June 5, 1934. J. H. HOWARD 1,961,362

ROCK CORE DRILL HEAD

Filed May 18, 1931

Fig. 1.

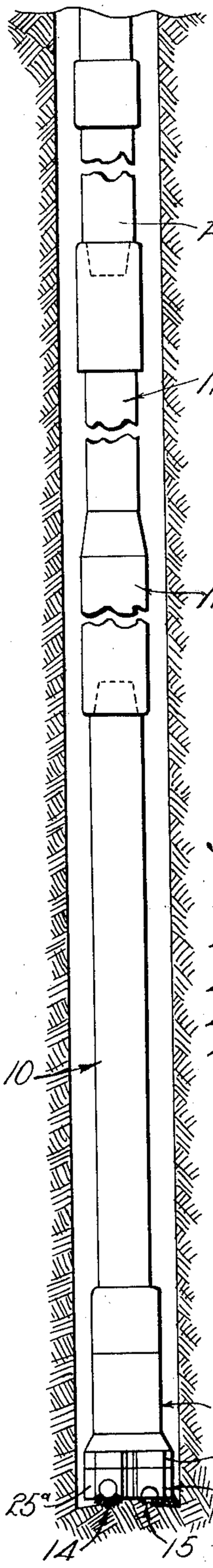


Fig. 2.

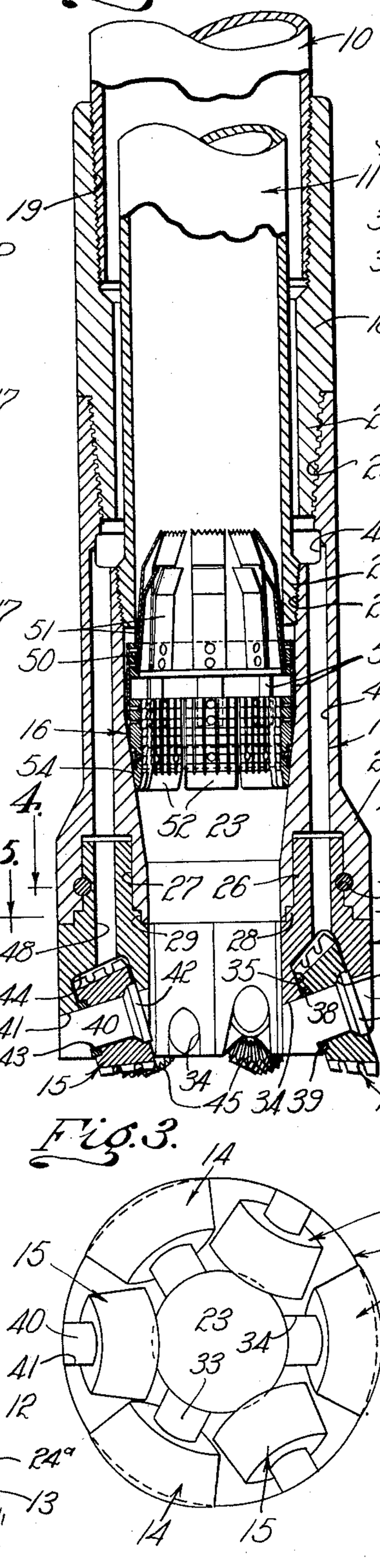


Fig. 3.

Fig. 4.

