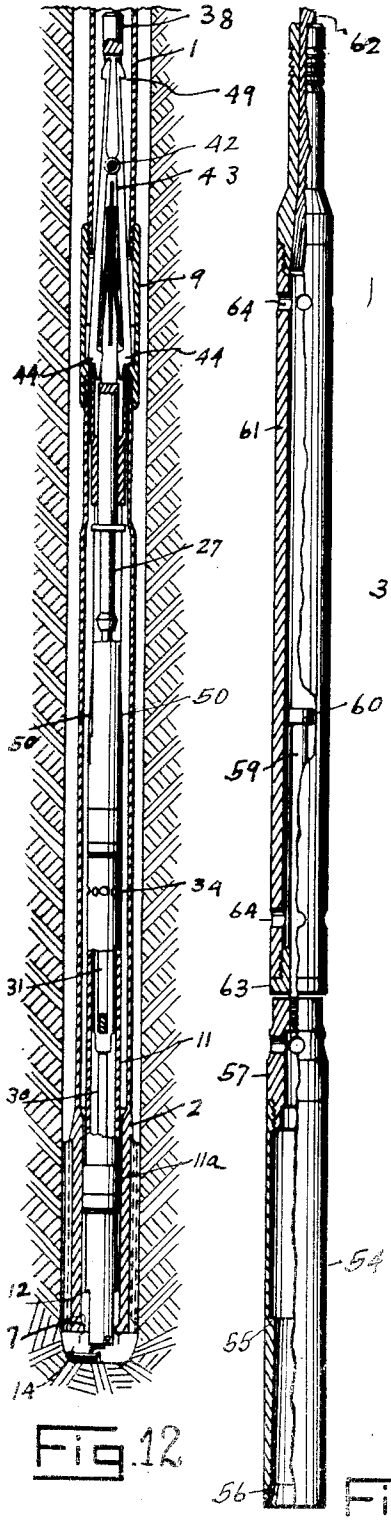


Fig. 12.

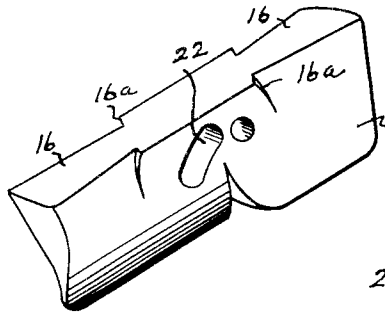


Fig. 15.

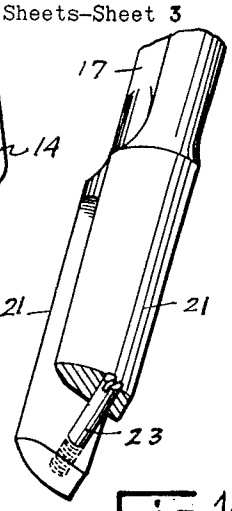


Fig. 16.

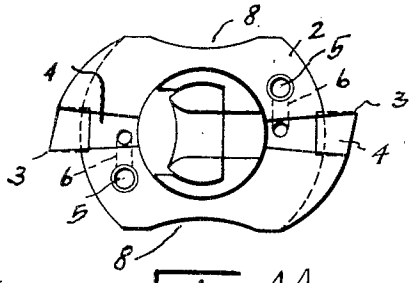


Fig. 14.

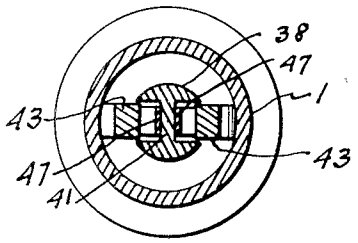


Fig. 10.

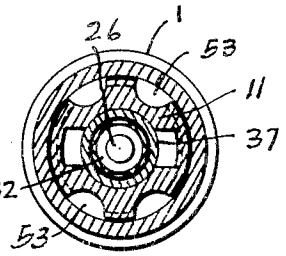


Fig. 11.

