(No Model.) 3 Sheets—Sheet 1.

M. C. BULLOCK & S. W. DOUGLASS.

ROCK DRILLING APPARATUS.

No. 474,080. Patented May 3, 1892.

Fig 1.

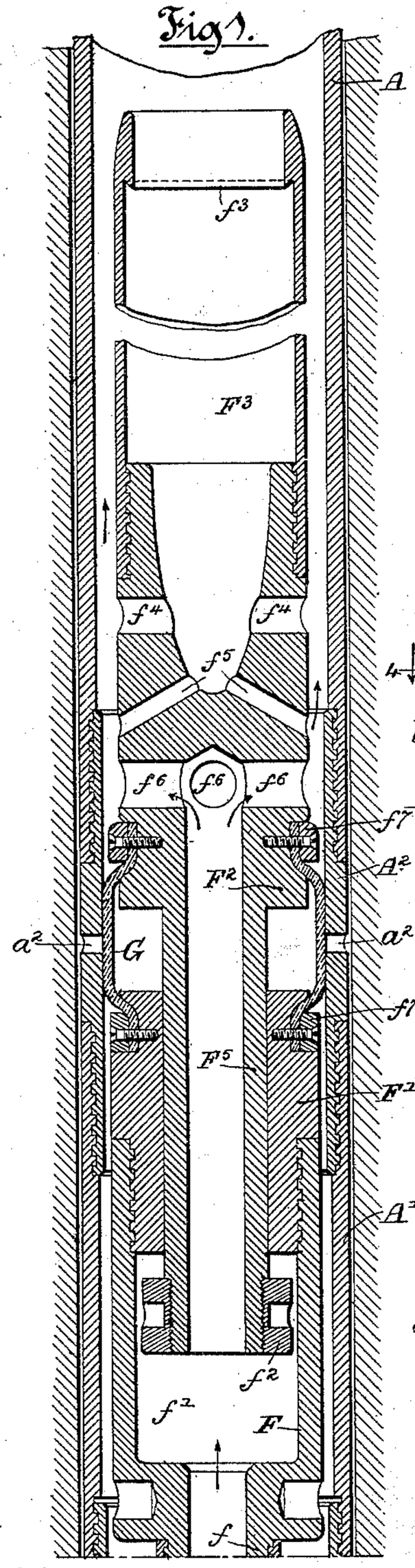


Fig 2.

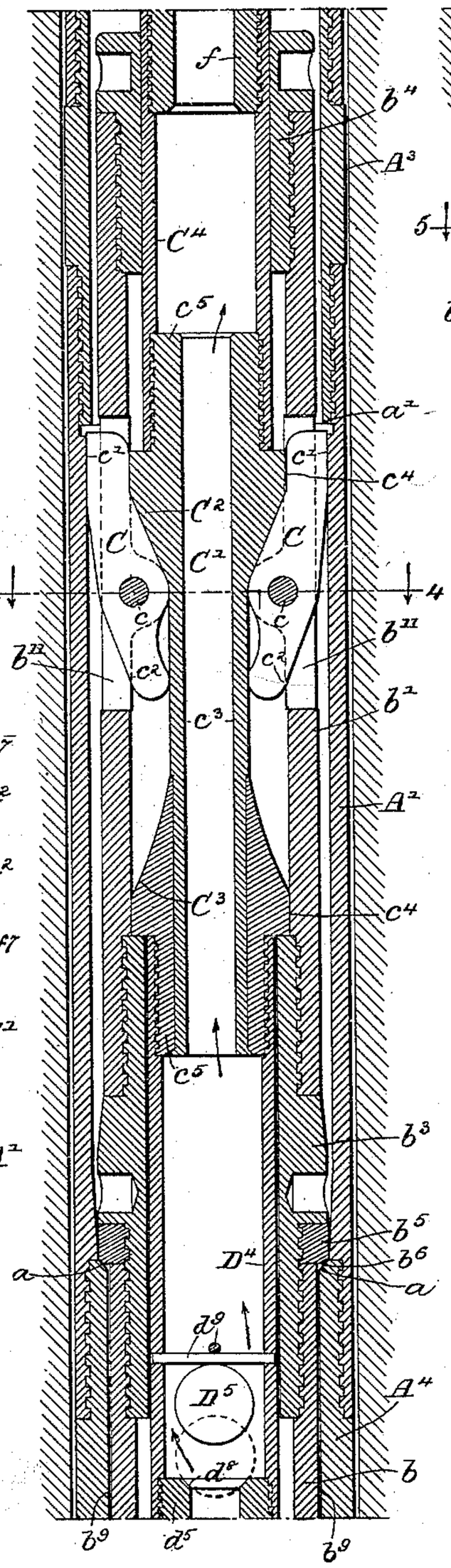
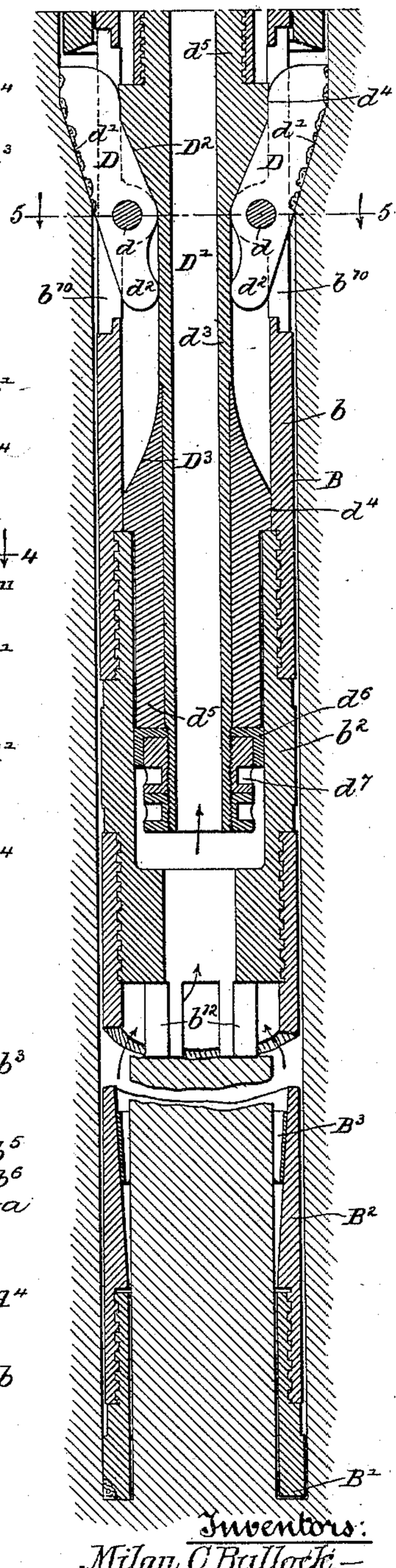


Fig 3.



Witnesses

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(No Model.) 3 Sheets—Sheet 2.

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Fig 4.