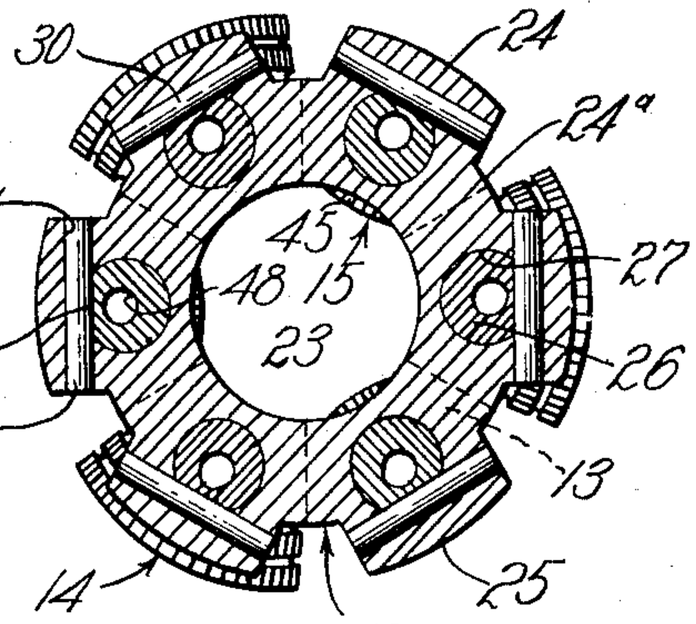


Fig. 5.

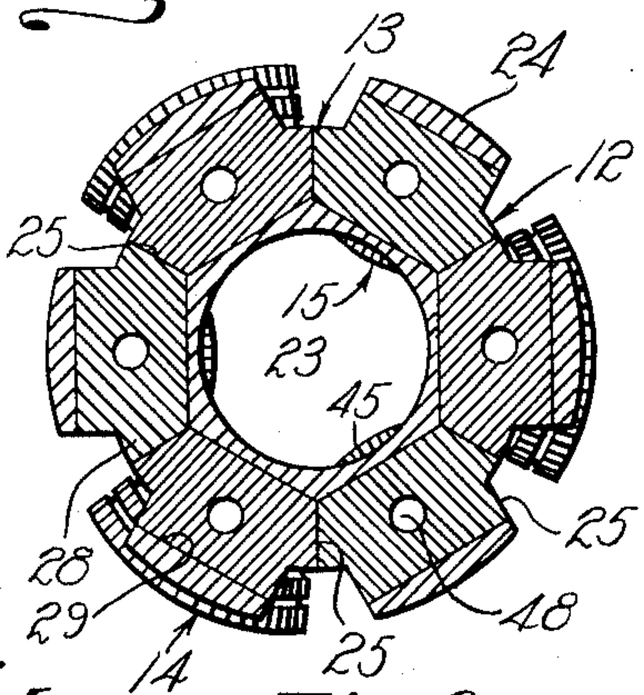
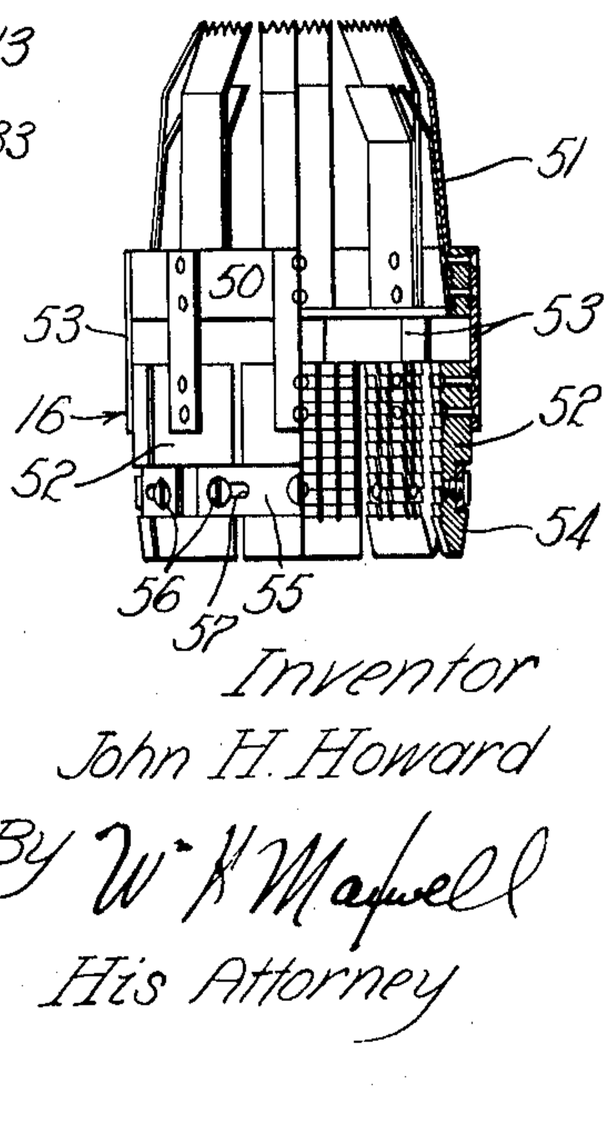


