

Dec. 31, 1929.

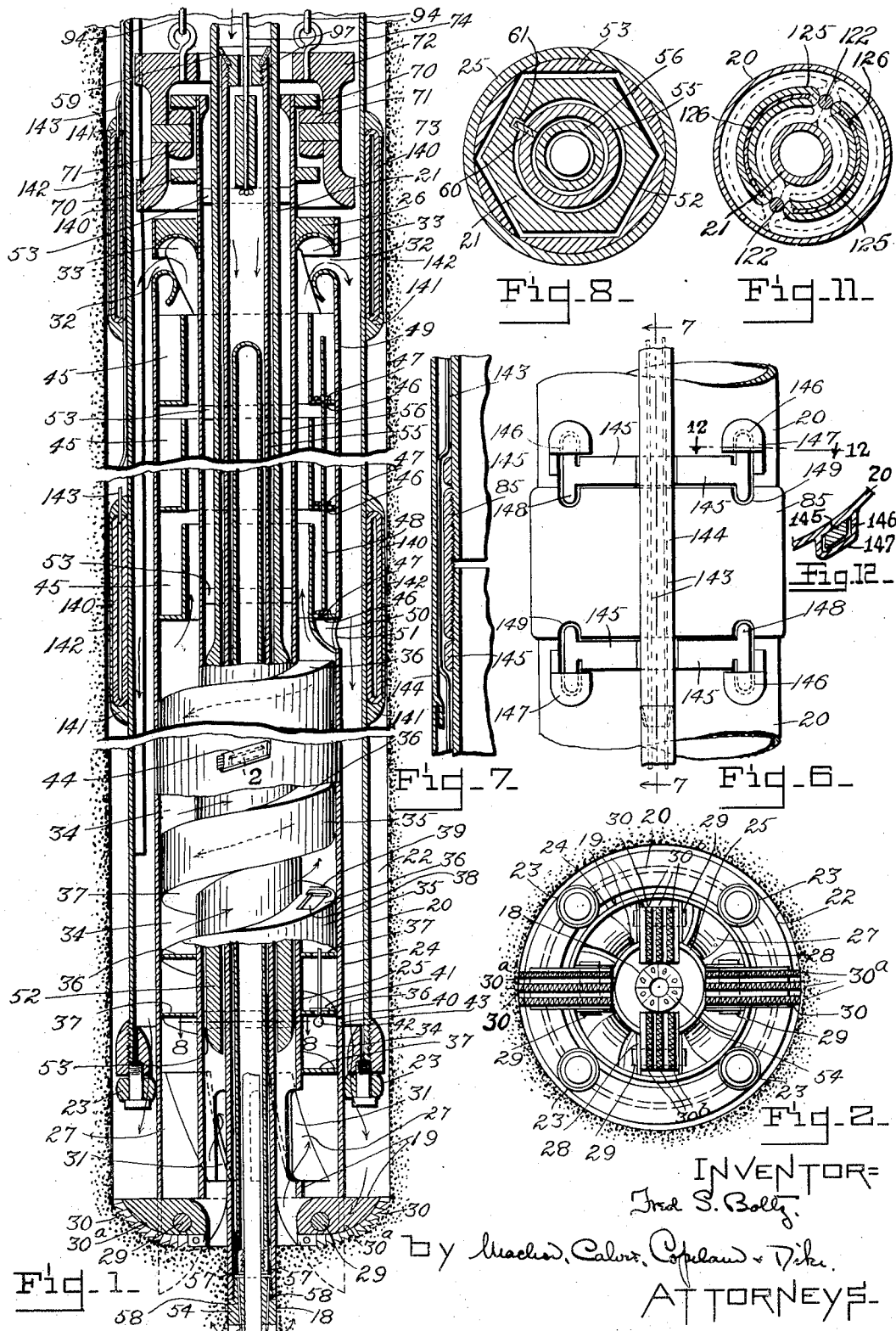
F. S. BOLTZ

1,741,497

EARTH DRILLING APPARATUS

Filed Sept. 9, 1925

2 Sheets-Sheet 1



INVENTOR
Fred S. Boltz
By Messrs. Calvin Copeland & Dike.
ATTORNEYS

Dec. 31, 1929.