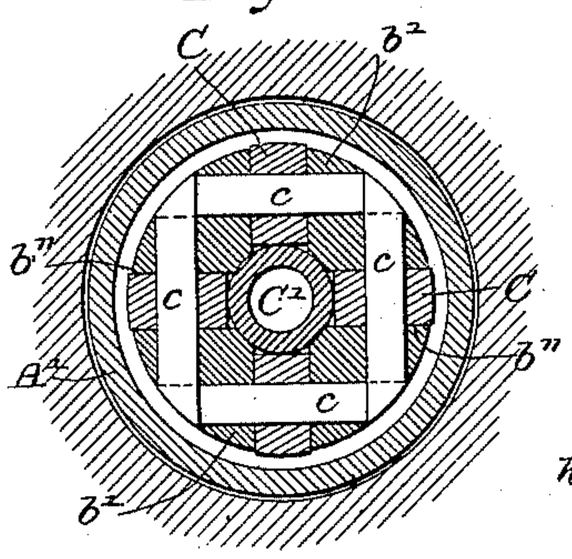


Fig 5.

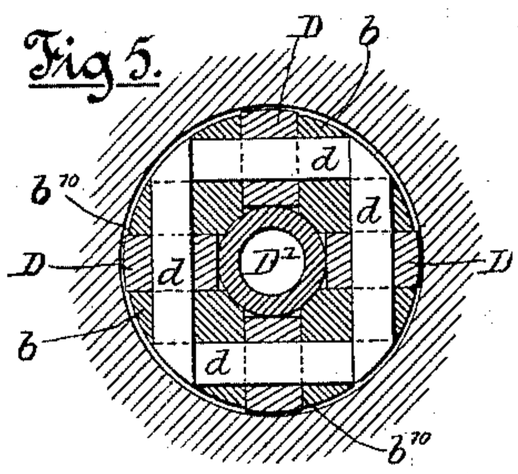


Fig 6.

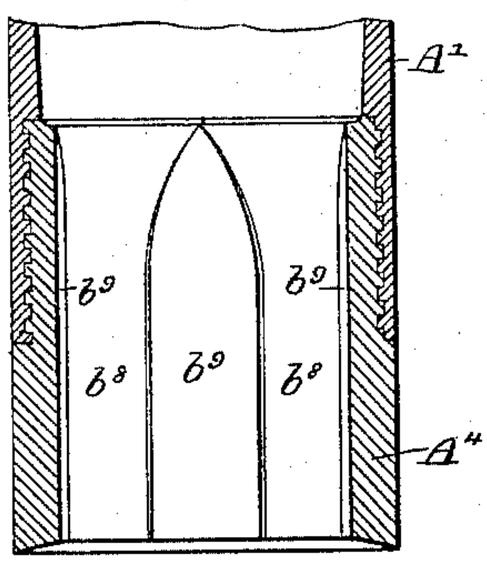
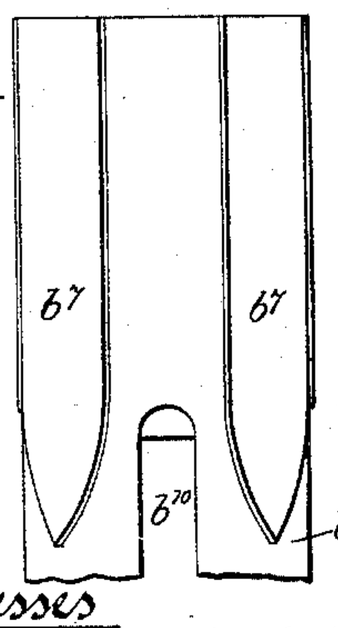


Fig 7.



Witnesses

Wm. F. Hemming. Louis M. T. Whitehead.

Fig 8.

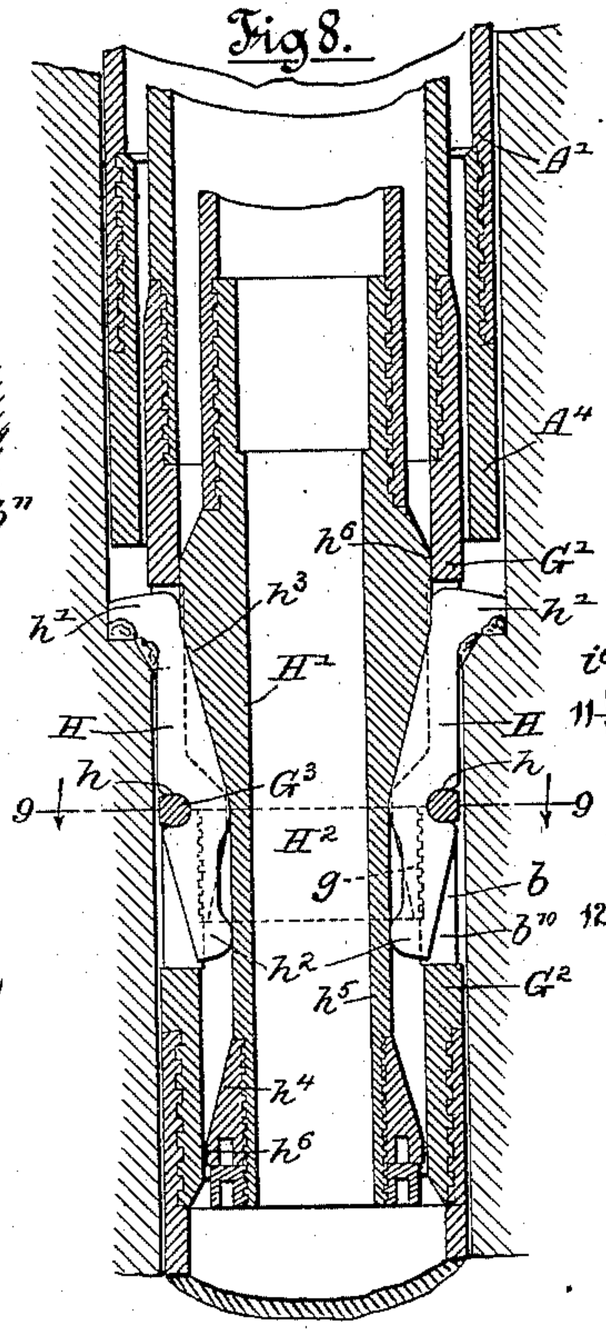


Fig 9.

