Jan. 24, 1939. J. W. PIPPIN 2,144,687

DRILLING APPARATUS

Filed Jan. 4, 1937 5 Sheets-Sheet 1

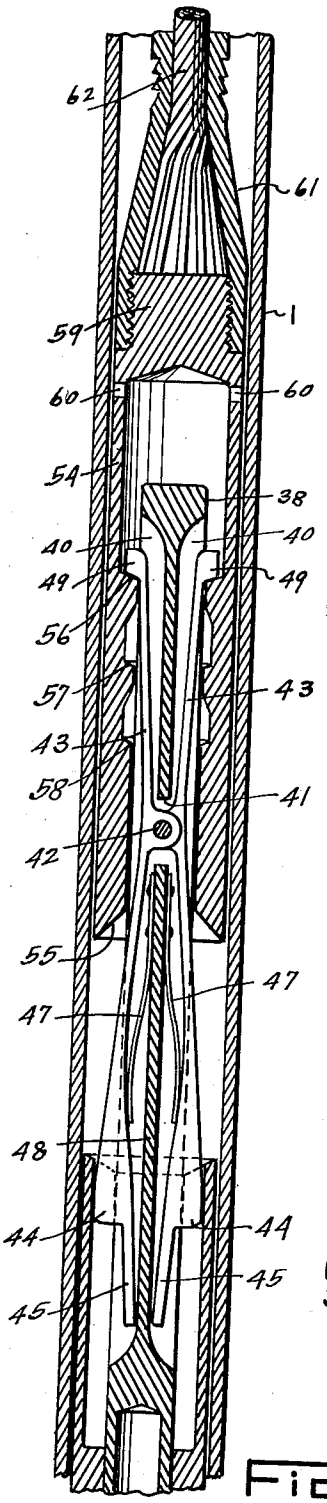


Fig. 1.

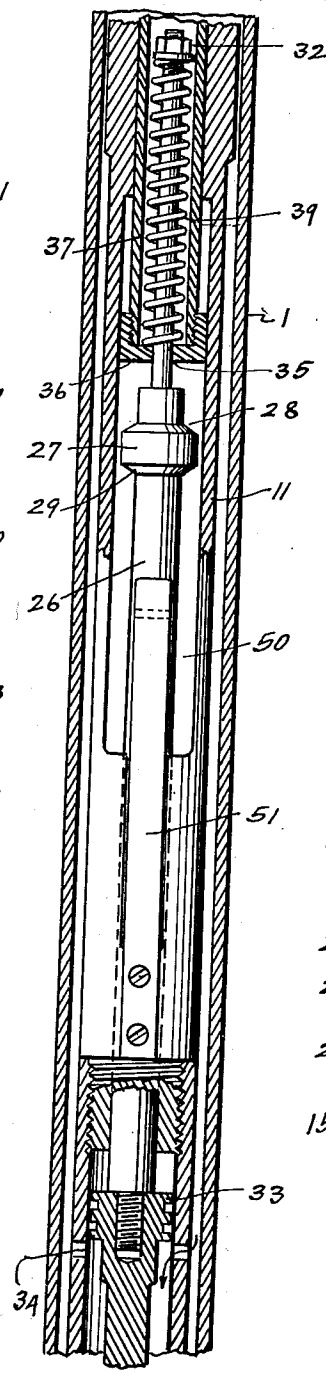


Fig. 2.

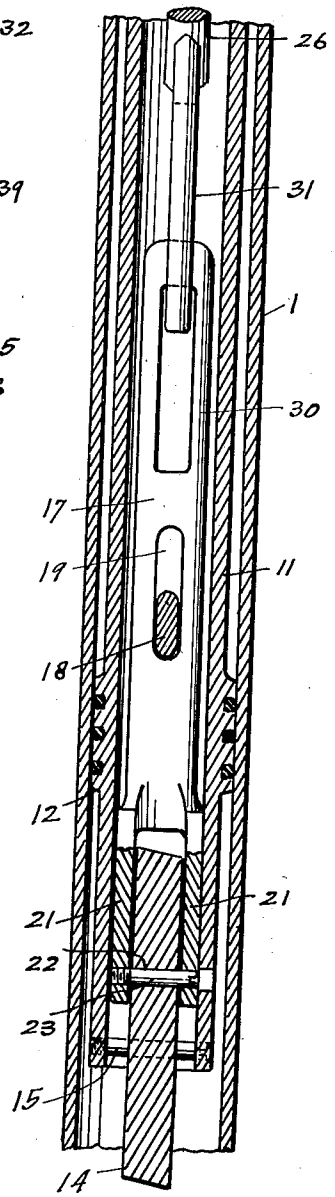


Fig. 3.

Inventor
John W. Pippin.

