April 16, 1963 J. D. BENNETT ET AL 3,085,636

SIDE WALL CORE TAKING APPARATUS

Filed Dec. 1, 1959

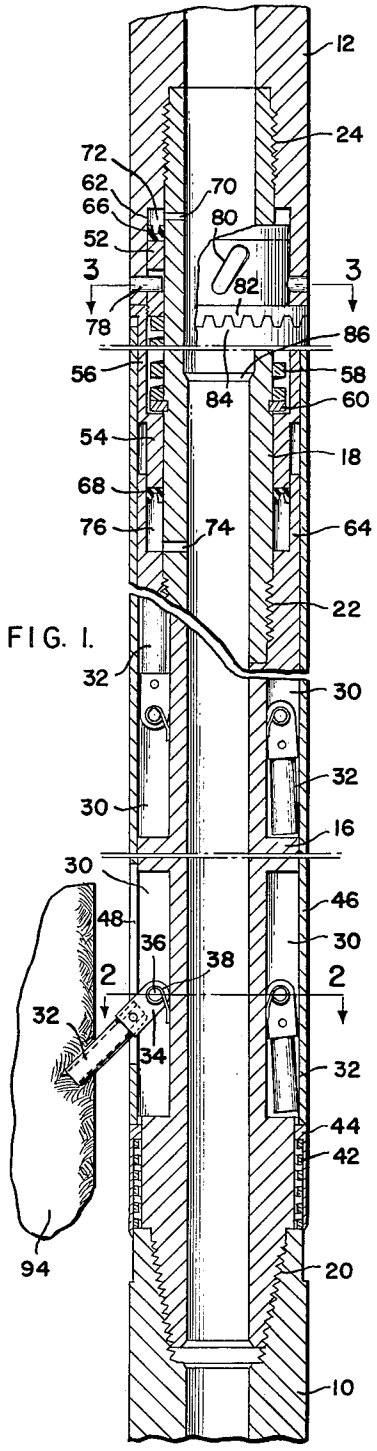


FIG. 1.

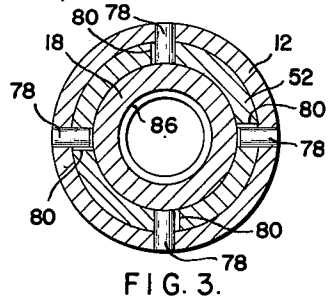


FIG. 3.

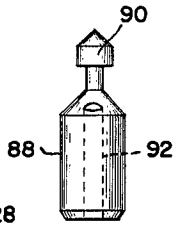


FIG. 5.

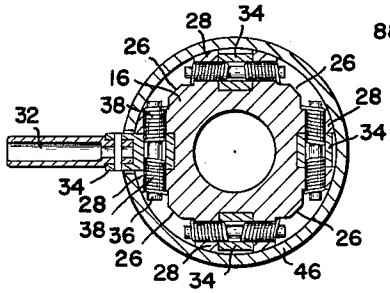


FIG. 2.

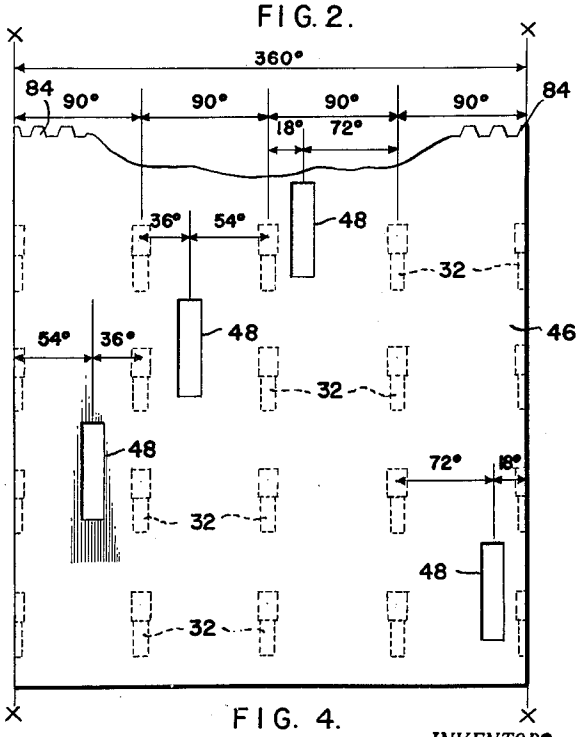


FIG. 4.