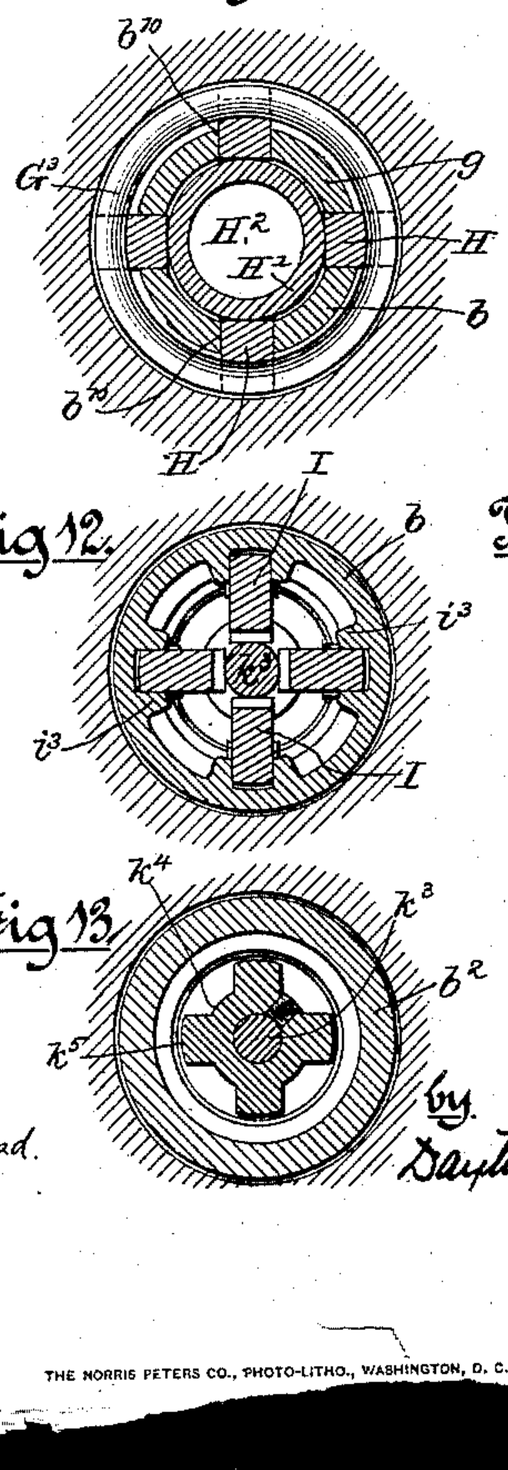


Fig 10.

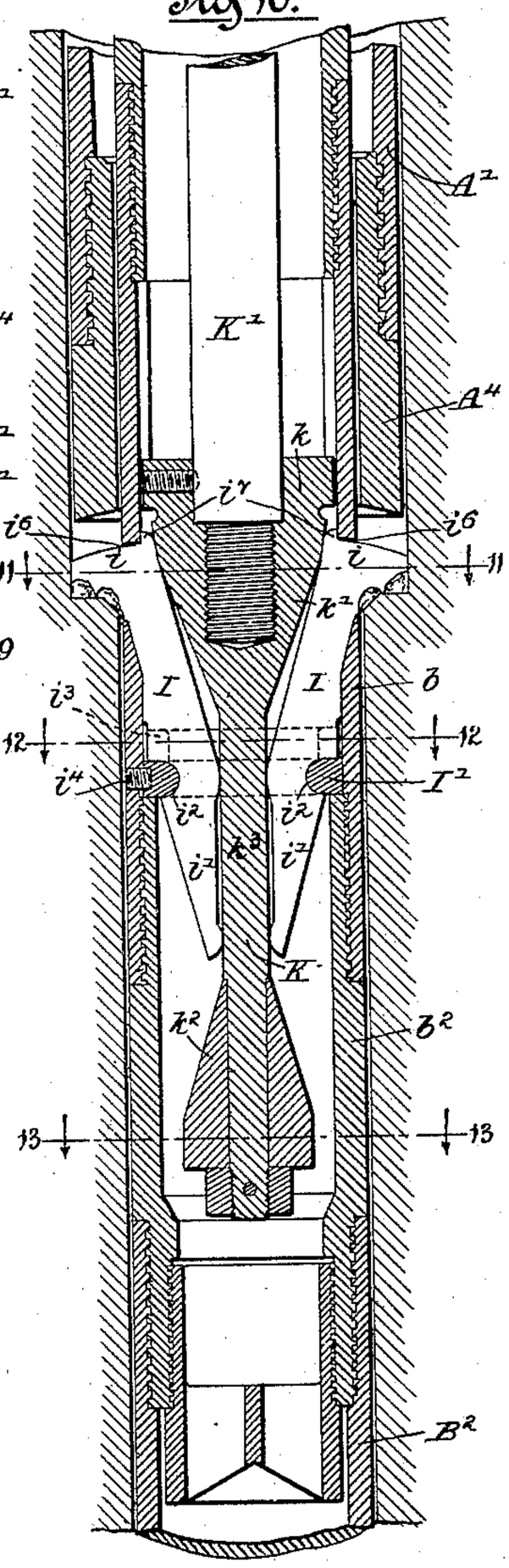


Fig 11.

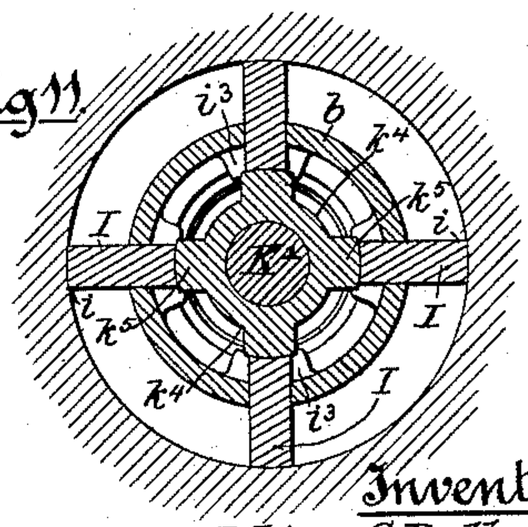


Fig 12.

Fig 13.

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(No Model.) 3 Sheets—Sheet 3.

M. C. BULLOCK & S. W. DOUGLASS.

ROCK DRILLING APPARATUS.