By
Edward V. Hardway.
Attorney

Jan. 24, 1939. J. W. PIPPIN 2,144,687

DRILLING APPARATUS

Filed Jan. 4, 1937 5 Sheets-Sheet 2

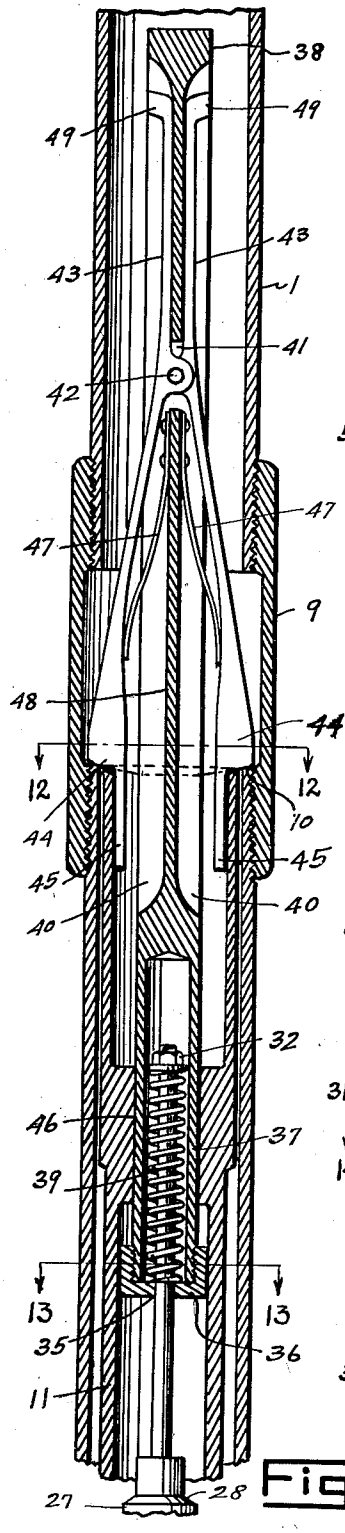


Fig. 4.

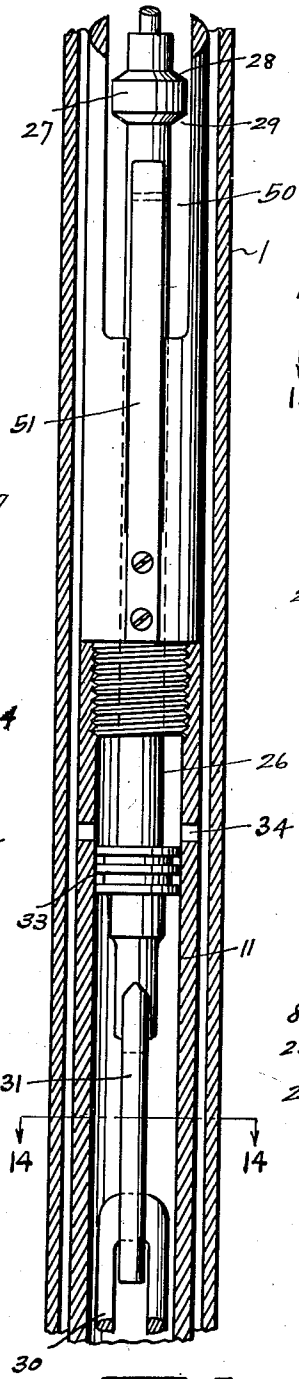


Fig. 5.

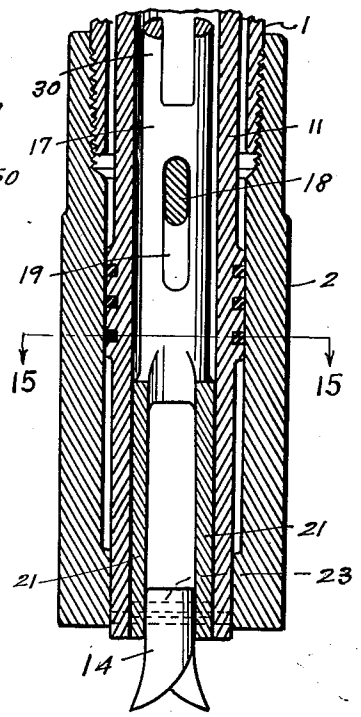


Fig. 6.

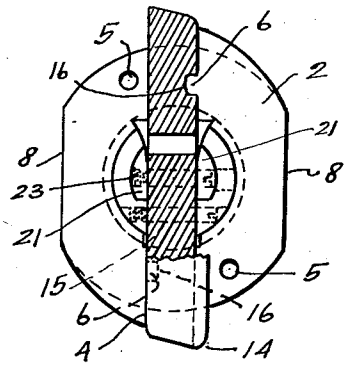


Fig. 7.

Inventor
John W. Pippin.

By
Edward V. Hardway
Attorney.

Jan. 24, 1939. J. W. PIPPIN 2,144,687

DRILLING APPARATUS

Filed Jan. 4, 1937 5 Sheets-Sheet 3

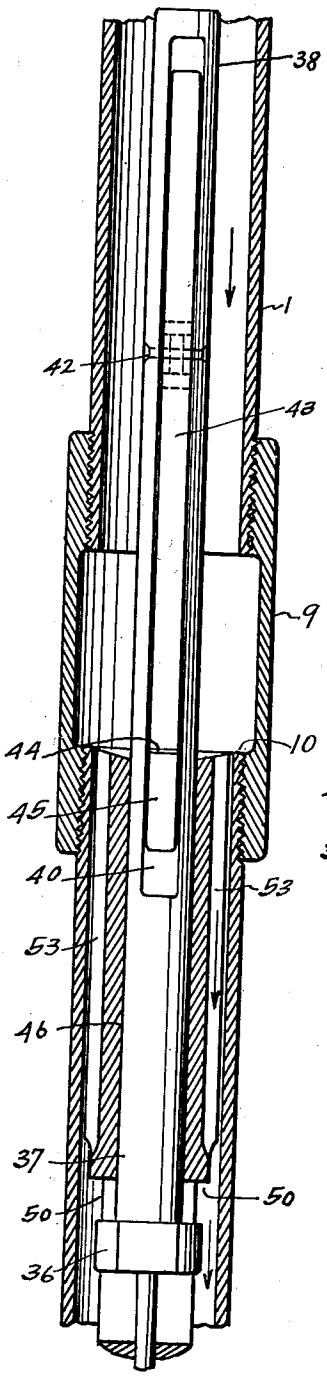


Fig. 8.

