April 2, 1929. R. H. RAMSEY 1,707,568

WELL DRILLING RIG

Original Filed Sept. 8, 1920 3 Sheets-Sheet 1

Fig. 6.

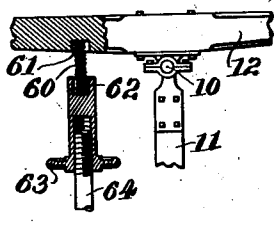


Fig. 7.

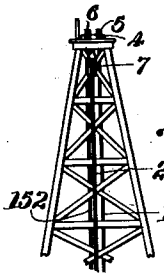
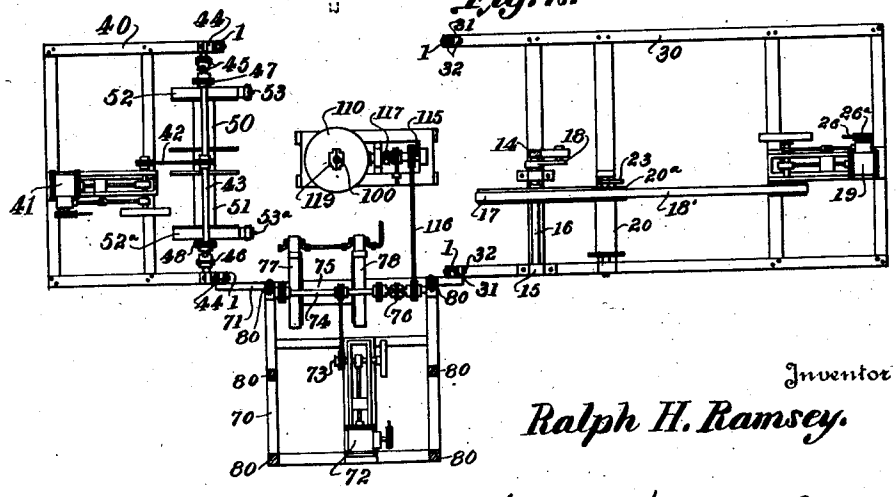


Fig. 1.

Fig. 2.



