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3,215,210

CORE SAMPLE APPARATUS

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Fig. 2.

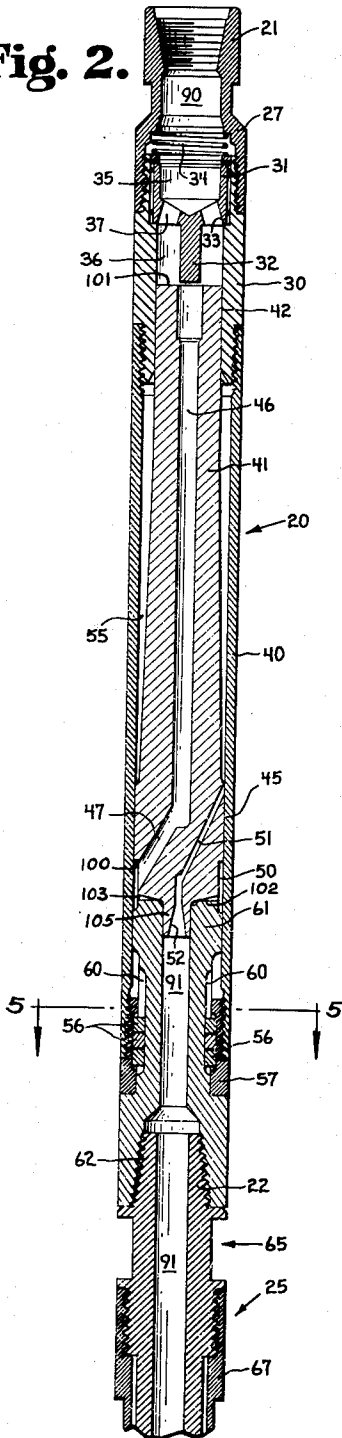


Fig. 3.

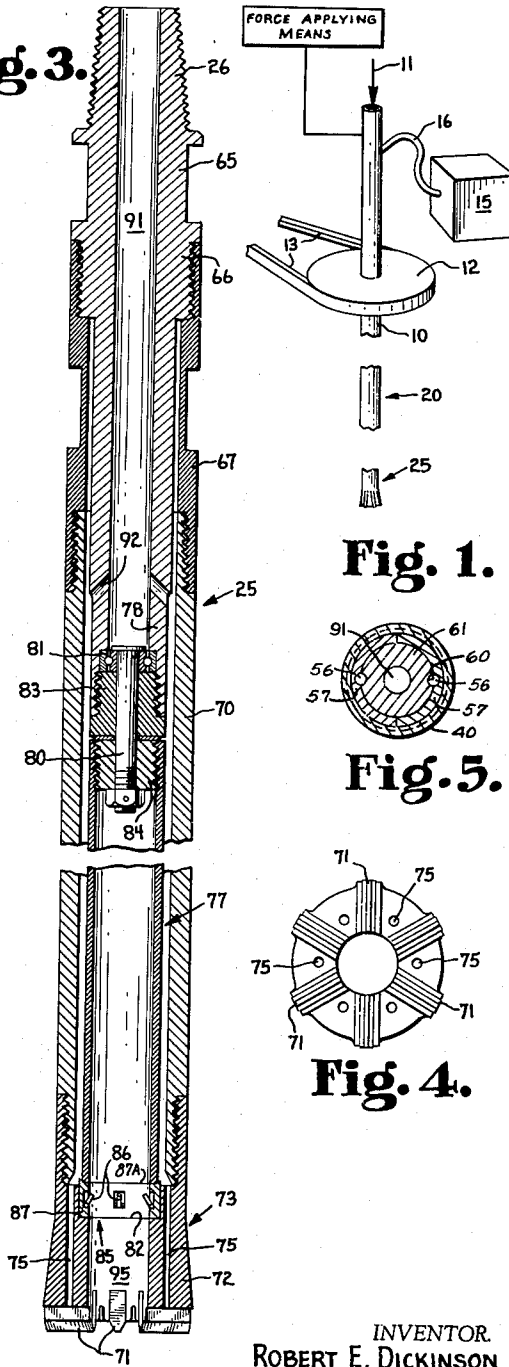


Fig. 1.