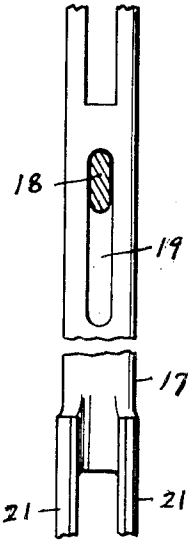


Fig. 17.

Fig. 13.

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UNITED STATES PATENT OFFICE

2,169,283

DRILLING APPARATUS

John W. Pippin, Corpus Christi, Tex.

Application October 25, 1937, Serial No. 170,811

9 Claims. (Cl. 255—75)

This invention relates to drilling apparatus and has particular relation to drilling apparatus wherein the drill proper is insertable into drilling position through the drill stem and is withdrawable to the ground surface through the drill stem while the drill stem remains in the well.

The invention herein described embodies certain improvements over that disclosed in my copending application for drilling apparatus filed January 4, 1937, Serial No. 118,947, now Patent No. 2,122,517, granted January 24, 1939.

It is an object of the present invention to provide in a drill of the character described a detachable and removable, drill cutter that may be attached to the lower end of the drill head, at the lower end of the stem and that may also be detached and withdrawn through the stem with novel means for operatively connecting the drill cutter to the head, while the cutter is in operative or cutting position, to prevent transverse movement of the cutter and also to prevent the cutter from becoming detached from the head when the drill is off bottom by the pressure of the drilling fluid being forced downwardly through the drill stem and head.

It is another object of the invention to provide in a drill of the character described novel means for detaching and withdrawing the drill cutter.

It is a further object of the invention to provide in drilling apparatus a head having channels leading downwardly therethrough to the cutters and which are lined with resilient material such as rubber vulcanized in place.

The lower end of the drill head is provided with transversely aligned grooves forming seats for the drill cutter and it is an object of the invention to provide means for flushing the grooves free from obstructing matter when the cutter is detached so that the cutter will readily seat in said grooves when it is again desired to attach it to the head.

It is a further object of the invention to provide means for controlling the flow of the drilling fluid.

With the above and other objects in view, the invention has particular relation to certain novel features of construction, operation and arrangement of parts, an example of which is given in this specification and illustrated in the accompanying drawings, wherein:

Figures 1, 2, 3 and 4 show fragmentary vertical sectional views of the drilling apparatus taken from above downwardly and showing the anchoring device in the position it will occupy in the drill stem while the drill cutter is anchored in active, or drilling, position, as shown in Figure 4.

Figures 5, 6, 7 and 8 show fragmentary vertical sectional views of the drill stem and drill taken from above downwardly and showing the extractor engaged with the anchoring device, all in position for lowering and withdrawing the cutter.

Figure 9 shows a cross sectional view taken on the line 9—9 of Figure 3.

Figure 10 shows a cross sectional view taken on the line 10—10 of Figure 1.

Figure 11 shows a cross sectional view taken on the line 11—11 of Figure 2.

Figure 12 shows a side elevation partly in section of the complete apparatus with the drilling cutter in drilling position.

Figure 13 shows a side view partly in section of the extractor.

Figure 14 shows a lower end view of the drill head.

Figure 15 shows a perspective view of the drill cutter.

Figure 16 shows a perspective view, partly in section, of the lower end of the cutter actuating bar, and

Figure 17 shows a fragmentary side view thereof.

