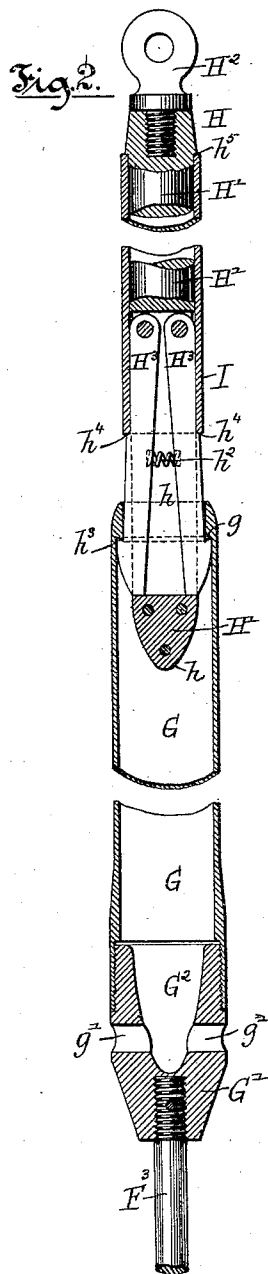
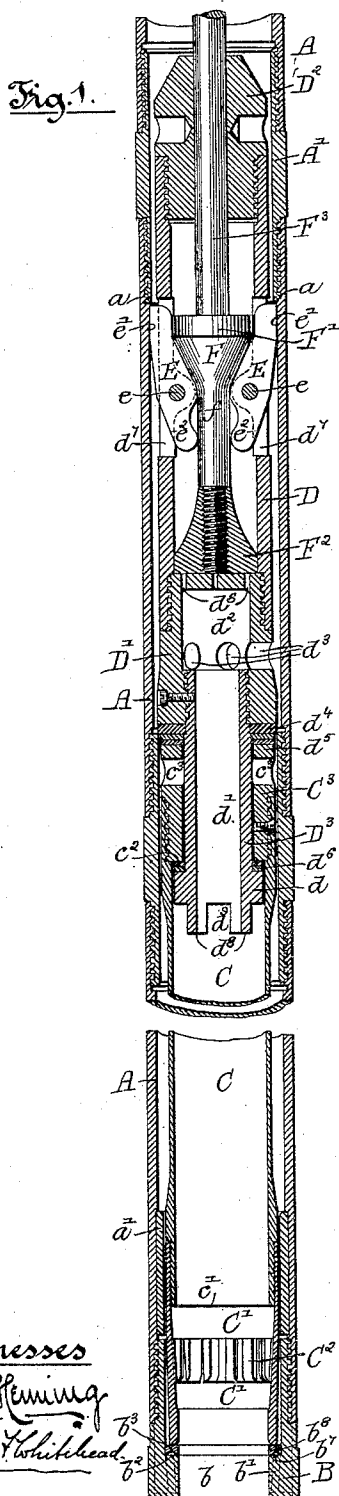


M. C. BULLOCK.
ART OF ROCK CORE DRILLING.

No. 473,910.

Patented May 3, 1892.



Witnesses

Wm. J. Heming
John M. Whithead

Inventor
Milan C. Bullock

by Clayton, Poole & Brown
Attorneys.

(No Model.)

