

March 22, 1932.

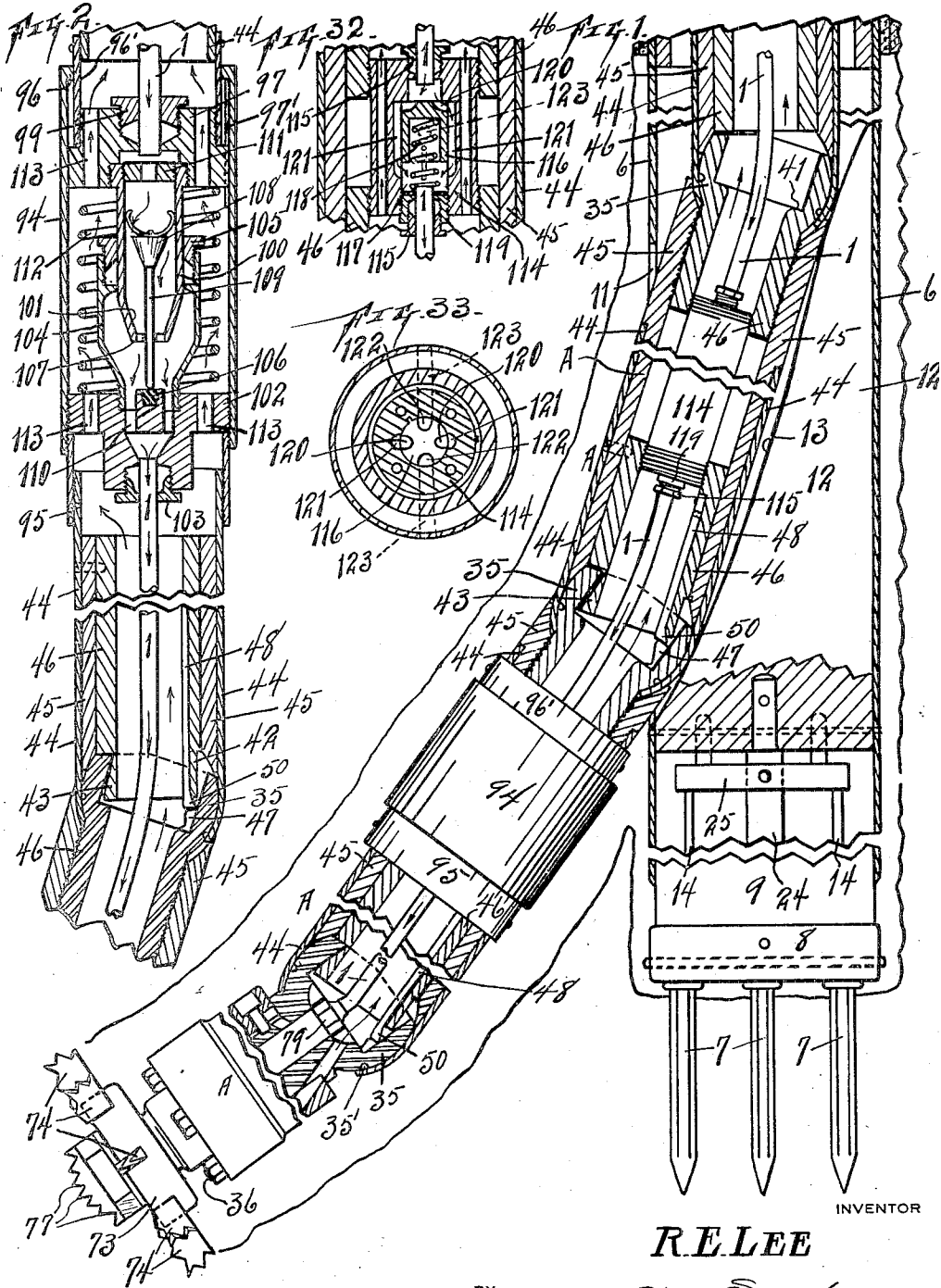
R. E. LEE

1,850,403

MECHANISM FOR DRILLING ANGULAR CHANNELS

Filed Oct. 8, 1931

7 Sheets-Sheet 1



INVENTOR

R. E. LEE

BY

John E. Cotton

ATTORNEY

March 22, 1932.

R. E. LEE

1,850,403

MECHANISM FOR DRILLING ANGULAR CHANNELS

Filed Oct. 8, 1931

7 Sheets-Sheet 4

Fig. 10.

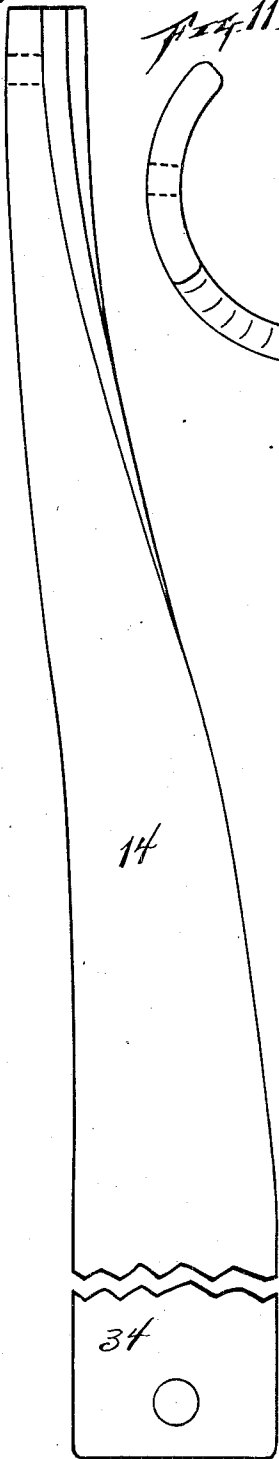


Fig. 11.

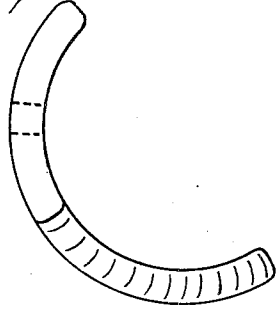


Fig. 8A.

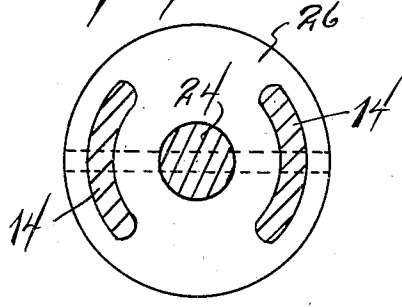
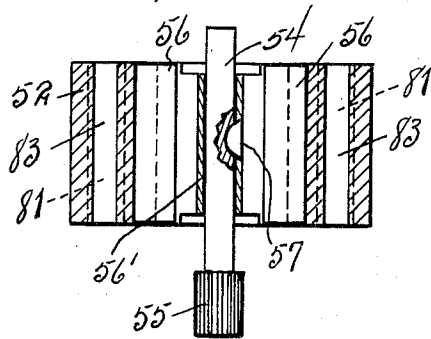


Fig. 36.