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WELL DRILLING RIG

Original Filed Sept. 8, 1920 3 Sheets-Sheet 2

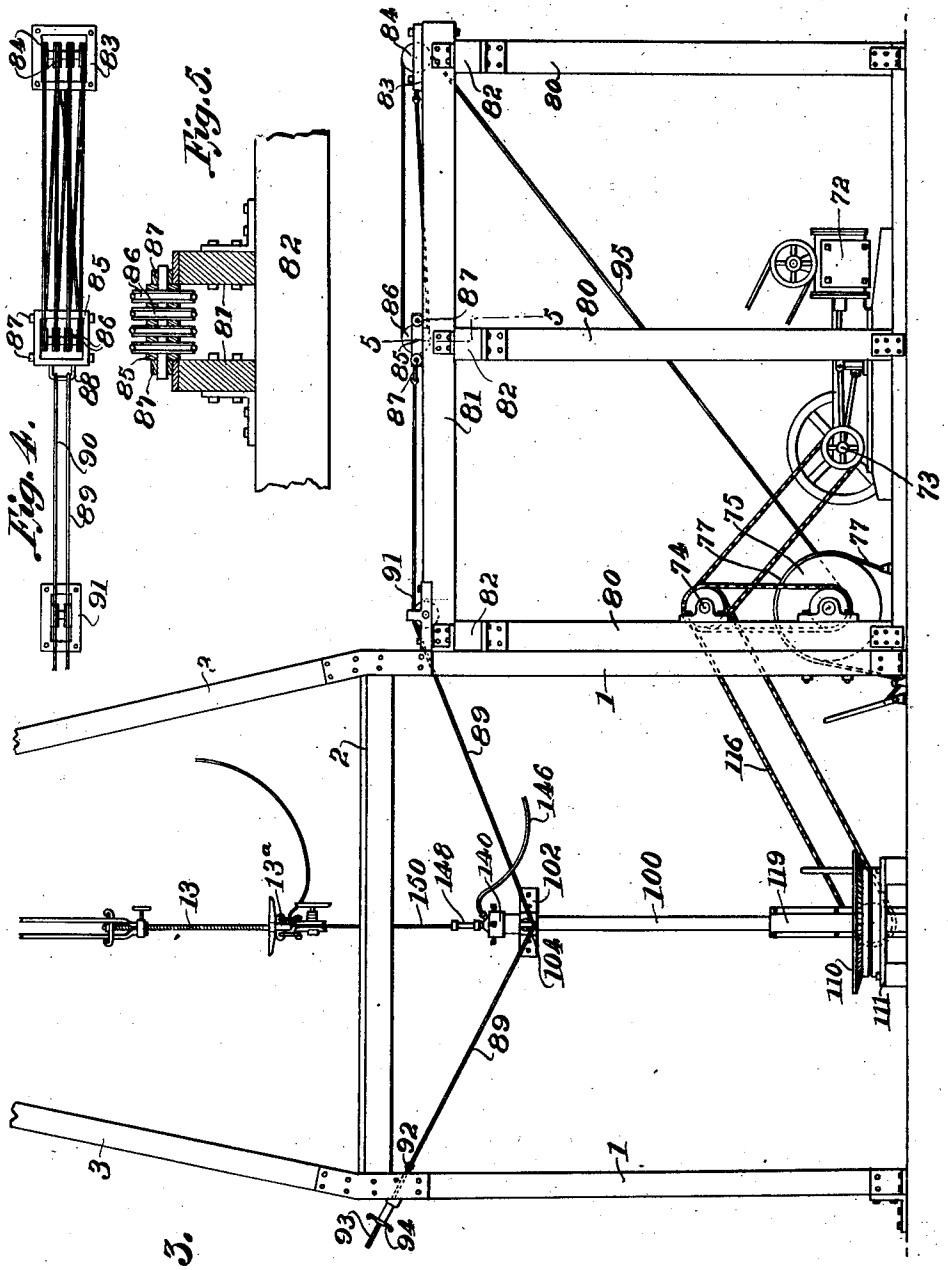

Fig. 3.

Fig. 4.

Fig. 5.

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WELL DRILLING RIG

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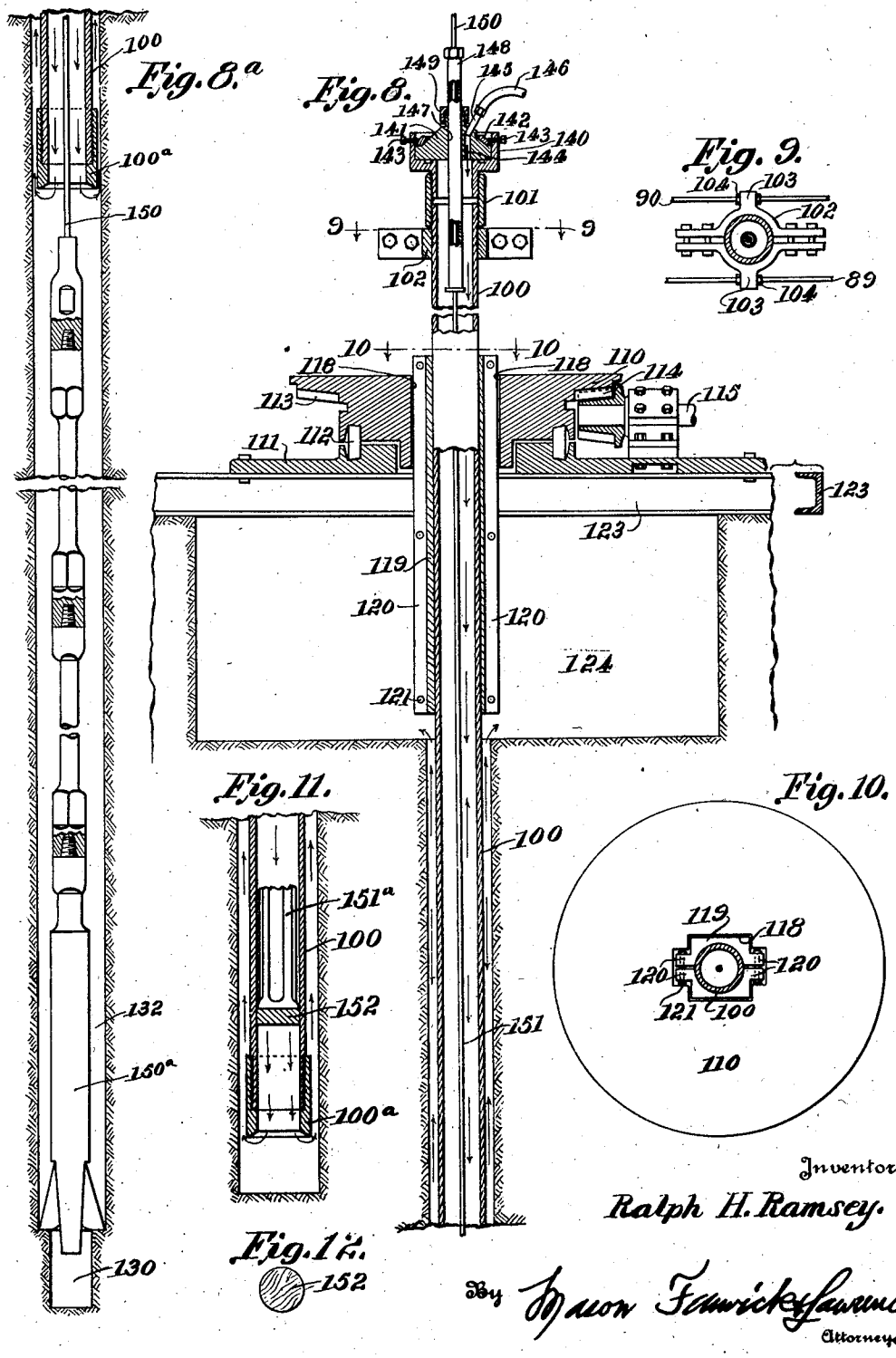