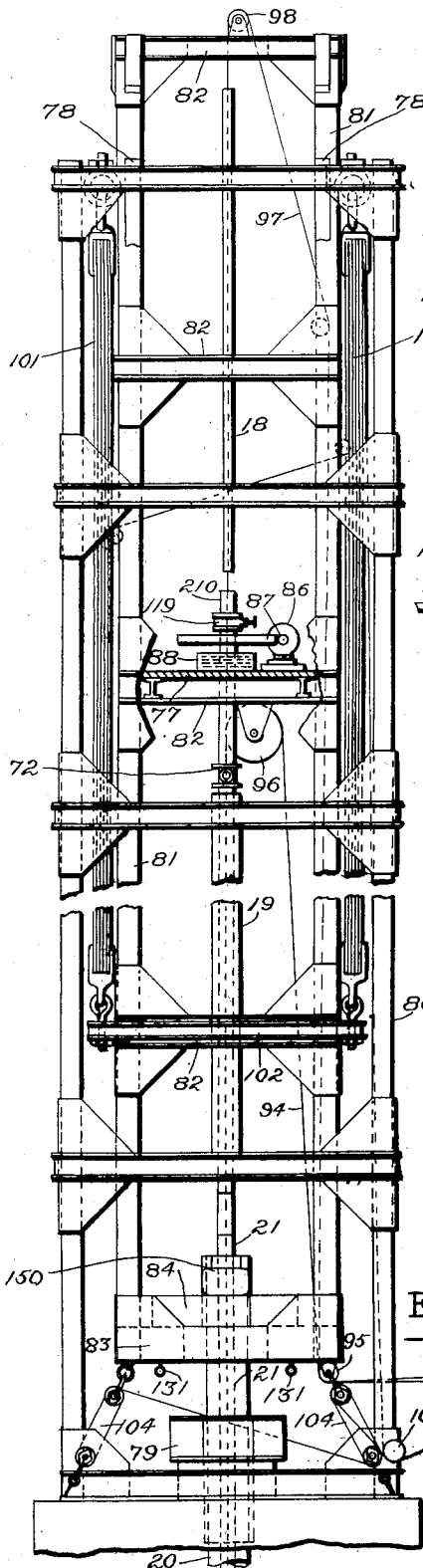
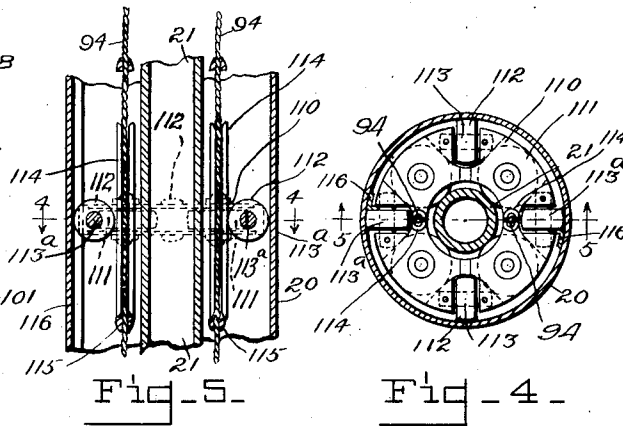
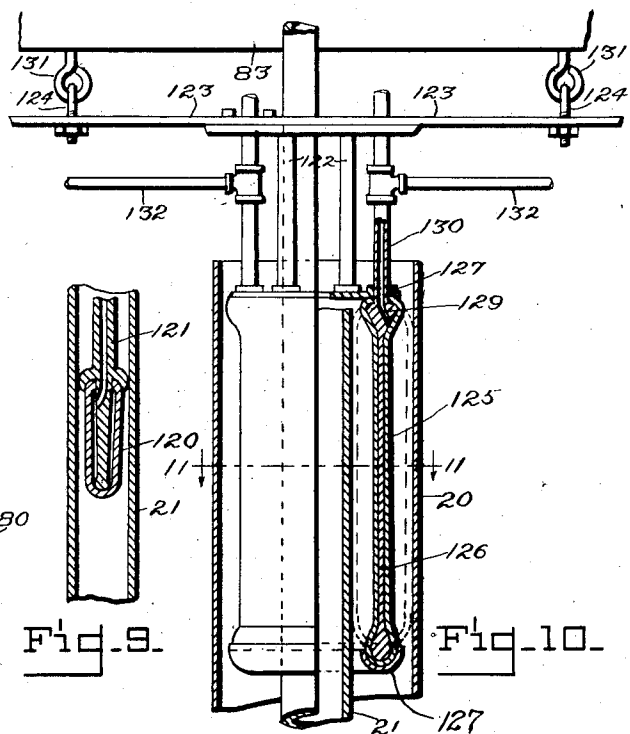
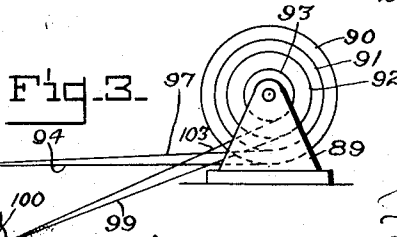
F. S. BOLTZ

1,741,497

EARTH DRILLING APPARATUS

Filed Sept. 9, 1925

2 Sheets-Sheet 2



INVENTOR=
Snd S. Boltz
ATTORNEYS-
C. C. Copeland & Thos.