Fig. 5.

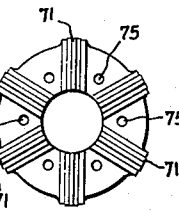


Fig. 4.

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CORE SAMPLE APPARATUS

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The present invention relates to an apparatus for taking a core sample.

In drilling oil wells and the like, it is frequently desirable to cut a cylindrical core from the rock being drilled in order to determine information about the rock. In the past, this procedure has been accomplished by rotary apparatus. In other words, a generally cylindrically shaped tool having a diamond cutting surface at its lower distal end is rotated in the hole causing a core sample to be received within the tool. This method of taking a core sample has proved to be relatively slow and expensive.

Consequently, a primary object of the present invention is to provide improved apparatus for taking a core sample, said apparatus being less expensive and faster than the conventional methods.

Related objects and advantages will become apparent as the description proceeds.

One embodiment of the method of the present invention comprises exerting a constant downward force on a generally cylindrical tool, repeatedly striking the tool in a downward axial direction and slowly rotating it about its axis to cause the material being sampled to move into said tool.

One embodiment of the apparatus of the present invention includes a core taking arrangement comprising a drill stem, means for rotating said drill stem, means for exerting a constant downward force on said drill stem, casing means mounted on the lower end of said drill stem, an anvil reciprocally received in said casing means, air-pressure-operated means for repeatedly striking and hammering said anvil downwardly, means for supplying air pressure through said drill stem to said air-pressure-operated means, a hollow cylindrical core barrel head fixed to said anvil, an outer tube fixed to and surrounding said core barrel head, an inner tube rotatably secured to said core barrel head and received within said outer tube and a drill bit carrying head secured to the distal end of said outer tube and having a central opening in registry with said inner tube.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

FIG. 1 is a perspective fragmentary schematic view of a drill rig embodying the present invention.

FIG. 2 is an axial section of a portion of the structure illustrated in FIG. 1.

FIG. 3 is an axial section of a core-taking attachment forming a part of the structure of FIG. 1 and partially shown in FIG. 2.

FIG. 4 is a bottom plan view of the structure shown in FIG. 3 showing the cutting face thereof.

FIG. 5 is a sectional view taken on line 5-5 of FIG. 2.

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawing and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally

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occur to one skilled in the art to which the invention relates.

Referring more particularly to the drawings, FIG. 1 illustrates a conventional drill rig including a drill stem or drill pipe 10 which has in conventional manner, such as by any force applying means shown diagrammatically in FIGURE 1, a force 11 constantly exerted thereon in order to urge the pipe downwardly into the hole. The pipe 10 is slowly rotated by means of a drill table illustrated schematically at 12, a belt 13 being shown for rotation of the table. Air under pressure is pumped into the drill stem 10 by means of a pump 15 connected to the stem by a suitable line 16. The above structure has not been described in greater detail since it is conventional and well known in the art.

Referring to FIG. 2, a major portion of the figure includes a means 20 for producing a continuous rapid pounding or hammering action. The illustrated means 20 is a commercially available impact tool although any conventional "down the hole" or "in the hole" air tool would be suitable. An example of a similar impact tool is shown and described in the patent to Bassinger 2,979,033. The impact tool 20 is threadedly mounted at its upper end 21 to the lower end of the drill stem 10 and conventionally would receive a drill bit (not shown) in the tapered threaded recess 22 at its lower end. When practicing the present invention, the drill bit is replaced by a core-taking structure shown in FIG. 3 and partially shown in FIG. 2, the upper end 26 of which is threadedly received in the recess 22.

Referring again to FIG. 2, the impact tool 20 includes a top member 27 having a top piston case 30 threadedly fixed therein. Between the piston case 30 and the top member 27, there is received a valve assembly 31 which is generally cylindrical in outward configuration but has a coaxial depending element 32. The valve assembly is urged downwardly by a compression spring 34 to seat against an annular shoulder 33 formed on the case 30, the upper end of said compression spring bearing against the top member 27. The valve assembly 31 has a hollow upper portion 35 which communicates with the hollow interior 36 of the top piston case 30 through radial slots 37.

