May 29, 1923. 1,457,181

W. MABLE

PNEUMATIC DRILL

Filed June 5, 1920 3 Sheets-Sheet 1

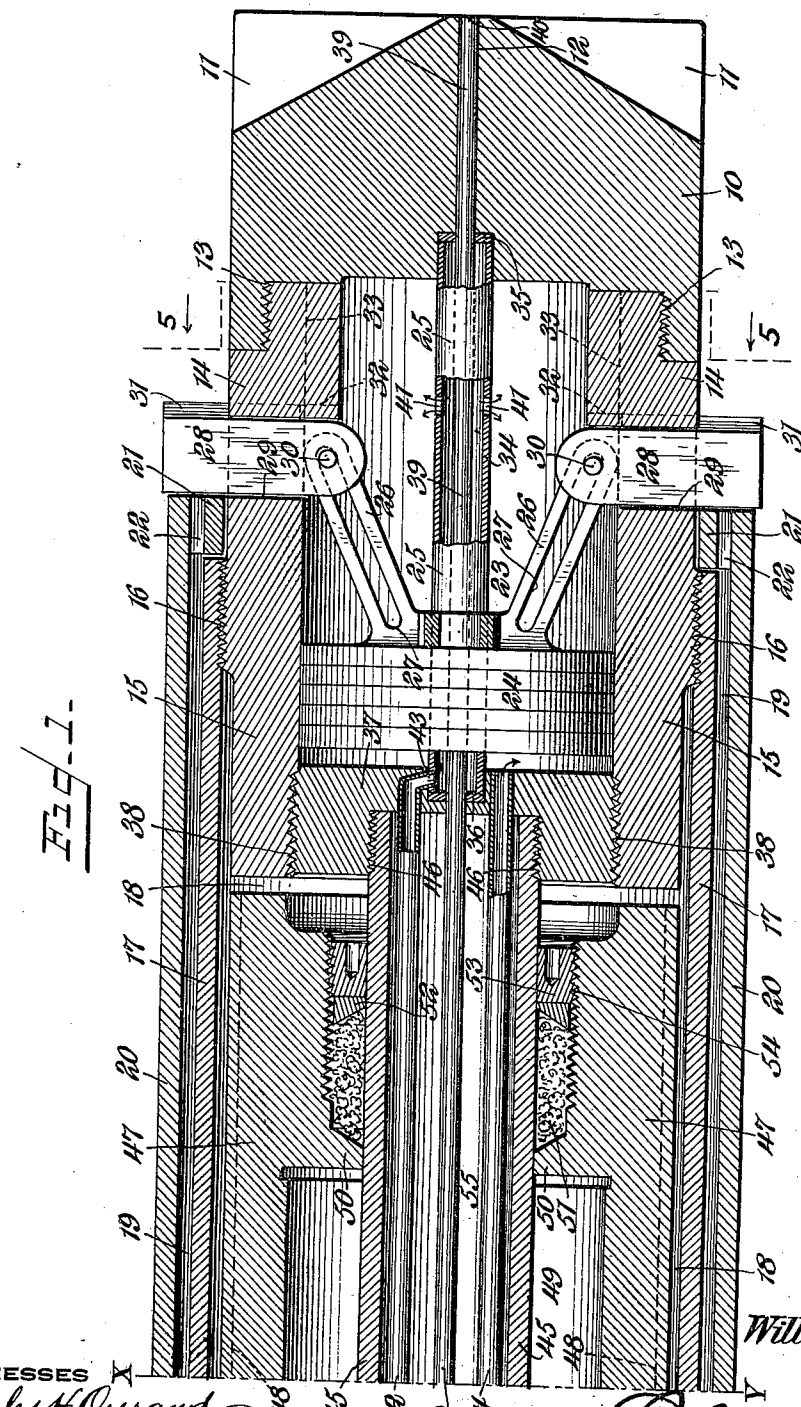


Fig. 1.