INVENTOR

R. E. LEE

BY

John C. [Signature]

ATTORNEY

March 22, 1932.

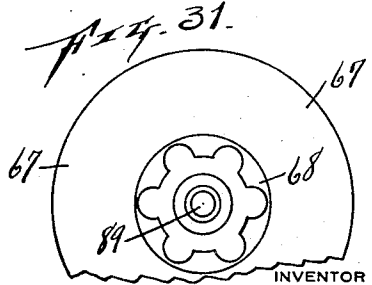
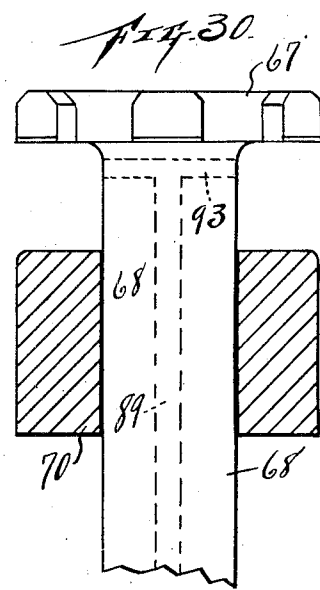
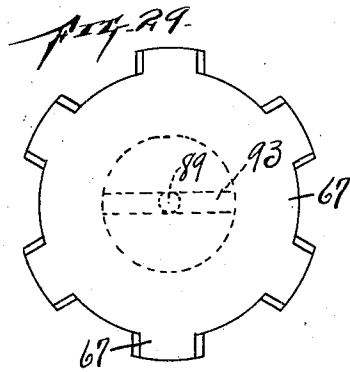
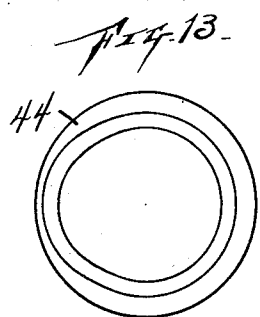
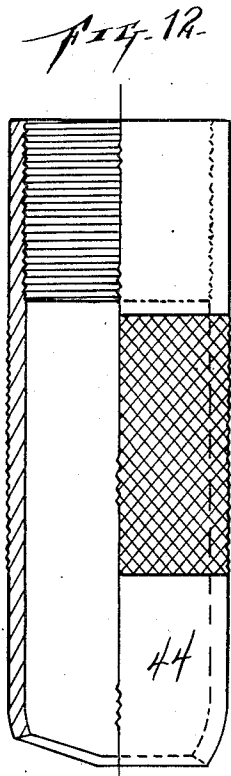
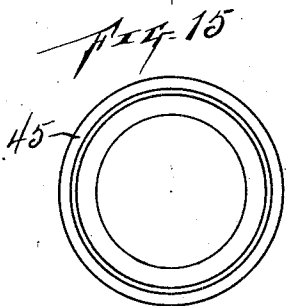
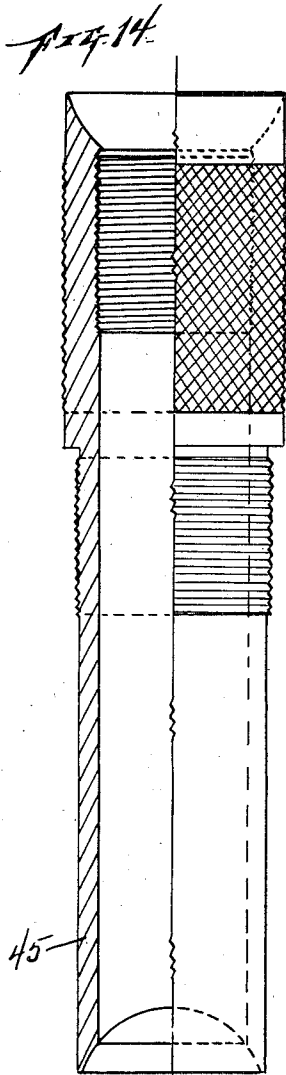
R. E. LEE

1,850,403

MECHANISM FOR DRILLING ANGULAR CHANNELS

Filed Oct. 8, 1931

7 Sheets-Sheet 5



RELEE

John C. Wilson.

INVENTOR

ATTORNEY

March 22, 1932.