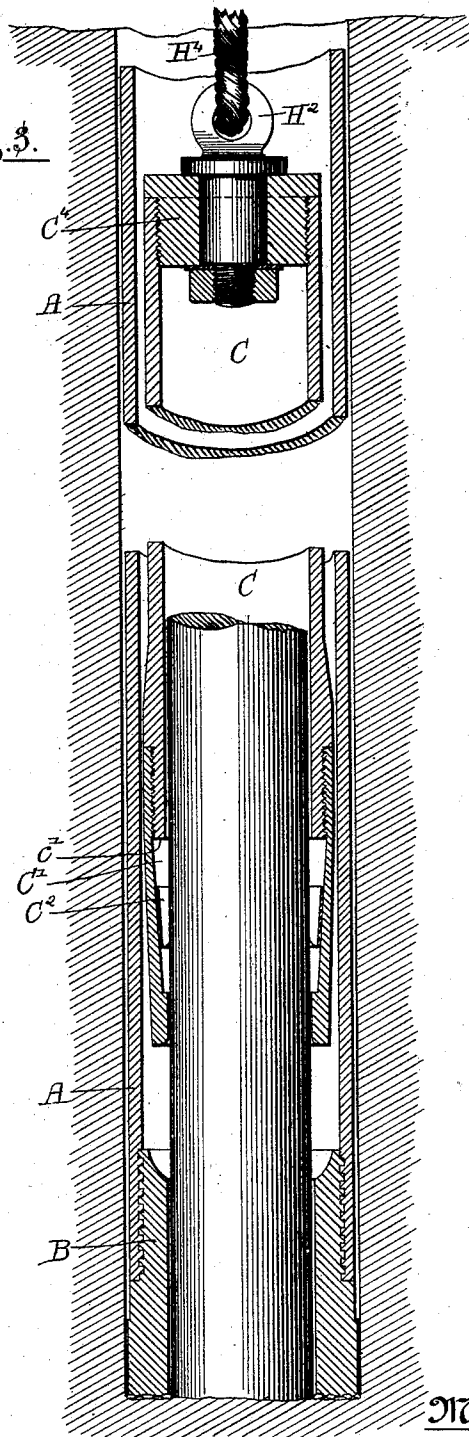
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Fig. 3.



Witnesses

Wm. F. Fleming.
Louis M. F. Whitehead.

Inventor

Milan C. Bullock

by Dayton, Poole & Brown
Attorneys.

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Fig. 4.

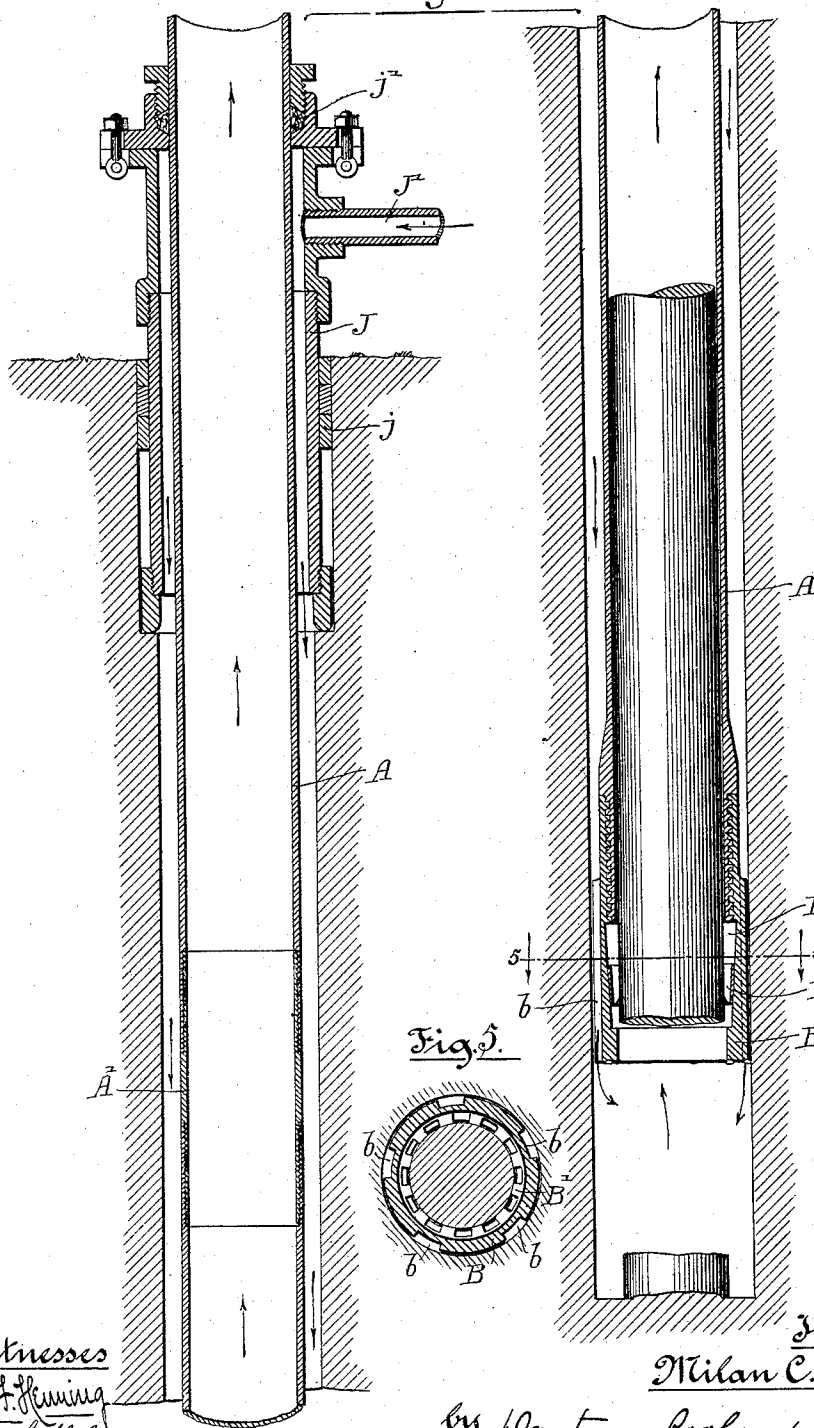
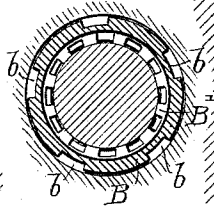


