(No Model.)

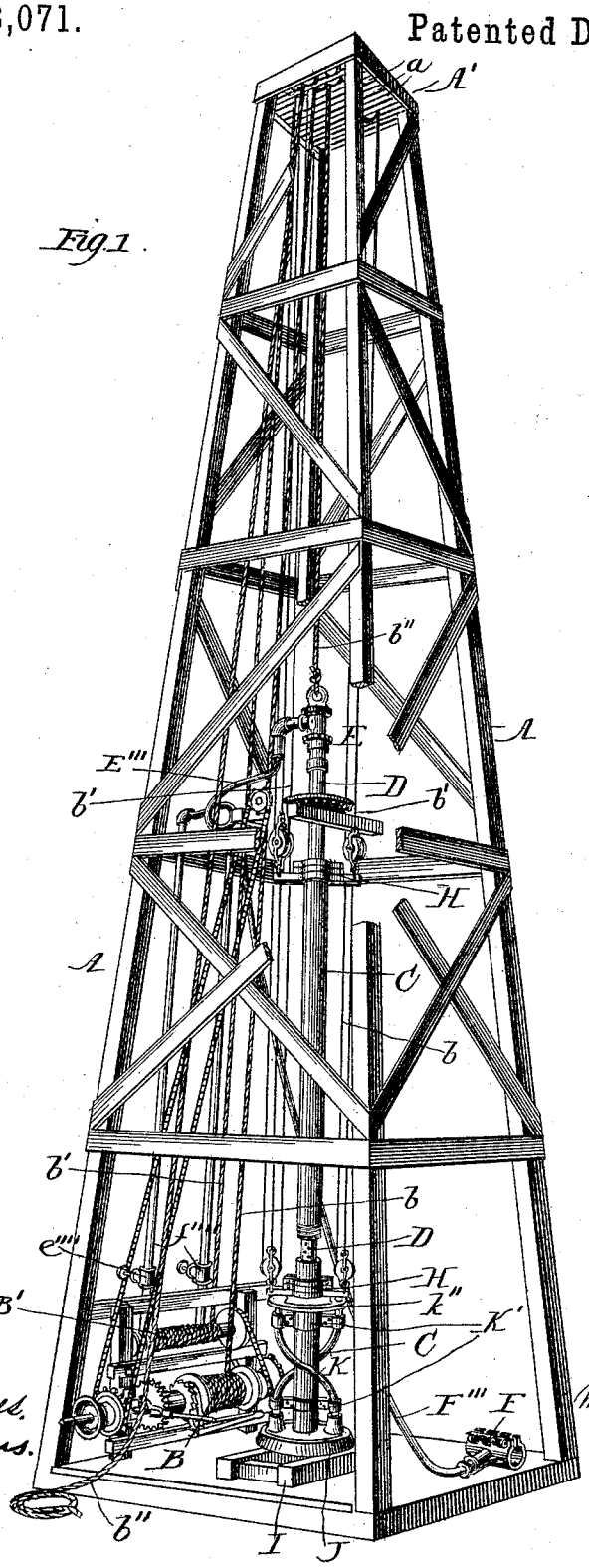
5 Sheets—Sheet 1.

M. T. CHAPMAN.

WELL SINKING APPARATUS.

No. 443,071. Patented Dec. 16, 1890.

Fig. 1.



Witnesses:
Harry T. Jones.
Albert H. Adams.

Inventor:
Matthias T. Chapman

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(No Model.) 5 Sheets—Sheet 2.

M. T. CHAPMAN.

WELL SINKING APPARATUS.

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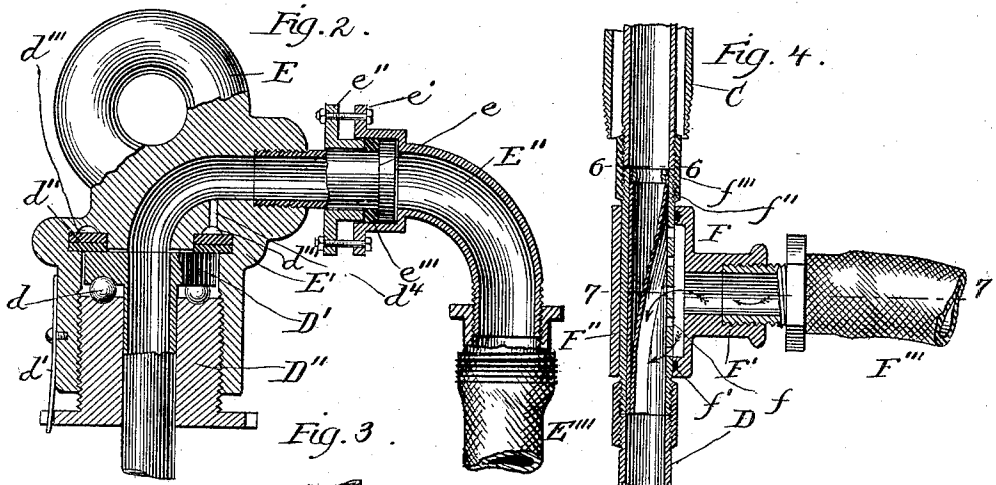