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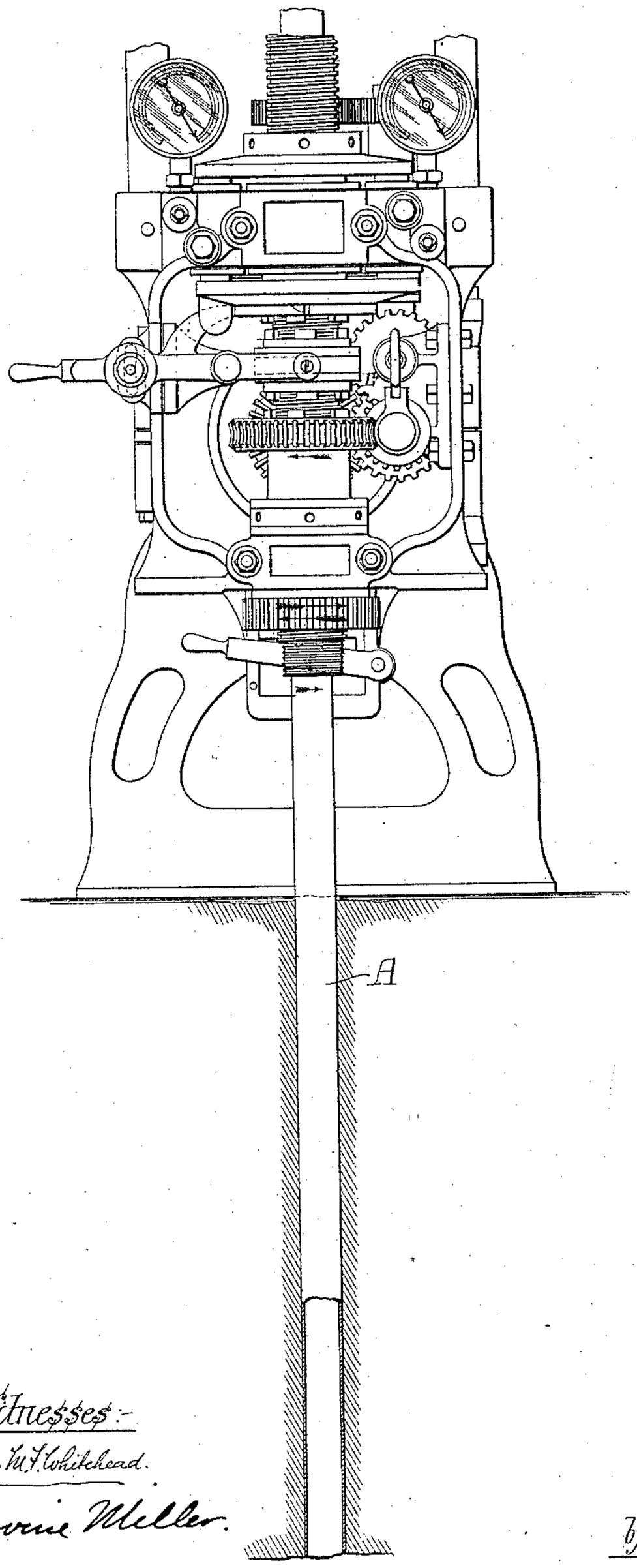
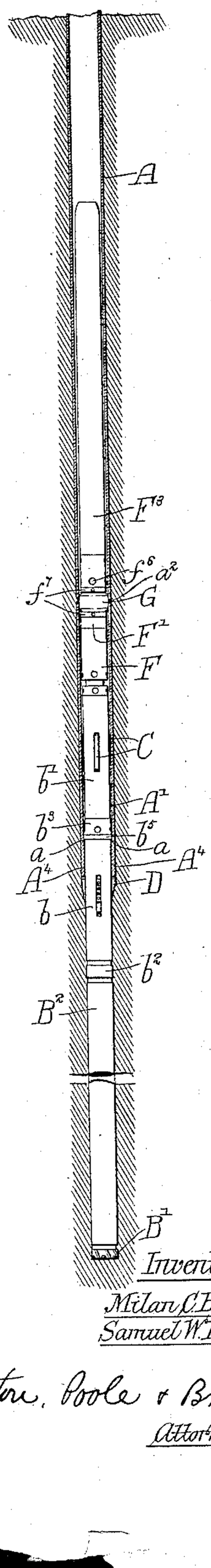
Fig. 14.





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Attorneys.

UNITED STATES PATENT OFFICE.

MILAN C. BULLOCK AND SAMUEL W. DOUGLASS, OF CHICAGO, ILLINOIS;
SAID DOUGLASS ASSIGNOR TO SAID BULLOCK.

ROCK-DRILLING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 474,080, dated May 3, 1892.

Application filed August 29, 1889. Serial No. 322,373. (No model.)

To all whom it may concern:

Be it known that we, MILAN C. BULLOCK and SAMUEL W. DOUGLASS, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Rock-Drilling Apparatus; and we 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 drilling apparatus for earth or rock boring of that class known as "diamond drills," or those having an annular cutting-head and a core-barrel, in which a core is formed as the cutting-head advances, and more particularly to that class of such drilling apparatus having a core-barrel to receive the core and in which the core-barrel and core are removed from the bored hole outwardly through a tubular drill-rod or casing-tube by which the cutting-head is actuated.

The invention consists in the features of construction and combinations of parts hereinafter fully described, and pointed out in the appended claims.

In the drawings, Figures 1, 2, and 3 show in three parts or sections a central vertical sectional view of the lower end of a casing-tube, a cutting-head, and parts connecting the same. Figs. 4 and 5 are views in cross-section taken, respectively, on the lines 4 4 and and 5 5 of Figs. 2 and 3. Fig. 6 is a detail central vertical sectional view of the lower end of the casing-tube. Fig. 7 is a detail view, in side elevation, of the adjacent portion of the part of the coupling device by which the core-barrel is connected with the casing-tube. Fig. 8 is a central vertical sectional view of a modified form of construction embodying my invention. Fig. 9 is a view in cross-section taken on the line 9 9 of Fig. 8. Fig. 10 is a central vertical sectional view illustrating another modification of the parts shown in Fig. 8. Figs. 11, 12, and 13 are sectional views taken, respectively, on the lines 11 11, 12 12, and 13 13 of Fig. 10. Fig. 14 is a view of a drilling apparatus embodying our invention, showing a machine for actuating the casing-tube, the lower part of said casing-tube being in section.

As shown in Figs. 1 to 7 of said drawings, A is an outer casing-tube or tubular drill-rod, which carries at its lower end a cutting-head B′ and a core-barrel B^2 and through which said parts are removed upwardly for taking out the sections of the core. The said casing-tube will be rotated and advanced by a drilling-machine such as is shown in Fig. 14 and fully described in Letters Patent No. 443,819, granted December 30, 1890, or by the use of any other suitable machine.

B is a tubular part smaller than the casing-tube and consisting of a core-barrel having an annular cutting-head and an upper tubular part extending into the casing-tube and provided with devices for connecting the core-barrel with said tube. The cutting-head and core-barrel are smaller in diameter than the casing-tube, and said tubular part B is provided above the core-barrel with a series of reamers, which operate to enlarge the hole made by the cutting-head sufficiently to receive said casing-tube, as hereinafter more fully described.

In the apparatus described in this specification it is intended to drive and rotate the cutting-head, core-barrel, and the reamers, which enlarge the hole to receive the casing-tube from the casing-tube A, by means of suitable connections between the same adapted to be disconnected to allow the withdrawal through the tube of the core-barrel and connected parts. The said casing-tube A protrudes above the surface of the ground and is driven or rotated by any suitable machine. Thus it will be seen that in this apparatus the said casing-tube A serves the purpose of a drill-rod, as well as that of a casing for the hole. Near its lower end said casing-tube A is provided with sections A′ A′, connected together by screw-threaded couplings A^2 and A^3.

Near its lower end the core-barrel is provided with a device to engage and clamp the core or core-lifter B^3, of familiar construction. Above the core-barrel the tube B is made in two parts or sections *b* and *b′*. The section *b* is connected with the upper end of the core-barrel by means of a tubular screw-

threaded coupling b^2, and a screw-threaded coupling b^3 connects its upper end with the lower end of the section b'. A ring b^5, preferably formed of steel, is arranged between the upper end of the section b and the coupling b^3 and is screw-threaded upon the said coupling. Said ring b^5 is of greater diameter than the section b, so as to project therefrom and form a shoulder b^6. At its upper edge the said ring is the same diameter as the coupling b^3, and said coupling is tapered gradually to meet the section b' to avoid any projection or shoulder at this point. The said section b' is provided at its upper end with a tubular sleeve b^4, having screw-threaded connections with said section b'.