WITNESSES

Charles H. Durand

Philip E. Siggers

William Mable
INVENTOR

BY E. G. Siggers

ATTORNEY

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W. MABLE

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3 Sheets-Sheet 2

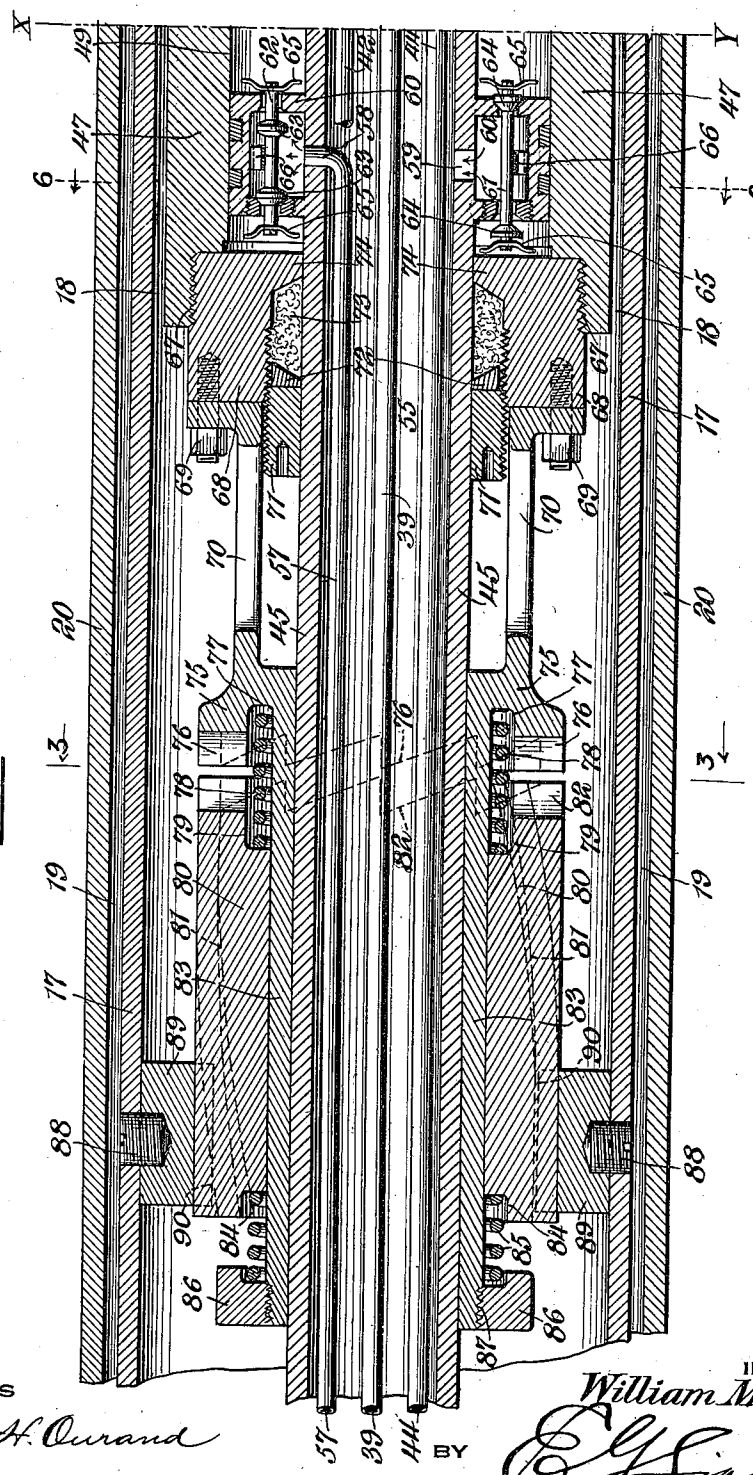


Fig. 2.

WITNESSES

Charles H. Durand

Philip E. Siggers

INVENTOR

William Mable

BY

E. G. Siggers

ATTORNEY

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W. MABLE

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Fig. 3.

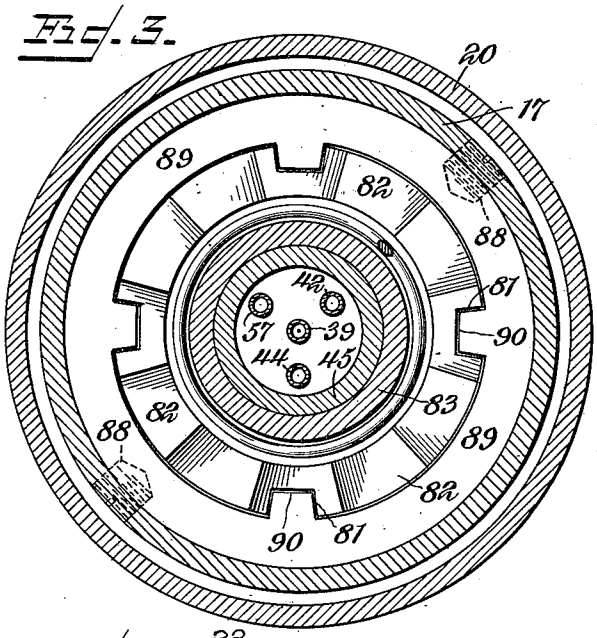


Fig. 4.