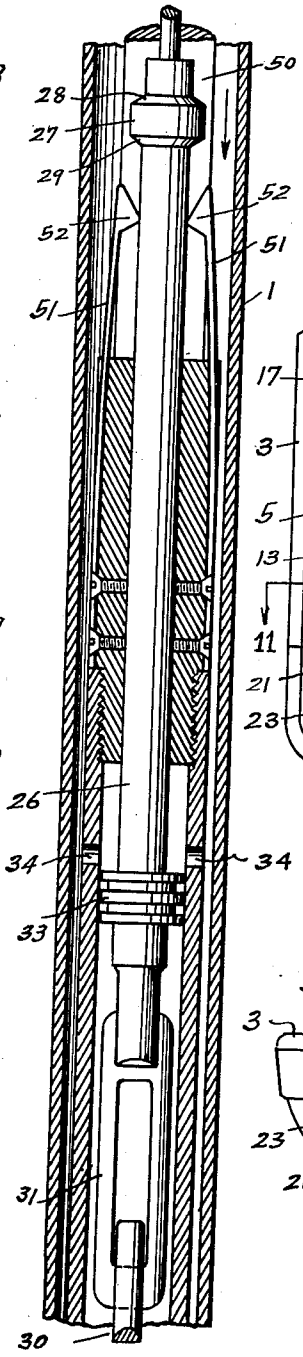


Fig. 9.

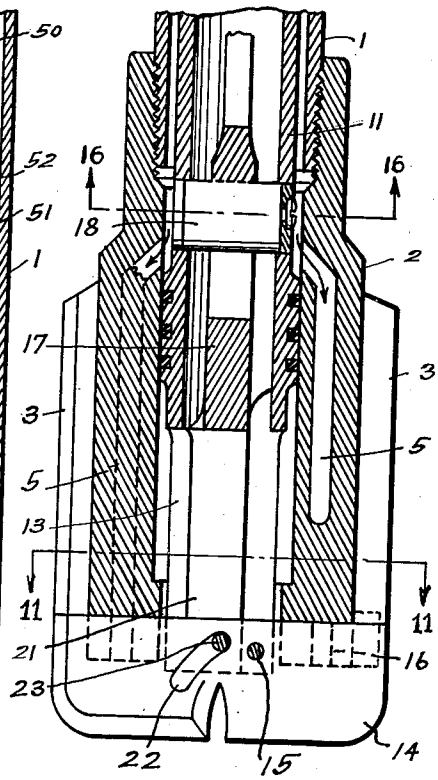


Fig. 10.

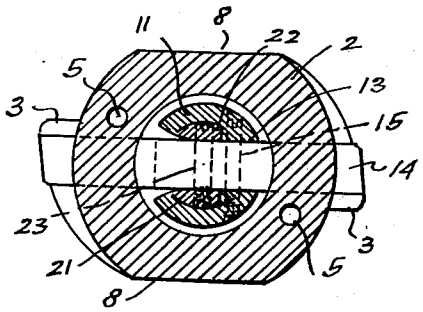


Fig. 11.

Inventor
John W. Pippin.

By Edward V. Hardway,
Attorney

Jan. 24, 1939. J. W. PIPPIN 2,144,687

DRILLING APPARATUS

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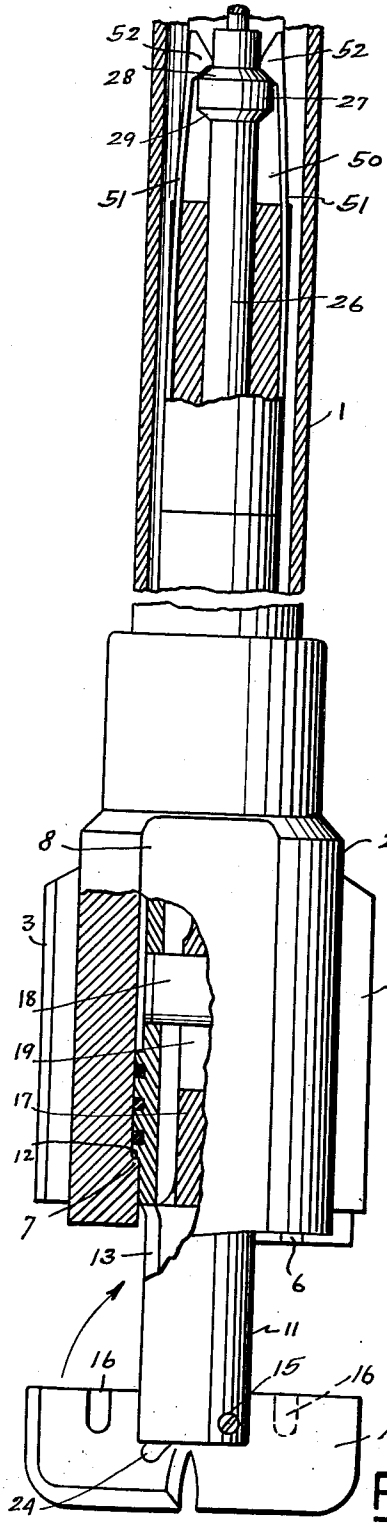


Fig. 17.