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UNITED STATES PATENT OFFICE.

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WELL-DRILLING RIG.

Original application filed September 8, 1920, Serial No. 408,961. Divided and this application filed October 10, 1923. Serial No. 667,746.

This invention relates to the art of drilling wells, and particularly to the drilling of oil wells, and is a division of my application filed September 8, 1920, Ser. No. 408,961.

It is an object of the invention to enable wells to be drilled and cased, simultaneously, by the use of one size of drilling tool and one size of casing pipe.

Other objects are to facilitate the handling of the well casing during the drilling and casing operations; to improve the organization and arrangement of parts that constitute a well rig; and to improve various details of well drilling apparatus, as will more particularly appear in the ensuing description and claims.

Two methods of drilling wells are at the present time in general use. The first of these methods is commonly known as the "standard" method, wherein a drill bit suspended by a cable is repeatedly lifted and allowed to fall to the bottom of the well hole gradually increasing the depth of the hole by its percussion or impact, the comminuted earth cut by the drill being removed by bailing. The second method, commonly known as the "rotary" employs an earth auger secured to the end of a string, or series of sections of pipe, which are rotated while being fed longitudinally into the hole, the comminuted earth being washed out by water forced into the well hole.

By the standard method of drilling the hole is started with a mammoth sized bit, said hole being usually approximately twenty inches in diameter. The twenty inch hole is drilled to say fifty or one hundred feet and is then cased by an equal length of large and heavy well casing. The drilling tool, stem and shank and also the bailers used for cleaning out this large hole, are of great size and weight and require arduous labor to get them in place and great power to operate them. After the well hole has been drilled with the mammoth sized drill and cased with the large casing, the string of mammoth tools have to be removed and replaced by another string having a drill bit of, say, twelve and one half inch diameter, which is used to drill an opening of similar size, to a depth of, say, three hundred feet more or less, below the surface. After the twelve and one half inch hole has been drilled to the depth intended, heavy casing of a size to fit it is inserted as a lining, this casing extending to the surface of the ground within the larger casing. After that, a hole ten inches in diameter, or thereabout, is drilled to a depth of, say, eight hundred feet, and that hole is cased from the bottom to the top of the ground within the twelve and one half inch casing. Following the ten inch casing another set of tools, say, eight and one quarter inches, is used and a depth of twelve hundred feet is drilled and cased, and in the same manner another depth of say sixteen hundred feet of a diameter of six and five eigth inches is drilled and cased; and then a further depth is drilled by a smaller bit, and a smaller casing inserted, until the necessary depth of hole to reach the oil sand has been drilled and cased, generally from two thousand to four thousand feet. The lowest portion of the hole is of the smallest diameter, and the casing of the smallest diameter reaches from the bottom of the well to the top of the ground within the several large casings. After the well has been completely cased it is then necessary to withdraw the strings of casing, of larger section, leaving only the string of casing of smallest section in the hole. It will thus be seen that a great deal of labor and expense is required in the usual practice of the standard method of drilling by reason of the heavy tools and extensive equipment required, the labor of changing tools, setting different sizes of casing pipe, the labor of removing casing that is not used after the well is drilled, and the expenditure of time.