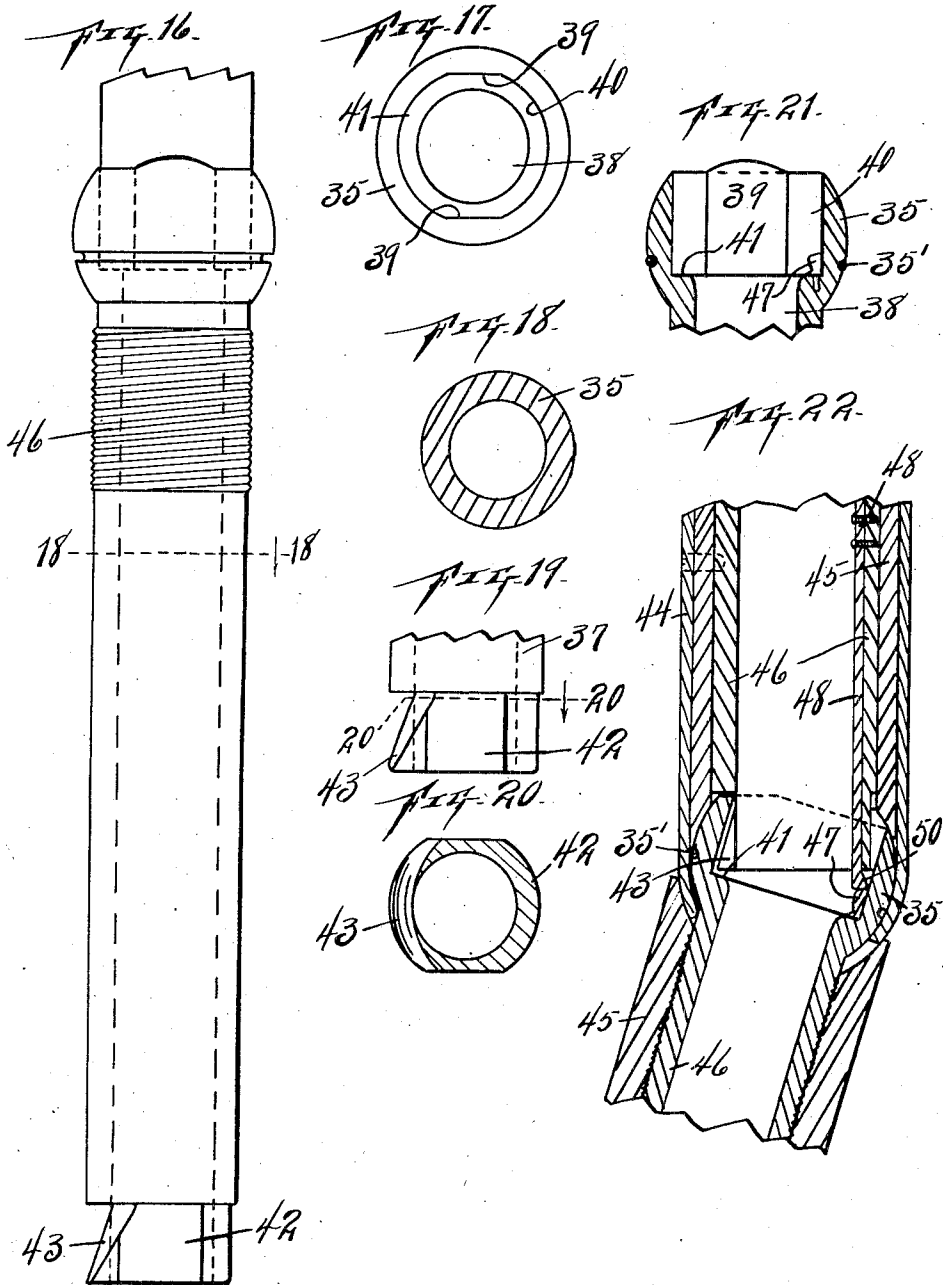
R. E. LEE

1,850,403

MECHANISM FOR DRILLING ANGULAR CHANNELS

Filed Oct. 8, 1931

7 Sheets-Sheet 6



INVENTOR

R. E. LEE

BY

ATTORNEY

March 22, 1932.

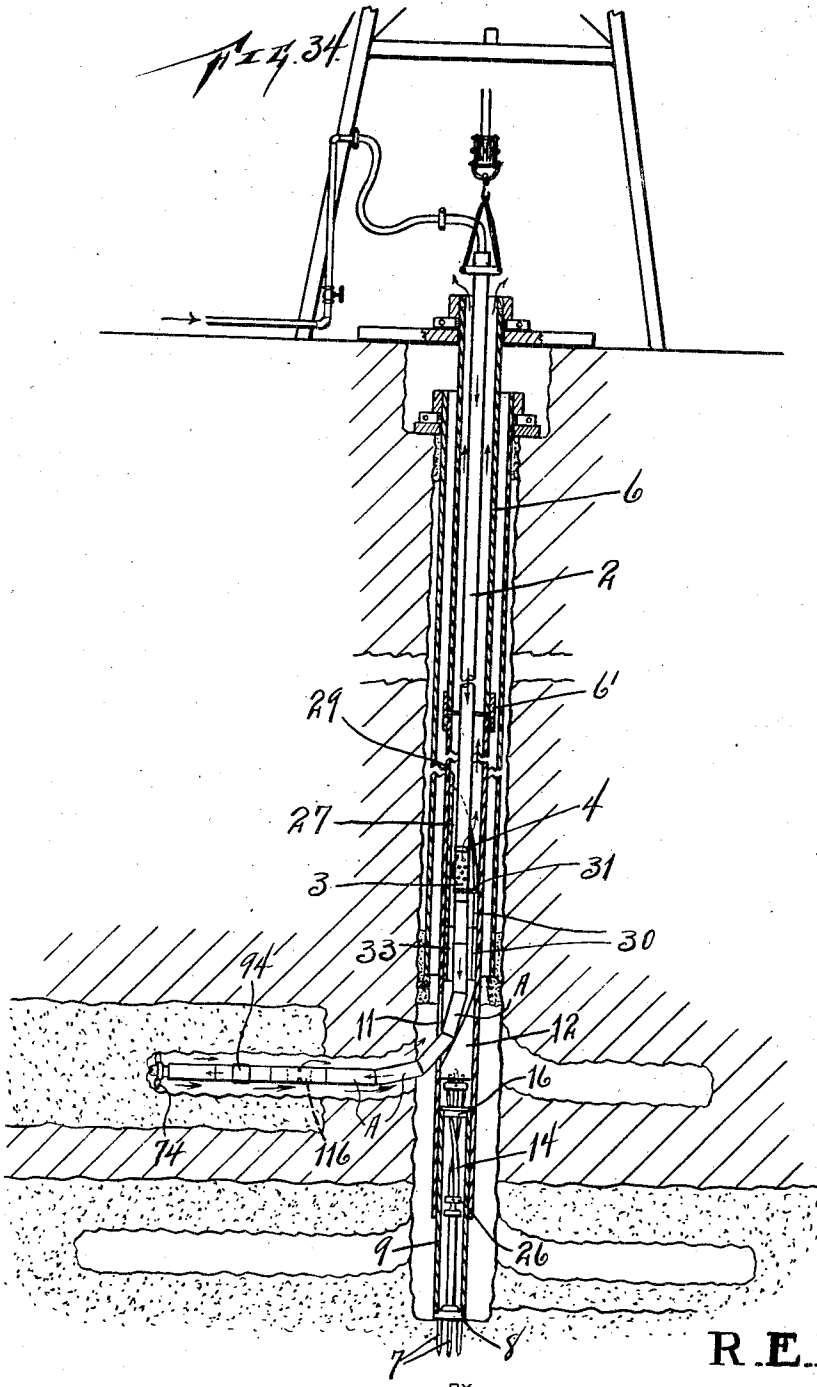
R. E. LEE

1,850,403

MECHANISM FOR DRILLING ANGULAR CHANNELS

Filed Oct. 8, 1931

7 Sheets-Sheet 7



BY

INVENTOR

R. E. LEE

John C. Miller

ATTORNEY

UNITED STATES PATENT OFFICE

ROBERT E. LEE, OF FORT WORTH, TEXAS

MECHANISM FOR DRILLING ANGULAR CHANNELS

Application filed October 8, 1931. Serial No. 567,630.

My invention relates to drilling tools and more particularly to tools for drilling angular channels; and the object is to provide apparatus for drilling wells which is provided with means for making angular channels from the vertical opening in the earth known as the well. The object is to make channels extend out through the surrounding area from the vertical well. Another object is to provide positive means for drilling a given or predetermined angle from the vertical opening. An advantage of this invention is that the producing sands or reservoir may be penetrated at various angles from the vertical hole or opening in the earth. Another advantage of this invention is that several channels may be drilled angularly from the vertical opening at approximately the same level without removing the apparatus from the well. Another advantage of this invention is that the various angular channels may be directed from the vertical opening by one deflector unit which is controllable from the top of the well. Another advantage is that there is provision made for determining the drill bit pressure in angular drilling. Another advantage is that means are provided to flush out the drill cuttings from the angular channels without removing the drilling tools. Other objects and advantages will be fully explained in the following description and the invention will be more particularly pointed out in the claims.

Reference is had to the accompanying drawings which form a part of this application.