Referring now more particularly to the drawings wherein like numerals of reference designate the same parts in each of the figures, the numeral 1 designates the tubular drill stem attached to the lower end of which there is a tubular drill head 2, of somewhat greater transverse diameter than that of the drill stem. This head has the side reamers 3, 3 thereon for reaming out the bore as drilling progresses. The lower end of this drill head also has the oppositely disposed transversely aligned grooves 4, 4, which are gradually widened outwardly from their inner ends and the head has the channels 5, 5, leading downwardly therethrough and terminating in front of the respective grooves. Said channels are lined with resilient material, preferably rubber vulcanized in place, to reduce the abrasive effect of the gritty substance in the drilling fluid which is forced under pressure therethrough and the lower ends of these channels divide forming branches 6, 6, which terminate in the grooves 4, 4, so as to wash out said grooves and to remove obstructing matter therefrom when the drill cutter is not seated herein. Within the head and adjacent the lower end thereof there is an inside annular upwardly facing shoulder 7. On opposite sides the head is provided with vertical shallow channels 8, 8, thus making provision for the return of the drilling fluid up outside of the head.

Incorporated into the drill stem at a selected distance above the head there is a special coupling 9 of somewhat larger inside diameter than that of the stem proper, thus providing an inside annular shoulder 10 for a purpose to be hereinafter explained, and the passageway through this coupling gradually tapers or converges upwardly as shown in Figures 1, 6 and 12.

The numeral 11 designates a tubular mandrel which is axially slidable through the stem and head. This mandrel has an external shoulder 12 which faces downwardly and is adapted to land on the shoulder 7. Above the shoulder 12 the mandrel is provided with a suitable surrounding packing sleeve 11*a* to form a fluid tight joint between it and the head. As shown the mandrel is provided with the downwardly pitched ratchet teeth within the packing sleeve to engage with said sleeve to prevent displacement of the sleeve during withdrawal or insertion of the drilling cutter.

The lower end of the mandrel is provided with a transverse slot 13 therethrough, in which the drilling cutter 14 is pivoted. This cutter is formed of very durable material and its major diameter extends transversely of the axis of the drill head, the ends of the cutter extending out beyond said head when the cutter is in active position. The cutter is mounted on the transverse pin which is disposed to one side of the drill head and whose ends are anchored to the mandrel. The cutter is thus mounted to swing about the pivot pin 15 as an axis. It may be swung with its major diameter into vertical position into the slot 13 in the manner hereinafter described and, as shown in Figure 8, or with its major diameter extending transversely of the head or in its active position as illustrated in Figure 4. The type of cutter shown is what is generally known as the "fish tail" type, having forwardly directed side cutting edges or blades. The channels 5, through the head are arranged to discharge the drilling fluid on the forward sides of said blades while drilling. The cutter 14 has its upper margin formed with the inwardly tapering, or dovetailed tenons 16, 16, which conform to and seat snugly in the oppositely disposed grooves 4, 4. The inner ends of these tenons terminate at the respective side shoulders 16*a*, 16*a* of the cutter, said shoulders fitting up snugly into the central bore of the head when the cutter is in active position. The cutter is thus very firmly and securely held against transverse movement and the pin 15 is relieved of the stress of such movement.

Slidable axially through the mandrel 11 is the actuating bar 17. There is a cross key 18 which extends through a vertical slot 19 in the actuating bar as shown in Figure 4. The upper margin of the cross key 18 has the end notches 24. Slidable on the mandrel there is a latch 20 whose lower end fits into a corresponding notch 24 to lock the cross pin 18 in position. This latch is retained in position by a suitable set screw 25 which is fitted through a vertical slot in the latch and is screwed into the mandrel. The cross pin 18 may be removed by loosening the screw 25 and releasing the latch 20 from the notch 24.

The lower end of the bar 17 is vertically slotted forming the side prongs 21, 21, whose lower ends embrace the drilling cutter as illustrated in Figures 4 and 8. This drilling cutter has an arcuate slot 22 and a pin 23 works through the slot 22 and has its ends anchored to the prongs 21.