The rotary method is generally employed where the earth is free from rock. If rock is met with, the drilling tool, which is on the end of a long string of pipe which is built up by sections as the depth of the hole increases, has to be removed from the hole and sharpened and a new tool affixed, the drill pipe sections being unscrewed as the drill is drawn upward. Furthermore, this method is hazardous because the rotary tool may bore completely through a producing oil sand without the knowledge of the driller and the well be thereby ruined.

It is proposed in the practice of my invention, to drill the well hole by reciprocating cable sustained tools operating on the impact principle, and to follow these tools as they sink into the earth with a single

string of one size well casing, thereby preventing caving of the well. One size of drill, by this method, may be used throughout and one size of well casing, which may be set in the hole, closely following the drill, by working the casing down with the assistance of a suspending apparatus swiveled to the topmost casing section and an ordinary rotary of the kind used for rotating the drilling tool in practicing the rotary drilling method.

In practicing my invention it is deemed desirable in order that the casing may sink without difficulty into the well hole that a drilling tool of a size adapted to work freely up and down within the casing be first used, and that said tool be then withdrawn and another tool, which is ready attached to an independent cable and controlled by an independent bull wheel, be lowered through the casing and used to undercut the hole below the lower end, or shoe, of the casing so that the casing may follow down through the earth after the undercutting tool without meeting any obstruction. The undercutting tool may then be drawn up by its own particular cable and bull wheel and the drilling tool lowered through the casing by means of the cable to which it is suspended, controlled by the bull wheel to which said cable is connected.

The invention more particularly consists in the construction set forth in the following description, illustrated in the accompanying drawings and defined in the appended claims.

In the accompanying drawings, in which similar reference characters designate corresponding parts throughout the several views:

Figure 1 is an elevation of a rig designed to carry out my invention with, however, the rotary draw works removed for purposes of clearness;

Figure 2 is a section through the lower part of the derrick showing three independent power units assembled in position to operate the various tools and instrumentalities needful in the drilling operation;

Figure 3 is an enlarged side elevation of the draw works and rotary, and the lower portion of the derrick as viewed from the left of Figure 1, but with the bull wheel and power unit therefor removed;

Figure 4 is a detail plan view of a portion of the hoisting mechanism operated by the draw works for handling the casing;

Figure 5 is a cross section on the line 5—5 of Figure 3;

Figure 6 is a detail showing a yieldable counter-pressure device for steadying the operation of the walking beam;

Figure 7 is an elevation of the top of the derrick showing two sheaves or pulley wheels over which pass, respectively, the cables of the drilling tool and the under reamer; and a third sheave or pulley wheel for sustaining the cable of the sand bailer;

Figures 8 and 8ª taken together are a cross section of a well hole, showing the casing, an undercutting tool working in the well hole below the casing, a rotary for assisting in setting the casing, and a means for forcing out of the well hole the earth, sand, mud and slush formed by the drilling tools;

Figure 9 is a cross section on the line 9—9 of Figure 8;

Figure 10 is a cross section on the line 10—10 of Figure 8;

Figure 11 is a vertical section of the lower portion of a well hole and casing illustrating a plug being driven through the casing to clear it of mud and sand;

Figure 12 is a plan view of a wooden plug designed to be forced through a casing.