Fig. 1 is a vertical section of a well casing, showing the drilling apparatus being deflected by the deflector.

Fig. 2 is a vertical section of a portion of the drilling tool, showing the drill bit pressure indicating mechanism.

Fig. 3 is a vertical section of the lower end of the drilling tool and drill bit, showing the ports for pneumatically operating the bit.

Fig. 4 is a vertical section of the deflector and its housing, showing the guide for the drilling tool and anchoring means for the housing.

Fig. 5 is a vertical section of a portion of

the deflector housing taken at right angles to Fig. 4, showing the lateral opening in the housing.

Fig. 6 is a plan view of the ratchet for actuating the deflector.

Fig. 7 is a vertical section of the same, showing the retaining ring for the rotor of the ratchet.

Fig. 8 is a plan view of the retainer for the ends of the guide arms that pass through the ratchet.

Fig. 8A is a top plan view of the rotor with the guide arms passing therethrough.

Fig. 9 is a perspective view of the guide and slot member which is made integral with the deflector housing for directing the drill tool.

Fig. 10 is an enlarged view of one of the guide arms that pass through the ratchet.

Fig. 11 is a plan view of the same, showing the extent of its spiral curvature from the top to the bottom.

Fig. 12 is a detail view of the outer housing or casing of one of the flexible drill units.

Fig. 13 is an inverted plan view of the same.

Fig. 14 is a detail view of the center element of one of the flexible drilling units, showing the enlarged portion at the top thereof to form the upper outer portion of the unit.

Fig. 15 is an inverted plan view of the same.

Fig. 16 is a side view of the inner element of one of the drill units, shown partly in section and illustrating the ball joint.

Fig. 17 is a plan view of the ball joint.

Fig. 18 is a sectional view of the inner element taken on the line 18—18 of Fig. 16.

Fig. 19 is a detail view of the lower portion of the inner element, showing the cut out portion formed to conform with the inner periphery of the ball joint.

Fig. 20 is a sectional view of the same taken on the line 20—20 of Fig. 19.

Fig. 21 is a vertical section of the ball joint, showing the locking lug.

Fig. 22 is a vertical section of a joint of the drill stem, showing the joint locked in an angular drilling position.

5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

Fig. 23 is an inverted plan view of the drill bit, shown partly in section, with a number of cutting blades removed.

Fig. 24 is a plan view of the pneumatic motor for rotating the drill bit.

Fig. 25 is a plan view of the gearing connecting the motor with the drill bit.

Fig. 26 is a detail view of a portion of the gearing and the lower housing therefor, showing the housing in section and the housing teeth to engage and operate the face clutch of the rotating rifle bar of the drill bit.

Fig. 27 is a plan view of the valve controlling the pneumatic element directed upon and actuating the piston for tamping the drill bit.

Fig. 28 is a side elevation of the valve shown partly in section.

Fig. 29 is a plan view of the rotating rifle bar, showing the face clutch for receiving the lower end of the rotating internal gear housing.

Fig. 30 is a side elevation of the upper portion of the rotating rifle bar of the drill bit, showing the drill bit piston positioned thereon and in section.

Fig. 31 is an inverted plan view of the lower end of the rifle bar, showing the bar splined for longitudinal action in the drill bit.

Fig. 32 is a vertical section of the flush valve for diverting the power medium from the drill bit mechanism into the well for flushing the drilled cuttings out of the drilled channels or hole.

Fig. 33 is a plan view of the same, showing the side walls of the unit containing the same in cross section.

Fig. 34 is a vertical section of a well or deflector housing, showing the drill tool penetrating one of a plurality of angular channels projecting from the vertical hole.

Fig. 35 is a sectional view of the motor casing taken on the line 35—35 of Fig. 24.

Fig. 36 is an enlarged side elevation of the motor for actuating the drill bit.

Similar characters of reference are used to indicate the same parts throughout the several views.

My invention relates to the operating end or drilling end of the drill stem and the power element is supplied to the drill mechanism through a flexible pipe 1. This element may be air, gas or any other suitable element that is forced through the drill stem 2 to the flexible tube 1. Fig. 4 shows the upper extent of the flexible tube where it registers with the drill stem 2.

The drill stem tubing 2 will extend down from the top of the well to the flexing units A. A joint 3 is interposed between the drill stem tubing 2 and the first flexing joint A. The joint 3 has a swivel connection 4 with the tube 2 and is screwed to the first flexing

joint or unit A. The joint 3 is provided with perforations 5 for the escape of the exhaust power element from the drill bit motor and other working parts. The joint 3 functions as the positioning element for the drill stem so that the flexing direction of the units A will align with the deflector and the deflector housing opening. The joint 3 is provided with a plug 3' integral with the upper portion thereof and this lug is provided with a packing gland 4' which receives and secures the upper end of the tube 1.

When this device is used in a vertical hole or well, a deflector housing 6 is inserted into the well and extends from the top of the well to the bottom, or it may be set as a liner with sufficient number of joints to give the required weight and length for the stationary guide and to serve as an anchorage in the well. If set as a liner it may be actuated with the ordinary trip spear on a line (not shown). The deflector housing 6 is elevated and lowered to change the direction of deflector of the drill units. The housing 6 is provided with anchor points or engaging members 7 at the bottom thereof to project into the ground at the bottom of the hole. The anchor points 7 are provided with a retainer member 8 in which they are anchored and this retainer member 8 is provided with an upwardly projecting housing 9 screwed and secured thereto. The deflector housing 6 telescopes over the housing 9. The housing 6 is provided with a deflector 12 which is rigidly positioned therein and placed in the housing 6 at any required position above the bottom of the vertical hole for directing the drilling mechanism at an angle from the vertical. The deflector housing is provided with an opening 11 in the side thereof and opposite the deflector member 12 for the passage of the drilling units A for making angular channels form the vertical opening or well.

The deflector member 12 is cylindrical at its bottom portion to conform with the deflector housing 6 and provided with an elongated curve or angle 13 at the top thereof for deflecting the drilling unit through the opening 11. The deflector housing 6 is elevated and lowered for changing the direction of the deflector angle 13 and when the housing 6 is raised it will telescope on the anchor housing 9 thus allowing the rotor of the ratchet to revolve without causing a similar movement of the anchor housing 9.