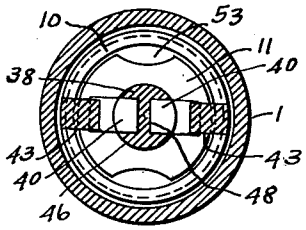


Fig. 12.

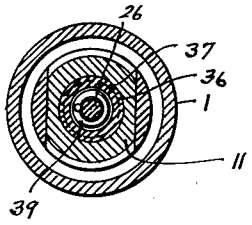


Fig. 13.

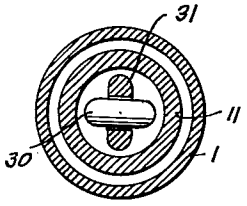


Fig. 14.

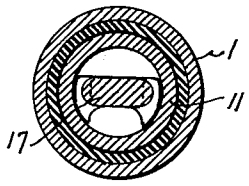


Fig. 15.

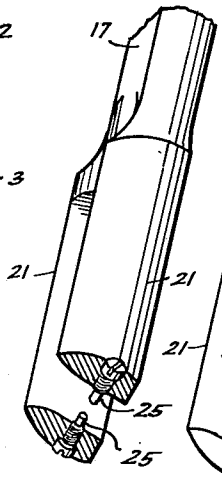


Fig. 18

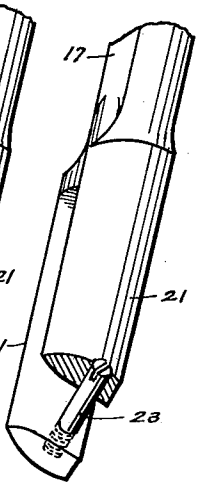


Fig. 19.

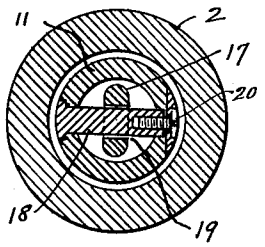


Fig. 16.

Inventor
John W. Pippin.

By
Edward V. Hardway.
Attorney

Jan. 24, 1939. J. W. PIPPIN 2,144,687

DRILLING APPARATUS

Filed Jan. 4, 1937 5 Sheets-Sheet 5

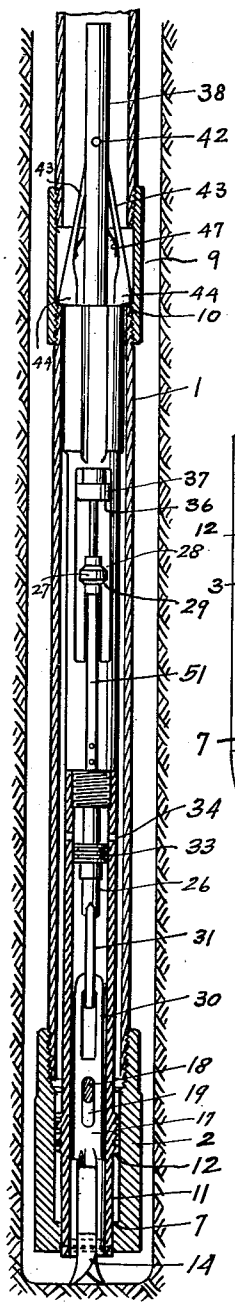


Fig. 21.

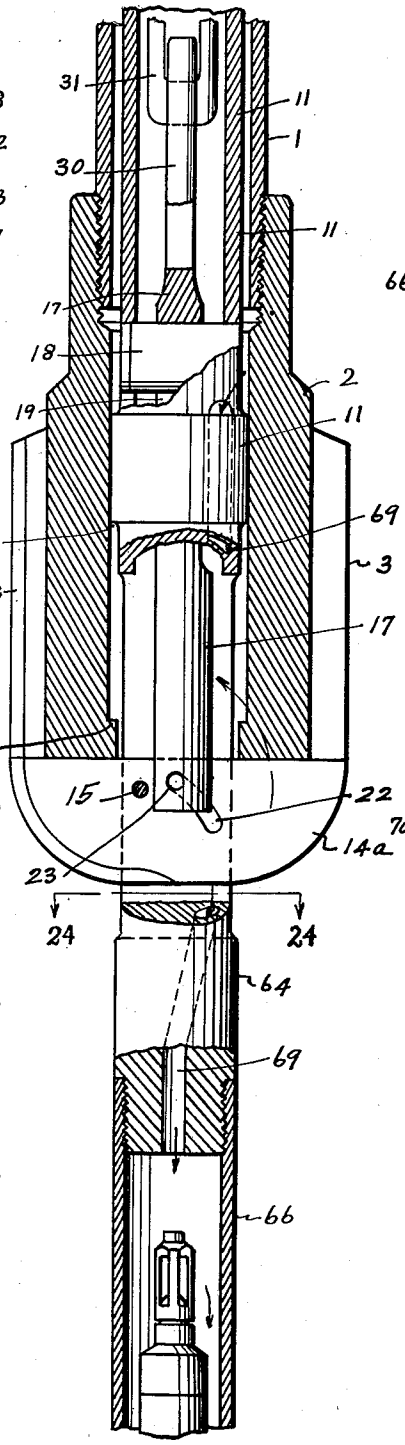


Fig. 22.