Fixedly and threadedly receiving the top piston case 30 is a further casing 40 herein termed the hammer casing. A hammer 41 is received within the casing 40 for vertical reciprocation, the hammer 41 having two annular bearing portions 42 and 45.

The hammer 41 has a passage 46 extending centrally therethrough for a major portion of its length and then extending somewhat radially at 47 to terminate in an annular recess 50 in the periphery of the hammer. The hammer is also provided with a passage 51 which leads from the lower end 52 of the hammer to the space 55 between the casing 40 and the hammer 41 and acts as a vent for the space 55 so that the hammer 41 freely reciprocates.

A plurality of guide and limit pins 56 are fixedly mounted upon the lower end of the hammer casing 40 by a threadedly received mounting element 57. The pins 56 extend radially into vertically extending slots 60 in the outer periphery of an anvil 61.

The mounting element 57 may be, for example, a nut which is longitudinally split into two or more sections so that when the pins 56 are placed in the slots 60, the nut sections can be positioned in proper place and then screwed into the lower end of the hammer casing 40. (See the above mentioned patent to Bassinger.) If desired, there may be provided four or more of the slots 60 at equally spaced intervals around the member 61 and with appropriate pins 56. The anvil is vertically reciprocal within the hammer casing and members 57 and is

limited in its vertical movement by the ends of the slots 60 engaging the pins 56. The slots 60 and pins 56 also function to prevent rotation of the anvil 61 relative to the hammer casing 40.

The core-taking structure 25 is, as mentioned, threaded-ly fixed to the anvil 61, this fixed connection being accomplished by means of the threaded upper end 26 of the core barrel head 65. The core barrel head has a generally cylindrical shape with an enlarged portion 66 generally at the center thereof and receiving in threaded fixed relation thereon an annular adapter 67. Threadedly fixed to the lower end of the adapter 67 is an outer tube 70 having a bit carrying head 73 mounted in threadedly fixed relation on the lower end thereof. The head has spaced bits 71 extending radially and fixed to the lower distal end 72 thereof and formed of conventional hard carbide material. Between the various bits 71, there are located vertically extending passages 75 which communicate between the lower distal end of the bit carrying head 73 and the interior of the outer tube 70. An inner core carrying tube 77 is rotatably mounted upon the lower distal end 78 of the core barrel head 65 by means of a bolt 80 which extends through a suitable ball bearing assembly 81 and end closure members 83 and 84 fixed in the core barrel head and the inner tube, respectively. By reason of the bearing assembly 81, the inner tube 77 can rotate relative to the outer tube 70 or can remain stationary (or float) relative to the rotating outer tube 70.

The inner tube 77 is maintained in a generally axial position relative to the outer tube 70 by means of the recess 82 in the bit carrying head 73. The core lifter 87 described below is received within recess 82 and has in its upper end a recess 87A which receives and maintains centered the lower end of the inner tube 77. The member 87 is freely placed between the members 73 and 77 and is an easily replaced wearable item. Slight spacing is provided between the recess 87A and the distal end of the inner tube 77 so that a small portion of the air moving between the outer and inner tubes escapes between the core lifter 87 and the inner tube keeping the core somewhat free from dust and preventing locking or seizing of the inner tube by the head and core lifter.

The core lifter 87 is provided for maintaining the core within the inner tube 77, and includes a plurality of springs 86 which project inwardly and upwardly from their mounting in the core lifter 87. The springs 86 permit movement of the core upwardly into the inner tube 77 but resist downward movement of the core out of the inner tube so that when the rig is lifted out of the hole, the core moves with it.