Means are provided in the bottom of the deflector 12 for causing the deflector to be revolved when the deflector housing 6 is lowered. A ratchet member is placed in the upper portion of the anchor housing 8, see Fig. 4, to receive and guide directing arms or rotating arms 14. The ratchet wheel or rotor 15 is provided with a housing 16 which is screwed to the upper portion of the anchor housing 9. The housing 16 is provided with

teeth 17 on the inner periphery thereof to be engaged by pawls 18 which are carried by the rotor 15. The pawls 18 or dogs are each held in engagement with the teeth 17 of the housing 16 by means of a plunger 19 which reciprocates in an opening in the rotor 15. These openings are drilled into the rotor 15 from the outer periphery thereof and coil springs 20 are inserted into the openings for pressing against the plungers 19 to cause a resilient engagement of the plungers 19 with the pawls or dogs 18. A retainer ring 21 is screwed into the housing 16 for holding the rotor in working relation with the teeth 17 of the housing 16. The rotor 15 is provided with slots 22 for the passage therethrough of the directing arms 14. The rotor is provided with a center opening 23 for the passage therethrough of a directing arm retainer stem 24. The arm or stem 24 is made rigid with the deflector member 12 and projects downwardly therefrom. The arm or stem 24 is provided with collars 25 and 26 for holding the top and bottom respectively of the directing arms 14. The stem 24 is made of sufficient size and strength to hold the directing arms 14 rigid with the deflector 12 and to withstand the weight of the deflector housing 6 and its cooperating parts. The stem 24 rests upon the anchor housing 8 when in normal position.

When the deflector housing 6 is raised the bottom portion of housing will telescope upon the anchor housing 9, the directing arm 14 will pass through the slots 22 of the rotor 15 causing the rotor to revolve independent of the teeth 17 of the ratchet housing 16. When the housing 6 is lowered the rotor 15 will be held against rotation by the engagement of the pawls 18 with the teeth 17 of the ratchet housing 16 thus causing a rotation of the housing 6 and its deflector 12 to the extent equivalent to the spiral twist or longitudinal form of the directing arms 14. The collars 25 and 26 cooperate with the stem 24 to hold the directing arms 14 rigid with the deflector 12 and housing 6. It is apparent that the rotation of the housing 6 only extends to that portion below the swivel joint.

A stationary direction means is provided in the housing 6 for alining the drilling units with the deflector angle 13. This device is positioned above the deflector 12 at a sufficient height for its length to correspond with the flexing units A or extend to a greater length than the total length of all the flexing units used. This device consists of an inner liner 27 which is made rigid with the deflector housing 6 and provided with a top rim 28 which is cut to slope from a tip 29 down to and terminating into a slot 30. The tip 29 is positioned in the housing 6 directly above and in a central line with the opening 11 of the housing 6. This causes the projection 31 on the joint 3 to be directed into the

slot 30 by following the rim 28 as the drilling units are being lowered into the housing 6, see Figs. 4, 5, and 9. The directing means 27 causes the drilling units to be turned as they are lowered into the well, so that the flexing direction of the units A will be directed towards the opening 11 in the housing 6. The joint 3 is provided with a lug 31 projecting radially therefrom that is sufficient in width to pass into the slot 30 and to be retained therein. A leaf spring 32 is mounted on the outer periphery of the joint 3 so as to resiliently engage the inner periphery of the liner 27 and hold the joint 3 and the flexing units A centrally in the stationary guide to make the traveling guide or lug 31 ride the top flange 28 of the stationary guide and into the slot 30 of the stationary guide 27. Additional stationary guides 33 are added to the stationary guide 27 by positioning them under the stationary guide 27 so that there may be a continuation of the slot 30 to a sufficient depth in the well to insure perfect alinement of the flexing units A with the opening 11 of the housing 6.

The directing arms 14 for turning the deflector 12 may be formed with a sufficient spiral to give a predetermined part of a complete turn to the housing 6 as the housing is lowered. The arms 14 are provided with a straight portion 34 which allows longitudinal movement of the housing 6 without a rotary motion. This allows for the longitudinal stretch of the line giving a neutral action in the raising and lowering of the housing 6 relative to the rotary motion of the housing. The portion 34 of the arms 14 are parallel with the arm 24.

Each of the flexing units A are provided with ball joints 35 so as to give the necessary turn to the units as they are deflected in their downward movement through the opening 11 of the housing 6. The hollow ball joints 35 are each made integral with the top of each unit A, see Fig. 16. The ball joint is made integral with the last unit A or drill bit unit by means of bolts 36. The joint 35 is cast integral with the inner element or tubing 46 of the unit. The lower part of the joint is provided with an opening 38 the diameter of which is equivalent to the inner periphery of the tube 46, and the upper portion of the ball joint is provided with an enlarged opening 40 which terminates at its base in a shoulder 41. The side of the opening 40 is provided with flat side portions 39 positioned opposite each other to act as a bearing for the lower portion 42 of the next unit above. The lower portion 42 of the member 37 is formed to conform with the opening 40 of the ball 35. A portion of the part 42 is cut away so as to allow the necessary swing of each unit A in making the angular channel to the vertical opening in the earth. This part 43, see Figs. 19 and 20,

is cut away so that the cut-away portion 43 will fit against the curved side of the opening 40 in the ball joint 35 when deflected, as shown in Fig. 22. The form of the ball joint 35 and its cooperating part 42 allows only the one swinging angle of one of the units A to the other. The units A are provided with an outer shell 44, a center element 45, and an inner tube 46 all of which are pinned together. The lower end of the outer shell 44 is formed to fit over the ball joint 35 and the upper end extends approximately to the next ball joint above. The center element 45 is enlarged at its upper portion and forms the outer shell from the upper end of the member 44 up to and surrounding a portion of the upper ball joint 35, see Fig. 22, leaving a space between the member 44 and the joint 35 to receive the curved portion of the outer shell 44 of the next unit above.

The cut-away portion of the lower end of the inner element 45 allows only one angle of flexion of the units A. Some of the ball joints of the units are provided with locking means for holding the units when they are turned at angles to each other or flexed. The locking means consists of a lug 47 which is rigidly anchored on the shoulder 41 in the opening 40 of the balls 35. This lug 47 is anchored in the ball joints 35 and are positioned adjacent to the slant 13 of the deflector 12 when in operative position. The inner element 46 is provided with an elongated leaf spring 48 the upper end of which is rigidly attached to the inner element 46. A longitudinal slot 49 is made in the inner periphery of the inner element 46 to receive the spring 48. The lower end of the spring 48 is provided with an extension 50 which engages the lug 47. When the units A are deflected through the opening 11 of the housing 6 by the deflector 12 they will bend to the extent that the projection 50 will ride against the side of the lug 47 until it rides above the lug 47 and comes to rest on the top of the lug 47. This is locked position, as shown in Fig. 1. The unlocked position is shown in Fig. 3. When the drilling units are drawn back into the housing 6 the leaf spring 48 will bend until the projection 50 is pulled off of the lug 47 thus releasing the units A or unlocking the ball joints 35. This locking means may be used on only the lower unit or drill bit unit, or it may be used on any number of the joints 35 of the units A. The lower unit or the drill bit unit contains a motor for rotating the drill bit and a reciprocating piston for tamping the bit. The piston gives a forward movement to the rotary drill bit when the power element is forced through the flexible tube 1.