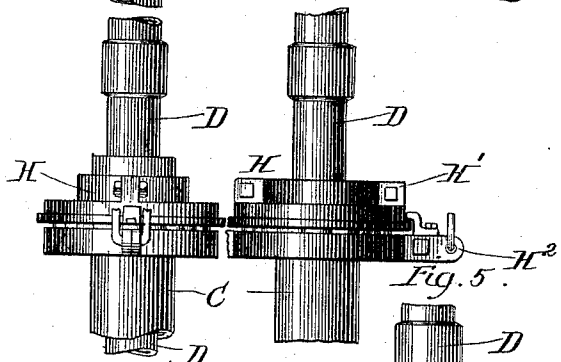

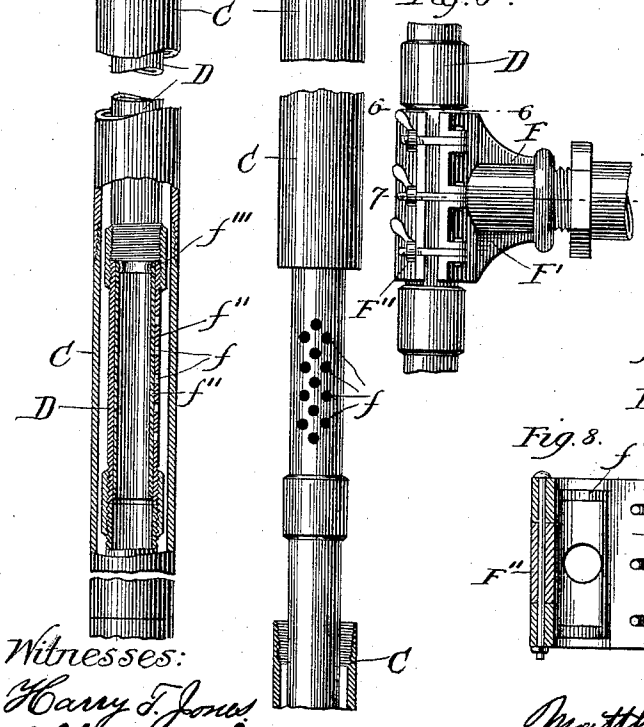

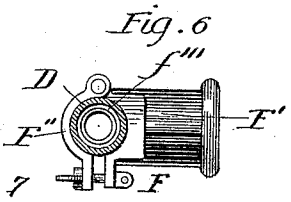

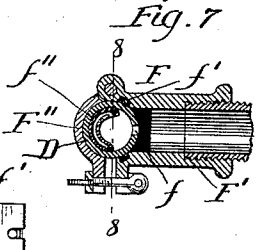

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(No Model.) 5 Sheets—Sheet 3.

M. T. CHAPMAN.

WELL SINKING APPARATUS.

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Fig. 9.

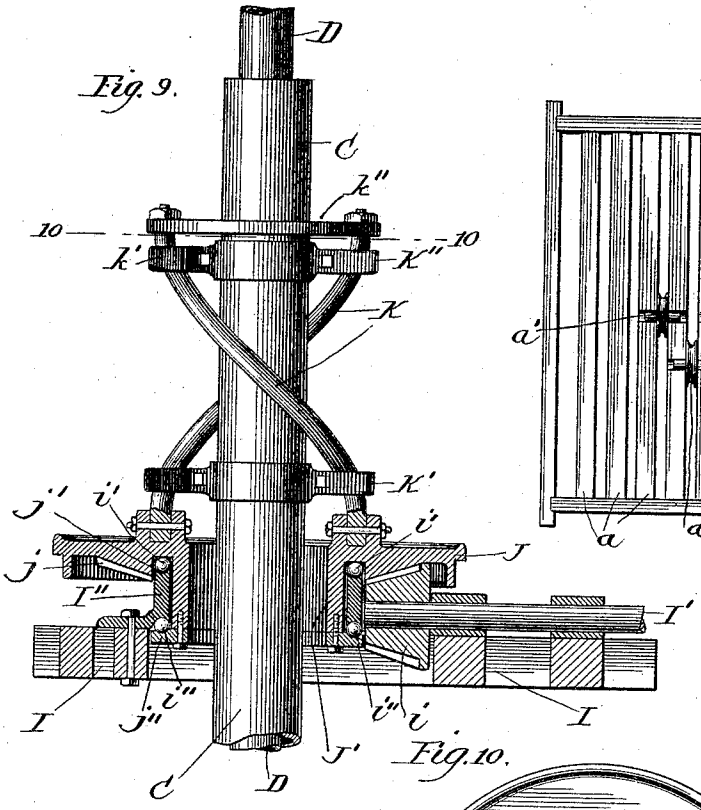


Fig. 11.

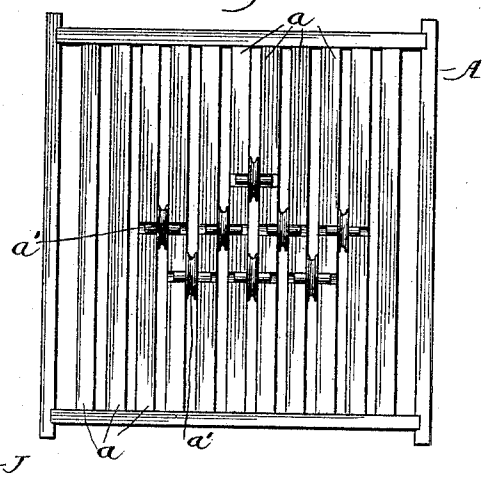
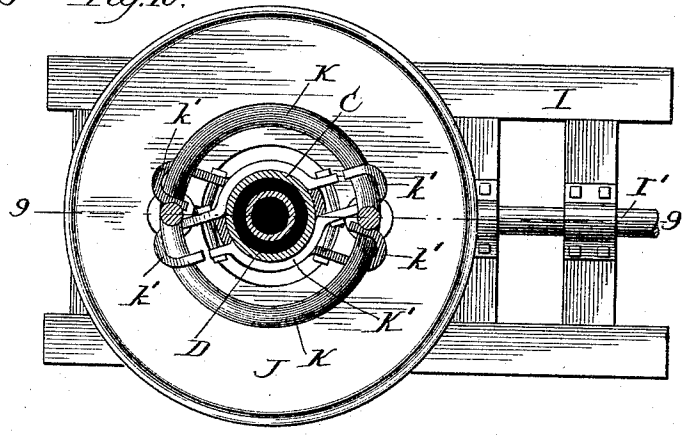


Fig. 10.



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(No Model.)

5 Sheets—Sheet 4.

M. T. CHAPMAN.

WELL SINKING APPARATUS.

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Fig. 12.