When it is desired to detach and remove the drilling cutter the mandrel may be lowered, in a manner hereinafter explained, so as to move the drilling cutter out of the slots 4 and into position spaced beneath the head. An upward movement of the bar 17 relative to the mandrel will therefore, in an obvious manner, swing the drilling cutter 14 about the axis of the pin 15, carrying said cutter through the slot 13 and into position between the prongs 21 with its major diameter in vertical position, so that it may be moved upwardly through the head and through the drill stem as illustrated in Figure 8 and likewise when the assembly is lowered through the drill stem and the shoulder 12 lands on the shoulder 7 with the drilling cutter 14 in said vertical position and spaced beneath the head a downward movement of the bar 17 relative to the mandrel will swing the drilling cutter 14 into position with its major diameter extending transversely of the axis of the head. The mandrel and actuating bar may then be elevated to seat the drilling cutter in the transverse seats or grooves 4 in a manner to be fully hereinafter explained. The key 18 limits the longitudinal movement of the bar 17 relative to the mandrel 11. Axially slidable in the upper end of the mandrel 11 there is a tension rod 26 which is vertically slidable through the sleeve 27 whose lower end is enlarged and formed with the upwardly and downwardly tapering faces 28, 29, as shown in Figures 2 and 7. The upper end of the bar 17 is slackly connected to the lower end of the rod 26 by means of the respective interconnecting links 30, 31 as shown in Figures 3 and 4, said links being formed on said bar and rod respectively and thus forming a jar for a purpose to be hereinafter explained. The upper end of the rod 26 has a nut 32 threaded thereon. The lower end of the rod has an upwardly opening cup-shaped plunger 33, thereon, which fits closly within the mandrel and which is located beneath the side ports 34 of said mandrel when the drilling assembly is in active position as shown in Figures 1 to 4 inclusive.

The upper end of the rod 26 extends up through an axial bearing 35 of the sleeve 27 and the upper end of this sleeve is screwed into the lower end of the cylinder 37. The sleeve 27 has an outwardly extended radial flange 36 thereon which abuts the lower end of the cylinder 37. This cylinder is formed on the lower end of the tension shaft 38. Within the cylinder 37 and surrounding the upper end of the rod 26 there is a strong coil spring 39 which is interposed between the nut 32 above and the upper end of the sleeve 27 beneath.

The shaft 38 has the longitudinal slot 40 therethrough and is also provided with a longitudinal web 41 extending across the lower portion of said slot as shown more clearly in Figures 1 and 6. Pivoted on a common pin 42 and working in said slot are the confronting side arms 43, 43. These arms are slightly arcuate with their concaved sides outwardly and their lower ends are outwardly widened forming the supporting shoulders 44, 44 adapted to engage and rest on the inside shoulder 10 and the lower ends of the arms have the downward extensions 45, 45 beneath said shoulders and whose outer margins converge downwardly. The extensions 45 project down into the upper end of the mandrel 11 and are of such a length as to never become disengaged therefrom. The mandrel 11, beneath its upper end, is inwardly thickened to form an axial bearing 46, through which the lower end of the shaft 38 is closely fitted as shown in Figure 2. There

are the springs 47, 47 which are anchored at their upper ends to the web 41 and whose lower ends are free and outwardly curved and bear against the lower ends of the arms 43. The upper ends of said arms have the external shoulders 49, 49 thereon and their outer margins above said shoulders converge upwardly.

Beneath the cylinder 37 the mandrel has the side slots 50, 50 and there are the spring dogs 51, 51 whose lower ends are countersunk into and secured to said mandrel beneath said slots and whose upper ends are formed with the inwardly extended catches 52, 52 approximately triangular in shape and which work inwardly through the slots 50 and whose apexes normally rest against the sleeve 26a which surrounds the rod 26 and which is spaced beneath the lower end of the sleeve 27. The catches 52 are located in position to engage the enlarged lower end of the sleeve 27. As will be noted from an inspection of Figures 2 and 11, the upper end of the mandrel 11 is outwardly enlarged and said enlarged portion also has the vertical side grooves 53, as shown in Figure 11, to provide passageway for the drilling fluid through past the enlarged portion of the mandrel.