Fig. 6.



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UNITED STATES PATENT OFFICE

1,961,362

ROCK CORE DRILL HEAD

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11 Claims. (Cl. 255—72)

This invention relates to a well drilling tool, and relates more particularly to a rock core drill for use in connection with the rotary method of well drilling. It is a general object of the present invention to provide a simple, practical, and effective drill head or cutter head for a rock core drill.

An object of this invention is to provide a simple, sturdy drill head or cutter head for a core drill that embodies a plurality of roller cutters.

Another object of the invention is to provide a core drill embodying a cutter head of the character mentioned in which the roller cutters are dependably and effectively mounted and are independently and detachably carried by the body or barrel of the core drill. The cutter head provided by the present invention includes a plurality of units or wings in each of which is mounted a cutter and each of which is independently detachable from the barrel or body of the drill.

It is another object of this invention to provide a core drill that includes inner roller cutters having cutting parts for acting on the formation at the bottom of the well bore and end cutting parts for trimming and cutting the core.

A further object of the invention is to provide a novel and improved means for rotatably mounting a roller cutter on the cutting head of a core drill.

It is a further object of the invention to provide a rock core drill of the character mentioned that provides means for effectively washing each cutter with the circulation fluid.

A further object of the present invention is to provide a core catcher for use in connection with a core drill that includes slips or grips for engaging the core that are operable to tightly grip the core upon the tool being withdrawn or pulled upwardly.

It is another object of the invention to provide a core catching means of the character mentioned in which the weight of the core operates to cause the slips to tightly and effectively grip and hold the core as the tool is being withdrawn from the well.

Other objects and features of the invention will be best and more fully understood from the following detailed description of a typical form and application of the invention, throughout which description reference will be had to the accompanying drawing, in which:

Fig. 1 is a side elevation of the core drill provided by the present invention, showing it carried on the lower end of a string of drill pipe and in operating position in a well bore. Fig. 2 is an enlarged vertical detailed sectional view of the lower portion of the tool. Fig. 3 is a diagrammatic view of the lower end of the drill head, illustrating the arrangement of the cutters. Figs. 4 and 5 are transverse detailed sectional views taken as indicated by lines 4—4 and 5—5 respectively on Fig. 2. Fig. 6 is a side elevation of the core catcher provided by the present invention, showing it apart from the other parts of the tool, and showing certain parts in cross section.

The core drill provided by this invention includes, generally, an outer barrel 10, an inner barrel or core retainer 11, a cutter head or body 12 on the lower end of the outer barrel 10, a plurality of segmental units or wings 13 removably attached to the head 10, sets or series of cutters 14 and 15 carried by the wings 13, and a core catcher or core engaging means 16.

The outer barrel 10 is an elongated tubular member adapted to be attached to the lower end of a string of drill pipe P, or the like. The barrel 10 may be mounted on the lower end of the operating string in any suitable manner, for example, it may be connected with the lower end of the string of pipe P through a drill collar 17. A sub or tubular connecting member 18 is provided on the lower end of the outer barrel 10. A socket 19 may be provided in the upper end of the connecting member and the lower end of the barrel 10 may be screw-threaded into the socket.