The drill bit motor is provided with a housing which consists of a base plate 51, side walls 52 and a top 53. A vertical drive shaft 54 projects through the top plate 53

and through the base 51 down to a sufficient length below the base plate 51 to carry a drive pinion 55 which is rigidly attached to the lower end of the shaft 54. Vanes 56 are carried by a rotor 56' which is shaft 54 by means of a key 57. It is apparent that various gearing arrangement may be used to cause a rotary motion to be imparted from the motor to the drill bit. A planetary type of gearing is preferable and such a type is shown, see Figs. 3, 25, and 26. A stationary gear housing 58 is provided with teeth 59, and a rotary gear housing 60 is provided with teeth 61. The teeth of each housing being made on the inner periphery of the housings. The pinion 55 meshes with and drives a set of gears 62. The gears 62 are provided with shafts 63 made integral therewith and journaled in end plates 64. The gears 62 mesh with the teeth 59 of the stationary housing 58 which causes the gears 62 to be revolved around the pinion 55. The shafts 63 are each provided with gears 65 rigidly attached thereto and positioned below the gears 62. The gears 65 mesh with the teeth 61 of the rotary housing 60 and drives the housing 60. The housing 60 is provided with a face clutch 66 on the lower end thereof which engages and drives a clutch 67 which is made integral with the upper end of the rotating rifle bar 68 of the drill bit. The rifle bar 68 is provided with a bearing 69 for holding the clutches 66 and 67 in operative relation. A piston 70 telescopes upon the rifle bar 68 and in a cylinder 71 which extends from the bearing 69 and below the top of the drill bit head 72. The lower end of the rifle bar 68 is splined, as shown in Fig. 31, to fit into similar splines in the drill head 72 so as to give a longitudinal action to the head 72 relative to the rifle bar and to hold the bar 68 in operative relation to the head 72.

The drill bit head 72 is provided with an enlarged portion 73 at the base thereof to form a retainer for a series of collapsible cutting blades 74, as shown in Fig. 3. The face of the portion 73 of the drill head is provided with slots 75 radiating from the center thereof to receive the cutting blades 74, as shown in Fig. 23. The blades 74 are journaled in the slots 75 so that they may have a swinging motion in the slots. The normal position of the blades 74 are shown in dotted outline in Fig. 3. The center part of the member 73 is drilled and threaded to receive a bolt 76 which holds the blades 74 in pivotal relation to the slots 75. The bolt head 76 is provided with cutting teeth 77 which assist the blades 74 in drilling. The ends of the blades 74 adjacent the center of the member 73 are provided with an enlarged rounded surface 78 which projects into an internal radial slot 79 of the bolt head 76. The surface 78 of the blades are so shaped as to retain the blades in the slots 75 when

the bolt 76 is screwed into the member 73. A leaf spring 75' is positioned in the slots 75 so as to bear against the face of the blades 74 and hold the blades in a collapsed or normal position, as shown in Fig. 3, dotted outline. This structure of the bit and cooperating parts gives two forms of drilling, namely the rotary action and the tamping action. The rotary action is attained by the motor and the tamping action is attained by the reciprocating piston 70 which travels inside the cylinder 71 and tamps the head 72 of the drill bit. This piston gives what is termed as a hammer action on the drill bit.

The power element is conveyed to the actuating mechanism in the drill bit unit A by means of a flexible tube 1 which is screwed into the upper end of the lower unit by means of a nipple 79. The power element is conveyed from the tube 1 through the nipple 79 and through ports 80 in the motor housing top 53 to the motor vanes 56 which causes the vanes to revolve thus causing the motor shaft 54 to be driven. The power element exhausts from the vanes 56 through exhaust ports 80' in the motor housing side-walls 52 which register with ports 81 that are drilled longitudinally in the housing 52. The ports 81 register with the openings 40 in the ball joints 35 and extend longitudinally in the drill bit housing down to approximately the level of the top of the bit head 72 and serve as exhaust ports from the motor and the piston 70.

A port 82 is provided in the base of the ball joint 35 below the nipple 79 so that some of the power element may pass around the motor and its gearing down to the piston 70. The port 82 registers with a port 83 which extends through the side walls of the motor housing 52 and stationary gear housing 58 to a pressure actuated valve 84 which controls the supply element to the piston 70. The valve 84 which is commonly known as a pneumatic current thrown or operated by the poppet valve, as shown in Figs. 27 and 28, is actuated by the power element so that the element will travel to the top of the piston 70 through the port 85 intermittently. The exhaust of the power element from the top of the piston passes through the exhaust port 86 in the side wall of the cylinder 71 as the piston reaches its extreme lower position. The port 86 registers with the exhaust port 81 which allows the exhaust to pass up the units A between the inner element 45 of the units and the flexible supply tube 1. The compression set up below the piston 70 passes through the port 87 which is located in the cylinder 71 near the top of the drill head 72 and registers with a compression chamber 88 which is drilled longitudinally in the wall of the cylinder 71. The rotating rifle bar 68 is centrally drilled to provide a port 89 for the passage of the power element to the cut-

ting blades 74. The port 89 is provided with a check valve 90 in the bottom thereof to keep the cuttings from the hole and other foreign matter out of the port 89. The power element passes through the port 89 by the check valve 90 and into ports 91 which are drilled through the enlarged portion 73 of the drill head and made to register with the blades 74 so that the cuttings may be blown away from the cutting edges of the drill. The bar 68 is provided with a port 92 which is drilled into the port 89 and positioned under the clutch portion 67 of the bar 68. The port 92 registers with a similar port 93 which passes through the bearing 69 of the shaft or rifle bar 68 and registers with the port 83 for supply of power element to flush the cuttings from the blades 74. The power element is passed through ports 82, 83, 93, 92 and down 68 to the drill for flushing the cuttings from the drill head.

A bit pressure regulator and gauge is provided in the next unit above the drill bit unit A. This mechanism may also be placed in any of the units above the drill bit unit. This mechanism replaces the usual weight indicator in the regular rotary drilling. It is apparent that the regular form of weight indicator would not function efficiently in angular drilling due to the friction of the drill stem against the side of the angular portion of the hole. This mechanism consists of a housing 94 which is inserted between two joints 35 and constructed as to telescope between the two. The housing 94 is provided with a lower extension 95 which is made integral with the outer shell 44 of the unit and the upper part of the housing 94 is provided with an upper extension 96' which is made integral with the upper portion of the shell 44. An inner annular rim 96 rides against the extension 96' and is adapted to telescope thereon. The extension 96' is provided with an internal thread and a plug 97 is inserted therein. The plug 97 is provided with a shoulder adjacent the lower extremity of the extension 96' and which acts as a stop for the annular rim 96 in its downward movement, and serves as a sealed joint. The rim 96 and the shoulder control the telescopic movement of the housing 94. The housing 94 is keyed to the plug 97 by a key 97' so that the alignment of the flexion of the flexing units are maintained. The plug 97 is provided with a packing gland 99 in the upper side thereof to receive and secure the end of the flexible tube 1. The lower portion of the plug 97 is provided with a valve housing 100 which is rigidly attached to the plug and the lower portion of the housing 100 is swedged to form a valve seat 101. The lower end of the regulator housing 94 is provided with a similar plug 102 and this plug is provided with a packing gland 103 which receives and secures the other end of the flexible tube 1. The top of