The devices by which the casing A and tube B are detachably connected are as follows: In the walls of the tubular part or section b', about midway its length, is formed a series of vertical slots b^{11} b^{11}, in which are fitted radially-moving locking-dogs C C, which are adapted to engage at their upper ends with shoulders in the casing-tube in such manner as to hold the core-barrel from rising into said casing-tube. Said dogs are mounted between their ends on pivots c c and have their outer faces c' c^2, 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 in bearing against the casing-tube A the lower ends stand within the tube b', and vice versa. The casing-tube is provided with an internal upwardly-facing shoulder a near its lower end, adapted to engage with the shoulder of the tube B, formed by the ring b^5, and to thereby sustain the core-barrel and connected parts as the casing-tube is being lowered into the hole and prevent disengagement of the parts under other circumstances. The shoulder a is herein shown as formed at the upper end of the lowermost section or shoe A^4 of the casing-tube. The dogs C C are so placed that when the shoulder b^6 of the ring b^5 rests upon the upwardly-facing shoulder a they may be expanded to project beneath and engage a downwardly-facing shoulder a', formed within the casing-tube, preferably by the lower end of the coupling A^3 of the said tube. The dogs C C therefore retain the tube B and core-barrel in their proper position with relation to the casing-tube and prevent any relative longitudinal movement of said parts.

For connecting the casing-tube and core-barrel, so that said parts will rotate together and the core-barrel and cutting-head will be positively driven from or by the casing-tube, the section b is provided with vertical ribs b^7 b^7 and the inner surface of the lower or end section or shoe A^4 of the casing A is provided with corresponding recesses b^8 b^8, with intermediate ribs b^9 b^9, adapted to fit between the ribs b^7 b^7 of the coupling b. The lower ends of the ribs b^7 b^7 and the upper ends of the ribs b^9 b^9 are pointed, as shown, this construction of the interlocking ribs obviously enabling them to be easily engaged with each other when the core-barrel is lowered through the casing-tube to its place.

When the parts are locked together and in position for operation, the core-barrel terminates somewhat below the lower end of the casing-tube, and in the section b of the tubular part B are formed a series of vertical slots b^{10} b^{10}, in which are located the reamers or reaming-cutters D D, by which the hole is enlarged to receive the casing-tube. Said reamers are mounted upon pivots d d, inserted through adjacent parts of the said section b. Said reamers are furthermore provided on their outer sides, above their pivots, with vertical downwardly and inwardly inclined faces d' d', which are provided with cutting-points or diamonds and which project outwardly beyond the tubular section when the parts are in position for operation. Below their pivots the said reamers are provided with actuating-arms d^2 d^2, which extend downwardly and engage devices hereinafter described, by which the reamers are retracted, the outer faces of said arms being arranged at such an angle that when the reamers are thrown outwardly, or in position for cutting, said faces will stand considerably within the outer surface of the tubular section b, and when the surfaces d' d' are retracted or brought within the casing the lower ends or arms of said reamers will not project through the slots or beyond the tubular section.

The devices for expanding and contracting the reamers and the locking-dogs are constructed as follows: Located adjacent to the said dogs C and reamers D, respectively, are two hollow and longitudinally-movable spools C′ and D′. The spool C′ consists of two cones C^2 and C^3, arranged with their smaller ends toward each other and connected by a spindle c^3. Said spool C′ is provided on its outer ends with cylindric portions c^4 c^4, adapted to fit and slide within the tube-section b'. The spool D′ consists of two cones D^2 and D^3, arranged with their smaller ends toward each other and connected by a spindle d^3. Said spool D′ is provided on its outer ends with cylindric parts d^4 d^4, adapted to fit and slide within the section b. The said spools C′ and D′ are limited in their upward movement by their top or cylindric portions coming in contact, respectively, with the lower ends of the hollow nut b^4 and coupling b^3, whose interior diameters are somewhat less than that of the sections b' and b, into the upper ends of which said parts are inserted and held by screw-threaded joints. The downward movement of said spools is limited by contact of their lower ends with the upper ends of the couplings b^3 and b^2, which couplings project inwardly beyond the inner surface of the said sections. The said spools are provided at each end with screw-threaded extensions d^5 d^5 and c^5 c^5. The said spools

are connected together by means of a coupling-tube D^4, which is interposed between the spools and connected with the extensions on the adjacent ends thereof, preferably by screw-threaded joints.

To the upper extension c^5 of the spool C′ a coupling-tube C^4 is connected by a screw-threaded joint, said coupling-tube being attached at its upper end to the lower screw-threaded head f of a recessed head F. The external diameters of the coupling-tubes C^4 and D^4 are the same as the internal diameters of the couplings b^4 b^3, thereby forming additional surfaces to guide the spools in their vertical movement.

At the lower end of the spool D′ is a cylindric extension d^5, which slides in the cylindric bore of the coupling b^2, said extension being preferably provided with a packing d^6, which serves to make a tight joint at this point to prevent the passage of water between the exterior of the casing-tube and the interior of the core-barrel through the slots b^{10} b^{10}. The lower cone or head of the spool D′ and cylindric extension d^5 are preferably made integral with each other and separate from the upper part of the spool, and the stem d^3, which connects the heads of the spool, is extended through the lower head and extension and provided at its lower end with a nut d^7, which holds said head on the stem and between which and the lower end of the extension d^5 the packing d^6 is placed.

In the drawings the spools are shown as located at the lower limit of their movement, and consequently the dogs and reamers will be expanded by reason of the upper cone-sections of said spools resting between the upper ends of and holding outwardly said dogs and reamers. When in this position, the dogs will engage the shoulder a' of the casing-tube and the reamers will be in position to cut or ream out the walls of the hole. When the spool C′ is lifted, the spool D′ also rises, and their lower cone-sections C^3 and D^3, respectively, pass between the lower ends of the dogs and reamers and thereby expand said lower ends. The cone-sections C^2 and D^2 being carried upwardly from between the upper ends of said dogs and reamers, the latter are permitted to swing inwardly. When the spools are thus moved, therefore, the tubular section B is freed from its engagement with the outer casing and can be drawn upwardly through the same.

As before described, the recessed head F is connected with the upper end of the coupling C^4, said head being recessed in its upper portion, as shown at f', and connected at its upper end with a short tubular section F′ by a screw-threaded joint.

F^2 indicates a head provided with a hollow depending spindle F^5, which is adapted to pass through the tubular section F′, and below said section is provided with a screw-threaded portion near its end, upon which is placed a nut f^2 to connect said spindle with the section F′. The said spindle is capable of a sliding motion within the section F′.

F^3 is an upwardly-extending sheath or tube provided at its upper end with an internal downwardly-projecting flange f^3. Said sheath or tube is adapted to receive a detachable lifting device, called a "harpoon," such as shown in a separate application for patent, Serial No. 278,571, filed by me in the United States Patent Office June 29, 1888, and which is provided with expansible jaws adapted for automatic engagement with the flange f^3 of said tube and is lowered by a rope through the casing-tube, so as to reach and engage the said sheath. A conical recess is formed in the upper end of the head F^2 to receive the lower end of the harpoon in the same manner as the corresponding feature shown in said separate application. The head F^2 is provided with a series of horizontal water-passages f^4 and inclined water-passages f^5, which lead from within the recess F^3 to the sides of said head, said passages being to allow the escape of water and sediment from the sheath F^3 and the said conical recess. The passage through the spindle F^5 is continued upwardly into the head a convenient distance and is provided with horizontal water-passages f^6, which lead therefrom to the outside of the head.