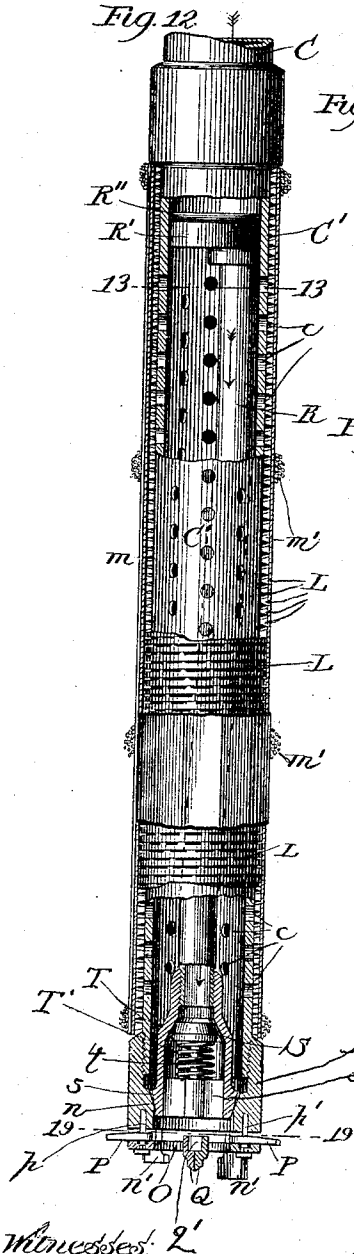


Fig. 13.

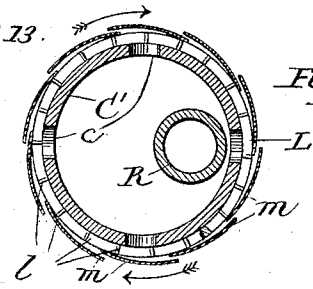


Fig. 14.

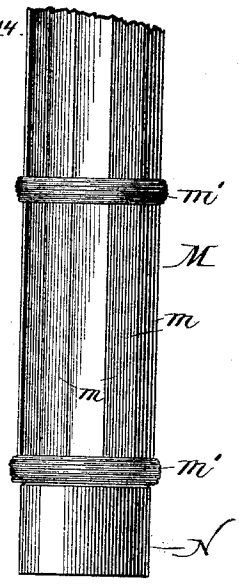


Fig. 15.

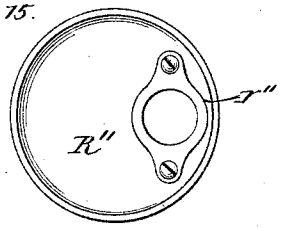


Fig. 16.

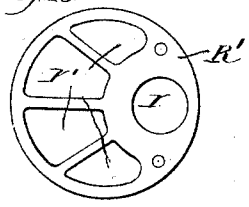


Fig. 17.

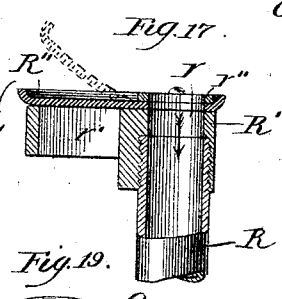


Fig. 18.

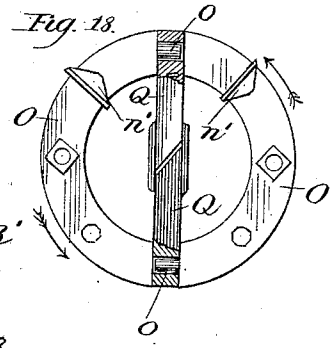
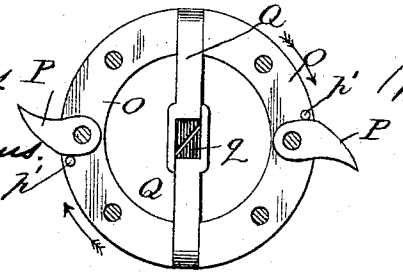


Fig. 19.



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(No Model.) 5 Sheets—Sheet 5.

M. T. CHAPMAN.

WELL SINKING APPARATUS.

No. 443,071. Patented Dec. 16, 1890.

Fig. 20.

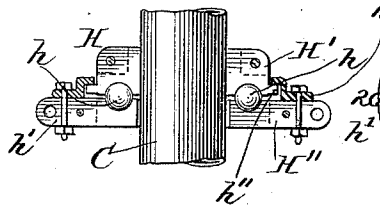


Fig. 21.

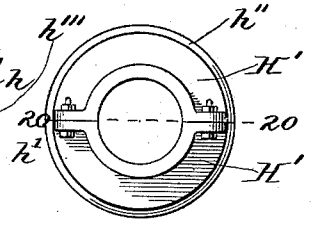


Fig. 22.

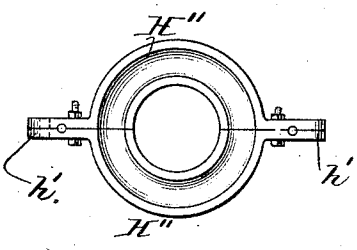


Fig. 27.

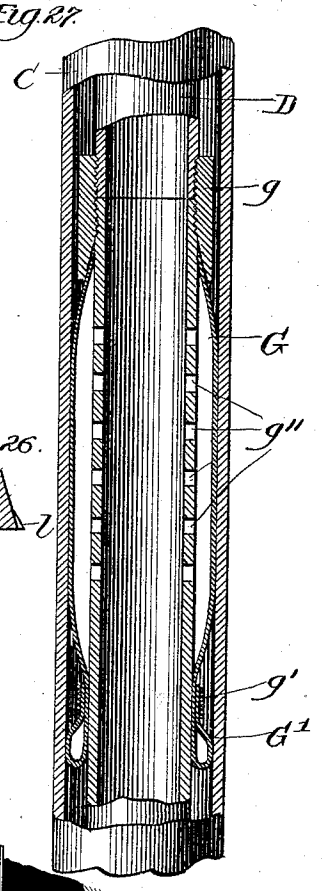


Fig. 23.