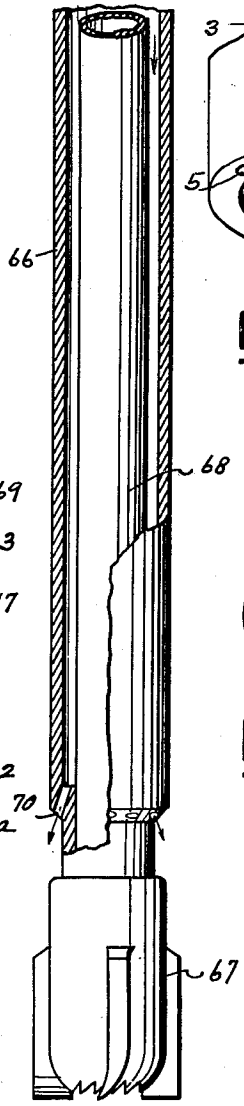


Fig. 23.

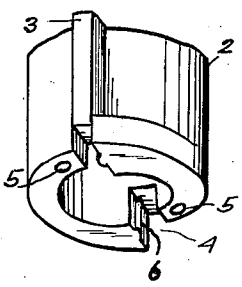


Fig. 20.

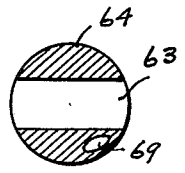


Fig. 24.

Inventor
John W. Pippin.

By Edward V. Hardway.
Attorney

Patented Jan. 24, 1939 2,144,687

UNITED STATES PATENT OFFICE

2,144,687

DRILLING APPARATUS

John W. Pippin, Corpus Christi, Tex.

Application January 4, 1937, Serial No. 118,947

13 Claims. (Cl. 255—76)

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 likewise withdrawable to the ground surface through the drill stem while the drill stem remains in the well.

The invention embodies not only drilling means for forming the bore of the well but also core taking apparatus which may be inserted down through the drill stem and withdrawn through the drill stem together with the main drill when it is desired to take a core in advance of the drill.

In well drilling as now commonly carried on a drill is attached to the lower end of a drill stem and when the drill becomes dull it is necessary to withdraw the drill stem and detach the drill and substitute another therefor and the drill stem then again lowered into the well to proceed with the drilling operations. This requires much time. Furthermore while carrying on drilling operations by present day methods it is necessary to case the well, that is to lower casing into the well as the bore is deepened to maintain the walls of the well as well as to provide means for the attachment of blowout preventer equipment to prevent blowouts, while drilling in the presence of a gas pressure, which are liable to occur when the drill stem is withdrawn.

It is a prime object of this invention to provide drilling apparatus equipped with a drill which may be lowered through the drill stem and attached to the lower end thereof and which may be withdrawn through the drill stem, allowing the drill stem to remain in the well and thus perform the function not only of a drill stem but of a well casing as well.

It is also well known that while drilling a well heavy drilling fluid is forced down through the drill stem to the drill and is returned back up through the bore outside of the drill stem. This drilling fluid keeps the drill cool, carries away the drill cuttings, and maintains the walls of the well. It also overcomes gas pressure in case gas under pressure is encountered in the well. With the present method of drilling whereby it is necessary to withdraw the drill stem to remove and replace the drill a blowout is most liable to occur while withdrawing the drill stem and also it is necessary to case the well to prevent caving. This present method necessitates the use of heavy blowout preventer equipment attached to the upper end of the casing to control the pressure. With the present invention the drill stem being at all times in the well and serving the purpose also of a well casing dispenses with the necessity of blowout preventer equipment and equipment for breaking up and removing the drill stem as well as the usual heavy equipment for lowering it into the well thus greatly reducing the amount of investment necessary for drilling a well and also greatly reducing the time and expense of drilling.

It is another object of the invention to provide well drilling equipment of the character described wherein the drill proper may be lowered through the drill stem and anchored firmly in place on the lower end of the drill stem and which may be readily detached and removed as necessity may require.

It is a further object of the invention to provide novelly arranged and controlled fluid passageways therethrough which drilling fluid may be supplied either to the main drill or to the core drill, if the latter is used, with means for controlling the passageways to the end that there may be a free flow of the drilling fluid through the drilling apparatus while it is being lowered or withdrawn so that the drilling fluid will not interfere with the lowering or withdrawal of the apparatus through the stem.

It is a further object of the invention to provide drilling apparatus of the character described that is of very sturdy construction and will be very durable in use and which may be positively and firmly anchored in active position, but at the same time may be quickly and readily detached and removed to the ground surface through the drill stem. 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:—

Figure 1 shows a fragmentary, vertical, sectional view of the drill stem showing the upper portion of the anchoring means in section and in the position occupied while withdrawing or lowering the drill showing also the overshot which may be employed for that purpose.

Figure 2 shows a side view, partly in section of the intermediate portion of the anchoring device in the position it will occupy while lowering or withdrawing the drill.

Figure 3 shows a side view, partly in section, of the lower portion thereof.

Figures 4, 5 and 6 show upper, intermediate and lower portions respectively of the anchoring device in the position it will occupy in the drill

stem while the drill is anchored in active, or drilling position as shown in Figure 6.

Figure 7 shows a bottom end view of the drill, shown partly in section.

Figure 8 shows a fragmentary, vertical, sectional view of that portion of the apparatus shown in Figure 4 taken at right angles to the view shown in Figure 4.

Figure 9 shows a fragmentary, vertical, sectional view of that portion of the apparatus shown in Figure 5 taken at right angles to the view shown in Figure 5.

Figure 10 shows a vertical, sectional view of the drill head and drill taken at right angles to the view shown in Figure 6.

Figure 11 shows a transverse, sectional view taken on the line 11—11 of Figure 10.

Figure 12 shows a transverse, sectional view taken on the line 12—12 of Figure 4.

Figure 13 shows a transverse, sectional view taken on the line 13—13 of Figure 4.