For the purpose of lowering the assembly, into and withdrawing it from, the drill stem, a suitable extractor, or overshot, has been provided. This overshot includes a tubular body 54, which is provided with the inside upwardly facing annular shoulder 55. Beneath the shoulder 55 the body is internally flared downwardly and its lower end is further downwardly and outwardly flared as at 56. A hollow tubular head 57 is screwed into the upper end of the body and has an annular, inside, downwardly facing shoulder 58 adjacent its lower end. A shaft 59 has its lower end threaded to the head 57 and the upper end of this shaft is provided with an enlarged head 60. The numeral 61 designates a tubular socket member for the attachment, thereto, of a cable 62. Screwed into the lower end of the socket member 61 there is a gland 63, which closely surrounds the shaft 59 and which is smaller in internal diameter than the diameter of the head 60. The socket member 61 has the openings 64 therein above the gland 63.

As shown more accurately in Figures 5 to 8, inclusive, the assembly is in inactive position, that is, in position to be lowered or elevated. In this position the overshot is engaged over the upper end of the shaft 38 and the shoulders 49, of the arms 43, are engaged with the inside shoulder 55 of the tubular body 54. In this position the lower ends of the arms 43 will be maintained in retracted position within the upper end of the mandrel 11. While in this position the jar bar 17 will be in its upper position with the key 18 supporting the mandrel 11 on the lower end of the slot 19. The jar bar 17 being in its upper position the cross-pin 23, as shown in Figure 8, will hold the drilling cutter 14 in vertical position withdrawn into the slot 13 and resting between the prongs 21. While in this position the plunger 33 will be above the ports 34 so that as the assembly is moving upwardly the drilling fluid may readily pass inwardly through the ports 34 and on down through the mandrel and out of the lower end thereof and if the assembly is being moved downwardly the liquid beneath will pass in the reverse direction so as not to interfere with the free movement of the assembly through the drilling fluid in the drill stem. The entire assembly in the position shown in Figures 5 to 8, inclusive, may thus be readily lowered into or withdrawn from the well.

Before attempting to withdraw the assembly from, or to lower it through, the drill stem, said stem should be lifted off of bottom. In lowering the assembly for the attachment of the drilling cutter to the lower end of the head 2 it may be assembled as shown in Figures 5 to 8, inclusive, and lowered downwardly through the drill stem until the shoulder 12 is landed on the shoulder 7. At this time the drilling cutter 14 will still be in vertical position, or in the position shown in Figure 8 relative to the mandrel 11 and jar bar 17; said bar, however, will move on downwardly under its own weight, or may be jarred downwardly by the jars 30, 31, the pin 23 operating in the slot 22 to move the drilling cutter 14 into transverse position. The enlargement at the lower end of the sleeve 27 will spread apart the catches 52 and pass beneath and engage under said catches, as shown in Figure 7 and the assembly may then be elevated by an upward pull on the cable 62. During the initial upward movement the mandrel 11 and jar bar 17 will move together until the drilling cutter 14 engages the lower end of the drill head 2 and upon further upward pull on the cable the rod 26 will be moved upwardly and the links 30, 31 will interengage thus stopping the further upward movement of the rod 26. A continued upward pull on the cable 62 will place the spring 37 under compression thus allowing a further independent upward movement of the shaft 38 until the shoulders 44 clear the upper end of the mandrel and the shoulder 10. When the shoulders 44 have cleared the shoulder 10 the springs 47 will force the lower ends of the arms 43 outwardly. It is to be noted that while in this position the upper ends of said arms are held under tension by the small upper end of the flared portion of the body 54 as shown in Figure 6 so that when this tension is released by the shoulders 44 clearing the upper end of the mandrel 11 and the shoulder 10, as shown in Figure 1, said lower ends will spring outwardly causing the shoulders 44 to seat on the shoulder 10 with the spring 37 under compression thus securely locking the assembly in the drill stem, the upper ends of the arms 43 moving inwardly to release the shoulders 49 from the inside shoulder 55. The tubular body 54, beneath the shoulder 55, is flared downwardly and outwardly, as explained, so as to permit the free outward movement of the lower ends of the arms 43. The cable and overshot may be then withdrawn and the drill stem set down on bottom. It may happen that while in this position the drill cutter 14 will be diagonal with respect to the slots 4 but upon turning the drill stem and head to carry the slots into registration with the cutter the cutter will be suddenly seated in the slots by the expansible force of the spring 37 and thereafter the cutter will be maintained securely seated in said slots.