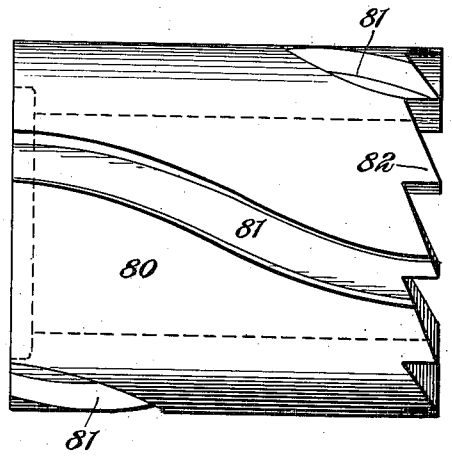


Fig. 5.

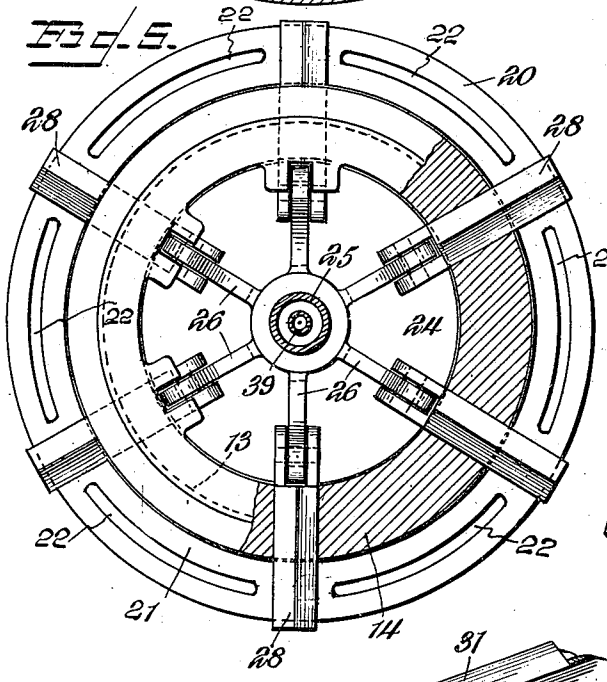


Fig. 6.

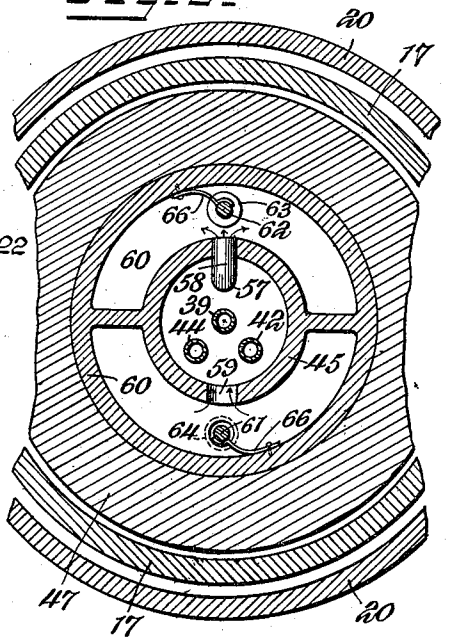
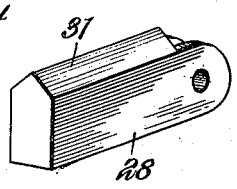


Fig. 7.



WITNESSES

Charles H. Durand

Philip E. Siggers

William Mable
INVENTOR

BY E. G. Siggers
ATTORNEY

Patented May 29, 1923. 1,457,181

UNITED STATES PATENT OFFICE.

WILLIAM MABLE, OF FORT COLLINS, COLORADO, ASSIGNOR OF ONE-HALF TO DELIA GOODALE, OF FORT COLLINS, COLORADO.

PNEUMATIC DRILL.

Application filed June 5, 1920. Serial No. 386,717.