In the accompanying drawings, numeral 1 indicates four upright columns preferably arranged at the corners of a rectangle on any suitable foundation and extending upward to a horizontal framing and platform 2. Tapering upward from the upper ends of the columns 1 and from platform 2, is the framing of the derrick 3, which, from the platform upward, may be constructed like the usual oil well derrick. At the top of this derrick there is mounted a transverse shaft 4 carrying two grooved sheaves or crown pulleys 5 and 6. Just below the top of the derrick on the right hand side as shown in Figure 1, is a third sheave or sand pulley 7. The pulleys 5 and 6 support the cables to the ends of which the drilling and undercutting tools, respectively, are attached, and the pulley 7 supports the cable to the end of which a bailer is attached, as will be more fully set forth hereinafter.

Fulcrumed at 10 on a suitable support or Samson post 11 rising from the platform 2 is the walking beam 12, to one end of which is attached the temper screw 13 and cable clamp 13ª and to the other end of which is attached a long pitman 14 by means of which said walking beam is vibrated.

On the foundation at one side of the foot of the derrick and journaled in bearings 15 is an axle 16 to which is secured a band wheel 17. The said axle 16 is provided with a crank 18, to which the lower end of said pitman 14 is connected. Said band wheel 17 is rotated by means of a belt 18 driven by an engine 19 in a manner that is usual.

The sand reel is indicated at 20 and has a friction pulley 20ª, connected so as to rotate with it, which is so mounted that it may be moved into contact with the perimeter of the band wheel 17 whereby to operate said sand reel from said wheel 17. The position of the sand reel may be controlled

by the driller from the platform 2, by means of the lever 21, reach or link 22 and sand reel lever 23, the arrangement of said parts being such that the driller may turn the lever 21 down upon the platform and place his foot upon it to hold it so as to maintain the friction pulley 20ª in contact with band wheel 17 in order to keep said sand reel rotating. A sand line 24 is wound upon the sand reel and extends upward over the sheave 7 and then down toward the platform 2 and carries on its end a bailer 25 which normally rests upon the platform ready to the hand of the driller when desired.

The throttle of the engine 19 may be controlled by the driller from the platform 2 by means of the endless band 26 passing around a valve-operating wheel 26ª at the engine, and a sheave or idle wheel 27 mounted above the platform 2. The link mechanism of the engine 19, by which its speed may be varied or by which it may be reversed, is controlled by a push rod 28 reaching up to a point above the platform 2, convenient to the reach of the driller.

In operating the walking beam a considerable weight is lifted as that end of the beam to which the cable is attached rises; but on the reverse motion the weight of the drilling tools tends to pull that end of the beam downward and the result is that a jerky motion is likely to be imparted to the band wheel and crank. In order to assist in equalizing the resistance to be overcome by the band wheel I prefer to place an adjustable spring beneath that arm of the walking beam 12 which is on the drill-sustaining side of the fulcrum. As the weighted end of the walking beam falls its fall is resisted by the tension of the compression spring 60 in which energy is thereby stored to be utilized in aiding to lift the tool as the pitman 14 pulls down the opposite end of the said beam. The spring 60 may be fitted to a socket 61, shown as formed in the walking beam in the embodiment illustrated, and the other end may be fitted in a socket 62 in the end of a nut 63, which is adjustable on a threaded standard 64 rising from the platform 2.

The engine 19, band wheel and sand reel are mounted upon a rectangular frame 30, which is shown as resting on the foundation and bolted firmly to columns 1 by means of uprights 31 and bolts 32. The frame 30, engine, band wheel and sand reel mounted thereon constitute one power unit used for operating the drilling, undercutting tools and bailer; and this power unit may be detached and removed as a unit or brought up separately and assembled with other units appertaining to the rig.