G indicates a tubular packing of flexible material, preferably rubber, which is connected at its upper and lower ends, respectively, to the lower end of the head F^2 and the upper end of the tubular section F′. The ends of the tube G are herein shown as inserted in annular grooves or recesses in said parts F′ and F^2 and secured therein by rings f^7 f^7. The weight of the head F^2 of the harpoon-sheath acts to expand the tubular packing G against the interior surface of the casing A when the parts are in operative position, as shown; but when a lifting strain is applied to the sheath G for lifting the parts through the casing-tube to remove the core-barrel and core said packing is contracted and released from the casing-tube. The purpose of said packing G is to make a close joint between the tubular parts within the casing-tube and the inner surface of said tube at the time the parts are in operative position, so that water forced downwardly either inside or outside of the casing-tube will be forced to pass through the core-barrel and around the cutting-head to remove detritus therefrom instead of finding its way between the casing-tube and said tubular parts within the same.

A plurality of small openings or apertures a^2 a^2 are formed in the outer casing A adjacent to the tubular packing. Said openings are closed when the said packing is expanded, but open when the packing is contracted, their object being to secure a flow of water at the outer surface of the packing at the time the said packing is released from the tube by the lifting of the parts above the same to remove any sediment which may

have been deposited in contact therewith when the packing was expanded.

The tubular coupling b^2, which connects the section b with the core-barrel, is provided on its lower end, which extends into said core-barrel, with a plurality of depending lugs or projections b^{12} b^{12}, which serve to prevent the upper end of the core from rising within the said core-barrel, so as to close the lower end of said tubular coupling, and thus stop the flow of water therethrough.

During the drilling operation it is preferable to force the water, which lubricates the reamers and cutting-heads and serves to carry off the sediment, downwardly outside of the casing-tube and core-barrel, so that it will flow around the cutting-head and then upwardly within the said core-barrel and casing-tube. The employment of a water-current flowing in this manner is preferred, for the reason that it affords a more forcible upward current of water, and thereby insures the prompt and rapid removal of detritus from the cutters, and at the same time tends to keep the broken sections of the core from being destroyed by grinding or rubbing against each other, as fully set forth in separate applications for patent, Serial Nos. 250,156 and 250,157, filed September 20, 1887. After passing upwardly within the core-barrel the water passes through the tubular coupling b^2, then through the hollow spools or cores D′ C′, the coupling-tubes D^4 and C^4, the recessed head F, and the hollow spindle F^5 of the head F^2, from whence it passes through the horizontal water-passages f^6 into the casing-tube, and then upwardly to the top of the same. An upwardly-opening check-valve is located at the upper end of the core or spool D′. Said valve conveniently consists of a ball D^5, adapted to rest upon an annular seat d^8, located upon the upper end of the extension d^5. Cross-pieces d^9 d^9 are arranged within the coupling D^4 and form a cage to prevent the upward current of water from carrying the ball D^5 upwardly against the lower end of the core or spool C′, and thereby closing the water-passage therethrough.

The operation of the drilling apparatus above described is as follows: As before described, the casing-tube is used as a drill-rod to rotate and drive the cutting-head and reamers and also for the purpose of casing and protecting the hole. It is obvious that said casing-tube need not necessarily be used in the first instance, when the boring of the hole begins, but can be applied at any stage of the drilling operation—as, for instance, when it is found necessary to provide a casing for a hole which has already been bored to a considerable depth. In this case the tubular part carrying the cutting-head and reamers will be attached to the lower end of the casing-tube in the ordinary manner, when the reamers will operate to enlarge or ream out the previously-drilled hole for the reception of the casing, and the cutting-head will not come into operation until the reamers and casing-tube have been advanced sufficiently to bring said cutting-head to the bottom of the hole. Commonly, however, the casing-tube arranged to drive a core-barrel cutting-head and reamers adapted to be removed through the casing-tube will be employed where no hole has been previously bored, the reamers and cutting-head in this instance operating together as soon as the said cutting-head penetrates a sufficient distance to allow the reamers to come into action.

When it is desired to remove or take out a detached piece of the core, which becomes necessary in all cases as soon as the total length of the core equals that of the core-barrel, a harpoon such as has been heretofore described is lowered by a rope through the casing-tube until it enters and engages the sheath F^3. The said harpoon is drawn upwardly, thereby lifting the spools C′ and D′, which contracts the dogs C C and the reamers D D, whereupon the entire inner casing B and the core can be withdrawn upwardly through the casing-tube from the hole through the casing, the tension of the rope tending to keep the spools in their uplifted positions. The ball check-valve D^5 in the tubular part B prevents the column of water within the outer casing from flowing downwardly upon the upper end of the core in the core-barrel and forcing the same from the core-barrel, as would be liable to occur in case the hole were of considerable depth. When the core has been removed from the core-barrel and it is desired to reinsert the casing B, the harpoon is again connected with the harpoon-sheath and said casing is lowered downwardly through the casing A until the vertical ribs b^7 b^7 of the section b enter the recesses b^8 b^8 between the vertical ribs formed on the inner surface of the casing-shoe. When this point has been reached, the downward movement of the casing B will be stopped by reason of the ring b^5, resting upon the shoulder a. It will be noted that when the casing B is being lowered through the casing A the tension of the rope will hold the spools in their uplifted position, so that when it is desired to connect the casings together the harpoon is lowered still farther, whereby the spools are allowed to descend independently of the surrounding casing, the descent of the spools expanding the dogs C C, which pass outwardly and engage with the downwardly-facing shoulder a' of the coupling A^3. At the same time that the dogs are expanded the reamers are also expanded, and the apparatus is then in position for operation.

It is obvious that during the drilling operation the upward current of water will have the effect of carrying the detritus made by the cutters upwardly within the outer casing and that part of such detritus is liable to settle within said outer casing between it and the spool sheath and head, and is thus liable to prevent the free upward movement of the

inner casing. In such case, when the said head is elevated to contract the rubber packing and free the same from the casing-tube to allow the parts to be easily withdrawn therefrom, the apertures in the outer casing will be opened, whereupon a small quantity of water will flow in through said holes and upwardly between the outer casing and the spool-sheath, and thus carry off all sediment deposited at this point.

In Figs. 8 and 9 is shown a modified construction of the cutting-reamers and the actuating-spool therefor. It is found that in the use of the actuating-spool having the central opening through it, as shown in Fig. 3, said opening or passage is not large enough in some instances to permit a quantity of water to pass upwardly therethough in sufficient quantity to afford a desirably ample flow past or around the advance cutting-head of the drilling apparatus. In this form of the apparatus the section *b* of the inner casing consists of an upper part or section G′ and a lower part or section G^2. The main portions of said parts G′ and G^2 are of the same diameter; but the lower end portion of the upper part G′ is reduced or contracted, as shown at *g*, so that it fits within the upper end of the lower part G^2, with which it is connected by a screw-threaded joint. A shoulder is formed between the main portion of the upper part G′ and its contracted lower end *g*, and an annular space is formed between the said shoulder and the upper end of the lower part G^2 for the reception of a bearing-ring G^3, hereinafter referred to. The said section *b* is formed with vertical slots b^{10} b^{10} for the expanding reamers, and said slots extend into both the upper and lower parts G′ and G^2.