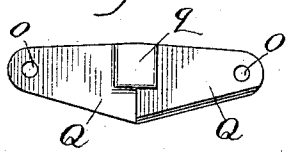


Fig. 24.

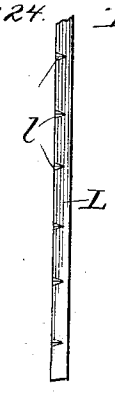


Fig. 25.

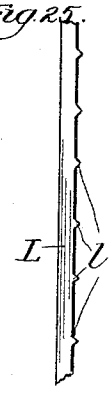


Fig. 26.

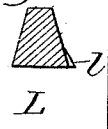


Fig. 28.

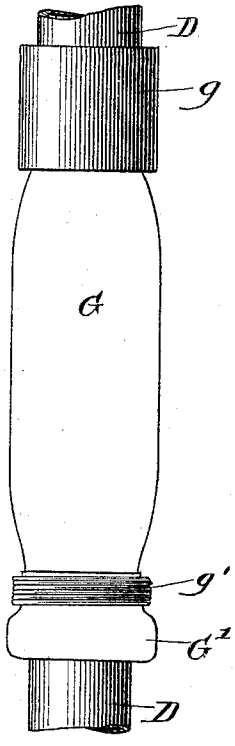
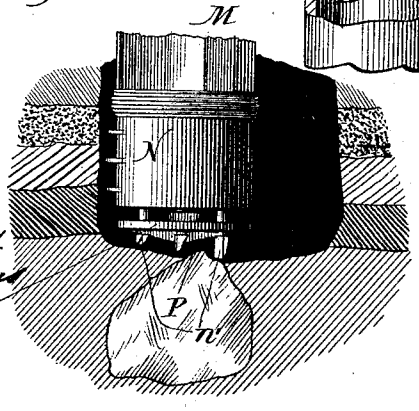


Fig. 29.



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Inventor.
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UNITED STATES PATENT OFFICE.

MATTHEW T. CHAPMAN, OF AURORA, ILLINOIS, ASSIGNOR TO HIMSELF AND MARK C. CHAPMAN, OF SAME PLACE.

WELL-SINKING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 443,071, dated December 16, 1890.

Application filed May 27, 1889. Serial No. 312,224. (No model.)

To all whom it may concern:

Be it known that I, MATTHEW T. CHAPMAN, residing at Aurora, in the county of Kane and State of Illinois, and a citizen of the United States, have invented certain new and useful Improvements in Well-Sinking Apparatus, of which the following is a specification, reference being had to the accompanying drawings, in which—

Figure 1 is a reduced perspective view of so much of the apparatus as is above the ground. Fig. 2 is a detail, being a side elevation, partly in section, showing the water-swivel, the supporting-clamp, and the tube and water-supply pipe in section at the point where the water-joint is to be applied. Fig. 3 is a detail, being an elevation of a section of the tube and the water-supply pipe at the point where the water-joint is to be applied. Fig. 4 is a detail, being a vertical section through the water-supply pipe and the water-joint applied thereto. Fig. 5 is a detail, being an elevation of the water-joint applied to the water-supply pipe. Fig. 6 is a detail, being a horizontal section at line 6 6 of Figs. 4 and 5. Fig. 7 is a detail, being a horizontal section at line 7 7 of Figs. 4 and 5, showing the position of the flexible tube or pipe when water is passing in through the water-joint. Fig. 8 is a detail, being a vertical section through the water-joint detached at line 8 8 of Fig. 7. Fig. 9 is a detail, being a section through the rotating apparatus at line 9 9 of Fig. 10, some parts being in elevation. Fig. 10 is a detail, being a horizontal section at line 10 10 of Fig. 9. Fig. 11 is a plan view of the top of the derrick. Fig. 12 is an enlarged detail, being an elevation, some parts being broken out, of the strainer and interior pipe, and also showing the rotary cutter in section. Fig. 13 is a detail, being a horizontal section at line 13 13 of Fig. 12. Fig. 14 is an enlarged detail, being an elevation of a part of the strainer. Fig. 15 is a detail, being a top view of the valve at the top of the interior pipe. Fig. 16 is a detail, being a top view of the valve-seat at the top of the interior pipe. Fig. 17 is a detail, being a vertical section through the valve and its seat at the top of the interior pipe. Fig. 18 is a detail, being a bottom view of the cutter. Fig. 19 is a detail, being a section at line 19 19 of Fig. 12. Fig. 20 is a detail, being a vertical section through the supporting-clamp at line 20 20 of Fig. 21. Fig. 21 is a top view of the supporting-clamp. Fig. 22 is a top view of the under plate of the supporting-clamp. Fig. 23 is an enlarged detail, being an elevation of the blades for cutting the core. Figs. 24, 25, and 26 are enlarged details showing the wire for wrapping the perforated tube-section to form a strainer. Fig. 27 is an enlarged detail, being a vertical section through the packing for the lower end of the water-supply pipe. Fig. 28 is an enlarged detail, being an elevation of the packing for the water-supply pipe. Fig. 29 is a detail showing the path cut by the cutter when a bowlder has been struck.

This invention relates to hydraulic well-sinking apparatus of the class shown in Letters Patent No. 382,689, granted to me May 15, 1888.

The objects of this invention are to improve the construction and operation of this class of well-sinking apparatus generally; and its nature consists in the several parts and combinations of parts hereinafter specified, and particularly pointed out in the claims.

In the drawings, A represents the framework of the derrick. The top A′ of the derrick A, as shown in Fig. 11, consists of a rectangular frame, which is provided with a number of parallel cross-bars *a*, on which a number of pulleys *a′* are supported in suitable bearings. The pulleys *a′* are arranged on the cross-bars *a* in such manner as to bring the ropes for operating the apparatus in proper arrangement, dispensing with the use of the numerous pulley-blocks at the top of the derrick heretofore used.