It will be noted that air pressure can pass from the drill stem 10 down to the distal end of the bit carrying head 73. This air pressure passes through the hollow interior 90 of the top member 21 through the passages 35, 37, 36, 46 and between the anvil and the hammer, thence downwardly through the passage 91 and radially outwardly through passages 92 in the core barrel head. Most of the air under pressure then moves downwardly through the passages 75 to blow rock and other loose debris in the hole out of the hole and outside of the structure 10, 20 and 25 although, as mentioned, a small portion of the air moves between the inner tube and the bit carrying head to remove dust from the core.

The above described apparatus is used to provide advantageous results in the following manner. The force 11 is exerted upon the drill stem 10, thereby maintaining a constant downward force on the bit carrying head 73. The drill table 12 is slowly rotated producing a slow rotation of the bit carrying head 73. It has been found in one specific embodiment of the invention that the most desirable speed of rotation of the bit carrying head is from 25 to 50 r.p.m. and that the most appropriate force 11 exerted on the drill stem is 1,000 pounds.

Pressure is produced within the drill stem by means of the pump 15. This pressure causes the hammer 41 to

reciprocate vertically and to repeatedly strike the anvil 61 producing a jolting or pounding action of the bit carrying head 73 against the rock being drilled. Hammer 41 comprises an upper lateral surface 101 and a lower substantially lateral surface 102 forming a space 103 between the hammer and anvil 61 when these members are engaged. The area of surface 101 is less than the effective lateral area of surface 102 such that hammer 41 is raised when pressure air is supplied to space 103. The hammer 41 reciprocates to pound the anvil 61 because of the manner in which the air under pressure passes through the means 20. In FIG. 2, the hammer 41 is shown just completing a hammering stroke against the anvil 61. The pressurized air passes through the hollow interior 90, passages 35, 37, 36, 46 and 47 and acts upwardly on the surface 100 which causes the hammer to move upwardly. Of course, the pressure acts downwardly on the hammer at 101 but this is balanced by the air pressure acting upwardly at 102. In other words, the hammer moves upwardly because the area upon which pressure is acting is greater at the bottom of the hammer than it is at the top.

As the hammer 41 rises, the bottom finger valve 105 moves out of the passage 91, allowing the air in the hammer and below it to pass out through the passage 91, thence downwardly. The rising hammer also over-travels the depending element 32 (which is also a finger valve) whereby element 32 projects into passage 46 cutting off flow of air through the passage 46. With the pressure below the top finger valve reduced, the valve assembly 31 is forced downwardly by the air and spring 34 into the passage 46. The full air pressure now acts only on the upper end 101 of the hammer 41 forcing the hammer downwardly to strike the anvil 61 a powerful blow. With the hammer in the down position, the above cycle is repeated. The fact that the upper valve assembly or finger valve is vertically movable means that the valve moves downwardly with the hammer keeping the passage 46 closed off an instant longer prolonging the full air pressure on the top 101 of the hammer so as to give a more powerful blow to the anvil. The impact tool 20 is so designed as to produce from 2,800 to 3,000 blows per minute, the number of blows depending on the pressure and volume of air used. Thus, it can be appreciated that the rotation of the head 73 at from 25 to 50 r.p.m. is merely sufficient to insure that the bits 71 come down against the rock at a different angle for each blow. The rotation of the head 73 in no way produces any actual cutting or drilling. It should be understood that the pressure and volume of air delivered to the hammer 41 determines the number of blows per minute but that variation of such pressure and volume affects only the rate of hammering and penetration and not the efficiency and operability of the arrangement.

As the head 73 (with its circular pattern of radially extending drill bits) repeatedly strikes the rock, it rapidly cuts therethrough and causes a core of the rock to move upwardly through the opening 95 in the head upwardly into the inner tube 77. It has been found that the present arrangement produces almost 100% recovery. That is, the vertical height or length of the core is equal to the amount of rock which has been drilled and thus, the core is a true representative sample of the rock. It should be emphasized that the present invention includes the concept of maintaining a constant axial downward force on the bit carrying head as well as repeatedly pounding that head against the rock and slowly rotating the head. Such a procedure reduces expense since the bits can be conventional carbide type bits instead of diamond bits. Furthermore, the time involved in taking the core is much less also by approximately one-third.