The inner barrel or core retainer 11 is arranged within the outer barrel 10 and is provided to receive the core or sample of the formation. The core retainer 11 extends longitudinally and centrally through the outer barrel 10, and is spaced from the inner walls of the barrel 10 to provide an annular fluid passage. In accordance with the common practice, the upper end of the core retainer 11 may be provided with a suitable relief valve or vent (not shown) to provide for the displacement of fluid during passage of the core into the barrel. The core retainer 11 extends downwardly through the connecting sub 18 and is connected with the cutter head 12, as will be hereinafter described.

The head 12 is the main or body portion of the cutting assembly provided by the present invention and is an elongated tubular member carried on the lower end of the sub 18. The head 12 is provided at its upper end with a socket 20 for receiving a screw-threaded pin 21 on the lower end of the sub 18. The upper portion of the head

12 may be of the same external diameter as the sub 18. A threaded portion 22 is provided on the lower end of the core retainer 11 to thread into the upper end portion of the opening 23 of the head. This connection of the core retainer 11 with the head 10 effectively centers the core retainer in the tool and maintains it in a position where it is spaced from the inner walls of the outer barrel 10 and the sub 18. An enlarged lower end portion 24 is provided on the head 12 to provide sufficient stock for effectively carrying the cutter units 13. The enlarged portion 24 is provided with a plurality of circumferentially spaced vertical grooves 24a.

The units or wings 13 are individually mounted on the lower end of the head 12 so as to be readily removable or replaceable as independent units. The wings 13 are arcuate or segment shaped in their general configuration, and may be alike in size and shape externally. The assembly of the several wings 13 constitutes a contiguous sectional annular structure on the lower end of the head 12. The opposite sides or vertical side surfaces 25 of the units are preferably radial to effectively abut or co-operate with one another. Vertical notches 25a are provided in the outer sides of the wings to register with the grooves 24a to provide a plurality of passages for the returning circulation fluid. The wings 13 may be of the same thickness or width as the enlarged end portion 24 of the head, so as to be flush with the inner and outer sides of the head as illustrated throughout the drawing.

The means for removably attaching the units or wings 13 to the lower end of the head 12 includes a pin 26 projecting from the upper end of each wing 13. The pins 26 fit or extend into spaced sockets 27 in the lower end of the head 12. The pins 26 and sockets 27 may be of any suitable cross sectional configuration, for example, they may be round, as illustrated in Fig. 4 of the drawing. A projecting rib or flange 28 is provided on the upper end of each wing 13 at the base of its pin 26 to co-operate with a slot 29 in the lower end of the head to hold the wing against rotation or turning. Means is provided for holding the cutter units or wings 13 against longitudinal displacement from the head 12. Locking pins 30 are passed through horizontal or tangential openings 31 in the head and notches 32 in the pins 26 to hold the pins against longitudinal movement in the openings 27. It will be apparent how the several cutter carrying units or wings 13 may be individually removed from the head 12 for exchange or replacement.

Each of the wings 13 carries a cutter. The cutters 14 are the outer cutters for making an annular cut in the formation and for cutting the well bore to the desired size for passing the core drill. The cutters 15 are the inner cutters of the bit and are provided to make an annular cut within the cut made by the outer cutters 14 and to trim the core. The cutters 14 and 15 are in the nature of rock or roller type cutters and may be related to one another in various manners. In the particular arrangement illustrated in the drawing, there are three outer cutters 14 and three inner cutters 15 interposed or spaced between the outer cutters.