B represents a winding-drum for supporting the tube or casing, and B′ represents a windlass for raising and lowering the sections of tubing.

b represents the rope for supporting the tube or casing, *b′* the rope by which the sections are raised, and *b″* the rope by which the water-supply pipe is raised. The ropes *b b′ b″* run over the pulleys *a′* in the frame A′.

C represents the drill tube or casing. This tube or casing C is made of sections coupled together.

D represents the water-supply pipe. This pipe D extends down inside of the tube C a short distance below the surface of the ground, and is designed to supply water continuously to the tube C while the tube is being sunk and without stopping the supply of water while the successive sections are being added to the tube C. In sinking the tube C through quicksand and similar strata it is necessary to keep a continuous supply of water passing downward through the tube and upward outside of the tube to prevent the walls of the well from caving or falling in and stopping the drill. Water is supplied to the pipe D continuously by means of a water-swivel E at the top and a water-joint F, which are constructed and operate as hereinafter described.

E represents the water-swivel, which is swiveled on the top of the water-supply pipe D. The upper end of the pipe D is provided with a circular head D′, as shown in Fig. 2. The shell or casing E′ of the water-swivel E fits around the head D′, and a plug D″, having an exterior screw-thread to enter the screw-threaded opening in the shell E′, supports the head D′. A number of anti-friction balls *d* are placed between the head D′ and the plug D″ to reduce the friction at that point. A catch *d*′, which is secured on the shell E′, engages with one of a number of notches in the periphery of the plug D′ to prevent the plug from being turned in the shell E′ by the rotation of the pipe D. An annular packing *d*″ is placed in a groove *d*‴ in the shell E′ above the head D′ to prevent the escape of water around the edge of the head D′.

d⁗ is a hole in the shell E′ above the groove *d*‴, through which water can pass and press down on the top of a packing *d*″, pressing the packing against the head D′. The shell E′ is provided with an eye, to which the rope *b*″ can be attached. A coupling *e*, having an annular flange at its outer end, is screwed into an opening in one side of the shell E′, as shown in Fig. 2, and a coupling E″, having an annular flange *e*′, is fitted over the end of the coupling *e*. A packing-ring *e*‴ surrounds the coupling *e* near its flange, and a collar *e*″ is drawn against the packing-ring *e*‴ by bolts or otherwise, pressing the packing-ring against the flange on the coupling *e*, forming a stuffing-box. A hose E‴ is connected to the coupling E″, through which water is supplied to the swivel E. By this construction the hose E‴ is not buckled or twisted when the water-swivel E is raised or lowered. The supply of water to the swivel E can be regulated by a valve *e*⁗ in the hose or pipe E‴.

F represents the water-joint. The water-supply pipe D is provided with a number of holes *f* on one side, as shown in Figs. 2, 3, and 4, at a little greater distance from the swivel E than the length of one section of the tube C, as shown in Fig. 1. The water-joint F consists of two sections F′ and F″, hinged together on one side and adapted to be clamped around the pipe D by means of bolts on the opposite side or otherwise, as shown in Figs. 5, 6, and 7. The section F′, as shown in Figs. 6 and 7, has a nipple, to which a hose F‴ can be attached, as shown in Figs. 1 and 4, and, as shown in Figs. 7 and 8, the interior face of the section F′ is provided with a packing *f*′, which fits around the pipe D to prevent the escape of water between the section F′ and the pipe D. When the water-joint is placed around the pipe D, it is to be placed so that the section F′ will cover the holes *f*.

As shown in Figs. 2, 4, and 6, a rubber hose *f*″ is secured in the pipe D by a ring *f*‴ a little above the holes *f*, so that the hose *f*″ will cover the holes *f*, as shown in Fig. 2. When water is being supplied to the pipe D through the water-swivel E, as shown in Figs. 1 and 2, the water will press the hose *f*″ outward against the pipe D, as shown in Fig. 2, preventing the escape of any water through the holes *f*. When water is supplied to the pipe D through the water-joint F, as shown in Figs. 4, 5, and 7, the force of the water will cause the hose *f*″ to buckle, as shown in Figs. 4 and 7, permitting the water to pass downward and preventing it from passing upward through the pipe D.

Water is to be supplied to the pipe D through the water-swivel E at the top until the top of the tube C descends below the holes *f* in the pipe D. Then the water-joint F is to be attached to the pipe D, as shown in Figs. 4 and 5, and water admitted to the hose F‴ by means of the valve *f*⁗. The water to the swivel E is then shut off by means of the valve *e*⁗ and the swivel E uncoupled from the pipe D. An additional section of tubing can then be passed down over the top of the pipe D and the swivel E again coupled to the top of the pipe D. As soon as water has again been admitted to the swivel E the water to the joint F is shut off by means of the valve *f*⁗ and the joint F removed from the pipe D, when the parts will be in the position shown in Fig. 1. The additional section can then be lowered and coupled to the tube C. This entire operation can be performed without stopping the continuous flow of water downward through the supply-pipe D. The joint F is entirely detached from the pipe D when the point of attachment is within the tube C, so that it does not interfere with the tube C nor enlarge the pipe D nor materially reduce the water-supply, as would be the case with an ordinary valve.

G represents the packing on the lower end of the water-supply pipe D, which prevents the passage of water upward between the pipe D and the tube C. This packing, as shown in Figs. 27 and 28, consists of a flexible tube, which is secured at its top to the pipe D by a ring *g*, and at its bottom is secured by a cord or wire *g*′, wrapped around it, it being folded back, as shown in Fig. 27, to form a fold G′. The pipe D is provided with one or more holes *g*″ between the ring *g* and wire or

cord G′, through which a small amount of water can pass, expanding the tube G and pressing it against the tube C. The pressure of the water upward against the fold G′ will cause it to press outward against the tube C, assisting in forming a tight packing around the pipe D. The greater the force or pressure of the water in the pipe D the greater will be the force with which the tube G is pressed outward against the tube C. The flexibility of the tube G will permit it to pass up or down in the tube C without catching at the couplings and at rough places in the tube, and still prevent the passage of water upward between the pipe D and the tube C.