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SIDE WALL CORE TAKING APPARATUS

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12 Claims. (Cl. 175—77)

This invention relates generally to well drilling apparatus, and more particularly to improvements in side wall coring devices.

One object of the present invention is to provide an improved side wall coring device which effectively serves as a section of the drill stem and remains in the drill stem during the drilling operation, while being controllable from the surface.

Another object is to provide such a device with a plurality of core takers which, after samples are taken, are completely encased for protecting the samples against contamination by drilling mud.

Still another object is to provide a coring apparatus for the sequential taking of cores at different positions. This is accomplished by the provision of a cylindrical shield embracing the drill stem and provided with openings through which the core takers may extend for selectively taking sequential samples, and by the provision of control means for stepping the sheath about the drill stem thereby to effect projection of the core takers through said openings in predetermined sequence for taking samples.

A further object is to provide such a device with control means actuated by producing drilling mud pressure differentials internally of the drill stem by starting and stopping the drilling mud pumping means.

Other objects of the invention will appear more fully from the following description when read in conjunction with the accompanying drawing, in which:

FIGURE 1 is a longitudinal section through a side wall coring device constructed in accordance with the invention, showing one of the core takers shortly after beginning its entry into the side wall of the well;

FIGURE 2 is a section on the plane indicated at 2—2 in FIGURE 1;

FIGURE 3 is a section on the plane indicated at 3—3 in FIGURE 1;

FIGURE 4 is a developed view looking at the sheath which embraces the core takers, the openings in the sheath and the core takers being shown in non-registering relation, the condition that obtains when the device is lowered into the well; and

FIGURE 5 is an elevation of a slug adapted to be dropped into the drill stem for the control of coring operations.

A preferred form of apparatus constructed in accordance with the invention includes a lower drill stem section 10 (which ususally would be either the drill collar or a section immediately thereabove), an upper drill stem section 12 and a tubular body interposed between the drill stem sections 10 and 12 and including a lower body section 16 and an upper body section 18. The lower end portion of section 16 is threaded into the upper end portion of section 10, as at 20. The lower end portion of section 18 is threaded into the upper end portion of section 16, as at 22, and the upper end portion of section 18 is threaded into the lower end portion of section 12, as at 24. Section 16 is grooved, as at 26, to provide four longitudinally extending circumferentially equally spaced formations 28. In each of the formations 28 are formed four longitudinally spaced pockets 30. Each pocket 30 accommodates a core taken in the form of a tube 32 mounted in a fitting 34 through which fitting extends a pin 36 mounting torsion springs 38.

Wrapped around the lower end portion of section 16 is a compression spring 42 which is embraced by a collar 44 for its protection against damage during drilling, and seated upon the collar 44 is the lower end portion of a cylindrical sheath 46. The torsion springs 38 bias the core takers outwardly and upwardly, but normally they are secured against such movement by the sheath 46.

Referring particularly to FIGURE 4, the sheath 46 is provided with four openings 48 respectively for the four tiers of pockets 30 formed in the section 16. These openings 48 are arranged, as shown, so that they register with the pockets 30 one at a time.

Embracing section 18 is a piston including an upper end portion 52, a lower end portion 54 and an intermediate portion 56. The intermediate piston portion 56 is enlarged in diameter to provide an annular space extending about section 18. This space accommodates a compression spring 58 seated upon a ring 60 embracing section 18. The lower end portion of section 12 is counterbored, as at 62, to provide an annular space extending about section 18 and into which is slidably fitted the upper end 52 of the piston. The upper end portion of section 16 is counterbored at 64 to provide a space extending about section 18 and into which is slidably fitted the lower end 54 of the piston. The upper end of the piston is fitted with a ring seal 66, and the lower end of the piston is fitted with a ring seal 68. Section 18 is bored at 70 to provide communication between the interior of the drill stem and the space above the ring seal 66, designated 72. Section 18 is also provided with a bore 74 placing the interior of the drill stem in communication with the space 76 underlying the ring seal 68. Fixed to section 12 and projecting radially inwardly therefrom are four circumferentially equally spaced pins 78 received, respectively, by the lower end portions of elongated openings 80 extending helically at an angle relative to the axis of the drill stem and formed in the upper end 52 of the piston.

Formed on the intermediate portion 56 of the piston are downwardly extending teeth 82 which mesh loosely with upwardly extending teeth 84 formed on the upper terminal portion of the sheath 46.