Fig. 5.



Witnesses
Wm. F. Fleming
Louis H. Holbrookhead.

Inventor
Milan C. Bullock
by Clayton, Poole & Brown
Attorneys.

UNITED STATES PATENT OFFICE.

MILAN C. BULLOCK, OF CHICAGO, ILLINOIS.

ART OF ROCK-CORE DRILLING.

SPECIFICATION forming part of Letters Patent No. 473,910, dated May 3, 1892.

Application filed February 24, 1891. Renewed November 3, 1891. Serial No. 410,715. (No model.)

To all whom it may concern:

Be it known that I, MILAN C. BULLOCK, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in the Art of Rock-Core Drilling; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in the art of rock-core drilling and more especially to the method of withdrawing the core from a hole drilled or being drilled.

The invention consists, broadly and essentially, in withdrawing the core upwardly through the hollow drill-tube, while the drill-tube itself is allowed to remain in the hole either at work or at rest.

Heretofore, in the employment of hollow drills for cutting the hole and leaving a core, to withdraw the core the drill-tube has been lifted entirely out of the hole, bringing the core with it. This is an operation which involves the expenditure of a large amount of time when the hole has reached a considerable depth and adds greatly to the cost of this mode of drilling. For example, when the hole has reached the depth of two thousand feet about ten hours of continuous work is required to withdraw the drill-tube, remove the core from the latter, and return the tube into the hole ready for resumption of drilling. By the method herein set forth the core can be withdrawn from the same depth in a space of twenty minutes or half an hour. The core being taken out in sections, usually not exceeding fifteen to thirty feet in length, and the operation of removing the core being therefore repeated at every advance of the drill to this distance, the great utility of the present improvement becomes apparent.