Figure 14 shows a transverse, sectional view taken on the line 14—14 of Figure 5.

Figure 15 shows a transverse, sectional view taken on the line 15—15 of Figure 6.

Figure 16 shows a transverse, sectional view taken on the line 16—16 of Figure 10.

Figure 17 shows a side elevation of the lower end of the drill stem and the drill head, partly in section, showing the anchoring means in position to attach or to withdraw the drill.

Figures 18 and 19 show perspective views, partly in section, of the lower end of the drill actuating bar.

Figure 20 shows a perspective view of the lower end of the drill head.

Figure 21 shows a side view, partly in section, of the complete drilling apparatus shown in active, or drilling position.

Figure 22 shows a fragmentary, vertical, sectional view showing a modified form of drill with core barrel attached.

Figure 23 shows a side view, partly in section, of the lower end of the core taking apparatus, and

Figure 24 shows a cross sectional view taken on the line 24—24 of Figure 22.

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 a tubular drill stem attached to the lower end of which 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 the drill head also has a transverse groove 4 therein which will be more specifically hereinafter referred to, and the head has the channels 5, 5 leading downward therethrough and terminating in front of the groove 4 on each side. The head also has the oppositely disposed vertical lugs 6, 6 projecting into the groove 4 from opposite sides and for a purpose to be hereinafter explained. 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 the flat faces 8, 8 thus making provision for side spaces to provide for the return of the drilling fluid up outside of the head.

Incorporated into the drill stem at a selected distance above the head 2 there is a special coupling 9 of somewhat larger inside diameter than that of the stem proper thus providing an inside annular shoulder 10, the purpose of which will be hereinafter explained.

The numeral 11 designates a tubular mandrel which is axially slidable in the stem and through the head. This mandrel has an external annular shoulder 12 which faces downwardly and is adapted to land on the shoulder 7. Above the shoulder 12 the mandrel is provided with suitable packing to form a fluid tight joint between it and the head. The lower end of the mandrel has a vertically extended, 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 to pivot on the transverse pin 15 which is disposed to one side of the axis 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 as illustrated in Figure 3 or with its major diameter extending transversely of the head and in active position as shown in Figures 10 and 21. The type of cutter shown is of the usual fish-tail type having the 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 also has vertical grooves 16 to receive the lugs 6 when the cutter is seated in the transverse slot 4 of the head. 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 bar 17. The key 18 has a head, at one end, countersunk into the mandrel 11 and its other end is secured to said mandrel by the set screw 20 as more accurately shown in Figure 16.

The lower end of the bar 17 is vertically slotted forming the side prongs 21, 21 whose lower ends embrace the drilling cutter 14. As shown in Figure 10 the 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 as shown in Figure 19; or the drilling cutter may have the arcuate side grooves as 24 in which case the prongs 21 should be provided with the inwardly projecting studs 25, 25 whose inner ends work in the grooves 24. With the mandrel 11 in its lower position, as shown in Figure 17, 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 as shown in Figure 3 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 a downward movement of the bar 17 will swing the drilling cutter 14 into position with its major diameter extending transversely of the axis of the head and into the position it occupies as shown in Figure 17. 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 formed with an annular external enlargement 27, above

the mandrel and whose upper and lower ends are provided with the upwardly and downwardly tapering faces 28, 29 as shown in Figures 2, 5, 9 and 17. The upper end of the bar 17 is slackly connected to the lower end of the tension rod 26 by means of the respective inter-connecting links 30, 31 formed on said bar and rod respectively thus forming a jar for a purpose to be hereinafter explained. Above the enlargement 27 the rod 26 is reduced and extended upwardly and has the nut 32 threaded on the upper end thereof. The rod 26 is formed with a plunger 33 thereon which may be formed in any suitable manner as by means of conventional packing rings as shown which fit closely within the mandrel and which is located beneath the ports 34 of said mandrel when the drilling assembly is in active position as shown in Figures 5, 9 and 21.

The reduced upper end of the rod 26 extends up through an axial bearing 35 in the lower end cap 36 which is screwed onto 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 reduced upper end of the rod 26 there is a very strong coil spring 39 which is interposed between the cap 36 beneath and the nut 32 above.

The shaft 38 has the longitudinal side slots 40, 40 therein on opposite sides thereof which slots merge through the intermediate opening 41. Pivoted on a common pin 42 are the side arms 43, 43 which work in said slots. 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 44. The extensions 45 project down into the upper end of the mandrel 11 and are of such 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 4. There are the flat springs 47, 47 which are anchored, at their upper ends, to the web 48 between the grooves 40 and whose lower ends are free and outwardly curved and bear against the arms 43. The upper ends of said arms have the outwardly turned lugs 49, 49 whose lower margins are outwardly and upwardly beveled.

Beneath the cylinder 37 the mandrel 11 has the side slots 50, 50 and there are the spring dogs 51, 51 whose lower ends are secured to the outside of the mandrel and whose upper ends are formed with the triangular shaped catches 52, 52 which work inwardly through the slots 50 and whose apexes are directed inwardly in position to engage with the enlargement 27. As will be noted from an inspection of Figure 4 and Figure 8 the upper end of the mandrel 11 is outwardly enlarged but said enlarged portion also has the vertical, oppositely arranged, side grooves 53, 53 as more accurately shown in Figures 8 and 12 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 overshot has been provided. This overshot includes a tubular body 54 whose lower end is outwardly and downwardly flared as at 55. The lower portion of this body is inwardly thickened and is provided with a series of upper, intermediate, and lower inside shoulders 56, 57 and 58 whose upper faces are tapered downwardly and inwardly. The upper end of the body 54 is formed with an outwardly threaded pin 59 and beneath said pin the body has the outlet openings 60, 60. A socket member 61 is screwed onto the pin 59 for the attachment of a cable 62 which extends to the ground surface and by means of which the assembly may be lowered or withdrawn.