To all whom it may concern:

Be it known that I, WILLIAM MABLE, a citizen of the United States, residing at Fort Collins, in the county of Larimer and State of Colorado, have invented a new and useful Pneumatic Drill, of which the following is a specification.

This invention relates to pneumatic drills.

The object of the invention is to provide a tool for drilling or boring into the earth, whether for water, gas, oil or other minerals.

The tool of the present invention preferably employs compressed air for its operation, and the compressed air not only rotates and drives the cutter downwardly, but forces the loosened earth up to the surface of the ground between the well casing and the drill, while the drill itself positively drives the well casing downwardly.

The invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawings forming part of this specification, with the understanding, however, that the invention is not confined to any strict conformity with the showing in the drawings, but may be changed and modified so long as such changes and modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:—

Fig. 1 is a longitudinal sectional view of the lower portion of the improved tool showing the same in operative relation to the well casing.

Fig. 2 is a similar view of the remainder of the tool, the entire tool being illustrated in Figs. 1 and 2 when taken together.

Fig. 3 is a section on the line 3—3 of Fig. 2.

Fig. 4 is an elevation of the spiral slotted member of the clutch.

Fig. 5 is a cross section on the line 5—5 of Fig. 1, parts being broken away to illustrate the construction more clearly.

Fig. 6 is a fragmentary cross section on the line 6—6 of Fig. 2.

Fig. 7 is a perspective view of one of the dogs.

The working end of the tool comprises a detachable cutter 10 provided with blades 11. A bore 12 extending axially of the cutter 10 is provided for a purpose to be described. The cutter is preferably held by screw threads 13 upon the lower shoulder 14 of a cylinder or cutter head 15. The lower end of the cylinder 15 is closed by the cutter 10, while the upper end is closed by a partition 37 secured by screw threads 38 within the cylinder.

The cylinder 15 is threaded, as at 16, within the lower end of the drill casing 17. Thus, when the cylinder 15 reciprocates and turns, the drill casing 17 moves with it.

A well casing surrounds the drill in spaced relation thereto and moves downwardly into the well as the drill advances. In the simple embodiment of the invention illustrated in the drawings, the well casing comprises a single section 20, but it will be understood that in practice when drilling deep wells a casing is built up comprising many sections secured together as the drilling progresses. The well casing 20 is spaced from the drill casing 17, as indicated at 19, this space being provided for the purpose of allowing the loosened earth and the like to move upwardly to the surface of the ground, such action being aided by pneumatic pressure, as will be described. The lower end of the well casing has an annular shoulder 21 projecting inwardly in advance of the drill casing, whereby the drill as it advances may engage with the well casing to force the same downwardly. At intervals, passageways 22 are provided in the shoulder 21 so that the earth may enter the space 19, as stated.

A plurality of bits or dogs 28 are provided in the lower end of the drill and extend transversely and radially of the drill, so that when in their operative position they project laterally beyond the outer wall of the cylinder 15 and somewhat beyond the well casing 20. The function of the dogs 28 is to ream out the hole initially made by the cutter, larger than the diameter of the well casing, so that the latter may follow the drill down into the earth without encountering prohibitive resistance. Fig. 5 shows six of these dogs in active position but obviously any other number may be employed. The dogs are received within slots 29 provided in the sides of the cylinder 15 and have lower knife edges 31. A V-shaped groove 32 provided in the shoulder 14 receives the knife edge 31 of the corresponding dog, and together with the slot 29 provides a guide for the dog as it reciprocates or is projected alternately in and out of the cylinder 15.

Within the bore 23 of the cylinder 15 a pipe 25 is secured, said pipe extending longitudinally and coaxially of the cylinder and serving as a guide for a piston 24. Said piston at its lower end carries a plurality of arms 26 extending at an angle to the piston face, there being one of these arms for each of the dogs. The arms 26 have elongated slots 27 in which will move pins 30 pivotally mounted to the inner ends of the dogs. When the piston 24 descends within the cylinder, the arms 26 move downwardly into slots 33 provided in the lower end of the cylinder. This movement of the arms will pull the dogs inwardly, the pivot pins 30 sliding in the slots 27 to effect this result. When the piston 24 is moved in the opposite direction, the dogs will be thrust outwardly of the tool.