UNITED STATES PATENT OFFICE

FRED S. BOLTZ, OF MANSFIELD, MASSACHUSETTS

EARTH-DRILLING APPARATUS

Application filed September 9, 1925. Serial No. 55,276.

This invention relates to earth boring apparatus for use in well drilling as well as in mining and engineering operations and has for its general object to provide, in a single apparatus, a combined shaft or well casing, rotary drill, under-reamer, core drill, and bailer in which all of the several parts can be conveniently and independently operated, controlled and handled from the surface, said apparatus including also novel means for controlling and confining such fluid pressures, whether liquid or gaseous, as may be encountered during the drilling operations.

The foregoing and other objects of the invention, together with means whereby the latter may be carried into effect, will best be understood from the following description of one form or embodiment thereof illustrated in the accompanying drawings. It will be understood, however, that the particular construction and arrangement described and shown has been chosen for illustrative purposes merely, and that the invention, as defined by the claims hereunto appended, may be otherwise embodied without departure from the spirit and scope thereof.

In said drawings:

Fig. 1 is a vertical section of the drilling tools and associated parts, that is to say, those portions of the apparatus which enter the ground.

Fig. 2 is a bottom plan view thereof.

Fig. 3 is an elevation, on a reduced scale, of that portion of the apparatus which is located at the surface and is employed to handle, operate and control the instrumentalities shown in Fig. 1.

Figs. 4 and 5 are a horizontal and a vertical section, respectively, of one of the drill pipe guides.

Fig. 6 is a fragmentary elevation of one of the casing joints.

Fig. 7 is a section taken on the line 7—7, Fig. 6.

Fig. 8 is a section, on an enlarged scale, on the line 8—8, Fig. 1.

Fig. 9 is a fragmentary vertical section of the drill pipe packing.

Fig. 10 is a fragmentary view, partly in elevation and partly in vertical section, of

the packing device between the casing and the drill pipe.

Fig. 11 is a section on the line 11—11, Fig. 10.

Fig. 12 is a section on line 12—12, Fig. 6.

Referring to Fig. 1, the operative portion of the apparatus, or that portion which enters the earth to form the well or shaft 22, consists of a plurality of coaxially arranged instrumentalities including a casing 20, a combined rotary drill and under-reamer, designated as a whole by the numeral 19, and with which is associated a combined bailer, water circulating pump, and sand trap or separator, a drill pipe 21, and a core drill, designated as a whole by the numeral 18. The rotary drill 19 extends through and is enclosed by the casing 20, the drill pipe 21 extends into the rotary drill to operate the latter, and the core drill 18 extends through the drill pipe and rotary drill, the arrangement being such that either drill may operate independently of the other, while the core drill may be projected beyond the drill 19 to take test cores in advance of the main shaft.

The casing 20, which lines the well or shaft 22, comprises a sectional pipe or tube of a length corresponding to the depth of said well or shaft and of a sufficient diameter to enclose the other parts of the apparatus and may, except as hereinafter referred to, be of any usual or well-known construction. At its lower end said casing is preferably provided with a collar to which are secured a series of rollers 23 for guiding and centering the rotary drill 19.

The combined rotary drill and under-reamer 19 comprises an annular hollow wall formed by outer and inner spaced co-axial tubular members 24 and 25. The inner member 25 is slightly longer than the outer member 24 and projects beyond the same at the upper end of the drill, being connected with the upper end of said outer member by an annular spacing member 26. At their lower ends the members 24 and 25 are connected by a series of blades or vanes 27 constituting the impeller of a pump and also by a plurality of substantially radially disposed webs 28 carrying pivot pins 29 on which are pivot-