H represents a clamp for supporting the tube C and its sections as they are added successively. This clamp H, as shown in Fig. 20, consists of an upper ring H′ and a lower ring H″. The upper ring H′, as shown in Fig. 21, consists of two sections, which can be clamped around or otherwise secured to the tube C, and is provided with a flange h'' around its lower edge. The lower ring H″, as shown in Fig. 22, consists of two sections, which when clamped together fit loosely around the tube C. Between the rings H′ and H″ are placed a number of anti-friction balls h. The lower ring H″ is provided with an ear h' on each side, to each of which, as shown in Fig. 1, is to be attached a pulley for the supporting-rope. It is also provided with a hook h''' on each side, which hooks over the flange h'', as shown in Fig. 20. When the ring H′ is clamped around the tube C or one of the sections, the tube or section will be supported by the ring H′ resting on the anti-friction balls h, which run on the ring H″, permitting the tube to be rotated freely while its weight is supported. Two clamps H are used, as shown in Fig. 1, one for supporting the tube C and the other for handling the successive sections as they are placed in position.

I represents the frame on which the rotating apparatus is supported. This frame I is to be weighted down or anchored to the ground.

I′ is the driving-shaft, which can be rotated by any suitable means. It is provided on its inner end with a beveled gear i, as shown in Fig. 9. To the frame I is secured a vertical ring I″, which, as shown in Fig. 9, is provided on both its upper and its lower edges with grooves, in which anti-friction balls i' and i'' run.

J is a rotating plate having a central opening with a depending annular flange J′, and provided on its under side with beveled gear j, adapted to mesh with the beveled pinion i on the shaft I′. This rotating plate J rests upon the anti-friction balls i' on the vertical ring I″, the depending flange J′ fitting within the vertical ring I″. On the lower edge of the depending flange J′ is secured a ring j'', on which the anti-friction balls i'' run.

K K are two spiral arms secured to the rotating plate J on opposite sides, as shown in Figs. 1, 9, and 10. To the upper ends of the arms K is secured a ring k'', which holds the upper ends of the arms K in the same relative position as their lower ends.

K′ K′ are two clamps adapted to clamp the tube C. The ends of each clamp K′ are bent to form a hook k', adapted to fit around the arms K, as shown in Fig. 10.

The rotation of the plate J, which is driven by the shaft I′, carries around the arms K, which by means of one or both of the clamps K′ rotates the tube C. As shown in Fig. 9, the rotating plate J and arms K will rotate the tube C, and the spiral form of the arms K will cause them to force the clamps K′ and tube C downward, as is often found to be necessary. The greater the resistance to the rotation of the tube C the greater will be the force exerted upon the clamps K′ and the greater will be the force exerted downward on the clamps K′ and consequently upon the tube C. The anti-friction balls i'', running on the ring j'', will prevent the plate J from being lifted or raised from the frame I, and also prevent its binding or running hard. When the well has been sunk to a great depth and the weight of the tube is too great on the cutter, or at any time when it is desired to relieve the cutter of a part of the weight of the tube C, arms K of a spiral form in the reverse direction from that shown may be used, which will then tend to lift the clamps K′ and the tube C. The anti-friction balls i' on the ring I″ will prevent it from binding or running hard. When the lower clamp K′ has reached its downward limit, it is to be loosened and slipped up on the arms K against the upper clamp. Then the upper clamp is to be loosened and slipped up against the ring k''. It is not necessary to stop the rotation of the plate J and the tube C, and the clamps K′ can be adjusted alternately as frequently as necessary. As shown in Fig. 1, a similar rotating apparatus is located on a platform in the derrick A in position to clamp the water-supply pipe D just below the water-swivel E. This second rotating device is used to rotate the water-supply pipe D, as is sometimes necessary, and to prevent the pipe D from being forced upward out of the tube C by the force of the water, which sometimes becomes very great. When an expansion-drill is used in connection with the tube C, the second rotating apparatus may be used to rotate the tube of the expansion-drill. As shown in Figs. 12 and 13, a short section C′, provided with a number of holes c, is secured to the lower end of the tube or casing C.

L is a wire or metal band wrapped around the perforated section C′, as shown in Figs. 12 and 13. This wire or band L is broader at its exterior face than at its interior face, as shown in section in Fig. 26. It is also provided on one of its outer edges with small projections l at short intervals apart, as shown in Figs. 12, 13, 24, 25, and 26. This wire L is

secured to the section C′ by first covering the section C′ with a coat of solder or similar material, then wrapping the wire or band L tightly around the section, then passing a heated iron into the section, which heats it sufficiently to melt the solder, and then withdrawing the heated iron, when the solder will set around the edges of the wire or band L. By this method of securing the wire or band it can be readily and very quickly secured in place. The wire or band thus wrapped around the perforated section C′ forms a strainer, as the water will pass between the coils of the wire L and enter the holes *c*, the projections *l* preventing the adjacent coils from being pressed too close together. The wire or band L being broader at its exterior face than at its interior face, a channel is formed between the adjacent coils around the tube C′, through which the water can flow freely into and through the holes *c*.

M is a cover for the strainer. This covering consists of a number of strips *m*, of sheet metal, one edge of each being secured, as shown in Fig. 13, to the strainer by solder or other suitable means, the other edge being free and lapping over the adjacent strip. As shown in Fig. 13, the edges of the strips *m* are secured, so that when the tube is rotated, which is always in the direction indicated by arrows in Fig. 13, the wall of the well will tend to close or press the free edge of each strip *m* against the adjacent strip, preventing the passage of water and sand or gravel through the strainer. To securely hold the strips in place, the covering M is wrapped at short intervals, as at *m′*, with a wire or band. When a water-bearing stratum has been reached, the drill is stopped and the tube C opened at the top. The strips *m* will spring open sufficiently to allow the water to enter, and, passing between the coils of the wire or band L, enter the tube C through the holes *c*.