The pipe 25 is held at the lower end in the cutter 10 and is closed at that end as indicated at 35. The other end of the pipe is seated in the partition 37 and is closed as indicated at 36. Below the level of the dogs the pipe 25 has ports 41 for admitting air into the cylinder below the piston 24 whereby the latter may be raised to cause outward movement of the dogs. A tube 42 extends longitudinally near the center of the tool and has its lower end passing through the partition 37 and opening into the pipe 25, as indicated at 43. A similar tube 44, which passes through the partition 37, is open to the bore 23 of the cylinder at the upper end. Tubes 42 and 44 provide means whereby compressed air is admitted to both sides of the piston 24 so that reciprocation of the dogs is effected, the air from tube 44 causing the piston to descend, while the air from tube 42 passes through the pipe 25 and out through the ports 41 to cause reverse piston movement.

A third tube 39 extends centrally of the tool, being passed through the partition 37 and centrally through the pipe 25 down through the bore 12 in the cutter and terminating, as indicated at 40, in the cutting end of the drill. Live air passes down through the tube 39 into the bore reamed out by the cutter and the resultant air pressure in the bore forces the cuttings upwardly. The cuttings pass upwardly through the space 19 between the well casing and the drill and ultimately reach the surface of the ground. A pipe 45 houses the live air tubes 39, 42 and 44 within the passageway 55 and is detachably secured, as at 46, to the partition 37 closing the cylinder 15. This pipe 45 supports and guides reciprocable elements to be described which give to the cutter both a downward and a turning movement. When the cutter is so moved, it will be clear that the pipe 45 and the drill casing 17 will have a similar motion, these parts all being connected together. The well casing 20 on the other hand not being connected with the drill, has only a single motion, viz, downward. An air chest 47 is mounted upon the pipe 45 so as to reciprocate thereon. In its downward stroke the air chest acts as a hammer and strikes the cutter head; on its upward stroke it actuates certain mechanism to partially rotate the cutter, all as will be described. The air chest has a piston chamber 49 closed at the lower end by the wall 50 and has a sliding fit upon the pipe 45. A stuffing box is provided on each side of the air chest whereby the compressed air from the piston chamber 49 may not leak past the pipe 45 where it extends through the ends of the air chest. The lower stuffing box is shown in Fig. 1 and the upper in Fig. 2. Packing 51 is provided in the lower stuffing box, surrounding the pipe 45, and a gland 52 held in place by a ring 53 aids in compressing the packing. The ring 53 is adjustably mounted by screw threads 54 within a bore provided in the air chest. The gland 52 and ring 53 both surround the pipe 45. Thus it is seen that compressed air within the piston chamber 49 may not leak down past the pipe 45 and enter the space 18 between the drill casing 17 and the air chest but is properly confined.

Turning now to Fig. 2, wherein the upper part of the drill is shown, it is seen that the pipe 45 continues for the length of the tool concentrically of the drill casing and houses a fourth tube 57. The relative disposition of the various air tubes within the pipe is clearly seen in Figs. 3 and 6. The lower end of the tube 57 is bent as at 58 and passes through a hole in the wall of the pipe, being secured thereto. The air tube 57 discharges into the piston chamber 49. The air from the tube first enters the hollow piston 60 secured to the pipe 45 but slidable within the air chest 47. The hollow piston 60 carries intake and exhaust valves. The intake valves 63 are mounted on a valve stem 62 slidably supported by the hollow piston. Each end of the valve stem 62 carries a cross-piece 65 adapted to engage with the end walls of the piston chamber 49 when the piston reaches the end of each stroke. The valves 63 are housed within the hollow piston and a friction spring 66 presses against the valve stem 62 so as to hold the same in any position in which it may happen to be.

Diametrically opposite the intake valves the exhaust valves are placed. The exhaust valves 64 are mounted on a stem 61 whose movement is retarded by a friction spring 66. The ends of the stem 61 carry cross pieces 65. The exhaust valves 64 are mounted outside of the hollow piston 60. An exhaust port 59 is provided in the wall of the

pipe 45 diametrically opposite from where the tube 57 enters the pipe. There are seats provided in the top and bottom walls of the hollow piston for the valves 64 and there are seats provided interiorly of the hollow piston for the intake valves 63.