ally mounted radially disposed cutting tools 30. Preferably, and as shown in Fig. 2, two pairs of tools 30 are employed, the tools of one pair 30^a being of a suitable length to extend outwardly from the inner member 25 of the drill to a point beyond the periphery of the casing 20, and the tools 30^b of the other pair extending inwardly to the core drill 18 if the latter be employed, or substantially to the axial center of the device if the core drill be omitted. Preferably there will be provided, for the latter pair, tools of different lengths adapted respectively for use with or without the core drill. The tools 30 are freely pivoted on the pins 29, thereby rendering them collapsible, so that when the drill is inserted through the casing 20 said tools will depend by gravity into the position shown in dotted lines in Fig. 1, thereby permitting them to pass freely through said casing notwithstanding their greater effective diameter. The cutting faces of said tools, however, are of the curved form shown, eccentric to the pivots 29, so that upon engagement thereof with the earth at the bottom of the well or shaft they will be turned outwardly into the position shown in full lines in Fig. 1, this movement being limited by engagement thereof with the lower end of the member 24, so as to act as an under-reamer adapted to form an opening 22 of greater diameter than the casing 20 and capable of receiving the latter freely. The tools 30 may be of any suitable type heretofore used in the art, but preferably each comprises a series of bits detachably secured in a tool holder, as by being received in undercut grooves therein, so that said bits may be readily replaced from time to time as occasion requires, making it possible to keep on hand a quantity of factory made bits, and doing away with field tool dressing.

At its lower end the space between the members 24 and 25 of the drill 19 communicates with the interior of the member 25 through openings 31 formed in the wall of the latter adjacent the impeller vanes 27. At its upper end said space communicates with the space between the casing 20 and the outer drill member 24 through openings 32 in the latter adjacent which are located, between the members 24 and 25, vanes 33, similar in construction and arrangement to vanes 27 previously described, said vanes 33 constituting the impeller of a second pump. It will therefore be seen that, as the drill is rotated, water supplied to the casing will be caused to circulate as indicated by the full line arrows on Fig. 1, said water passing upwardly through the bottom of the member 25, thence flowing outwardly through the openings 31, thence passing upwardly through the space between the members 24 and 25, thence passing outwardly through the opening 32, and finally descending between the casing 20 and

drill 19 to the tools 30. In this manner water is continuously supplied to the tools 30, and, since said water is circulated in a closed circuit, a relatively small amount thereof is required.

Above the pump 27 a helical water passage 34 is formed between the members 24 and 25 by a hollow helix or helical sediment chamber 35 having upper and lower walls 36 and 37 forming respectively the lower and upper walls of the water passage 34. The upper wall 36 of the helix 35 is provided at intervals with openings 38 at the upper side of each of which is located a baffle 39. As the water passes upwardly through the helical passage 34, during its circulation as above described, the cuttings, sand, and other solid particles carried in suspension tend to gravitate to the bottom of the stream, to strike the baffles 39, and to enter the hollow helix 35 through the openings 38. Said helix therefore acts as a sand trap or separator and is gradually filled by the cuttings and other solid matter carried upwardly by the water from the cutting tools 30. When said helix has been filled, the drill is removed from the earth, by means hereinafter described, and the chamber in the helix 35 emptied. To this end the lower wall 36 may be formed at intervals with clean-out openings 40 normally closed by valves or covers 41 having operating stems 42 which are accessible through small openings 43 in the member 24. When the covers 41 are opened, the sediment is discharged into the water passage 34 from which it may readily be washed. If desired, and in order to facilitate this operation, the outer wall of said passage may be formed at intervals with clean-out openings 2 normally closed by covers 44.

The direction of rotation of the drill is as indicated by broken line arrows on Fig. 1, and when so rotated it will be seen that the helix 35 will act as a screw or helical pump to assist the pumps 27 and 33 in maintaining the upward circulation of the water through the drill, and particularly through the passage 34, as indicated by the full line arrows.

Above the helix 35 the space between the members 24 and 25 is provided, adjacent its outer wall, with a series of annular sediment chambers 45 having open tops. Any solid particles which fail to enter the helix 35, and which are carried by the water beyond the same, are caused, by centrifugal action, to enter the sediment chambers 45 and to accumulate therein. The bottoms of the sediment chambers 45 are formed with aligned openings 46 normally closed by valves or covers 47 carried by a stem 48 operable to open said valves through an opening 49 in the member 24. When said covers are opened the sediment in said chambers may be discharged through a passage 50 communicat-

ing with a clean-out opening 51 in the member 24.

The drill 19 is rotated, from mechanism hereinafter described located at the surface, through the sectional drill pipe or hollow drill rod 21, the lower end of which is located within the member 25 and is formed with a hexagonal or other non-circular portion 52 having driving engagement with one or more sets of lugs 53 (see also Fig. 8) formed at spaced intervals on the inner side of said member 25.