N is a cutter-head, which is screwed onto the lower end of the section C. It is provided on its interior with a shoulder or bevel *n*, as shown in Fig. 12.

O O are two segments, which form a ring. Each segment is provided with a journal *o* on one end, as shown in Fig. 18.

n′ are the teeth of the cutter, which pass through angular holes in the ring O, and are secured in the cutter-head N. One of the teeth projects downward farther than the others to cause the cutter to pass around a bowlder, as shown in Fig. 29 and hereinafter described. The stems of the teeth *n′* are angular, so that they cannot turn in the angular holes in the ring O.

P P are two expanding blades, which are pivoted on pivots *p* between the cutter-head N and the ring O. The ring O is provided with a projection *p′* on each side near the pin *p*, against which the expanding blades P strike, preventing the blades from swinging backward too far. When the drill is rotated in the direction indicated by the arrows in Fig. 19, the blades P will be forced open, causing them to cut a larger hole than has been cut by the teeth *n′*.

Q Q are two blades, one pivoted on each journal *o* in the ring O. These blades Q extend across the central opening in the cutter, cutting out the core, which otherwise would be left. Each of these blades, as shown in Fig. 23, has a notch at its upper inner corner, into which notch, as shown in Fig. 12, a wedge *q′* of wood can be driven to prevent the inner ends of the blades from dropping downward. The lower inner edges of the blades Q press against each other, preventing the blades from being pushed upward by the core when the drill is in operation. If the cutter becomes worn or is unable to cut through any strata which it may reach, an expansion-drill may be inserted in the tube C, as shown in my said patent, No. 382,689, which will strike the blades Q, crushing the wooden wedge, forcing the blades Q downward, and allowing the blades of the expansion-drill to expand below the teeth of the cutter on the tube C. Any material may be used in place of the wooden wedge *q′* which will yield and permit the blades Q to swing down out of the way of the expansion-drill.

R is a small pipe, which is located, as shown in Fig. 12, in the interior of the perforated section C′, and is a little longer than the perforated portion of the section C′. On the upper end of the pipe R is secured a valve-seat R′, whose diameter is nearly equal to the interior diameter of the perforated tube C′. This valve-seat R′, as shown in Fig. 16, has a circular opening *r* near one side, in which opening the pipe R is secured, and it has a number of openings *r′* in its opposite side.

R″ is a valve secured on the valve-seat R′ by means of a plate *r″*, as shown in Figs. 12, 15, and 16, which valve R″ closes downward over the openings *r′* in the valve-seat R′, preventing the passage of water downward through the openings *r″*, but permitting the water to pass downward through the opening *r* and pipe R.

S is a valve-cage, which is secured on the lower end of the pipe R, and is provided at its lower end with a shoulder or bevel *s*, which is adapted to engage with the shoulder or bevel *n* in the cutter-head N.

T is a valve, which is located in the valve-cage S and seats upward to close the pipe R. This valve T is closed by a spring T′, which surrounds the stem *t* of the valve T and abuts against a web *s′* in the lower end of the cage S.

When the drill is operated, the water is forced downward through the tube C and passes down through the opening *r*, through the pipe R, and opens the valve T. It is discharged through the cutter at the point of cutting. It then passes up outside of the tube C, carrying the cuttings up to the top of the ground. When it is desired to test the water in any strata which the cutter has reached, the supply of water to the water-supply pipe

D is stopped and the tube C is opened at the top. If a strong vein of water has been reached, the water will enter through the strainer in the perforated section C′ in the manner already described, pass upward through the valve R″, and flow out at the top of the tube C. If the water-vein is not strong enough to cause the water to flow out at the top of the tube C, the water-supply pipe D can be taken out and a pump put into the tube C and the water raised through the strainer and perforated section C′, as already described. If the water in the strata thus tested is not satisfactory, the drill can again be rotated and the tube C sunk as before. Any of the succeeding strata can be tested, as above described, until a satisfactory stratum has been reached. The tube C, which is to form the casing of the well, is rotated by means of the rotating apparatus, as already described. While the tube C is being sunk by rotation, a continual supply of water is forced downward through it to wash away the cuttings and prevent the wall of the well from falling in. The ropes by which the apparatus is operated run over the pulleys a' on the parallel bars a. The pulleys a', all being mounted on a single frame, cannot be twisted together, as they are liable to be when pulley-blocks are used. Their axles, as shown in Fig. 11, pass each other in their bearings on the parallel bars a, so that they can be placed close together. The continuous supply of water to the tube or casing C is furnished by means of the pipe D, to which water is supplied through the water-swivel E and water-joint F. The water is prevented from rising upward between the pipe D and tube C by the packing G. The spiral arms K on the rotating apparatus, as shown, force the tube C downward, but may be reversed to lift upward. When they act to force the tube C downward, the plate J is held from being lifted off from the pinion by means of the ring I″ and ring j'''. When the spiral arms are reversed to lift upward on the tube, the weight is supported on the plate J, ring I″, and anti-friction balls i'. The balls i' and i'' at the top and bottom of the ring I″ running in annular grooves instead of rollers, as heretofore used for supporting the rotating plate, there can be no binding of the plate, and the tendency of rollers to wedge outward is avoided. The successive sections can be added to the tube C, as already described, without stopping the rotation and descent of the tube C. The sections are raised into position and handled by means of one of the clamps H, and the tube C is supported by means of the other clamp H.

The water is discharged at the bottom of the well or the point of cutting by means of the pipe R, the valve R″ preventing it from passing downward into the perforated section C′ and out through the strainer. The water discharged at the point of cutting rises upward outside of the tube C to the surface of the ground, washing away the cuttings, and is prevented from entering the tube-section C′ by the pressure of the water in the tube C downward on the valve R″. Whenever the supply of water downward through the tube C is stopped, the clear water from the stratum in which the strainer is will flow into the perforated section C′ through the strainer and pass upward through the valve R″ into the tube C, the valve T at the bottom of the tube C preventing the passage upward of the water at the bottom of the well through the pipe R and tube C.