The manner in which the compressed air led downwardly through the tube 57 causes reciprocation of the cutter will now be described. When the live air passes outwardly through the end 58 and into the interior of the hollow piston, and if we suppose the parts to be in the position of Fig. 2, the air will pass under the unseated intake valve 63 and through the lower piston port in which the stem 62 loosely fits, and the piston chamber 49 will become filled with live air, whereupon it will move downwardly and strike against the tool head. When the upper cross piece 65 provided on the end of the exhaust valve stem 61 engages with the upper wall of the valve chamber 49, the lower exhaust valve 64 will be unseated, whereupon the compressed air in the piston chamber may pass out through the hollow piston 60 to the discharge port 59 and upwardly through the pipe 45. The upper exhaust valve 64 will now be seated, while the lower intake valve 63 will also be seated. Air pressure admitted from the tube 57 will now be led to the upper side of the piston 60, causing upward movement of the member 47 until the lower wall of the piston chamber engages the cross pieces 65 on the valve stems for effecting a re-shifting of the valves. The friction springs 66 hold each valve stem in either position until it is shifted by engagement with the end walls of the piston chamber. The stroke of the member 47 may be varied by moving the cross-pieces 65 along the valve stem or by changing the shape of the same so that the valves will be closed sooner or later, as desired.

Reciprocation of the hollow piston chamber causes a downward movement on the part of the cutter head 15 and the drill casing 17. The latter carries with it the well casing 20. The upper end of the piston chamber 49 is closed by a stuffing box 68 removably secured to the air chest 47 by screw threads 67. The stuffing box surrounds the pipe 45 and has a bore receiving packing 73. A gland 72 and a ring 71, respectively similar to the gland and ring of the previously described stuffing box, provide means for holding the packing in compressed condition about the pipe. In the lower part of the stuffing box 68 is a wall 74 having a sliding fit upon the pipe 45.

A clutch member 75 provided with a plurality of ratchet teeth 76 on its upper face is connected by a plurality of arms 70 and by studs or the like 69 to the stuffing box 68. As the stuffing box in turn is secured upon the upper end of the air chest 47, it will be clear that reciprocation of the air chest is participated in by the clutch member 75.

The upper face of the clutch member 75 has a recess 77 for receiving a coil spring 78. This coil spring is also received by a recess 79 provided in an upper clutch member 80. The last named element has ratchet teeth 82 similar to the ratchet teeth 76. In the illustrated embodiment of the invention, there are twelve of the ratchet teeth for each clutch member, but any other number may be employed. The upper clutch member 80 is shown separately in Fig. 4, and as there seen, has a plurality of spiral slots 81 on its periphery. It is preferred that there be four of these spiral slots.

A ring 89 having inwardly projecting blocks 90 is secured interiorly of the drill casing 17 by screws 88. Each block 90 is received within a spiral slot 81. The spiral slots cause turning of the clutch member 80 a fraction of a turn with each stroke of the air chest. If there be twelve ratchet teeth employed in the clutch, each slot should rotate the upper clutch member 80 one-twelfth of a turn. Hence, with each reciprocation of the hammer one of the ratchet teeth 82 will be presented to a different one of the ratchet teeth 76. The spring 78 is designed to keep the clutch members separated when the parts are inactive. The lower clutch member 75 has an extension 83 surrounding the pipe 45 and set between the clutch member 80 and said pipe. The extension 83 is screw-threaded at its upper end, as at 87, and projects beyond the upper end of the clutch member 80. A spiral spring 85 is held upon the projecting end of the extension 83 and fits in a recess 84 of the clutch member, and a nut 86 engages with the screw threads 87 to hold the spiral spring 85 in place. The spiral spring 85 prevents the upper clutch member 80 from separating too far from the lower clutch member 75, whereby member 80 may be said to be balanced between the two springs.

When the air chest or hammer 47 is reciprocated by the action of the air upon the air chest in the manner which has been described, it will alternately engage and disengage the clutch members. When the air chest moves upwardly the clutch engages; when it moves downwardly the clutch parts are separated. Upward strokes of the air chest cause upward movement of the clutch member 80. The latter because of the action of the slots 81 on the blocks 90 secured to the drill casing, produces turning of the casing through one twelfth of a revolution or through thirty degrees.

The combined turning and hammering of the cutter makes the tool a very efficient one in boring its way into the earth. Each downward stroke of the drill casing forces

the well casing further into the ground. The compressed air led to the bottom of the hole by the tube 39 forces the cuttings upwardly between the tool casing and the well casing to the surface of the ground. Thus it is seen that the tool is self-acting and does not depend upon a rotating cable to bore its way through the earth, as is common with so many earth boring tools. In many details of construction and operation, I regard the tool as broadly new and desire to be limited only by the scope of the appended claims.