Numerous forms of apparatus may be employed for carrying my improved method into effect, three of which are herein illustrated. In one of these—namely, that which is illustrated in Figures 1 and 2—the core-lifter is intended to be present within the lower end of the drill-tube during the operation of drilling and forming the core, while in that form shown in Fig. 3 the core-lifter is not necessarily pres-

ent during the operation of drilling and forming the core, but is intended to be lowered into the core-barrel and into a position embracing the core when the latter is to be withdrawn. In Fig. 4 an apparatus is shown which is without any mechanical devices for lifting the core, the latter in this case being forced upwardly by means of an upward current of water within the drill-tube. Describing these figures more specifically, Fig. 1 is a central vertical section of the lower end of a tubular drill-rod, terminating in one of many possible forms of tubular cutter-head, and also a corresponding section of a tubular core-lifter, together with devices for returning the core-lifter in its place at the bottom of the drill-tube. This figure also shows a construction of the core-lifter or core-barrel and its attachments, whereby the barrel may not necessarily partake of the rotary movement of the drill-tube, or, in other words, whereby the barrel may remain stationary; or if it should rotate its rotary speed may be less than that of the drill-tube. In the upper part of Fig. 1 is also shown a mechanism for locking and releasing the devices which detachably fasten the core-barrel in the drill-tube. Fig. 2 shows in its lower part a tube connected with the locking and releasing devices of Fig. 1, together with a harpoon adapted to be lowered into the tube for seizing the core-barrel by its connections and first releasing and then lifting it with the core through the drill-tube. Fig. 3 shows the lower end of a drill-tube in position in a hole being drilled in rock, a rock-core standing in the drill-tube, and a core-lifter which is being let down into the drill-tube and around the core preparatory to lifting out the latter. Fig. 4 shows in central vertical section the upper and lower ends of a tubular drill-rod adapted for the forcing of a current of water downwardly without and upwardly within said drill-rod. Fig. 5 is a sectional view on line 5 5 of Fig. 4.

First describing fully the mechanism shown in Figs. 1 and 2, A A is a tubular drill-rod composed of sections of tubing connected by suitable couplings A' A'.

B is any suitable form of annular drill or cutter head, which is shown in Figs. 1 and 3 as a single piece attached to the lower end of the drill-rod A, but which may be otherwise

constructed. By the rotation of the drill-rod and the cutter-head an annular cut will be made in a rock, leaving a central core standing within the drill-tube A. The cutter-head B is commonly armed with diamonds; but for the general purposes of my invention it may be constructed in any suitable manner to cut away the rock, so as to leave a core.

C is the core-lifter or core-barrel located within the tubular drill-rod A and adapted in size to be raised and lowered therein. It occupies the lower part of the drill-rod and is of any desired length, being commonly from sixteen to thirty feet long or of sufficient length to accommodate the longest section of core which it may be desired to take out at one time. Interiorly the core-barrel is of about the same diameter as the central passage b through the cutter-head, or it may be slightly larger than said passage. The core-barrel when to be retained in the drill-tube, as stated, will be commonly supported upon an annular shoulder projecting from the inner surface of the drill-rod. In the present instance such a shoulder is shown as being formed by the upper end of the coupling A' of the drill-rod seen at the lower end of Fig. 1, and the core-barrel structure is seen to be supported from this shoulder by the loose steel ring d^1 . The lower end of the core-barrel is shown in the same figure as also resting upon a loose ring b^3 , which is in turn supported by an annular shoulder b^2 on the inner surface of the cutter-head B.

The core-barrel C is provided near its lower end with a conical enlargement C' of its interior space, having its greater diameter at the top, and within this conical enlargement or recess is located a contractible metal ring C² for the purpose of gripping and thereby breaking and upholding the core when the core-barrel is raised. The ring C² is open at one side to permit of its spreading and contracting, and it is also desirably slashed or cut part way through vertically from the interior at several points, as shown, so as to be freely flexible. The gripping-ring C² is of such normal diameter as to drop to or near the lower part of the conical recess C', and in this position its interior diameter is less than that of the core which will be left by the drill. On the other hand, when expanded on the upper part of the conical recess C' the ring C² will have an interior diameter large enough to permit the core to pass through it. The ring will be forced upward and expanded by the core as the latter is formed and the core-barrel descends, and when the core-barrel is lifted the ring, which embraces it closely, will be moved into a lower and narrower part of the conical recess. This causes the ring to bite or grip the core, and through this gripping action of the ring the core will be broken off and brought upward with the core-barrel. This gripping-ring or core-breaker has been used in the older method referred to.