The outer cutters 14 may be carried by three symmetrically or equally spaced wings 13. The cutters 14 may be frusto-conical in their general configuration and are provided at their exteriors or peripheries with cutting parts or teeth. The outer cutters 14 are rotatably mounted on pins 33 carried by the wings 13 disposed in vertical planes radial relative to the central longitudinal axis of the drill, and are inclined upwardly and outwardly. In accordance with the broader principles of the invention, the pins 33 may be secured to the wings 13 in any suitable manner. In the embodiment of the invention illustrated in the drawing, the pins 33 are welded in openings or slots 34 provided in the lower ends of the units or wings 13. The pins 33 may extend completely through the wings 13, and their ends may be flush with the inner and outer sides of the wings. Openings 35 are provided in the wings 13 to pass or carry the cutters 14 with suitable clearance. The pins 33 may be hard faced and may be provided with means for holding the cutters 14 against longitudinal movement and for taking the thrusts during operation. An annular radial flange 36 is provided on each pin 33 to fit a groove 37 in an end of each cutter 14. The flanges 36 are provided to take the working or cutting end thrusts, and their inner sides may be beveled to co-operate with beveled inner walls of the grooves 37. The inner walls of the recesses 37 and the inner sides of the flanges 36 may be pitched or tapered at any suitable angle relative to the longitudinal axis of the pins. Annular bushings 38 are provided on the pins 33 to co-operate with or fit in grooves 39 formed in ends of the cutters 14. The cutters 14 project downwardly from the lower ends of the wings 13 so that their cutting parts act on the formation at the bottom of the well bore. The outer cutters 14 also project outwardly beyond the outer sides of the wings 13 to engage the formation and cut the bore to the proper size to pass the core drill.

The inner cutters 15 may be carried by the units or wings 13 spaced between the wings carrying the outer cutters 14. The inner cutters 15 may be similar, generally, to the outer cutters, i. e., they may be roller cutters of frusto-conical configuration. In accordance with the invention, the inner cutters 15 may be mounted in the units 13 in substantially the same manner as the outer cutters 14. The inner core trimming cutters 15 are rotatably mounted on pins 40 inclined downwardly and outwardly relative to the longitudinal center of the tool. The pins 40 may be substantially radially disposed, and their inner and outer ends may be flush with the interiors and exteriors of the wings 13. Like the pins 33, the pins 40 may be welded in openings or sockets 41 in the lower ends of the wings 13. A thrust shoulder or flange 42 is provided on each pin to co-operate with a groove in one end of each cutter 15, while a bushing 43 may be provided on the pin to fit into a groove in the opposite end of the cutter 15. Suitably shaped openings 44 are provided in the wings 13 to carry the cutters 15. The cutters 15 are mounted and proportioned so as to project downwardly beyond the lower ends of the units 13 to act on the formation at the bottom of the well bore. Further, the cutters are mounted so that their inner edges project inwardly beyond the inner walls of the units or wings 13. Suitable teeth or cutting parts are provided on the peripheries of the cutters 15 to engage the formation at the bottom of the bore. It is a feature of the present invention that cutting parts 45 are provided on the inner ends of the cutters 15 to cut or trim the core that is received by the core barrel 11. The cutters 15 may be mounted and proportioned and the cutting parts 45 may be formed so as to trim the core the desired diameter to readily pass into the

drill. It is to be noted that the two sets of cutters 14 and 15 may be arranged as described above so that their action on the formation at the bottom of the well bore overlaps to make an annular cut without the formation of irregularities or projections on the bottom of the bore.

In accordance with the invention, means is provided for discharging circulation fluid downwardly onto each cutter 14 and 15. An annular recess 46 is provided in the inner walls of the head 12 at the lower end of the socket 20. The recess 46 is in full communication with the annular space between the outer barrel 10 and the inner core retainer 11. A plurality of spaced longitudinal openings 47 are provided in the head 12 to extend downwardly from the annular recess 46 to the upper ends of the openings 27. A vertical or longitudinal opening 48 is provided in each unit or wing 13 to extend downwardly from the upper end of its pin 26 to the opening carrying the cutter. The openings 48 are in register or communication with the openings 47 and discharge downwardly into the openings 35 and 44. It will be apparent how the circulation fluid is discharged downwardly onto the cutters 14 and 15 to effectively wash them and remove any cuttings that may have accumulated on their cutting parts. The circulation fluid discharged into the openings 35 and 44 cannot strike against the core and, accordingly, does not wash out or destroy the core. A free and continuous circulation of fluid may be maintained at all times to insure the effective operation of the cutters 14 and 15.