From the above description, it will be evident that the present invention provides an improved apparatus for taking a core sample, said apparatus being less expensive and faster than conventional commercially available apparatus.

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While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention and the scope of the claims are also desired to be protected.

The invention claimed is:

1. Core taking apparatus comprising a drill stem, means for rotating said drill stem, means for exerting a constant downward force on said drill stem, casing means fixedly mounted on the lower end of said drill stem so as to rotate therewith, an anvil reciprocably received in said casing means, means disposed between said anvil and said casing means to prevent relative rotation therebetween air-pressure-operated means in said casing including a hammer for repeatedly striking and hammering said anvil downwardly, means for supplying air pressure through said drill stem to said air-pressure-operated means, a hollow cylindrical core barrel head fixed to said anvil, passage means in said anvil so that air from said supply means actuating said hammer may exit through said anvil, an outer tube fixed to and surrounding said core barrel head, an inner tube rotatably secured to said core barrel head and received within said outer tube, a drill bit carrying head secured to the distal end of said outer tube and having a central opening in registry with said inner tube.

2. A core taking arrangement comprising a drill stem, means for rotating said drill stem, means for exerting a constant downward force on said drill stem, casing means fixedly mounted on the lower end of said drill stem, a hammer reciprocably received in said casing means, passage means in said hammer for conducting air therethrough and to the exterior of said hammer below its lower end to raise said hammer, an anvil reciprocably received in said casing means below said hammer, pins fixed to said casing means and extending into vertical slots in said anvil to permit limited vertical reciprocation of said anvil but to prevent rotation of said anvil relative to said casing means, means for supplying air pressure through said drill stem to the upper end of said casing above said hammer, an axial passage in said anvil so that air may exit therethrough first valve means between said hammer and the upper end of said casing for alternately opening and closing said passage means in said hammer and second valve means between said hammer and anvil for alternately opening and closing said passage means in said anvil whereby said air pressure causes said hammer to reciprocate and repeatedly strike said anvil driving it downwardly while said valve means is sequentially opening and closing, a hollow cylindrical core barrel head fixed to said anvil, an outer tube fixed to and surrounding said core barrel head, an inner tube rotatably

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secured to said core barrel head and received within said outer tube, a drill bit carrying head secured to the distal end of said outer tube and having a central opening in registry with said inner tube, and drill bits secured to and spaced around the distal end of said bit carrying head.

3. A core taking arrangement comprising a drill stem, means for rotating said drill stem, means for exerting a constant downward force on said drill stem, casing means mounted on the lower end of said drill stem, a hammer reciprocably received in said casing means, an anvil reciprocably received in said casing means below said hammer, pins fixed to said casing means and extending into vertical slots in said anvil to permit limited vertical reciprocation of said anvil but to prevent rotation of said anvil relative to said casing means, means for supplying air pressure through said drill stem to the upper end of said casing above said hammer, said hammer and anvil each having a duct therethrough which in given positions of said hammer and anvil permit passage of air under pressure downwardly through said hammer and anvil, valve means between said hammer and the upper end of said casing and between said hammer and said anvil whereby said air pressure causes said hammer to reciprocate and repeatedly strike said anvil driving it downwardly, said valve means sequentially opening and closing said ducts to cause said air pressure to reciprocate both said hammer and said anvil, said duct in said hammer having a radial branch which directs air around said hammer above said anvil to raise the hammer during reciprocal operation thereof, a hollow cylindrical core barrel head fixed to said anvil, an outer tube fixed to and surrounding said core barrel head, an inner tube rotatably secured to said core barrel head and received within said outer tube, a drill bit carrying head secured to the distal end of said outer tube and having a central opening in registry with said inner tube, drill bits secured to the distal end of said outer tube and spaced around said bit carrying head, said core barrel head having air passages therethrough communicating between the inside of said core barrel head and the inside of said outer tube, said outer tube having air passages therethrough communicating between the inside of said outer tube and the distal end of said outer tube between said bits.

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