What is claimed is:—

1. A pneumatic drill for earth boring comprising a cutter, a cylinder supporting the cutter, a drill casing connected to the cylinder, reciprocating dogs supported by the cylinder for reaming out the hole in advance of the well casing, and positively reciprocated means in the cylinder for actuating the reaming dogs.

2. A drill for earth boring comprising a cutter, a cylinder supporting the cutter, means for delivering hammer blows to the cylinder, a drill casing connected to the cylinder, means for reaming out the hole in advance of the well casing, reciprocable means in the cylinder for actuating the reaming means, and means for turning the drill casing and cutter.

3. A drill for earth boring comprising a cutter, a cutter head supporting the cutter, a drill casing connected to the cutter head, a well casing surrounding the drill casing, means for delivering hammer blows to the cutter head and hence to the drill casing, and means whereby the drill casing engages the well casing to drive the latter downwardly.

4. A pneumatic drill for earth boring comprising a cutter, a cutter head supporting the cutter, a drill casing connected to the cutter head, a well casing surrounding the drill casing, means supported by the cutter head for reaming out the hole in advance of the well casing, reciprocable means in the cutter head for actuating the reaming means, means for turning the drill casing and cutter, means for delivering hammer blows to the cutter head and means whereby the drill casing engages with the well casing to drive the same downwardly.

5. A pneumatic drill for earth boring comprising a cutter, a cutter head supporting the cutter, a drill casing connected to the cutter head, a well casing surrounding the drill casing in spaced relation thereto, means supported by the cutter head for reaming out the hole in advance of the well casing, means whereby the drill casing engages with the well casing to drive the same downwardly, and means for conducting live air through the cutter to the bottom of the hole whereby the cuttings are forced upwardly between the well casing and the drill.

6. A pneumatic drill for earth boring comprising a cutter, a cylinder supporting the cutter, a drill casing connected to the cylinder, means supported by the cylinder for reaming out the hole in advance of the well casing, said means comprising a piston reciprocable longitudinally of the cylinder, dogs reciprocable radially of the cylinder, and means for connecting the piston with the dogs, said dogs projecting outwardly therefrom the maximum distance when the piston is in its uppermost position and withdrawing within the drill when the piston is farthest down.

7. A pneumatic drill for earth boring comprising a cutter, a cylinder supporting the cutter, a drill casing connected to the cylinder, means supported by the cylinder for reaming out the hole in advance of the well casing, said means comprising a piston reciprocable longitudinally of the cylinder, dogs reciprocable radially of the cylinder, slotted arms secured in angular positions on the under side of the piston, and pins pivotally connecting the dogs to the arms and slidable in the slots, said dogs projecting outwardly therefrom the maximum distance when the piston is in its uppermost position and withdrawing within the drill when the piston is farthest down.

8. A pneumatic drill for earth boring comprising a cutter, a cylinder supporting said cutter, a piston reciprocable in the cylinder, reaming means projecting from said cylinder and connected with said piston, a pipe set coaxially of the cylinder, said piston being slidable on the pipe, tubing extending coaxially of the pipe and of the cutter for discharging live air at the lower end of the cutter, said pipe being closed to the cylinder except at a point below the lowermost position of the piston, and means for delivering live air into the cylinder above the piston and into said pipe.

9. A pneumatic drill for earth boring comprising a cutter, a cylinder supporting said cutter, a piston reciprocable in the cylinder, arms secured to the lower part of the piston and extending at an angle thereto out to the side wall of the cylinder, slots receiving the outer ends of said arms, transverse slots in the cylinder walls, dogs slidably held within the transverse slots, and means connecting the arms and dogs whereby the dogs are reciprocated when the piston is reciprocated.

10. A pneumatic drill for earth boring comprising a drill casing, a cutter supported on the lower end thereof, means for delivering hammer blows to the cutter, and independently acting means for reaming out the hole in advance of the well casing.

11. A pneumatic drill for earth boring

comprising a drill casing, a cutter supported on the lower end thereof, means for delivering hammer blows to the cutter, independently acting means for reaming out the hole in advance of the well casing, and separate and independent means for cleaning out the hole.

12. A pneumatic drill for earth boring comprising a drill casing, a cutter supported on the lower end thereof, means for delivering hammer blows to the cutter, means for rotating the cutter a portion of a revolution with each reciprocation, and reciprocating dogs actuated independently of the cutter and drill casing but rotated with said parts.