In accordance with the broader aspects of the invention, any suitable form of core catcher may be employed in the tool. In the drawing, I have illustrated an improved core catcher 16 for catching or gripping the core within the drill. The core catching means 16 includes a ring 50 freely slidable in the upper portion of the head opening 23. A plurality of circumferentially spaced spring fingers 51 are provided on the ring 50 to engage the core. The spring fingers 51 are in the nature of leaf springs and project upwardly from the ring 50 and normally project or bend inwardly toward the vertical center of the opening 23. The spring fingers 51 may be multiple or double, i. e., they may each consist of two leaf springs having their upper ends bent inwardly and spaced apart to engage the core at vertically spaced points. The upper ends of the longest spring fingers may be toothed or serrated to effectively grip the core.

The core catching means 16 includes a plurality of slips or grips 52 suspended from the ring 50. The grips 52 are arcuate in their general configuration and are operable upon relative longitudinal movement between the core and the head 12 to tightly grip the core. The grips 52 are suspended from the ring 50 by flexible bands or springs 53 riveted or otherwise attached to the exterior of the ring and the exteriors of the grips. The outer sides 54 of the grips are tapered or inclined downwardly and inwardly to effectively cooperate with or slide on the inclined walls of the opening 23. The interiors or inner sides of the grips 52 are roughened or provided with gripping parts to engage the core. The several grips 52 may be interconnected by straps or bands 55 loosely attached to their outer sides. The bands may be attached to the grips by rivets or screws 56 slidable in slots 57 in the bands 55. The bands 55 connect the grips so that the grips are free to shift together or toward one another when forced into gripping engagement with the core.

It is believed that the operation of the core drill provided by the present invention will be readily appparent from the foregoing detailed description. During drilling or operation, the inner and outer cutters operate to make an annular cut in the formation, leaving a cylindrical core to be received by the core retainer 11. The inner cutters 15 act on the formation at the bottom of the well bore and also trim or cut the exterior of the core as it passes into the opening provided by the annular assembly of wings 13. The two sets of cutters 14 and 15 operate to effectively form an annular cut without projections or irregularities which might come into contact with the lower ends of the segmental wings 13. The circulation fluid may be discharged downwardly through the tool at all times to pass downwardly through the openings 48 against the cutters 14 and 15 to effectively wash the cutters. During drilling the core passes into the openings 23 and into the retainer 11, and the fingers 51 are forced or pressed outwardly against the interior of the core barrel. Passage of the core into the barrel causes the ring 50 to assume an up position where it is in engagement with the lower end of the core retainer 11. After the desired amount of core has been obtained, the tool may be withdrawn from the well. Upon the tool or drill being drawn upwardly, the spring fingers 51 bite into the core so that the assembly of the ring 50 and grips 52 remain stationary relative to the core. Upward movement of the head 12 relative to the segmental grips 52 causes the inclined walls of the opening 23 to co-operate with the tapered exteriors of the grips to force the grips inwardly into tight holding engagement with the core. The engagement or grip obtained by the grips 52 on the core is sufficient to break or pull the core loose from the earth upon the continued upward movement of the tool. It will be noted that the weight of the core after being broken loose is supported by the assembly of the spring fingers and grips so that the grips 52 are maintained in a down position where they are tightly forced against the core to effectively carry the core as the tool is withdrawn from the well bore.

It is to be noted that the invention provides a simple and effective means for mounting roller cutters on the lower end of a core drill or barrel. The several cutter carrying wings 13 may be easily and quickly removed for replacement, or the like, and are particularly simple and inexpensive of manufacture. The cutters 14 and 15 are dependably and effectively mounted in the units 13. The inner cutters 15 in trimming the core insure the proper shaping and proportioning of the core as it is passed into the core barrel.