While in drilling position the plunger 33 is beneath the ports 34 and the packing 11a on the mandrel is beneath the upper ends of the channels 5, as shown in Figures 3 and 4, and the drilling fluid from above is thus forced on down between the mandrel and drill stem and passes through the channels 5 and is discharged onto the drilling cutter 14 above and in front of its cutting edges.

If it should now be desired to detach and remove the assembly the drill is lifted off bottom and the overshot is again lowered into the drill

stem and will be guided by the flared face 56 over the upper end of the shaft 38, the shoulders 49 and the upper ends of the arms 43, being retracted, at this time, as shown in Figure 1. As the overshot is lowered it will engage the arms 43 beneath the pivot 42, disengaging the shoulders 44 from the shoulder 10. Inasmuch as the shoulders 44 are firmly seated against the upper end of the mandrel 11 and above the shoulder 10 as shown in Figure 1 the weight of the overshot may not be sufficient to disengage them. In such event the socket 61 may be alternately elevated and dropped to cause the gland 63 to strike against the upper end of the head 57 so as to drive the overshot downwardly and to force the lower ends of the arms 43 inwardly into retracted position. However, this downward movement of the overshot is limited by the shoulder 58 which will engage the upper end of the shaft 38 so as to limit such downward movement to prevent the wedging of the overshot too tightly over the arms 43. Upon disengagement of the shoulders 44 the assembly may be moved on down to carry the drilling cutter 14 down beneath the lower end of the head 2. A sudden upward pull on the cable 62 will then cause the catches 52 to spread so as to permit the enlarged lower end of the sleeve 27 to pass above said catches and a further upward pull will operate, through the pin 23, to swing the drilling cutter into vertical position within the slot 13 and between the prongs 21 and the lower end of the slot 19 will then engage the key 18 and the complete assembly may be withdrawn from the drill stem.

While the apparatus is in drilling position as indicated in Figures 1 to 4, inclusive, and while drilling is being proceeded with the pressure of the drilling fluid will act against the plunger 33 tending to force said plunger downwardly against the resistance of the spring 37. The slots 4 therefore have been flared outwardly, as shown in Figure 14, and the corresponding portions 16, 16 of the drilling cutter have been also flared to fit closely, or dove-tail, into said slots when the drilling cutter 14 is in drilling position, so that should the pressure of the drilling fluid force the plunger 33 downwardly releasing the tension on the jar bar 17, the cutter 14 would pivot about the pivot 15 which in turn would cause a binding or wedging action of the dove-tailed portions 16 of said cutter in the correspondingly shaped slots 4 thus preventing the unseating of the cutter 14 from said slots by the downward pressure of the drilling fluid.

When the well is completed the drilling assembly may be withdrawn but the drill stem may be left in the bore for production.

The drawings and description disclose what is now considered to be a preferred form of the invention by way of illustration only, while the broad principle of the invention will be defined by the appended claims.

What I claim is:

1. In drilling apparatus a tubular drill stem having a tubular drill head on the lower end thereof having transverse seats across its lower end, said head being provided with channels for fluid terminating in the seats and a lining around the channel formed of resilient material vulcanized in place.

2. Drilling apparatus comprising a tubular drill stem adapted to be lowered into a well and having a tubular drill head on the lower end thereof having transverse seats across its lower end and having channels for flushing fluid terminating in said seats, an assembly including a drilling cutter which is mounted to pivot about a transverse axis on the assembly, said assembly being movable downwardly through the stem to locate the cutter beneath the head, means included in the assembly for moving the cutter into active position seated in said seats upon upward movement of the assembly, and means included in the assembly adapted to engage the stem upon further movement thereof to lock the cutter in said active position.