To the upper end of the core-barrel C is se-

cured a tubular head C³, presenting an interior shoulder c^2 at its lower end and having lateral passages c^3 for water. Above the head C³ of the core-barrel is located a short tube D, having at its lower end an axially-recessed head D' and at its upper end a longitudinally-pierced head D², secured thereto by screw-threads, as shown, or otherwise in any suitable manner. The head D' is connected to the head C³ by means of a swivel-pin D³, which is provided at its lower end with a head or enlargement d_1 extending beneath the shoulder c^2 on the head C³, and at its upper end is screwed or otherwise fastened to the lower end of the head D'. This swivel-pin D³ thus forms a connection between the head D' and the head C³, which permits their relative rotation and through which the core-barrel may be raised by force applied to the head. The central passage d' through the pin D³ communicates with the recess d^2 in the head D², and from the latter extend radial openings d^3 to afford passage for water, either from the interior of the core-barrel to the interior of the drill-rod, or in the opposite direction, according with the mode of introducing water to the cutter. Between the heads D' and C³ are desirably placed steel friction-rings d^4 d^5 , and between the shoulder c^2 and the head d_1 are placed corresponding rings d^6 .

In the walls of the tube D, between the heads D' and D², are cut a series of vertical slots d^7 , in which are fitted dogs E, mounted between their ends on pivots e , and having their outer faces e' e^2 , respectively, above and below these pivots arranged at an obtuse angle with each other, as shown, so that when the upper ends of the dogs are thrown outward through the slots into bearing against the drill-tube A the lower ends stand inward, and vice versa. The dogs E are so placed that when the core-barrel rests upon its supporting-shoulder, as described, they may be expanded to project beneath the lower end of an adjacent coupling A' in the drill-tube, which coupling forms a shoulder a , having its face directed downwardly. The dogs E therefore retain the core-barrel in its proper position against any tendency on the part of the core or of water-pressure within the drill-rod to raise it.

For the purpose of expanding and retracting the upper ends of the dogs E a spool F is provided, consisting of two cones F' F², connected with their smaller ends toward each other by a spindle f . The spool F has a vertical movement between the heads D' and D², and in a downward movement of said spool to the position shown in Fig. 1 its upper cone F' descends between the upper ends of the dogs E and forces them outward, while an upward movement of the spool brings the lower cone F² between the lower ends of the dogs and, spreading these, contracts the upper end of said dogs, so as to release them from engagement with the shoulder a or to enable them to clear said shoulder. When the dogs

E are thus retracted, the core-barrel and its immediate connections may be all lifted out of the drill-rod, and in such upward movement of the core-barrel the core is gripped firmly by the ring C^2 and broken off, allowing the core, which occupies the core-barrel C, to be withdrawn with said core-barrel precisely as in former constructions, in which the core-barrel is part of the drill-rod.

The lifting of the core-barrel and its adjuncts described is accomplished through the medium of a short rod F^3 , which is connected with the upper end of the spool F, and passing through the axial aperture in the head D^2 is attached at its upper end to a part adapted to be engaged by the grapple. Such part, as here illustrated, consists of a tube G, having near its upper end an inner annular undercut shoulder g , and at its lower end a head G^2 , provided in its upper end with a recess G^2 . This head G^2 is fastened to the rod F^3 , which rod is enough larger than the head D^2 , through which it passes, to allow of the desired vertical movement of the spool F between the heads D^2 and D^2 .