13. A pneumatic drill for earth boring comprising a drill casing, a cutter supported at the lower end thereof, a pipe secured to the cutter, means for delivering hammer blows to the cutter, tubing for conducting live air to the drill housed in said pipe, and means whereby the actuation of the hammer blow delivering means causes step by step rotation of the cutter.

14. A pneumatic drill for earth boring comprising a drill casing, a cutter supported at the lower end thereof, a pipe secured to the cutter, a clutch mounted on said pipe, said clutch including a spirally slotted upper member and a lower member, the drill casing having means engaging with said slots, the lower member mounting the upper member, and means tending to separate the two parts of the clutch.

15. A pneumatic drill for earth boring comprising a drill casing, a cutter supported at the lower end thereof, reciprocatory means for driving the cutter into the earth, a pipe secured to the cutter, a clutch mounted on said pipe, said clutch including a spirally slotted upper member and a lower member, the two members having matching ratchet teeth, the drill casing having means engaging with said slots, and the lower member being connected with said reciprocatory means to move therewith into and out of engagement with the upper member, the slots causing turning of the upper member an angular distance equal to the length of one of said teeth.

16. A pneumatic drill for earth boring comprising a drill casing, a cutter supported at the lower end thereof, a pipe secured to the cutter, a clutch mounted on said pipe, said clutch including a spirally slotted upper member and a lower member, the two members having matching ratchet teeth, the drill casing having means engaging with said slots, resilient means normally holding the clutch members apart, and similar means preventing too great a separation of said members whereby the upper clutch member is balanced between the two resilient means.

17. A pneumatic drill for earth boring comprising a drill casing, a cutter supported at the lower end thereof, a pipe secured to the cutter, a clutch mounted on said pipe, said clutch including a spirally slotted upper member and a lower member, the two members having matching ratchet teeth, the drill casing having means engaging with said slots, opposed recesses provided on the two clutch members interiorly of the ratchet teeth, a spiral spring housed in said recesses and holding the clutch members normally disengaged, the lower clutch member having an extension, the upper clutch member being slidable on the extension, and a spiral spring interposed between the extension and the upper end of the upper clutch member for preventing undue separation of the parts of the clutch.

18. A pneumatic drill having a cutter, reciprocatory means for hammering said cutter, reaming bits, means for operating the bits independently of the cutter, and means for turning the cutter a part of a revolution at every up-stroke of the reciprocatory means.

19. A pneumatic drill having a cutter and a casing supporting the cutter, means for driving the cutter downward by hammer blows, said casing carrying a well casing along with it, means for reaming out the hole for the well casing, pneumatic means for forcing the cuttings upwardly between the two casings, and means connected to the drill casing and engaged by said driving means when moving away from the cutter whereby the drill casing and cutter are turned through a portion of a revolution intermittently and in the same direction.

20. A pneumatic drill comprising a drill casing, a cutter supported at the lower end thereof, means for delivering hammer blows to the cutter, a clutch supported within the casing for step-by-step movement, means connecting the clutch with the hammer blow delivering means to move the said clutch, and means connecting the clutch with the drill casing to cause the turning of the latter.

21. A pneumatic drill comprising a drill casing, a cutter supported at the lower end thereof, means for delivering hammer blows to the cutter, and means within the drill casing and connected thereto and also connected to the hammer blow delivering means whereby the upward or inward movement of the last-mentioned means effects the turning of the drill casing.

22. A pneumatic drill comprising a drill casing, a cutter supported at the lower end thereof, means for delivering hammer blows to the cutter, reaming bits for reaming out the hole made by the cutter in advance of the well casing, and means for operating the bits independently of the cutter.

23. A pneumatic drill comprising a drill

casing, a cutter supported at the lower end thereof, an air chest constituting a hammer to deliver blows to the cutter, means for actuating the air chest to reciprocate the same, means for rotating the drill casing and cutter intermittently and in the same direction, and means connecting the air chest with the said rotating means to translate the reciprocating movement of the air chest into a turning movement for the drill casing and cutter.

24. A pneumatic drill having a cutter and a casing supporting the cutter, means for driving the cutter downward by hammer blows, and means connected to the drill casing and engaged by said driving means when moving away from the cutter whereby the drill casing and cutter are turned through a portion of a revolution intermittently and in the same direction.

In testimony, that I claim the foregoing as my own, I have hereto affixed my signature.

WILLIAM MABLE.