the plug 102 is provided with a tube 104 which projects upwardly therefrom and passes around the valve housing 100. The tube 104 and housing 100 are made telescopically connected, one with the other, and provided with a packing gland 105 so that the power element will not escape from this connection between the plugs 97 and 102. The top center part of the plug 102 is provided with fibrous material which forms a seat 106 for the swedged end 107 of the housing 100 to rest upon. A valve 108 is slidably mounted in the housing 100 and provided with a valve stem 109 which rests upon the seat 106. Ports 110 are drilled around the seat 106 of the plug 102 for the passage of the power element from the tube 104 through the plug 102 and through the flexible tube 1. A perforated plug 111 is screwed into the upper end of the valve housing 100 to limit the upper movement of the valve 108. A coil spring 112 is placed between the plugs 97 and 102 and around the telescoping tube 104 and valve housing 100. The plugs 97 and 102 are each provided with ports 113 near their outer periphery to serve as an opening for the passage of the exhaust power element that passes up through the units A and around the spring 112. Fig. 2 illustrates the regulator in working or normal position. The power element passes through the regulator as shown by arrows in the Fig. 2. The valve in the regulator is actuated by the weight of the drill line on the drill bit. When there is a sufficient amount of bit pressure the regulator will allow the power element to pass through the valve housing 100 to the drill bit motor and tamping means but if there is insufficient pressure on the drill bit the spring 112 will expand and allow the valve 108 to seat in the valve housing seat 101 thus cutting off the power element from the drilling mechanism. If there is too much pressure applied to the drill bit the spring 112 will be compressed to the extent that the valve housing end 107 will rest upon the seat 106 thus closing off the supply of power element to the bit mechanism. As long as the drill bit is being actuated by the power element through a regulator of this type the operator knows that there is a sufficient bit pressure on the drill bit.

A flushing mechanism for flushing the cuttings from the hole is provided in one of the units, preferably in the second unit above the drill bit unit. This mechanism may be in any of the units above the regulator or bit pressure regulator. The flushing mechanism is a valve which is operated by the pressure of the power element. A portion of the inner element or tube 46 of one of the units A is cut away and the cut-away portion is supplanted by a plug 114 rigidly attached therein. The plug 114 is provided with packing glands 115 at both ends which receives and secures the ends of the flexible pipe 1. The

center of the plug 114 is drilled to form a chamber 117 which registers with the openings in each connecting end of the flexible tubing 1. A cup shaped valve 116 is slidably mounted in the chamber 117 and will reciprocate therein by the pressure of the power element. A coil spring 118 is placed in the chamber 117 so that it will rest upon the packing gland housing 119 of the lower packing gland 115 and projects into the cup valve 116 and push the valve up against the top of the chamber 117. The valve 116 is keyed in the chamber 117 so that there will not be a rotation of the valve in its reciprocating movement in the chamber, keeping the valve ports and plug ports in proper relation to each other. The chamber 117 is provided with internal longitudinal grooves 121 which extend from the top of the chamber down to a sufficient distance to allow the power element to pass around the valve 116. The top of the valve 116 is provided with slots 120 which register with the grooves 121. When the valve 116 is in normal position, as shown in Fig. 32, the power element will pass through the grooves 120 of the valve 116 through the grooves 121 of the chamber 117 and on to the drill mechanism through the flexible tube 1. The spring 118 is of sufficient strength to withstand a given pressure of the power element on the top of the valve 116 and this amount of pressure is the maximum pressure to be used on the drilling mechanism. When a greater amount of pressure is sent through the tube 1 the tension of the spring 118 will be overcome to the extent that the valve 116 will move down in the chamber 117 below the lower extremity of the grooves 121 and seat on the gland housing 119 thus shutting off the power element to the drilling mechanism. When this is done the power element will be directed out through the unit A and into the drilled channel or hole to act as a flushing means. The valve 116 is provided with grooves 122 in the upper end thereof which are similar to the grooves 120 in the valve and which register with horizontal ports 123, as shown in Fig. 33. The ports 123 pass through the unit A out to the drilled channel or hole. The grooves 122 only register with the ports 123 when the valve 116 is at its lowest extremity in the chamber 117 and the power element is cut off from the drilling mechanism. This allows the power element to be used for forcing out the drill cuttings from the angular chamber and vertical hole.

It is apparent that all of the units are alined so that the flexion of the units A are in the same direction.

The exhaust of the power element from the motor and the cylinder 21 is conveyed through the flexing units A around the flexible tube 1 up to and out of the perforations

5, in the connection 3, and into the housing 6 around the drill stem tube 2.

What I claim is:

1. In a well provided with a casing; a deflector housing projected therethrough and extending below said casing, means for anchoring said housing in the bottom of said well, a lateral opening provided in said housing near the bottom thereof, a deflector mounted in said housing for directing drilling means out of said opening for drilling angular channels from said housing, and means for positioning the lateral opening in said housing, and a drilling means consisting of a plurality of flexing units and a drill head carried by one of said units.

2. In a well provided with a casing; a deflector housing projected therethrough and extending below said casing, means for anchoring said housing in the bottom of said well, a telescoping connection between said housing and said anchoring means, said housing provided with a lateral opening therethrough, a deflector mounted in said housing and positioned adjacent said opening for directing drilling means out of said opening, a hollow shaft of flexible units projected through and deflected out of said housing by said deflector, a drill head carried by said hollow shaft, means for alining the direction of flexion of said flexible units with said lateral opening, and means operated through said shaft for actuating said drill head.

3. In a well provided with a casing; a deflector housing projected therethrough and extending below said casing, means telescopically connected to said housing for anchoring said housing in the bottom of said well, said housing provided with a lateral opening near the lower end thereof, a deflector mounted in said housing for directing flexing drill units out of said opening and at an angle to said housing, means for elevating and lowering said housing for changing the direction of said deflector, a drill head carried by the lower unit of said flexing units, a pneumatic motor carried in said lower unit for revolving said drill bit, a piston carried in said lower unit for tamping said drill bit, and a flexible tube carried through said units for supplying a power element to said motor and to said piston.

4. In a well provided with a casing; a deflector housing projected therethrough and extending to the bottom of said well, means for rotatably anchoring said housing in the bottom of said well, said housing provided with a lateral opening near the bottom thereof, a deflector mounted in said housing, a drill stem carried through said housing consisting of tubing flexing units swivelly connected thereto, means for rotating said housing for positioning said lateral opening, said units adapted to be deflected through said lateral

opening and at an angle to said housing, a drill bit carried by the lower unit of said flexing units, means carried in said lower unit for rotating and tamping said drill bit a flexible tube projected through said flexible units, and a power element carried through said tubing and said flexible tube for actuating said rotating and tamping means.