H H indicate reamers or reaming-cutters located within vertical slots b^{10} b^{10}. Said reamers are each recessed or notched on their outer sides at a point between their ends, as at *h h*, said notches being of proper size to receive the bearing-ring G^3 and being engaged therewith, so that said notches and the ring afford a pivotal connection between the reamers and said section *b*. The reamers are provided on their outer sides above their pivots with overhanging heads or projections *h′ h′*, having diamonds or cutting-points in the outer or lower faces thereof. Below their pivots the said reamers are provided with actuating-arms h^2 h^2, which extend downwardly and engage devices such as are above described for retracting and expanding said reamers. The outer faces of said arms are arranged at such an angle relative to the heads *h′* that when said heads stand without the casing said arms will stand considerably within the same. It is obvious that by dispensing with the pivot-pins and pivoting the reamers on a ring, as thus described, the pivots are brought nearer the outer surface of the tube supporting them, so that said reamers project a less distance into the tube and occupy less space within the same, thereby affording a larger opening for the passage of water.

H′ indicates an actuating-spool, consisting, as before described, of two cones h^3 and h^4, connected with their smaller ends toward each other by means of a cylindric stem h^5. Said spool is also provided at its ends with cylindric portions h^6 h^6, adapted to fit and slide within the section *b*. It will be noted that the said reamers are not secured or fastened to the said bearing-ring, but are held in engagement with said ring by the contact of their rear surfaces or edges with the central cylindric portions or stem h^5 of the spool. The said spool is provided with a central longitudinal passage or opening H^2, which is made considerably larger than the opening or passage through the spool shown in Fig. 3, owing to the fact that in this construction the reamers are of less width and the space which would otherwise be occupied by them is utilized by enlarging the spool and the passage for water therethrough. The operation of expanding and retracting the said reamers is the same as before described. It is entirely obvious that the reamers and the ring supporting them can be readily removed for renewal or repairs by disconnecting the two parts G′ and G^2, between which the said ring is held.

In Figs. 10, 11, 12, and 13 another modified construction is shown, which also relates to the expanding reamers and their actuating-spool.

The device shown in Figs. 2, 8, and 9 permits an adequate supply of water; but it is found that in this construction, as well as in that shown in Fig. 3, when the reamers are expanded and the depending actuating-arms are retracted within the lower portions of the slots that small pocket-like receptacles are formed, in which the detritus or sediment accumulates. It will be noted, furthermore, that there are small openings between the lower ends of the actuating-arms and the lower ends of the said slots, through which openings the particles accumulating in said receptacles can pass into the interior of the casing, where they are liable to clog the parts. To overcome this objection, the construction shown in said Figs. 10, 11, 12, and 13 has been devised. In this construction the casing-section *b*, coupling b^2, and the core-barrel B^2 are similar in their main features to the corresponding parts shown in Fig. 3. The reamers or reaming-cutters I I are in this instance each formed with an upper portion, having a head or projection *i*, in which the diamonds or cutting-points are located, and a downwardly-projecting actuating-arm *i′*. At a point between the ends of each of said reamers and on the outer side thereof a recess or notch i^2 is formed, which is adapted to receive a bearing-ring I′, secured within the casing-section *b* and affording pivotal support for the said reamers. The said bearing-ring I′ rests upon the upper end of the coupling b^2, which is secured within

the lower end portion of the said section *b* by a screw-threaded joint. The said bearing-ring is held in place upon the upper end of coupling-section b^2 by means of a plurality of lugs or projections i^3 i^3, formed upon the interior surface of the coupling-section *b* in position to bear upon the ring. The said lugs are also arranged one on either side of each of the reamers, and thus serve to hold the same from lateral displacement. A small screw i^4 passes through the casing-section *b* and enters the bearing-ring, said screw serving to prevent the same from turning. At a point adjacent to the cutting-heads *i i* of the reamers small slots i^6 i^6 are formed in the casing-section. The said slots are of proper size to allow the cutting-points of the head to project therethrough and are shaped to conform to the contour of the reamers, so that when said reamers are expanded the slots or openings in the casing-section will be entirely closed by the said reamers. Each of said reamers is provided with a stop or lug i^7, located at the upper end thereof and in such position that when the reamer is expanded the said stop i^7 will strike against the tubular part supporting it and limit the outward movement of said reamer.

K indicates a longitudinally-movable actuating core or spool, which is provided with an upwardly-extending spindle K′, which is indirectly connected with the actuating tube or sheath at the upper end of the inner casing, as before described. The said spool is provided at each end with conical enlargements k' and k^2 and at its upper end with an annular bearing-surface *k*, provided with grooves, Fig. 11, to allow the flow of water past the same. The bearing-surface *k* at the top of said spool is of a diameter equal to the interior diameter of the casing-section *b*, within which it slides. The enlarged portions k' k^2 are tapered inwardly from the outer or upper and lower ends thereof to a reduced central portion or stem k^3, which is cylindric, or approximately so. The actuating-spool is arranged in the usual manner centrally between the reamers, and the central cylindric portion k^3 serves to hold the said reamers in position by keeping them in contact with the bearing-ring. The said enlarged portions *k* k' k^2 are formed on their outer sides with V-shaped vertically-arranged equidistant grooves or recesses k^4 k^4, Fig. 11, preferably four in number and arranged at right angles, thus forming arms k^5 k^5, which register and bear against the rear faces of the reamers to actuate the same as the spool moves up or down in the manner hereinbefore described.

It will be seen that the openings or slots formed in the casing-section *b* are entirely filled up by the projecting cutting-heads of the reamers, which are made to fit the same, and thus prevent the detritus or sediment entering therethrough. It will also be noted that the conduit for the water is not through the interior of the spool, but that the passages formed by the V-shaped grooves in the enlarged portions of said spool and the surrounding casing-section *b* provide conduits which are large enough to permit a quantity of water sufficient for the purposes of lubrication and for carrying off the detritus to flow through the same.

The modified forms of construction have been described only with relation to the expanding reamers and their actuating-spool; but it is entirely obvious that the same construction can be applied equally well to the expanding dogs employed for connecting the inner and outer casings and the actuating-spool therefor, in which case minor structural changes not involving departure from the spirit of the invention, but only the employment of mechanical expedients, would be necessary in certain parts of the apparatus.

In the drawings and the above description this apparatus is shown and described as adapted for use only in connection with a downward flow of water outside of the drill-rod and upwardly within the same; but it is obvious that by dispensing with the upwardly-opening check-valve a downward flow of water through the drill-rod could be used equally as well.

We claim as our invention—

1. A drilling apparatus comprising a rotary casing-tube, means for actuating the same, a core-barrel provided with a cutting-head adapted to extend below the casing-tube, said core-barrel and cutting-head being smaller in diameter than and adapted to pass through the casing-tube, and means for detachably securing the upper end of the core-barrel to the lower part of the casing-tube, whereby the core-barrel is driven by the casing-tube and may be removed upwardly through the same, substantially as described.

2. A drilling apparatus comprising a rotary casing-tube, means for actuating the same, a core-barrel provided with a cutting-head adapted to extend below the casing-tube, said core-barrel and cutting-head being smaller in diameter than and adapted to pass through the casing-tube, stops or shoulders on the casing-tube and core-barrel to limit the downward movement of the core-barrel relatively to the casing-tube, and means for detachably securing the core-barrel to the casing-tube, substantially as described.