The core drill 18, which extends through the drill pipe 21 and projects at its lower end between the cutting tools 30, may be of any usual construction and as shown comprises the bit 54, co-axial outer case 55 and inner core sheath 56, and core lifters 57. The bit 54 is formed with longitudinal water passages 58 communicating with the face of the bit and with the space between the casing 55 and core sheath 56, while the casing 55 is provided at its upper end with a conical gasket 59 making a tight joint with the drill pipe 21, whereby water supplied to said drill pipe at the surface will be fed to the working face of the bit 54.

It will be obvious that when the drill 19 is in place, whether cutting or not, the water circulating devices above described will operate to circulate water to the bit 54 of the core drill as well as to the tools 30.

The core drill is rotated by a splined connection with the drill pipe 21, said connection, as shown in Fig. 8, comprising a feather 60 carried by the outer case 55 and entering a longitudinal groove 61 formed on the inside of the drill pipe.

The projecting upper end of the inner member 25 of the rotary drill 19 is provided with spaced collars 70 adapted to receive between them rollers 71 on an annular lifting head 72 through which said drill may be lifted to the surface, by means hereinafter described, to permit the discharge of the accumulated solid matter in the helix 35 and sediment chambers 45 as required.

The core drill 18 is lifted, by mechanism hereinafter described, through a rope or cable 97 carrying at its end a weight 73 which depends within said drill and which, when lifted, engages a thimble or bushing 74 within the upper end of the latter. Normally the weight 73 hangs slightly below the thimble 74, so as to permit rotation of the drill, but serves as effective means for raising the drill when desired.

Referring to Fig. 3, the operating mechanism, or that portion of the apparatus which is located at the surface, comprises a tower 80 of any suitable construction having vertical guides 78 for an elongated elevator structure comprising uprights 81 and suitably arranged cross members 82. At its lower end the elevator carries a platform 83

which supports a clamp 84 for the uppermost section of the casing 20, whereby successive casing sections may be lowered in superimposed relation into the well or shaft, said casing sections being connected with one another by the usual coupling sleeves 85 (Figs. 6 and 7). Beneath the elevator at the base of the tower is a stationary casing clamp 79. The clamps 79 and 84 may be of any suitable construction usual in the art and are therefore merely diagrammatically indicated in the drawings. Supported by a platform 77 carried by one set of elevator cross members 82 is a motor 86 connected by suitable gearing 87 with the uppermost section 210 of the drill pipe 21, whereby the latter, and through it the drills 18 and 19, may be rotated. Said drill pipe section 210 is supported by a ball or roller thrust bearing 88 on the platform, whereby said section is raised or lowered by the elevator. The mechanism whereby the other operative parts are lifted and lowered comprises a hoist or winch 89 driven from any suitable source of power and having a plurality of separately controlled drums 90, 91, 92 and 93. The drum 90 carries a rope or cable 94 which passes about a sheave 95 on the platform 83 and thence divides into two branches which pass about a sheave or sheaves 96 carried by the platform 82 and thence to the annular lifting head 72, whereby, by operating the drum 90, the drill 19 may be lowered into the well or shaft or withdrawn therefrom for the purpose of discharging the accumulated solid matter, as above described. The rope or cable 97 for raising and lowering the core drill 18 is wound on the drum 91, whence it passes about the sheave 95, thence about a sheave 98 at the top of the elevator, whence it leads to said core drill. The elevator is raised and lowered by means of a rope or cable 99 wound on the drum 92, said rope or cable passing about a sheave 100 at the base of the tower 80 and thence connecting with a series of block and fall tackles 101 supported at their upper ends at the top of the tower and connected at their lower ends to a frame 102 secured to said elevator adjacent the bottom thereof. In addition to the foregoing, a hold-down rope or cable 103 is wound on the drum 93, passes about the sheave 100, and operates a series of interconnected block and fall tackles 104 connecting the corners of the platform 83 with the base of the tower 80 at the corners of the latter.

By this mechanism it will be seen that the casing 20 and drill pipe may be raised and lowered by the elevator, and that the drills 18 and 19 may be independently raised and lowered and withdrawn from one another and from the casing and drill pipe as occasion may require.