H, Fig. 1, is a harpoon or grapple consisting of a rod H^1 , having at its upper end an eye H^2 for the attachment of a suitable rope. The lower end of the rod H^1 is contracted, desirably, to a conical form, as shown at h , and through the rod is a slot h' , extending nearly to the lower end. Within this slot are pivoted at their upper ends two expanding dogs H^3 , normally held apart or spread at their lower ends by a spring h^2 . The dogs are provided each with a shoulder h^3 on its outer face and near its lower end adapted in form to reliably engage with the correspondingly-shaped annular shoulder g on the inside of the tube G. A shoulder h^4 is provided at a higher point on one or each of said dogs.

I is a sleeve, which loosely surrounds the rod H^1 , and which, when raised, rises above the shoulder or shoulders h^4 on the dog or dogs and is supported thereby. The sleeve I is in thickness about equal to the projection of the shoulder h^4 and equal to or greater than the projection of the shoulders h^3 on the dogs and in diameter less than the mouth of the tube G. The dogs at the lower shoulder may therefore be sprung inward a distance equal to the length of said shoulders without releasing the sleeve from the upper shoulder or shoulders; but a further and sufficient retraction of the lower ends of the dogs will let the sleeve I fall. The dogs H^3 are so proportioned and constructed that when the sleeve I is in its upper position, as shown in Fig. 1, they may expand beneath the shoulder g on the tube G; but when the dogs are forced inward, so that their shoulders h^3 only project beyond the diameter of the rod H^1 , the tube I will drop down over them and against the shoulder h^4 thereon, and thereby retain the dogs in their retracted position. In this retracted position of the dogs they may manifestly pass out of the tube G without engag-

ing with the shoulder g . Below the shoulder h^3 the dogs are tapered to their ends, so that their lower extremities present no shoulder projecting beyond the diameter of the rod H^1 , but, on the other hand, a continuation of the taper or incline of the point h of said rod. If the grapple be lowered with the dogs extended, therefore it enters the tube G by a partial retraction of the dogs in passing the shoulder g , while if the grapple be still farther lowered until it rests in the recess G^2 its dogs will be found full retracted and its sleeve I will fall until it rests on the lower shoulder h^3 . Accordingly when it is desired to grapple the core-barrel, as when a core is to be withdrawn, the harpoon is lowered only far enough to catch on the shoulder g ; but when it is desired to release the harpoon from the core-barrel, as when the latter is returned to its place, the harpoon is let down within said tube G until it enters and rests with its weight in the recess G^2 , and the dogs H^3 being thus retracted the loose sleeve I drops down over them, after which the harpoon may be raised past the shoulder g and out of the drill-tube.

In letting the core-barrel and its connections down into the drill-tube by means of the harpoon above described the entire structure from the head D^2 downward is manifestly suspended by the rod F^3 and spool F and the upper cone F^1 is in bearing against the lower surface of said head D^2 . The spool is therefore held in its elevated position in this operation, and the dogs E are retained in their retracted attitude by the weight of the suspended structure. As soon, however, as the core-barrel strikes its stop or support the spool F will descend into contact with the head D^2 by its own weight and that of the tube G and head G^2 . In such descent of the spool the lower cone F^2 thereof is removed from between the lower ends of the dogs E and the upper spool F^1 enters between the upper ends of the said dogs and forces them outward, retaining them thus expanded until the spool is again raised.

To facilitate the lifting of the spool F, the upper end of the recessed head D^2 is provided with one or more passages d^3 for air or water for the equalization of pressure on the opposite surface of the spool.

Water may be supplied to the cutter at the lower end of the tubular drill-rod either by the long familiar mode of sending it downward through the rod and allowing it to rise outside the rod to the surface of the ground or rock or by sending the water downward through the hole externally to the drill-tube and upwardly through the latter. To facilitate the passage of water from the exterior of the drill-rod to the space between the drill-rod and the core-barrel, either of several constructions may be employed.