At the side of the derrick opposite the frame 30 and the power unit that controls the drilling tools and bailer is a second power unit mounted on a frame 40, which rests on suitable sills or other foundation (not illustrated) and is bolted to the other pair of standards or columns 1 in the same manner as has been described with reference to the frame 30. Upon the frame 40 is an engine 41, the crank shaft of which is banded, preferably by a sprocket chain 42, to a countershaft 43 journaled on the upright members 44 carried on the frame 40 and bolted to the columns 1. At each end of said counter shaft 43 is splined a clutch 45 and 46 respectively. Loosely journaled on said counter shaft 43 adjacent the clutches 45 and 46 are sprocket wheels 47 and 48 having notched hubs. By sliding the clutch 45 into engagement with a notched hub of the sprocket wheel 47 the latter will be driven with a counter shaft, and by moving the clutch 46 into engagement with the notched hub in the sprocket wheel 48 the said sprocket wheel will be driven with the counter shaft. The sprocket wheel 47 is belted by means of a sprocket chain to a sprocket wheel mounted on the bull wheel 50, on which the cable 150 that sustains the under reamer 150ª is wound, and the sprocket wheel 48 is connected likewise by a sprocket chain with a sprocket wheel mounted on the bull wheel 51, on which cable 151 that sustains the drill bit 151ª is wound. These bull wheels are independently rotatable and either one of them may be rotated at will by means of the mechanism described. Each bull wheel is provided with a separate band brake 52 and 52ª, respectively, said brake being controlled by rods or cables 53 and 53ª extending therefrom up to levers such as 54 on the driller's platform 2. The clutches 45 and 46 are also susceptible of being operated from the driller's platform 2 by means of levers, such as 54ª, pivoted thereon and jointed to clutch shifting levers, such as 55, pivoted on the upright 44.

The throttle of the engine 41 is controllable from the platform 2 by means of the band 56 passing around the wheel 57 on the stem of the throttle valve and around a sheave 58 mounted above the driller's platform, and the link mechanism of said engine 41 may be operated by the push rod 59 which extends to within reach of the driller on the platform 2, all in a manner similar to that which has been described with respect to the power unit which operates the drilling tools and bailer.

By the mechanism thus far described, comprising the two power units mounted on the bases 30 and 40, and the controlling mechanism therefor accessible from the driller's platform 2, the driller may control all parts of the rig essential for drilling and bailing out the well hole.

In order to handle the casing pipe, I have provided a rotary and third power unit including a draw works. The third power unit is mounted on a rectangular frame 70, which has a cross bar 71 adapted to reach between two of the columns 1 supporting the derrick and to be bolted thereto, as indicated in Figures 2 and 3. Upon the said frame 70 is mounted an engine 72 which may be controlled by a throttle valve and link motion, as in the case of the engines 19 and 41 forming parts of the other two power units described. The crank shaft 73 of said engine 72 is belted to a counter shaft 74 placed above a preferably two speed drum 75 and connected to said drum by change speed gearing and suitable clutch mechanism 76 whereby said drum may be rotated at different speeds as desired, in a known manner. Suitable brakes 77 and 78 are provided for controlling said drum when the same is disconnected from the driving mechanism of the draw works.

Instead of having the cable for sustaining and lowering the casing running over a sheave or pulley at the top of the derrick, as is customary, I have provided a new and improved means of handling the casing. Rising from the frame 70 are standards 80. Timbers or beams 81 spaced apart to form a trackway rest on top of sills 82 supported on the standards 80. At the outer end of the trackway formed by these beams 81 there is secured a fixed block 83 preferably having four sheaves 84. A movable block 85 likewise provided with four sheaves 86 is arranged to move along the track formed by the beams 81, said block 85 having rollers 87 extending laterally which travel on the upper surfaces of said beams, or on a track thereon. A hoisting cable 95 is rove through said block and wound upon the drum 75. To a strap 88 on the movable block are attached the ends of two steel cables 89 and 90, said cables passing over guide sheaves 91 mounted on the end of the tracks 81 opposite the fixed block 82 and adjacent the derrick. The opposite end of each cable is spliced or otherwise secured to the eye 92 of an eye bolt 93 each of which is adjustably mounted in a suitable cross beam secured to the derrick columns 1. By means of a nut 94 thrusting against a beveled washer each of said eye bolts 93 may be independently moved so as to adjust the tension of the cable 89 or 90, as may be necessary. The bights of the cables 89 and 90 sustain the casing.

In inserting casing into a well hole, the upper end of a section of casing pipe 100 being inserted has a pipe coupling screwed thereto, as indicated at 101. Loosely surrounding the casing 100 is a two part sustaining member 102, each part having a laterally projecting ear 103 carrying a grooved roller or sheave 104. The cables 89 and 90 may be passed under the said sheaves 104 and sustain the weight of the well casing; and by manipulating the brakes which control the drum 75 the said casing may be lowered, if desired, or by clutching said drum to the counter shaft the casing may be lifted.