It will be understood that, during the drilling operation, either, or both of the drills

18 and 19 may be located at the bottom of the well or shaft and may be rotated from the surface through the drill pipe 21 extending down through the casing 20 which lines the shaft for its entire length. In order to prevent vibration of the relatively long drill pipe, and to center the same in the casing 20, guiding devices such as are shown in Figs. 4 and 5 may be provided at suitable intervals. Each of these guiding devices comprises a collar 110 provided with horizontal and vertical guide rollers 111 and 112 respectively. Each of the collars 110 is split into two semi-circular sections which may be assembled about the drill pipe 21 and drill hoisting ropes or cables 94 and thereafter lowered into the casing 20, being held by the latter in assembled position. The vertical rollers 112 are journaled on pins 113, two of which, designated 113^a, constitute dowels for relatively positioning the sections of the collar 110. Said collar sections are formed respectively with cooperating members 114 of rope clamps adapted to engage the ropes or cables 94 which are provided at intervals with lugs 115 to support said clamps, whereby said guiding devices may be lowered into position as the drill 19 is lowered. Said guiding devices are further axially positioned and held against turning by vertical guide cleats 116 attached to the inner faces of the casing 20 and engaged laterally by two of the vertical rollers 112.

For the purpose of confining and controlling such liquids and gases under pressure as may be encountered as the drilling proceeds, the invention contemplates the provision of novel, pneumatic or hydraulic packing devices for sealing the interior of the drill pipe 21, the space between said drill pipe and casing 20 above the drills, and the space about the casing 20 and between the same and the wall of the well or shaft.

The device for sealing or blocking the drill pipe 21 may comprise a cut-off valve 119 (Fig. 3) at the top of the drill pipe section 210. Preferably however, and in order that the drill pipe may be closed at any point in its length, there is provided a hollow stopper 120 (Fig. 9) with which communicates a tube 121 by means of which said stopper may be lowered into the drill pipe (when the core drill has been lifted therefrom) and through which it may be inflated and expanded by fluid pressure. Said stopper may be composed of any suitable flexible fluid tight material, preferably heavy rubber reinforced by canvas.

Referring to Figs. 10 and 11, the device for sealing the space between the drill pipe 21 and casing 20 comprises two hollow semi-cylindrical gasket sections 125 composed of material similar to that of the stopper 120, and preferably carried by semi-cylindrical frames or webs 126 supported by plates 127.

The plates 127 are supported by rods 122 from carriers 123 having hooks 124 adapted for detachable engagement with eyes 131 on the bottom of the platform 83. When it is desired to use the device, the casing 20 is detached from the clamp 84 and engaged by the clamp 79, the hooks 124 are engaged with the eyes 131, the gasket sections swing into place about the drill pipe 21 and drill ropes 94 (if the drill is then in the ground) and the whole device lowered by the elevator into the casing. The webs 126 are formed with passages 129 communicating with the interior of the gasket sections 125 and with pipes 130 having flexible branches 132 through which fluid pressure may be admitted to said sections to expand the same into the position shown in dotted lines or exhausted therefrom to collapse the same and permit their ready insertion into or removal from operative position.

The packing devices for sealing the space about the casing 20 are preferably provided at suitably spaced points along the casing sections, whereby the pressure encountered may be confined at any one or more of a plurality of points. Said devices, as shown most clearly in Fig. 1, comprise annular hollow gaskets 140 held in position about the casing 20 by means of undercut collars 141 carried by the latter. The gaskets 140 are preferably composed of material similar to the packings 120 and 125 and are preferably provided with sheet lead coverings 142, whereby injury to said gaskets by contact with the rough walls of the well or shaft is prevented. Fluid pressure is supplied to and exhausted from the packings 140 independently through tubes 143 which extend to the surface through a sheath or conduit 144 (Figs. 6 and 7) formed on the exterior of the casing 20. Said conduit is formed in telescoping sections corresponding to the casing sections, and in order that the latter may be properly positioned axially to aline said conduit sections, together with the guide cleats 116, the positioning devices shown in Fig. 6 are preferably employed. Said positioning devices preferably comprise resilient arms 145 extending circumferentially of the casing sections adjacent the end of the latter, said arms having at each end lugs 146 which are received in recesses formed by undercut projections 147 on the casing sections and oppositely disposed lugs 148 which are received in recesses or notches 149 in the coupling sleeve 85. In this manner the adjacent casing sections may be axially alined with the coupling sleeve 85 and consequently with each other.