Fig. 1 shows the cutter-head provided with external vertical grooves, transverse grooves in the lower face of the cutter, and vertical holes through the inner projecting part of the

cutter, said holes opening at the ledge b^2 . If the friction-ring b^3 be present, it may be provided with an annular groove b^7 in its lower face in constant communication with the before-mentioned holes in the cutter-head and with a series of vertical holes b^8 through the ring, leading from this annular groove b^7 to the space between the drill-tube and the core-barrel. A sufficient quantity of water will usually pass beneath the face of the cutter (between the diamond-points or other cutting projections thereon) from outside the drill-rod into the core-barrel around the core, or vice versa, to carry up the detritus, so that the transverse grooves indicated may be omitted. The ring b^3 may be omitted.

In Fig. 1 the lowermost coupling A' of the tubular drill-rod is shown as approximating the exterior surface of the core-barrel and tubular head C^3 , and in Fig. 2 the drill-tube is shown as having an exterior sleeve a' just above the cutter-head, which similarly approximates the lower end of the core-barrel. While the space between the core-barrel and the coupling and sleeve mentioned is sufficient to allow free rotary motion of the one relatively to the other and also a sufficiently free passage for water about the core-barrel to prevent the latter from binding in the drill-tube, such space is, on the other hand, small enough to insure sufficient external support for the core-barrel and to prevent undue vibration of the latter as the drill-tube is rotated and consequent breaking up of the core.

The lower end of the swivel-pin D^3 is shown in Fig. 1 as being provided with projections d^8 , having spaces d^9 between them. These projections will be struck by the top of the core should the latter be cut long enough to reach them, and notwithstanding such contact the water will have free passage through the spaces d^9 . The projections d^8 therefore prevent interruption of the proper movement of water to the surface should the core be allowed to reach the extreme upper end of the core-barrel.

It will be understood that the swiveled connection of the core-barrel proper (shown in Fig. 1) is one that allows the tube D to rotate with the drill-tube through the bearing contact of the dogs E with the shoulder a or other contact, while the core-barrel C may stand still with the core or may rotate only slightly from contact with both the rotating drill-tube and the core. Such slight rotation of the core-barrel is not sufficient to destroy or seriously wear away the core itself, although the latter be quite soft.

In Fig. 3 the core-lifter consists of the tube C , provided near its lower end with the upwardly-widened conical recess C' and the expanding ring C^2 in said recess, together with a head C^4 at its upper end, in which is swiveled an eye H' for the attachment of a rope H^4 , by which the core-lifter may be lowered into the drill-tube A and withdrawn upwardly

therefrom. In lowering this simple form of core-lifter into the drill-tube it is held concentric, or substantially so, with the drill-tube by proximity with the walls of the latter and drops over the core of rock, which is seen in this Fig. 2, to raise within the drill-tube. In this dropping of the core lifter or tube C over and around the rock-core the gripping-ring or core-breaker C^2 is extended by the core and raised thereby until it strikes the shoulder c' , after which it is forced down around the core by contact with said shoulder and with the core in the same way in which the core rises into the stationary tube C of the preceding Fig. 1. When the core-lifter of Fig. 3 in being lowered strikes the cutter-head or the head C^4 strikes the top of the core, it will be raised by an upward pull upon the rope H^4 , which results in gripping, breaking, and lifting the core, as in the former case described. The drill-tube A may not only be kept at the bottom of the hole, but may even be kept in operation while the core is being withdrawn, unless such rotation of the drill-tube is thought to imperil the integrity of the core being lifted by imparting a rotary and jarring movement to the core-lifter. In that case the drill-tube may be allowed to rest during this brief time in which the core is being withdrawn.