3. Drilling apparatus comprising a tubular drill stem adapted to be lowered into a well, a tubular drill head on the lower end of the stem having a transverse seat and having a channel for flushing fluid which terminates in said seat, an assembly including a drilling cutter, said cutter being mounted to pivot about a transverse axis on the assembly, said assembly being movable downwardly through the stem to locate the cutter beneath the head, means included in the assembly for moving the cutter into active position seated in said seat upon upward movement of the assembly, and tension means included in the assembly adapted to interlock with the stem upon further upward movement thereof to lock the cutter in said active position.

4. Drilling apparatus comprising a tubular drill stem adapted to be lowered into a well and including a tubular drill head at the lower end thereof, an assembly adapted to be lowered through and withdrawn upwardly through the stem, said assembly including a drilling cutter arranged to be lowered beneath the lower end of the head, said assembly also including means to actuate the cutter into interlocking relation with the lower end of the head upon upward movement of the assembly, said assembly having a channel for the passage of drilling fluid therethrough and means including a cup-shaped plunger for determining the course of the fluid through said channel.

5. Drilling apparatus comprising a tubular drill stem having a tubular drill head on the lower end thereof, said head having a groove forming a seat for a drilling cutter, an assembly including a drilling cutter movable downwardly through the stem and head and into position to seat the cutter in said seat on the subsequent upward movement of the assembly, said assembly having a channel for flushing fluid disposed to direct flushing fluid to the seat to flush foreign matter therefrom in advance of the seating of the drilling cutter therein.

6. Drilling apparatus comprising a tubular drill stem, a tubular drill head on the lower end of the stem, an assembly adapted to be lowered through the stem and including a single drilling cutter pivoted to move on a horizontal axis and movable about the axis from transverse position into vertical position to pass through the stem and head or into transverse, or active, position to engage the opposite ends of the cutter with the lower end of the head, tensioning means included in the assembly adapted to interlock with the stem to maintain the drilling cutter in said active position, a retracter including a body shaped to be lowered over said tensioning means and including a jar operative to release said tensioning means from the stem.

7. Drilling apparatus comprising a tubular drill stem, a tubular drill head on the lower end of the stem, an assembly adapted to be lowered through the stem and including a drilling cutter pivoted to move on a horizontal axis and mov-

able into vertical position to pass through the stem and head or into transverse, or active, position to engage the lower end of the head, tensioning means included in the assembly adapted to interlock with the stem to maintain the drilling cutter in said active position, a retracter including a body shaped to be lowered over said tensioning means and including a jar operative to release said tensioning means from the stem, said assembly and retracter having parts arranged to engage to limit the downward movement of said body relative to the tensioning means with the cutter spaced an appreciable distance beneath the head.

8. Drilling apparatus comprising a tubular drill stem, a tubular drill head attached to the lower end of the stem, an assembly including a drill arranged to be lowered through the stem into position to interengage the drill with the lower end of the head and in active position, tensioning means included in the assembly arranged to interlock with the stem to retain the drill in said active position, means for releasing said interlocking means, said releasing means including a downwardly flared overshot adapted to engage over said tensioning means, said releasing means also including a jar for driving said overshot to active position to release the tensioning means and interlocking means arranged to thereafter interengage to effect withdrawal of said assembly from the stem with said releasing means.

9. Drilling apparatus comprising a tubular drill stem having a tubular drill head on the lower end thereof, said head having a groove forming a seat for a drilling cutter, an assembly including a drilling cutter movable downwardly through the stem and head and into position to seat the cutter in said seat on the subsequent upward movement of the assembly, said assembly having a channel for flushing fluid disposed to direct flushing fluid to the seat, and a liner formed of resilient material for the channel.

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