From the foregoing it will be seen that the core drill 18 and rotary drill 19 may be operated independently, the former to take a core in advance of the operation of the latter, and the latter to advance the main shaft and under-ream the same in order to permit the

sinking of the casing 20, and that either drill may be withdrawn to the surface independently of the other, the core drill in order to remove the core, and the rotary drill to discharge the accumulated sediment and cuttings in the chambers 35 and 45. As the drilling operation proceeds, additional drill pipe and casing sections may be added as required. To this end the core drill 18 is first withdrawn from the upper section 210 of the drill pipe by operation of the drum 91, as shown in Fig. 3. Said upper drill pipe section, which is supported by the bearing 88, is permanently associated with the elevator and extends only to a point adjacent the bottom of the latter, the drill pipe sections which enter the shaft or well being coupled in series to the lower end thereof. The drill 19 may therefore be withdrawn from the casing about said drill pipe section 210 by operation of the drum 91. Thereafter the upper end of the uppermost casing section is released from the clamp 84 and secured in place by the stationary clamp 79, the end of the drill pipe section adjacent the upper section 210 being temporarily secured to said casing section by a clamp 150. Said last named drill pipe section may then be uncoupled from the section 210 and the elevator raised by operation of the drums 92 and 93 to separate said sections as shown in Fig. 3. At the same time, a new casing section, with a drill pipe section therein and secured thereto by a clamp 150, may be secured by suitable tackle to the eyes 131 on the platform 83 and lifted or swung into place by the ascent of the elevator. The new casing and drill pipe sections are then coupled in place, the former being engaged by the clamp 84, the clamp 79 released, the clamps 150 removed, and the drills 18 and 19 lowered into operative position by operation of the drums 90 and 91, whereupon the apparatus is in condition to proceed with the drilling.

Having thus described my invention, I claim:

1. In an earth drilling apparatus, a rotary drill comprising spaced coaxial inner and outer tubular members and cutting tools carried thereby at the lower end thereof, said inner member enclosing a space opening at the bottom of said drill adjacent said tools, said inner member having openings therethrough adjacent its lower end, and said outer member having openings therethrough adjacent its upper end, and vanes connecting said members and constituting the rotor of a pump.

2. In an earth drilling apparatus, a rotary drill comprising spaced co-axial inner and outer tubular members and cutting tools carried thereby at the lower end thereof, said inner member enclosing a space opening at the bottom of said drill adjacent said tools, said inner member having openings therethrough adjacent its lower end, and said outer member having openings therethrough adja-

cent its upper end, and vanes connecting said members adjacent their upper and lower ends and constituting the rotors of pumps for circulating water between said members and to and from said tools as said drill is rotated.

3. In an earth drilling apparatus, a rotary drill, comprising spaced coaxial inner and outer tubular members and cutting tools carried thereby at the lower end thereof, means associated with said drill for circulating water between said members and to and from said tools, and sediment chambers located between said members for separating solids from said water as it is circulated therebetween.

4. In an earth drilling apparatus, a rotary drill comprising spaced co-axial inner and outer tubular members and cutting tools carried thereby at the lower end thereof, said inner member enclosing a space opening at the bottom of said drill adjacent said tools, said inner member having openings therethrough adjacent its lower end, and said outer member having openings therethrough adjacent its upper end, vanes connecting said members and constituting the rotor of a pump for circulating water through the space between said members and to and from said tools, and sediment chambers located in said space for separating solids from said water as it is circulated.

5. In an earth drilling apparatus, a rotary drill comprising spaced co-axial inner and outer tubular members and cutting tools carried thereby at the lower end thereof, means associated with said drill for circulating water between said members and to and from said tools, a plurality of sediment chambers located between said members for separating solids from said water as it is circulated therebetween, each of said sediment chambers having clean-out openings, and covers for said openings accessible from the exterior of said outer member.

6. In an earth drilling apparatus, a rotary drill having a hollow annular wall and a helical sediment chamber formed in said wall and forming between its convolutions a helical water passage.

7. In an earth drilling apparatus, a rotary drill comprising spaced coaxial inner and outer tubular members and cutting tools carried thereby at the lower end thereof, a helical sediment chamber formed between said members and forming between its convolutions a helical water passage, and means associated with said drill for circulating water through said passage and to and from said tools.

8. In an earth drilling apparatus, a rotary drill comprising spaced co-axial inner and outer tubular members and cutting tools carried thereby at the lower end thereof, a helical sediment chamber formed between said members in the lower part of said drill and form-

ing between its convolutions a helical water passage, sediment chambers located in the upper portion of the space between said members adjacent the outer member, and means associated with said drill for circulating water through said helical passage, past said last named sediment chambers, and to and from said tools.