Having described only a typical preferred form of my invention, I do not wish to limit myself to the specific details set forth, but wish to reserve to myself any changes or variations that may appear to those skilled in the art or fall within the scope of the following claims:

Having described my invention, I claim:

1. A head for a core drill including a tubular body, a plurality of cutter carrying units, and means independently detachably mounting the units on the lower end of the body in positions where their sides are in abutment, the said abutting sides of the units having grooves forming external fluid channels in said assembly.

2. A head for a core drill including, a tubular body, a plurality of units detachably mounted on the lower end of the body and having their sides

in abutment forming an annular assembly, and roller cutters rotatably carried by the units.

3. A head for a core drill including, a tubular body, a plurality of units detachably mounted on the lower end of the body in edge to edge relation and forming a contiguous segmental assembly, and a cutter carried by each of the units.

4. A head for a core drill including, a tubular body, a plurality of units having their contiguous side faces in abutment to form a segmental assembly, parts on the units set in openings in an end of the head, means for removably holding the said parts in the openings, and cutters permanently mounted in the units.

5. A head for a core drill including, a tubular body, a plurality of units on the lower end of the body in side by side relation to form a contiguous segmental assembly, parts on the units set in openings in the end of the head, means for removably holding the said parts in the openings, pins extending through openings in the units, and roller cutters rotatably mounted on the pins, the contiguous sides of the units having registering grooves forming fluid passing channels in the exterior of the said assembly.

6. A head for a core drill including, a tubular body, a plurality of units independently and detachably mounted on the lower end of the body and having their adjoining side faces in abutment forming a segmental assembly, and cutters rotatably mounted in the units to have end cutting parts projecting inwardly from said assembly.

7. A head for a core drill including, a tubular body, a plurality of units independently detachably mounted on the lower end of the body, the units having their adjoining side faces in abutment to form a contiguous annular assembly, and cutters rotatably mounted in the units to have peripheral cutting parts projecting from the lower ends of the units and cutting parts projecting into the opening in said assembly.

8. A head for a core drill including, a tubular body, a plurality of units independently detachably mounted on the lower end of the body, the units having their adjoining side faces in abutment to form a contiguous annular assembly, a roller cutter rotatably carried in one of the units to have cutting parts projecting from the bottom of said assembly, and a roller cutter rotatably carried in another unit to have cutting parts projecting into the opening in said assembly.

9. A head for a core drill including, a tubular body, a plurality of units independently detachably mounted on the lower end of the body in side by side relation to form a contiguous segmental assembly, a roller cutter rotatably carried in one of the units to have cutting parts projecting from the bottom of said assembly, and a roller cutter rotatably carried in another unit to have cutting parts projecting into the opening in said assembly.

10. A head for a core drill including, a tubular body, arcuate wings at the lower end of the body, means for detachably mounting the wings on the body in positions where their side faces are in abutment to form an annular assembly, said means including, a projection on each wing fitting an opening in the body, and locking pins holding the projections in the openings, and a roller cutter rotatably mounted in an opening in each wing, there being a fluid passage in the body communicating with the said opening in the body, and a fluid passage in each wing in communication with the first mentioned fluid passage and discharging into the cutter carrying opening of the wing.

11. A core drill including, an outer barrel, an inner barrel within the outer barrel, there being an annular fluid passage between the two barrels, a head mounted on the lower end of the outer barrel, a plurality of wings at the lower end of the head, means for independently detachably mounting the wings on the lower end of the head to have their side faces in abutment and form a contiguous segmental assembly, and roller cutters rotatably mounted in openings in the wings and projecting from the wings, there being spaced fluid openings in the head communicating with the said fluid openings and discharging into the openings carrying the cutters.

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