In sinking wells, bowlders are often met, through which heretofore it has been often necessary to drill. By making one tooth of the cutter longer than the others, when the cutter strikes a bowlder or similar obstruction, as shown in Fig. 29, the cutter and tube will rotate on an axis through that tooth and erode a path, the force of the water-supply aiding in the erosion, until a path is formed at one side of the bowlder or obstruction, and the cutter can then pass down at one side of the bowlder or obstruction.

What I claim as new, and desire to secure by Letters Patent, is as follows:

1. In a well-sinking apparatus, the combination of the water-supply pipe D, having at its upper end the circular head D′, the shell E′, loosely fitting around and inclosing said head, the plug D″, inserted in the shell below the head and having notches in its periphery, the anti-friction balls d between the head D′ and plug D″, and a catch d' on the shell, to engage a notch of the plug and prevent the plug from turning in the shell with the water-pipe, substantially as described.

2. In a well-sinking apparatus, the combination of the water-supply pipe D, having at its upper end the circular head D′, the shell E′, loosely fitting and inclosing the head and having on its inside above the head the annular groove d''' and hole d'''', and the annular packing d'' in the groove beneath the hole, adapted to be pressed on the head by water entering the hole, substantially as described.

3. In a well-sinking apparatus, the shell E′ of a water-swivel, in combination with a coupling e, coupling E″, packing-ring e''', collar e'', and hose E‴, substantially as and for the purpose specified.

4. In a well-sinking apparatus, the combination of the water-supply pipe D, having holes f, the water-joint F, clamped around the pipe over said holes, the flexible tube f'', secured within said pipe, and the water-swivel E at the upper end of the pipe, substantially as described.

5. In a well-sinking apparatus, the combination, with a water-supply pipe having holes f, of a water-joint F, consisting of two sections F′ F″, clamped around the pipe D over the holes and provided with a packing f', substantially as and for the purpose specified.

6. In a well-sinking apparatus, the combination of a water-supply pipe D, having holes

f, a water-swivel E at the upper end of the pipe, and a detachable water-joint F, clamped on the pipe over the holes *f*, substantially as and for the purpose specified.

7. In a well-sinking apparatus, the combination, with a water-supply pipe D, having holes *g''*, of a tube G, fold G', ring *g*, and wire or cord *g'*, substantially as and for the purpose specified.

8. In a well-sinking apparatus, the combination, with a drill-tube and a ring H', secured thereon and having a flange *h''*, of a ring H'', anti-friction balls *h*, hook *h'''*, and ears *h'*, substantially as and for the purpose specified.

9. In a well-sinking apparatus, the combination, with a drill-tube or casing, of a rotating plate J, spiral arms K on said plate, and clamps K', having ends *k'* to engage said arms and adapted to be secured to said tube or casing, whereby they may act to rotate the tube or casing and force it endwise, substantially as described.

10. In a well-sinking apparatus, the combination, with the drill tube or casing C and the rotary plate J, having flange J', of the rings *j''* and I'', anti-friction balls *i' i''*, spiral arms K, and clamps K', substantially as described.

11. In a well-sinking apparatus, the combination, with a drill-tube, of the cutter-head N, the segments O, forming a ring and having holes, and the teeth *n'*, secured to the cutter-head and passing through the holes in the ring-segments, substantially as described.

12. In a well-sinking apparatus, the combination, with a drill-tube, of a cutter-head N, a ring O, having holes and located beneath the cutter, and teeth *n'*, secured to the cutter-head, passing through the holes in the ring and one projecting downward beyond the others, substantially as described.

13. In a well-sinking apparatus, the combination, with a drill-tube, of a cutter-head N, the ring-segments O, each having a journal *o* on one end and provided with holes and with pins *p'*, the expanding blades P, pivoted on the ring-segments, and the teeth *n'*, secured to the cutter-head and passing down through the holes in the ring-segments, substantially as described.

14. In a well-sinking apparatus, the combination of the cutter-head N, ring O, teeth *n'*, blades P, and blades Q, substantially as and for the purpose specified.

15. In a well-sinking apparatus, the combination, with a perforated tube-section C', of an interior pipe R of less diameter than the internal caliber of the tube-section to provide space for the upward passage between the two of water from a water-vein, a valve-seat R', of greater diameter than the pipe, located at the upper end thereof and fitting the interior of the tube-section, and an opening and closing valve R'', which permits said upward passage of water outside the pipe and prevents the downward passage of water outside said pipe, substantially as described.

16. In a well-sinking apparatus, the combination, with the perforated tube-section C', of a pipe R, valve-seat R', having a hole *r* and holes *r'*, and a valve R'' for closing the holes *r'*, substantially as and for the purpose specified.

17. In a well-sinking apparatus, the combination, with a perforated tube-section C' and cutter-head N, having a shoulder or bevel *n*, of a pipe R for the purpose set forth, and a valve-cage S, having a shoulder or bevel *s* adapted to engage with the shoulder *n* for supporting the pipe and cage in proper position, substantially as specified.

18. In a well-sinking apparatus, a rotary cutter having teeth extending on one side lower than the teeth on the other side, so that in meeting obstructions the lower teeth will strike first and cause the other teeth to swing on the lowest tooth and cut a large hole, substantially as and for the purpose specified.

19. In a point for well-sinking machines, the combination of a perforated tube, a block supported on the lower end of said tube, a pipe projecting upwardly from said block, a valve on the lower end of said pipe, a perforated disk on the upper end of said pipe, and a valve on said disk, substantially as described.

20. In a point for well-sinking machines, the combination of an outer perforated pipe, a smaller inner pipe extending above and below the perforations in the outer pipe, and a valve closing the space between the pipes above the perforations in the outer pipe, the space between the pipes below the perforations being closed, substantially as described.

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Witnesses:
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