As more accurately shown in Figures 1, 2 and 3 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 in engagement with the arms 43 beneath the pivot 42 so as to hold the lower ends of said arms retracted and the upper ends of the arms in extended position with the lugs 49 engaged over one of the shoulders in the body 54. 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 3, will hold the drilling cutter 14 in vertical position withdrawn into the slot 13 and resting between the prongs 21, as also shown in Figure 3. While in this position the plunger 33 will be above the ports 34 and the packing on the mandrel 11 will be above the upper ends of the channels 5 so that as the assembly is moving upwardly the drilling fluid may readily pass inwardly through the ports 34, as indicated by the arrow in Figure 2 and may pass on down through the mandrel and out of the lower end thereof and if the assembly is being moved downwardly the liquid beneath may 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 1, 2 and 3 may thus be readily withdrawn from the drill stem.

Before attempting to withdraw the assembly from, or 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 said Figures 1, 2 and 3 and lowered downwardly to the position shown in Figure 17 with the shoulder 12 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 3 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, or the studs 25 as the case may be, operating in the slot 22, or the grooves 24, respectively, to move the drilling cutter 14 into the transverse position shown in Figure 17. The enlargement 27 will spread apart the catches 52 and pass beneath and engage under said catches and the assembly may be then elevated by an upward pull on the cable 62. During the initial 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 pull on the cable 62 will place the spring 37 under compression thus allowing a further independent upward movement of shaft 38 until the shoulders 44 clear the shoulder 10. As the stress

of the pull increases the lugs 49 will disengage the upper shoulder 56 and they will successively engage the shoulders 57 and 58 beneath thus preventing the sudden release of the overshot from the shaft 38. When the shoulders 44 have cleared the shoulder 10 the springs 47 will force the lower ends of the arms 43 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 cable and overshot may then be withdrawn and the drill stem set down on bottom. It may happen that, while in this position, the drilling cutter 14 will be diagonal with respect to the slot 4, but upon turning the drill stem and head to carry the slot into registration with the cutter, the cutter will be suddenly seated in said slot by the expansive force of said spring 37 and thereafter the cutter will be maintained securely seated in said slot. It may be noted from an inspection of Figure 20 that the rear side of the slot 4 extends some distance down behind the cutter further than the forward side of the slot, this to provide suitable reinforcement behind the respective cutting edges. While in drilling position the plunger 33 is beneath the ports 34 and the packing on the mandrel 11 is beneath the upper ends of the channels 5, as shown in Figures 9 and 10 and the drilling fluid from above is thus forced on down between the mandrel and the drill stem and passes through the channels 5 and is discharged onto the drilling cutter 14 above and in front of the cutting edges.

If it be now 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 55 over the upper end of the shaft 38, the lugs 49 being retracted at this time as shown in Figure 4. As the overshot is lowered it will engage the arms 43 beneath the pivot 42 and retract the shoulders 44 disengaging them from the shoulder 10 and the assembly may be moved on down to the position shown in Figure 17 with the parts in the position thereshown. A sudden upward pull on the cable will then act to spread the catches 52 and permit the enlargement 27 to pass above them and a further upward pull will operate through the pin 23 or the studs 25 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.

As shown in Figure 22 the drilling cutter 14a has a substantially arcuate cutting edge and works through a vertically elongated slot 63 in the solid shaft 64, forming an extension of the mandrel 11 and its upper end is formed tubular for the admission of the lower end of the jar bar 17 which is connected by the cross pin 23 to the reamer 14a, working through the arcuate slot 22 thereof.

Connected to the lower end of the bar 64 there is a tubular stem 66 attached to the lower end of which there is a conventional core drill 67 for taking a core in the usual manner and this stem 66 has mounted therein the conventional type of core receiving barrel 68 arranged to receive the core or sample formed by the drill 67.

The bar 64 has a channel 69 leading downwardly therethrough from its upper to its lower end and terminating in the stem 66 through which the drilling fluid may pass into said last mentioned stem and out through the ducts 70 around the core drill.

The assembly shown in Figures 22 and 23 may be lowered through the drill stem and attached to the drill head or may be detached and withdrawn to the ground surface in the same manner as hereinbefore described in connection with the apparatus shown in Figure 21.

It is therefore obvious that, while drilling a well as strata are encountered thought to contain oil the drill proper may be detached and the core drill may be lowered and attached to the drill head as shown in Figures 22 and 23 and a sample of the formation taken at any time desired and removed to the ground surface for inspection.

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

If it be desired to lower a screen and set the same in the well the drill stem may be elevated the required distance and the screen, with the packer attached, may be lowered through the stem 1 until the screen is beneath the drill head 2 and the packer then set in the usual way above the shoulder 7.

The drawings and description disclose what are now considered to be preferred forms 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. Drilling apparatus comprising a tubular drill stem adapted to be lowered into a well, an assembly adapted to be lowered downwardly through the stem and including a drilling cutter mounted to pivot about a transverse axis and means for actuating the cutter into transverse position to engage the lower end of the stem upon upward movement of the assembly and means including a coil spring for yieldingly interlocking the assembly with the stem upon such upward movement.