3. A drilling apparatus comprising a rotary casing-tube, means for actuating the same, a core-barrel provided with a cutting-head extending below the casing-tube, said core-barrel and cutting-head being made smaller than and adapted to pass through the casing-tube, means for detachably securing the core-barrel to the lower part of the casing-tube, and expansible reamers connected with the core-barrel, said expansible reamers being adapted to enlarge the hole cut by the cutting-head for the reception of said casing-tube, substantially as described.

4. A drilling apparatus comprising a cas-

ing-tube, a core-barrel projecting below the same, means for connecting said core-barrel with the casing-tube, comprising expansible dogs connected with the core-barrel and adapted to engage the casing-tube, a cutting-head, and expansible reamers adapted to enlarge the hole cut by the cutting-head for the reception of the said casing-tube, substantially as described.

5. A drilling apparatus comprising a casing-tube, a core-barrel projecting below the same, means for connecting said core-barrel with the casing-tube, comprising expansible dogs connected with the core-barrel and adapted to engage the casing-tube, a cutting-head, expansible reamers adapted to enlarge the hole cut by the cutting-head for the reception of the said casing-tube, and means for retracting said dogs and reamers, whereby the said core-barrel can be drawn upwardly through the casing-tube, substantially as described.

6. A drilling apparatus comprising a casing-tube, a core-barrel having a cutting-head and projecting below said casing-tube, said core-barrel being provided with pivoted expansible dogs for detachably connecting the same with said casing-tube and with expansible pivoted reamers adapted to enlarge the hole previously cut for the reception of said casing-tube, and actuating spools or cores engaging said dogs and reamers and adapted to expand and retract the same, substantially as described.

7. A drilling apparatus comprising a casing-tube, a core-barrel provided with a cutting-head extending below the casing-tube, said core-barrel and cutting-head being smaller than and adapted to pass through the casing-tube, means for detachably securing the core-barrel to the casing-tube, and a packing interposed between the casing-tube and the core-barrel, substantially as described.

8. A drilling apparatus comprising a casing-tube, a core-barrel extending below the same, a tubular part attached to said core-barrel and extending upwardly within the casing-tube, said tubular part embracing two sections having sliding connection with each other, and a tubular packing attached to said sections and adapted to expand against the casing-tube by the weight of the upper section, substantially as described.

9. A drilling apparatus comprising a casing-tube, a core-barrel detachably connected therewith and projecting below the lower end of the same, said core-barrel being provided with a cutting-head and having expansible reamers, an actuating spool or core engaging said reamers, passages for water leading from the interior of said casing-tube through said spool to the core-barrel, and a packing interposed between said casing-tube and core-barrel, substantially as described.

10. A drilling apparatus comprising a casing-tube, a core-barrel extending below the same and detachably connected therewith, said core-barrel and cutting-head being removable upwardly through the tube, and an expansible packing interposed between the casing-tube and core-barrel, said casing-tube being provided with water-holes opposite the said packing, substantially as described.

11. A drilling apparatus comprising a rotary casing-tube, a core-barrel provided with a cutting-head arranged to project below the said casing-tube, a tubular part or section uniting the core-barrel with the casing-tube, extending upwardly within the latter, means detachably connecting the tubular part or section with the casing-tube, and an upwardly-opening check-valve in said tubular part, substantially as described.

12. A drilling apparatus comprising a casing-tube, a core-barrel detachably connected therewith and projecting below the lower end of the same, said core-barrel being provided with a cutting-head and having expansible reamers, an actuating spool or core engaging said reamers, a passage for water leading from the interior of the said casing-tube through said spool to the core-barrel, and an upwardly-opening check-valve in said passage, substantially as described.

13. A drilling apparatus comprising a casing-tube, a core-barrel detachably connected therewith and projecting below the lower end of the same, said core-barrel being provided with a cutting-head, pivoted expansible dogs connected with the core-barrel and engaging the casing-tube, a spool engaging and actuating said dogs, a tubular nut attached to the upper end of said spool, a longitudinally-sliding head engaging said tubular nut and having stops to limit the movement thereof, an external flexible packing-ring secured at its opposite ends to said nut and head, whereby the weight of said head will expand said packing-ring against the inner surface of the outer casing, and passages for water leading from the interior of said tube through the said spool to the core-barrel, substantially as described.

14. A drilling apparatus comprising a casing-tube, a core-barrel projecting below the same, and means for connecting the core-barrel with the casing-tube, comprising upwardly and downwardly facing shoulders in the casing-tube, a shoulder on the core-barrel engaging the upwardly-facing shoulder of the casing-tube, and expansible dogs connected with the core-barrel and engaging the downwardly-facing shoulder of the casing-tube, substantially as described.

15. The combination, with a tube and reamers or similar movable parts, of means for pivotally connecting the same with the tube, consisting of notches in the outer faces or edges of said reamers, and a ring upon the tube engaging said notches, substantially as described.

16. The combination, with a tube formed of two connected sections and reamers or similar movable parts, of means for pivotally connecting the same with the tube, consisting of

notches in the outer faces or edges of said reamers and a bearing-ring located in the joint which unites the said sections, substantially as described.

17. The combination, with a tube provided with slots and reamers or similar movable parts located in said slots and provided with notches in their outer edges or faces, of a ring upon the tube engaging said notches and an actuating core or spool engaging said reamers and adapted to hold the same in engagement with the said ring, substantially as described.

18. The combination, with a tube provided with slots formed therein and reamers or other similar movable parts located in said slots and having notches in their outer faces or edges, of a ring upon said tube adapted to engage the said notches and forming pivots for the reamers and an actuating core or spool engaging said reamers and adapted to hold the same in engagement with the said ring, said core or spool being provided with lateral recesses or notches to form passages for water between it and the walls of the said tube, substantially as described.

19. The combination, with a tube provided with a plurality of slots and an internal ring, of expansible reamers having notches in their outer faces or edges and engaged with said ring, said reamers being provided with cutting-heads adapted to fit within said slots when the reamers are expanded, and an actuating core or spool located within said tube adjacent to said reamers and adapted to hold the same in engagement with said ring, said actuating core or spool being provided with lateral recesses or notches to form passages for water between it and the walls of the said tube, substantially as described.

20. The combination, with a tube consisting of two connected sections, of a bearing-ring resting upon the shoulder formed by the end of one of said sections, lugs upon the other section, adapted to hold said bearing-ring against said shoulder, a plurality of slots formed in said casing or drill tube, expansible reamers having notches in their front faces or edges engaging said bearing-ring and provided with cutting-heads adapted to fit within and project through said slots when the reamers are expanded, stops upon said cutting-heads to limit the outward movement of said reamers, and an actuating core or spool adjacent to said reamers and adapted to hold the same in engagement with said ring, substantially as described.

In testimony that we claim the foregoing as our invention we affix our signatures in presence of two witnesses.

MILAN C. BULLOCK.
SAMUEL W. DOUGLASS.

Witnesses:
C. CLARENCE POOLE,
HARRY COBB KENNEDY.