Still other devices may manifestly be used for seizing and withdrawing the core without lifting out the drill-tube, and thus securing the advantages peculiar to the novel method herein set forth, and, furthermore, the core may be removed upwardly through the drill-tube without the use of a core-lifter or other mechanical lifting device—as, for instance, the core after detachment may be carried or forced upwardly through the drill-tube by an abundant and forcible flow of water forced downwardly exterior to the tube and upwardly within the same. In this case a mechanical device for breaking the core or detaching it from the rock may or may not be necessary. Commonly the rock is so stratified or fissured that the core becomes detached in sections or pieces of suitable length, and no special device is required for breaking the core; but in case it becomes necessary to break the core any well-known or preferable means may be employed for this purpose, the breaking of the core being a separate operation from that of removing it from the hole—as, for instance, the core may be broken into suitable lengths by any well-known form of clamp device located within the tube near its lower end, such as has heretofore been employed for lifting out the core-sections with the drill-rod.

An apparatus adapted for carrying out my novel method in the manner last referred to is shown in Figs. 4 and 5. In this instance A is a tubular drill-rod composed of sections of tubing and connected by suitable couplings, as shown at A' . B is an annular drill or cutter-head which is attached to the lower end of the drill-tube.

B' is a contractible gripping-ring held within a conical recess B² and operating to grip or grasp the core in the same manner as the similar device shown within the lower end of the core-barrel in Fig. 1. At its upper end the drill-tube A is shown as passing through a secondary tube J, which is constructed to form a tight joint with the surrounding walls of the hole by means of packing *j* and is provided with a gland or packing-ring *j'*, through which the drill-rod passes. A water-supply pipe J' communicates with the tube J and affords a means of supplying water to the hole exterior to the drill-rod.

The construction described enables the drill-rod to be rotated and advanced while water is forced downwardly in the drill-hole outside of the said rod. In this case the drill-rod operates in the usual manner and after a section of core is broken off water is forced downwardly outside of the drill-tube and flowing around the drill-head enters the drill-tube beneath the detached section of core and lifts the same upwardly through the drill-rod, the core practically filling the drill-rod, so as to form a piston against the lower end of which the water acts to lift the same.

The cutter-head B (shown in Figs. 4 and 5) is provided with external grooves *bb* to afford a free passage of water past the drill-head, this construction being, however, one which is common and heretofore well known. It will of course be understood that when the drill-head is provided with a gripping-ring B' the core will be broken by lifting the drill-rod preparatory to forcing the water downwardly within the drill-hole to lift the core. The lifting of the core above the bottom of the hole in the manner shown in Fig. 4 preparatory to forcing the water downwardly through the drill-hole is of advantage, inasmuch as it enables the water to act with full force in the first instance against the inner or lower surface of the detached section of core.

It will be seen that when the boring is horizontal or inclined upwardly the core may be

removed through the drill-tube by a less forcible current of water than is necessary for lifting the core in vertical and downward boring.

The method of removing the cylindric section of rock-core, as last above described—to wit., by upward pressure of water beneath the same—affords in itself an important and valuable improvement in the art, and is therefore herein claimed as part of my invention.

As far as the general method described is concerned—to wit., the lifting of the cylindric core-sections through the drill-tube while the latter remains in place within the drill-hole—the core-sections may be lifted by hand-tools inserted through the drill-tube by one of the mechanical lifting devices illustrated by the upward pressure of water from below or in any other manner, the general advantage gained in all cases being the same—to wit., the removal of the core as the drilling progresses without the necessity of frequently removing the drill-rod from the hole.

I claim as my invention—

1. The improvement in the art of rock-core drilling, which consists in forming a cylindric rock-core by means of a tubular drill and removing detached sections of the said cylindric rock-core upwardly through the tubular drill while allowing the latter to remain within the drill-hole, substantially as described.

2. The improvement in the art of rock-core drilling, which consists in forming a cylindric rock-core by means of a tubular drill and removing detached cylindric sections of the rock-core upwardly through the tubular drill by means of an abundant supply of water forced downwardly within the drill-hole outside of the tubular drill and upwardly within the same, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

MILAN C. BULLOCK.

Witnesses:

C. CLARENCE POOLE,
GEORGE W. HIGGINS, Jr.