By the construction described the upper works of the derrick are relieved of the weight of the heavy block and tackle and lengths of cable usual in mechanism for this purpose and the length of cable necessary to be used is shortened.

At 110 a rotary table is shown supported by a bearing base 111 through interposed roller bearings 112. The under side of said rotary 110 is provided with a gear 113 which meshes with a pinion 114 on shaft 115 which is connected by a sprocket chain 116 with the counter shaft 74 of the draw works. Suitable reversing clutch mechanism 117 interposed between the chain 116 and the pinion 114 enables the rotary table to be controlled by an operator stationed near said table. In the center of the rotary table 110 there is a generally cruciform opening 118 through which a clamp 119 of corresponding shape, secured to a section of well casing 100, is adapted to pass. The clamp 119 is made of two parts having flanges 120 through which bolts 121 are adapted to be passed in order to secure the two parts together and cause them to seize a section of well casing. With a section of well casing inserted in the well hole and sustained by the cables 89 and 90, the clamp 119 being clamped upon said casing and engaged in the opening 118 of the rotary table 110, the casing may be rotated by the table and may work its way into the well hole as the cables 89 and 90 are slackened. Thus, by keeping the casing constantly rotating and controlling its descent, the likelihood of the casing freezing or sticking in the well hole is eliminated should soft earth crowd against it.

The base 111 on which the table 110 rotates is preferably mounted on beams 123 which cross a pit 124 sunk in the earth. This pit is of sufficient depth to admit a man to enter it in order to remove or loosen the bolts 121 of the clamp 119 and push the latter upward to be rebolted higher up on the section of casing so that the casing may be sunk a further distance into the well hole. It will be observed from inspection of Figure 8 that the upper bolts may be released from above the table, in the position shown, and that a man in the pit 124 may loosen the remaining bolts and push the clamp 119 upward, when the two upper sets of bolts may be secured from above and the man in the pit may secure the lower set of bolts.

As before stated, the well may be drilled to full depth with a single size of drill mak-

ing a hole as illustrated at 130 in Figure 8ª, operating alternately in successive periods of time with an undercutting tool 150ª, which latter may from time to time be passed through the casing and be operated below its lower end so as to enlarge the hole 130 to make a reamed hole or counter bore in the earth, as shown at 132, into which the casing 100 may be easily set.

Although the removal of the sand, mud and the like from the well may be accomplished by a bailer or sand pump such as has been heretofore referred to, I contemplate using steam or air pressure within the casing as it is being moved downward in the well hole and while the drilling operation is proceeding whereby sand and slush may be kept out of the casing and caused to flow up in the well hole around the exterior thereof between the outer wall of the casing and the earthy walls of the well hole.

In order to keep the well clear and to drive out sand and slush by the pressure of an aeriform fluid I provide a swivel device to be connected to the top of the casing, said swivel device comprising a cup-like body 140 having a hollow threaded lower end adapted to be screwed into an ordinary pipe coupling 101 and having a swivel head 141 in the upper cup-like portion thereof. Said swivel head 141 is fitted fluid tight in the body 140 and is held in place by a ring 142 which may be secured by set bolts 143. Tapped into an opening 144 in said swivel head 141 is a connection 145 to which a flexible pipe 146 is coupled, the said flexible pipe being connected to a source of pressure such as steam or air, preferably steam. The said swivel head 41 is provided with a central opening 147 through which passes a tubular body 148, the opening being packed by a stuffing box 149 on said swivel head 141. The said tubular body 148 surrounds and is charged to a cable 150, which is a cable suspending a string of undercutting tools as shown, or may be a cable suspending a drill bit. As the cable 150 is raised and lowered, it raises and lowers with it the tublar body 148 which slides piston-tight through the stuffing box 149 and central orifice 147 in the swivel head 141.

By this construction it will be seen that the casing 100 is free to be rotated by the rotary 110 without twisting the drilling cable which passes through the swivel head 141 or disturbing the position of the flexible pipe 146 which permits steam or air to be forced into the interior of the casing, driving the slush, mud, and the like, down through the casing, out of the lower end thereof, and causing it to flow up the sides of the well hole outside of said casing, as indicated by the arrows in Figures 8 and 8ª.