Section 18 is provided internally with a circumferentially extending seat 86 adapted for supporting a slug 88 (FIGURE 5) including a spear head 90 and a restricted longitudinal passage 92. Alternatively, as later described, a housing of a bore hole logging apparatus may seat at 86.

The coring tool is connected in the drill stem and remains there during the drilling operation. When the drilling mud pump is operating, the drill mud pressure upon the upper end of the piston substantially equals the drilling mud pressure upon the lower end of the piston due to free flow between the passages 70 and 74, in consequence of which the spring 58 biases the piston upwardly so that the pins 78 are lodged in the lower end portions of the slots 80. At the same time spring 42 biases the collar 44 and the sheath 46 upwardly and the

teeth 84 into meshing engagement with the teeth 82. Initially the sheath 46 is positioned so that none of the openings 48 registers with a core taker, as indicated in FIGURE 4. The sheath holds the core takers in position in the lower end portions of the pockets 30 against the influence of the torsion springs 34.

Assuming, first, that logging is not involved, it is desired to core the side wall 94, the drill stem is raised a distance sufficient to place the lowermost tier of core takers 32 at the level of the side wall area to be cored, and the slug 88 is dropped into the stem. The slug comes to rest upon the shoulder 86 and is positioned by the latter between the openings 70 and 74. Generally this would occur during interruption of mud circulation. Then when circulation is resumed, the gradient in drill mud pressure caused by the resistance to flow of mud due to the restricted passage 92 through the slug 88 in the drill stem drives the piston and sheath downwardly against the influence of springs 58 and 42, the pressure at 70 considerably exceeding that at 74. Simultaneously, the piston is advanced about section 18 by the pins 78 working in slots 80. Since the teeth 82 and 84 are interlocked, the sheath 46 turns with the piston to a position in which one of the core takers in the lowermost tier thereof registers with the associated opening 48, whereupon the core taker is swung outwardly through the opening 48 under the influence of its springs 34. The free end of the core taker engages the side wall 94 of the well and is arrested thereby in a position extending outwardly and downwardly.

Now the drilling mud pump is stopped, or its pumping rate considerably reduced. This causes the return stroke of the piston, since the differential pressure between the opposite ends of the piston becomes zero or drops to a low value, in consequence of which the piston is forced upwardly and turned back to its initial position under the influence of the spring 58. The core taker projecting out of the opening 48 acts to arrest rotation of the sheath, and since the sheath cannot turn back with the piston, the teeth 84 of the sheath, acting upon the teeth 82 of the piston, tend to hold the piston and keep it from turning back too. However, under the urging of the strong spring 58, the teeth 82 and 84 mutually cam themselves out of engagement, against the influence of the relatively weak spring 42. While the sheath cannot turn back with the piston, it is free to and does move upwardly under the influence of spring 42, so that after a relative movement of the spring of successive teeth the teeth 82 and 84 reengage, but now with the sheath in a position advanced one tooth spacing with respect to its original position.

In order to take a sample the drill stem is now lowered a short distance, in consequence of which the core taker is driven into the side wall 94 of the well, and swings outwardly and upwardly through a horizontal position and emerges from the side wall when it is in a position extending outwardly and upwardly. As soon as the core taker is free of the side wall, the springs 34 flip the core taker further upwardly and into the upper end portion of the pocket 30. The sheath 46 is simultaneously freed for rotation.

The drill stem is then raised to position the second, i.e., next to the lowermost, tier of core takers at the level of the second side wall area to be cored. The core taking procedure outlined above, including reapplication of mud pressure by renewal of full flow, release of pressure, and downward drill stem movement is repeated, and this time a sample is taken by a core taker in the second tier of core takers and circumferentially spaced 90° from the core taker that took the first sample, this second core taker being now in alignment with an opening 48. The drill stem is then raised again to position the third, i.e., next to the topmost, tier of core takers at the level of the third side wall area to be cored. The core taking procedure is repeated again, and this time a sample is taken by a core taker in the third tier of core takers and diametrically opposite the core taker that took the first sample. The drill stem is again raised to position the topmost tier of core takers at the level of the fourth side wall area to be cored. The core taking procedure is repeated once again, and this time a sample is taken by a coretaker in the fourth tier of core takers and circumferentially spaced 270° from the core taker that took the first sample. Now the whole operation is repeated, starting with the second core taker in the first tier of core takers. In all, with the arrangement illustrated, sixteen core samples may be thus taken sequentially. It will be understood that each time the sheath 46 is advanced about the drill stem, an opening 48 is moved out of registry with an underlying pocket 30, whereupon the associated core taker and the sample just taken thereby are completely encased and protected from returning drilling mud, and another opening 48 is moved into registry with one of its associated pockets 30, whereupon another core taker is released for taking a sample.