9. In an earth drilling apparatus, in combination, a shaft casing, a shaft sinking drill operating in said casing, a core drill operating in said first named drill, a drill rod extending through said casing for operating said drills, an elevator for raising and lowering said casing and drill rod, and devices associated with said elevator for raising and lowering said drills independently of said casing and drill rod and independently of each other.

10. In an earth drilling apparatus, in combination, a shaft casing, a drill operating therein, ropes for raising and lowering said drill in said casing, a drill rod extending through said casing for operating said drill, an inflatable annular gasket surrounding said drill rod within said casing for sealing the latter, said gasket being composed of a plurality of sections assembled about said rod and ropes, and means for supplying fluid pressure to said gasket to inflate the same.

11. In an earth drilling apparatus, in combination, a shaft casing, a drill operating therein, ropes for raising and lowering said drill in said casing, a drill rod extending through said casing for operating said drill, an inflatable annular gasket surrounding said drill rod within said casing for sealing the latter, said gasket being composed of a plurality of sections assembled about said rod and ropes, an elevator, means whereby said gasket sections may be connected to said elevator and moved into place thereby, and means for supplying fluid pressure to said gasket to inflate the same.

12. In an earth drilling apparatus, a shaft casing comprising a plurality of sections and means for coupling the same, at least one of said sections having an exterior inflatable annular packing, a tube for supplying fluid pressure to said packing to inflate the same, said tube extending longitudinally of said casing, an exterior longitudinal sheath enclosing said tube, said sheath comprising a plurality of sections carried respectively by the several casing sections, and means for angularly positioning the several casing sections to aline the several sheath sections.

13. In an earth drilling apparatus, in combination, a shaft casing, a drill operating therein, ropes for raising and lowering said drill in said casing, a drill rod extending through said casing for operating said drill, and means for centering and guiding said rod in said casing comprising a collar having means to engage said ropes and composed of

a plurality of sections assembled about said rod and ropes and entering said casing.

14. In an earth drilling apparatus, in combination, a shaft casing, a drill operating therein, ropes for raising and lowering said drill in said casing, a drill rod extending through said casing for operating said drill, and means for centering and guiding said rod in said casing comprising a collar composed of a plurality of sections assembled about said rod and entering said casing and cooperating clamping members on the several sections for engaging said ropes.

15. In an earth drilling apparatus, in combination, a shaft casing, a drill operating therein, ropes for raising and lowering said drill in said casing, a drill rod extending through said casing for operating said drill, and means for centering and guiding said rod in said casing comprising a collar composed of a plurality of sections assembled about said rod and ropes and entering said casing, said ropes having lugs to support said collar.

16. In an earth drilling apparatus, in combination, a shaft casing, a drill operating therein, a drill rod extending through said casing for operating said drill, means for centering and guiding said rod in said casing comprising a collar composed of a plurality of sections assembled about said rod and entering said casing, and longitudinal guide cleats on the interior of said casing for guiding said collar.

17. In an earth drilling apparatus, in combination, a shaft casing comprising a plurality of sections and means for coupling the same, a drill operating in said casing, a drill rod extending through said casing for operating said drill, means for centering and guiding said rod in said casing comprising a collar composed of a plurality of sections assembled about said rod and entering said casing, longitudinal guide cleats on the interior of said casing sections for guiding said collar, and means for angularly positioning the several sections to aline the guide cleats thereon.

18. In an earth drilling apparatus, a shaft casing comprising a plurality of sections, coupling sleeves for connecting said sections, and resilient arms carried by said casing sections adjacent their ends, said arms being formed with oppositely extending lugs, and said casing sections and coupling sleeves being formed with recesses to receive said lugs.

19. In an earth drilling apparatus, a rotary drill comprising spaced coaxial inner and outer tubular members and cutting tools carried thereby at the lower end thereof, means associated with said drill for circulating water between said members and to and from said tools, and annular sediment chambers adjacent said outer tubular member adapted for collecting solids separated by the action

of centrifugal force from said water as it is circulated between said members.

20. In an earth drilling apparatus, a rotary drill comprising spaced coaxial inner and
5 outer tubular members and cutting tools carried thereby at the lower end thereof, said inner member enclosing a space opening at the bottom of said drill adjacent said tool,
10 vanes connecting said members and constituting a rotor of a pump for circulating water through the space between said members and to and from said tools, and sediment chambers located in said space for separating
15 solids from said water as it is circulated.

In testimony whereof I affix my signature.
FRED S. BOLTZ.