Should the casing be badly choked with heavy material difficult to remove or clear out completely by steam or air pressure, a plug 152 may be inserted in the casing and driven downward through it by impact of the drilling tool 151ª, as indicated diagrammatically in Figure 11. The plug 152, which should be of wood or other suitable frangible material, may be pushed down through the casing and out below the shoe at the lower end. Said plug falling into the hole will be subsequently cut to pieces by the operation of the drill, and its remnants will flow with the other débris made by the operation of the drill up through the well hole or be removed by the bailer, according to the method used for cleaning out the well.

In operation one driller will occupy the platform 2 and two or more men will remain upon the ground or foundation beneath the platform 2. The driller, from his elevated position, will control all the drilling and bailing operations.

There being two bull wheels and two strings of tools ready attached to cables and always at hand, no time is lost in changing from a drilling tool to an under reamer. These tools are very heavy and it is customary in practice to pull out a drill, uncouple it from the cable and couple on a reamer, or the reverse. Coupling and uncoupling the heavy tools is a difficult operation and consumes a lot of time. In the rig described two tools are always at hand, either may be lowered into the well casing as desired, and when its work is finished may be removed and the other tool inserted.

By inserting the well casing while the well is being drilled and following the drilling tools with it the danger of the wells caving in is eliminated. As the casing follows the drilling tool as closely as practicable, there is no opportunity for the earth walls of the well to fall inward and by this method of operation loss of wells from caving cannot occur.

In the rig described, after a well is drilled, the three power units forming part of my apparatus may be unbolted from the derrick and foundation and may be taken off as units and shipped or moved to another well with speed and convenience.

The saving of pipe and the labor of handling it by my method and apparatus is a very important item in the cost of material and cost of labor.

In the derrick construction and framing shown, a section of well casing may be hoisted and swung into an upright position by any hoisting mechanism suitable for the purpose of hoisting the casing, there being room enough between the rotary and the platform 2 to enable this to be done. In practice it is preferred to handle the casing pipe by the mechanism for that purpose hereinbefore described. The advantage afforded

by this roominess over the construction of the derricks heretofore in use, which necessitate bringing the casing sections obliquely into position under and between the cross ties or lattice work of the derrick, is apparent. The casing may be suspended in upright position and the rotary utilized for screwing a new section into the coupling at the top of the upper section in the well hole in the way a rotary is commonly used in screwing or unscrewing sections of rotary drilling pipe.

The upper structure of the derrick used with the rig of this invention may be made considerably lighter than the usual derrick, since it does not sustain the heavy blocks and cable used for raising and lowering well casing and the heavy weight of the casing.

It will be understood that water usually flows into the well hole from water-bearing strata penetrated by the earth drilling or boring tools. The tools therefore reciprocate in mud and slush in the well hole. If this mud and slush extends to the top of the well it interferes materially with the operation of tools of the standard or impact type. By maintaining an aeriform fluid under pressure in the casing, mud is kept from filling the casing and interfering with the efficient downward impact of the tools, while the pressure of said aeriform fluid forces the excess of mud and slush out of the well as described and into the pit, from which it can be pumped if necessary.

Having described my invention in such manner as to enable those skilled in the art to make and use the same, what I claim and desire to secure by Letters Patent, is:

1. A method of drilling wells and removing the comminuted earth from the well hole, which consists in starting a well hole, inserting casing therein, lowering an earth boring tool through the casing, operating the tool in the well hole in the presence of water while forcing aeriform fluid under pressure into said casing whereby to cause the mud and slush to flow upward between the casing and the wall of the well hole.

2. A method of drilling wells and removing the comminuted earth from the well hole, which consists in starting a well hole, inserting casing therein, lowering an earth boring tool through the casing, operating the tool in the well hole in presence of water, while simultaneously forcing aeriform fluid under pressure into said casing and rotating the casing whereby to cause mud and slush to flow upward between the casing and the wall of the well hole and prevent freezing of the casing.

In testimony whereof I affix my signature.

RALPH HAMILTON RAMSEY.