5. In a well provided with a casing; a deflector housing projected therethrough and extending below said casing, telescopic means for anchoring said housing in the bottom of said well, said housing provided with a lateral opening therethrough, a deflector mounted in said housing for directing drilling means out of said opening and at an angle from said housing, means for rotating said housing for varying the direction of said opening, a hollow shaft of flexing units projected through and deflected out of said housing by said deflector, a drill bit carried by one of said units, and drilling means operated through said units for actuating said bit.

6. A drilling stem consisting of tubing and flexing units swivelly connected thereto, means for flexing said units in one direction, means for locking one or more of said units in a flexed position, a housing for guiding said drill stem down in the well and provided with a lateral opening near its lower end, means for deflecting said units through said lateral opening, means for alining the flexion of said units with said lateral opening, means for automatically locking said locking units at the moment of their departure from said housing, a drill bit mounted on the lower end of said units, and means operated through said drill stem for actuating said drill bit.

7. A drilling stem comprising a tubing and flexing units carried thereby, a housing for guiding said drill stem down in the well and provided with a lateral opening near its lower end, means for changing the direction of said opening, means for deflecting said units out of said opening for drilling angular channels from said housing, a drill bit carried by the lower unit of said flexing units, pneumatic pressure means carried through said drilling stem for rotating and tamping said drill bit, a bit pressure regulator provided in one of said units to automatically control the pressure to the rotating and tamping means, a flush valve provided in one of said units for flushing out the cuttings from said channel with said pneumatic pressure.

8. A drilling stem consisting of a tubing and flexible units swivelly connected thereto, a housing for guiding said drill stem down in the well and provided with a lateral opening near its lower end, a deflector mounted in said housing for directing said units out of said lateral opening and at an angle to said housing, a collapsible drill bit carried on the

lower unit of said flexible units, a motor carried in said lower unit for rotating said drill bit, a piston carried in said unit for tamping said drill bit, and a power element carried through said drill stem for actuating said motor and piston.

9. A drilling stem comprising a tubing and flexing units swivelly connected thereto, a housing for guiding said stem down in the well and provided with a lateral opening near its lower end, a deflector mounted in said housing for directing said units out of said lateral opening for drilling angular channels from said housing means for flexing said units in one direction, means for automatically locking said units in a flexed position at the moment of their departure from said housing, guide means mounted in said housing for aligning said units so that they will flex towards said lateral opening, a collapsible drill bit carried by one of said units, pneumatic pressure carried through said drill stem for actuating said drill bit, and means provided in one of said units for automatically controlling the flow of said pressure relative to the drill bit pressure.

10. In a drilling stem comprising a tubing and flexing units, a housing for directing said stem down in the well and provided with a lateral opening near the lower end thereof, means for deflecting said units out of said housing for drilling angular channels to said housing, a drill bit carried by the lower unit of said units, a motor in said lower unit for rotating said drill bit, a piston in said unit for tamping said drill bit, pressure means carried by said drill stem for actuating said motor and piston, and means for diverting said pressure from said motor and said piston to said channels for flushing out the drill cuttings therefrom.

11. In a drilling stem comprising a tubing and flexing units carried thereby, a housing for directing said drill stem down in the well and provided with a lateral opening near the lower end thereof, means for deflecting said flexing units out of said housing and through said lateral opening, a collapsible drill bit carried by the lower unit of said flexing units, pressure means carried through said stem for actuating said drill bit, and automatic means carried in one of said units for cutting off the pressure from said drill bit when there is a variation from the predetermined bit pressure.

12. In a drilling stem comprising a tubing and flexing units carried thereby, a housing for directing said drill stem down in the well, and provided with a lateral opening near the lower end thereof, means carried by said housing for deflecting said units out of said housing, means for locking the lower units in flexed position at the moment of leaving said housing, a drill bit carried by the lower unit

of said flexing units, pressure means operated through said drill stem for actuating said drill bit, means for automatically cutting off the pressure from said drill bit when the drill bit pressure is too great or insufficient, and means for automatically unlocking said locking units as the drilling stem is being removed from said well.

13. In a drill stem comprising a tubing and flexing units carried thereby, means for flexing said units in one direction, a housing for directing said stem in the well and provided with a lateral opening near the bottom thereof, a deflector mounted in said housing for directing said flexing units out of said housing through said lateral opening for drilling angular holes therefrom, means for aligning the direction of flexion of said flexing units with said lateral opening, a collapsible drill bit carried by the lower unit of said flexing units, actuating mechanism for said drill bit carried by said lower unit, pressure means carried through said drill stem and flexing units for actuating said drill bit actuating mechanism means carried by one of said units for automatically cutting off the pressure from said mechanism when the drill bit pressure is insufficient or when the drill bit pressure is above a predetermined pressure, and means provided in one of said units for diverting said pressure from said mechanism for flushing the drill cuttings from said well.

14. In a drill stem comprising a tubing and flexing units connected thereto, a housing for directing said stem down in the well, each of said units provided with a housing curved at the lower end thereof, a hollow ball member formed integral with the upper end of said unit housing and adapted to fit into said curved lower end of the adjoining housing and to be held in pivotal relation thereto, a packing ring carried by said ball member and adapted to engage the well of said curve, said hollow ball member provided with a lug integral with the inner well thereof, a downwardly projecting member resiliently attached to the inner periphery of said unit housing and adapted to engage and bear against said lug when said units are in alignment with each other, said member adapted to rest upon said lug for locking said units in a flexed position, a drill bit carried by the lower unit of said flexible units, and a power element carried through said drill stem for actuating said drill bit.

15. In a drill stem comprising a tubing and flexing units swivelly connected thereto, a deflector housing for directing said stem down in the well and provided with an opening therethrough, each of said units provided with a housing curved at the lower end thereof, a hollow ball member formed integral with the upper end of said unit housing and adapted to fit into the curved lower end of the adjoining unit housing and to

be held in pivotal relation thereto, said units adapted to be flexed in one direction to each other, means for alining the flexion of said units with said opening in the deflector housing, a deflector mounted in said deflector housing and adapted to direct said units out of said opening, and means for locking said units in a flexed position at the moment of their departure from said deflector housing.

10 16. In a drilling stem consisting of a tubing and flexing units swivelly connected thereto, a housing for directing said units down in the well and provided with a lateral opening in the lower end thereof, means for elevating and lowering said housing for directing said units out of said opening angularly from said housing and at various elevations in the well, a drill bit carried by the lower unit of said flexing units, power element carried through said drill stem for actuating said drill bit, and a valve carried in one of said flexing units for determining the drill bit pressure.

In testimony whereof I set my hand this 25 5th day of October, 1931.

ROBERT E. LEE.

30

35

40

45

50

55

60

65