2. 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, 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 in engagement with the head upon upward movement of the assembly, and means including a yieldable member and included in the assembly adapted to be placed under tension and to engage with the stem, upon further upward 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, 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 in engagement with the head upon upward movement of the assembly, and tension means included in the assembly adapted to engage 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, an assembly adapted to be lowered through, and withdrawn upwardly through, the stem, said assembly including a drilling cutter pivoted to move on a horizontal axis and arranged to be lowered beneath the lower end of the stem, said assembly

also including tension means to actuate the cutter into active position to engage the stem and to yieldingly interlock the cutter with the stem upon upward movement of the assembly, said assembly having a channel for the passage of the drilling fluid therethrough and means for determining the course of the fluid through said channel.

5. 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, an assembly adapted to be lowered downwardly, and withdrawn upwardly, through the stem and including a drilling cutter mounted to pivot about a transverse axis eccentric with respect to the vertical axis of the stem, said assembly including an actuating bar connected to the cutter for actuating the same into active position in engagement with the lower end of the head, said assembly also including a tension rod, a tension bar yieldingly connected to the rod and interlocking means on the tension bar engageable with the stem and effective to maintain said tensioning means under tension to hold the drilling cutter in said active position.

6. 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, lower end seat, an assembly adapted to be lowered downwardly through and withdrawn upwardly through the stem and including a mandrel, a drilling cutter pivotally mounted on the mandrel to move into active position to cooperate with said seat, and movable to inactive position, said assembly also including means having a tension element therein and connected to the cutter for actuating said cutter into either of said positions and for locking the cutter yieldingly in active position and a sample taking apparatus connected to the mandrel and extending beneath the drill into the well.

7. Drilling apparatus comprising a tubular drill stem, a tubular drill head on the lower end of the stem having a transverse seat, an assembly adapted to be lowered through the drill stem, said assembly including a mandrel, a drilling cutter pivoted on the mandrel and movable into vertical position to pass through the stem and head, or into transverse position to seat in said seat, an actuating bar connected to the drilling cutter for moving the same into either of said positions, releasable means for maintaining said bar against movement relative to the mandrel, a tension rod slackly connected to said bar, a tension bar yieldingly connected to the tension rod, interengaging means between the tension bar and the stem whereby the drilling cutter is maintained firmly seated in said seat.

8. Drilling apparatus comprising a tubular drill stem adapted to operate in a well, a tubular drill head on the lower end of the stem, an assembly including a mandrel, a drilling cutter movably connected to the mandrel, an actuating bar longitudinally movable relative to the mandrel and connected to the cutter, means for limiting such relative movement, releasable means for interlocking said bar with the mandrel to prevent such movement, a tension rod slackly connected to the actuating bar, a tension bar yieldingly connected to the tension rod, said assembly being movable downwardly through the stem to carry the cutter beneath the head, the actuating bar when moved into one position relative to the mandrel being effective to move the cutter into vertical position to permit its downward passage through the stem and head and being movable to another position to move the cutter into transverse position whereby upon the subsequent upward movement of the assembly the cutter will move to active position in engagement with the lower end of the head, said tension bar being further movable upwardly and interlocking means carried by the bar and engageable with the stem, upon such further upward movement to lock the cutter in said active position.

9. Drilling apparatus comprising a tubular drill stem adapted to operate in a well, a tubular drill head on the lower end of the stem, an assembly including a mandrel, a drilling cutter movably connected to the mandrel, an actuating bar longitudinally movable relative to the mandrel and connected to the cutter, means for limiting such relative movement, releasable means for interlocking said bar with the mandrel to prevent such movement, a tension rod slackly connected to the actuating bar, a tension bar yieldingly connected to the tension rod, said assembly being movable downwardly through the stem to carry the cutter beneath the head, the actuating bar when moved into one position relative to the mandrel being effective to move the cutter into vertical position to permit its downward passage through the stem and head and being movable to another position to move the cutter into transverse position whereby upon the subsequent upward movement of the assembly the cutter will move to active position in engagement with the lower end of the head, said tension bar being further movable upwardly and interlocking means carried by the bar and engageable with the stem, upon such further upward movement to lock the cutter in said active position, and a core taking device depending from the mandrel beneath the cutter.

10. In drilling apparatus, a tubular drill stem adapted to be lowered into a well, an assembly adapted to be lowered downwardly through the stem and including a drilling cutter mounted to pivot about a transverse axis, means for actuating the cutter into transverse position to engage the lower end of the stem upon upward movement of the assembly, a sample taking apparatus carried by said assembly and extending beneath the drilling cutter into the well.

11. Drilling apparatus comprising a tubular drill stem adapted to be lowered into a well, an assembly adapted to be lowered downwardly through the stem and including a drilling cutter mounted to pivot about a transverse axis, a sample taking apparatus connected to the assembly and extending beneath the drilling cutter, means for actuating the cutter into transverse position to engage the lower end of the stem upon upward movement of the assembly and means for interlocking the assembly with the stem upon such upward movement.

12. 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 in its lower end, 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 head and a core taking device beneath the cutter, said assembly also including means to actuate the cutter into active position to seat in said seat upon upward movement of the assembly.

13. 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 provided with a transverse seat at the forward end of the head, an assembly adapted to be lowered through and withdrawn upward through the stem, said assembly including a core taking device and a drilling cutter arranged to be lowered with the assembly into position beneath the head, said core taking device having a transverse slot through which the cutter works, said assembly also including means to actuate the cutter into active position onto said seat upon upward movement of the assembly.

JOHN W. PIPPIN.