It will be evident from the foregoing that successive cores are taken in predetermined sequence, so that, by keeping a record of the levels at which the coring procedure is repeated, each core may be positively identified with the level at which it was taken.

Drilling may be resumed at any time by retrieving the slug to permit again the free flow of mud. This may be accomplished by lowering on a wire line an overshot to engage the spear head 90 so that upon withdrawal of the overshot the slug may be removed. If drilling is not to be resumed after taking cores, the slug 88 may, of course, be recovered on raising the drill stem to recover the cores and/or change the bit.

In connection with the use of this coring device it may be desirable to effect electrical or other logging. Suitable apparatus for electrical logging is disclosed in the application of John D. Bennett, Preston E. Chaney, Jack Weir Jones and Fred M. Mayes, Serial No. 818,162, filed June 4, 1959. As disclosed in this application an apparatus comprising a housing and a flexible electrode assembly is lowered through the drill stem so that the flexible electrode assembly becomes projected through openings in a bit, the apparatus coming to rest with the housing on a seat. If logging is to be accomplished with the present apparatus, the housing may come to rest on the seat 86 and then take the place of the slug 88 in restricting flow of mud, serving in the same fashion as the slug 88 to effect coring operations.

While other procedures may be used for both logging and coring, a typical and advantageous procedure might well involve the following:

After the completion of a drilling operation in which a new length of the bore hole is produced, the drill stem may be lifted from the bottom and the logging apparatus introduced at its upper end and permitted to drop, or be lowered, so that the flexible electrode will enter and pass through an opening of a jet bit and extend downwardly below the bit, the housing reaching its lowermost position when it comes to rest on the seat 86. At this time, the flexible electrode assembly would have its full length extended through the bit. The drill stem may then be raised, as described in said copending application to effect automatic logging of the desired portion of the bore hole which would usually be that portion last drilled.

Assuming that electrical logging of another earlier drilled portion of the hole had already been accomplished and the logging result had been analyzed, it might be desirable then to take cores at particular levels of special interest as exhibited by the log. For this purpose, then, the drill stem could be repositioned at successive levels to effect coring, during which operations the sequential core taking could be controlled by control of mud pressure, the housing of the logging apparatus then functions in the same fashion as the slug 88

to restrict mud flow and provide differential pressure to effect stepping movements of the sleeve 46. After completion of these successive logging and coring operations, the logging assembly could be removed by an overshot so that, if desired, drilling could be resumed. It will be noted that the coring apparatus contains a central passage which would not impede the projection of the electrode assembly.

It will be understood, of course, that the present invention is susceptible of various changes and modifications without departing from the general principles of the invention. For example, the number of core takers employed and the order in which the core takers operate may be varied. Accordingly, the invention is not to be regarded as limited except as required by the following claims.

What is claimed is:

1. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, means providing a sheath about said body rotatably mounted to rotate about the axis of said body, at least one core taker tube housed between said body and sheath and connected to said body for vertical swinging movement outwardly from said body, each of said core tubes when in either of its extreme positions being disposed within said sheath, said sheath having an opening therein for registration with each core tube, each core tube being arranged adjacent the rotative path of travel of an opening in said sheath, means for turning said sheath about said body for registration of each core tube with an opening formed in said sheath, and means biasing each core tube for vertical swinging movement outwardly from said body, the interior of said sheath abutting each of the core tubes in a retracted position thereof for releasably securing said core tube against such swinging movement, and said bias means being effective when said core tube and opening register for vertically swinging said core tube outwardly from said body through the associated opening in said sheath from one extreme position to the other.

2. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, means providing a sheath about said body rotatably mounted to rotate about the axis of said body, a plurality of core tubes housed between said body and sheath and connected to said body for vertical swinging movement outwardly and upwardly from said body, each of said core tubes when in either fully raised or fully lowered position being disposed within said sheath, said sheath having an opening therein for registration with each core tube, each core tube being arranged adjacent the rotative path of travel of an opening in said sheath, means for turning said sheath about said body for registration of each core tube with an opening formed in said sheath, and means biasing each core tube for vertical swinging movement outwardly and upwardly, the interior of said sheath abutting each of the core tubes in a retracted position thereof for releasably securing said core tubes against such swinging movement, and said bias means being effective when said core tube and opening register for vertically swinging said core tube outwardly and upwardly through the associated opening in said sheath from the fully lowered to the fully raised position thereof.

3. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, means providing a sheath about said body rotatably mounted to rotate about the axis of said body, a plurality of core tubes spaced about said body and housed between said body and sheath and connected to said body for swinging movement outwardly and upwardly from said body, each of said core tubes when in either fully raised or fully lowered position being disposed within said sheath, said sheath having an opening therein for registration with each core tube, each core tube being arranged adjacent the rotative path of travel of an opening in said sheath, means for turning said sheath about said body for registration of said core tubes one at a time with an opening formed in said sheath, and means biasing each core tube for vertical swinging movement outwardly and upwardly, the interior of said sheath abutting each of the core tubes in a retracted position thereof for releasably securing said core tubes against such swinging movement, and said bias means being effective when said core tube and opening register for vertically swinging said core tube outwardly and upwardly through the associated opening in said sheath from the fully lowered to the fully raised position thereof.

4. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, means providing a sheath about said body rotatably mounted to rotate about the axis of said body, a plurality of groups of core tubes spaced along said body, the core tubes of each group thereof being spaced about said body and housed between said body and sheath, said core tubes being connected to said body for swinging movement outwardly and upwardly from said body, each of said core tubes when in either fully raised or fully lowered position being disposed within said sheath, said sheath having an opening therein for registration with each core tube, each core tube being arranged adjacent the rotative path of travel of an opening in said sheath, means for turning said sheath about said body for registration of said core tubes one at a time in predetermined order respectively with openings formed in said sheath, and means biasing each core tube for vertical swinging movement outwardly and upwardly, the interior of said sheath abutting each of the core tubes in a retracted position thereof for releasably securing said core tubes against such swinging movement, and said bias means being effective when said core tube and opening register for vertically swinging said core tube outwardly and upwardly through the associated opening in said sheath from the fully lowered to the fully raised position thereof.

5. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, means providing a sheath about said body rotatably mounted to rotate about the axis of said body, at least one core tube housed between said body and sheath and connected to said body for vertical swinging movement outwardly from said body, each of said core tubes when in either of its extreme positions being disposed within said sheath, said sheath having an opening therein for registration with each core tube, each core tube being arranged adjacent the rotative path of travel of an opening in said sheath, reciprocable piston means operable for turning said sheath about said body in one direction for registration of each core tube with an opening formed in said sheath, and means biasing each core tube for vertical swinging movement outwardly from said body, the interior of said sheath abutting each of the core tubes in a retracted position thereof for releasably securing said core tube against such swinging movement, and said bias means being effective when said core tube and opening register for vertically swinging said core tube outwardly from said body through the associated opening in said sheath from one extreme position to the other.

6. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, means providing a sheath about said body rotatably mounted to rotate about the axis of said body, at least one core tube housed between said body and sheath and connected to said body for vertical swinging movement outwardly from said body, each of said core tubes when in either of its extreme positions being disposed within said sheath, said sheath having an opening therein for registration with each core tube, each

core tube being arranged adjacent the rotative path of travel of an opening in said sheath, a reciprocable piston embracing said body and arranged for executing a working stroke downwardly and about said body in one direction and a return stroke in the opposite direction, said piston being operable for progressively turning said sheath about said body in one direction for registration of each core tube with an opening formed in said sheath, and means biasing each core tube for vertical swinging movement outwardly from said body, the interior of said sheath abutting each of the core tubes in a retracted position thereof for releasably securing said core tube against such swinging movement, and said bias means being effective when said core tube and opening register for vertically swinging said core tube outwardly from said body through the associated opening in said sheath from one extreme position to the other.

7. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, means providing a sheath about said body rotatably mounted to rotate about the axis of said body, at least one core tube housed between said body and sheath and connected to said body for vertical swinging movement outwardly from said body, each of said core tubes when in either of its extreme positions being disposed within said sheath, said sheath having an opening therein for registration with each core tube, each core tube being arranged adjacent the rotative path of travel of an opening in said sheath, a reciprocable piston embracing said body and arranged for executing a working stroke downwardly and about said body in one direction and a return stroke in the opposite direction, means yieldably biasing said piston and sheath upwardly and into detachable engagement with one another, said piston being operative upon each working stroke for turning said sheath about said body in a predetermined direction for registration of each core tube with an opening formed in said sheath, and means biasing each core tube for swinging movement outwardly from said body, the interior of said sheath abutting each of the core tubes in a retracted position thereof for releasably securing said core tube against such swinging movement, said bias means being effective when said core tube and opening register for vertically swinging said core tube outwardly from said body through the associated opening in said sheath from one extreme position to the other, and said outwardly extending core tube being operative to arrest said sheath during the return stroke of said piston.

8. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, means providing a sheath about said body rotatably mounted to rotate about the axis of said body, at least one core tube housed between said body and sheath and connected to said body for vertical swinging movement outwardly from said body, each of said core tubes when in either of its extreme positions being disposed within said sheath, said sheath having an opening therein for registration with each core tube, each core tube being arranged adjacent the rotative path of travel of an opening in said sheath, a reciprocable piston embracing said body and arranged for executing a working stroke downwardly and about said body in one direction and a return stroke in the opposite direction, means detachably locking said sheath to said piston and thereby securing the same against turning relative to one another, means yieldably biasing said piston and sheath upwardly and into locking engagement, means for communication between the interior of said body and the top of said piston, said piston being operative upon each working stroke in response to fluid pressure applied to the top thereof through said communication means for turning said sheath about said body in a predetermined direction, against the influence of said upward bias, for registration of each core tube with an opening formed in said sheath, and means biasing each core tube for swinging movement outwardly from said body, the interior of said sheath abutting each of the core tubes in a retracted position thereof for releasably securing said core tube against such swinging movement, said core tube bias means being effective when said core tube and opening register for vertically swinging said core tube outwardly from said body through the associated opening in said sheath from one extreme position to the other, said outwardly extending core tube being operative during the return stroke of said piston to secure said sheath against turning movement with said piston while permitting vertical movement of said sheath under the influence of said upward bias for relocking with said piston in an advanced position thereof.

9. A core taking device for drilled wells comprising a body adapted for connection in a drill stem, a plurality of core taker tubes pivotally connected to said body and continuously biased for vertical swinging movement thereof outwardly from said body for taking samples, piston means responsive to the pressure of drilling mud within the drill stem and reciprocable in response to variations of the drilling mud pressure, means securing said core takers against outward swinging movement and operatively connected to said piston means for movement in response to piston means movement to a plurality of successive positions for releasing said core takers in successive order for swinging movement thereof outwardly for taking samples.

10. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, a plurality of core taker tubes pivotally connected to said body and continuously spring biased for vertical swinging movement thereof outwardly from said body for taking samples, piston means responsive to the pressure of drilling mud within the drill stem and reciprocable in response to variations of the drilling mud pressure, means securing said core takers against swinging movement outwardly under the influence of said spring bias and operatively connected to said piston means for movement in response to piston means movement to a plurality of successive positions for releasing said core takers in successive order for swinging movement thereof outwardly for taking samples.

11. A core taking device for drilled wells comprising a body adapted for connection in a drill stem, a plurality of core taker tubes distributed about and pivotally connected to said body and continuously biased for vertical swinging movement thereof from an initial position, outwardly from said body and through approximately 180 degrees to a final position, piston means responsive to the pressure of drilling mud within the drill stem and reciprocable in response to variations of the drilling mud pressure, means engaging said core takers and securing the latter against swinging movement and operatively connected to said piston means for indexing movement about said body in response to said piston means movement to a plurality of successive positions for releasing said core takers in successive order for swinging movement thereof outwardly for taking samples and for swinging movement to said final position.

12. A core taking device for drilled wells comprising means providing a tubular body adapted for connection in a drill stem, a plurality of core taker tubes arranged in groups thereof spaced longitudinally of said tubular body, the core taker tubes of each group thereof being distributed about said tubular body, means pivotally connecting said core taker tubes to said body and continuously biasing the same for vertical swinging movement thereof from an initial position in which an open end faces downwardly to a final position in which said open end faces upwardly, piston means responsive to the pressure of drilling mud within the drill stem and reciprocable in response to variations of the drilling mud pressure, means engaging said core takers and securing the latter against swinging movement and operatively connected to said piston means for movement in response to piston

means movement to a plurality of successive positions for releasing said core takers in successive order for swinging movement thereof outwardly for taking samples and for swinging movement to said final position.

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