Feb. 17, 1953 R. I. MAHAN 2,628,816

CORE-SAMPLING TOOL

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Fig. 1.

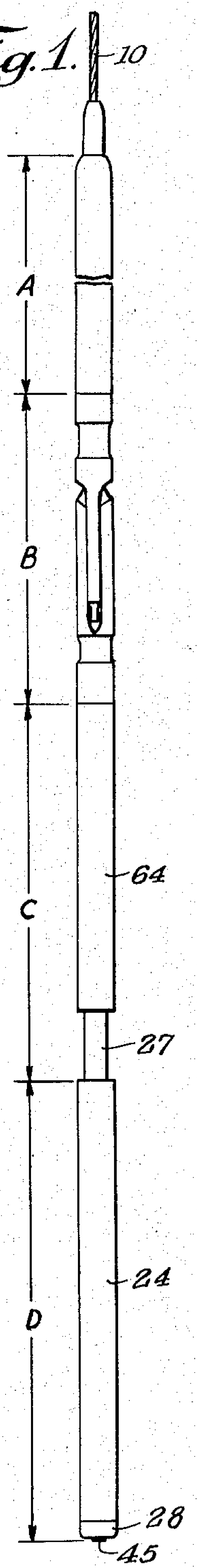

Fig. 2.

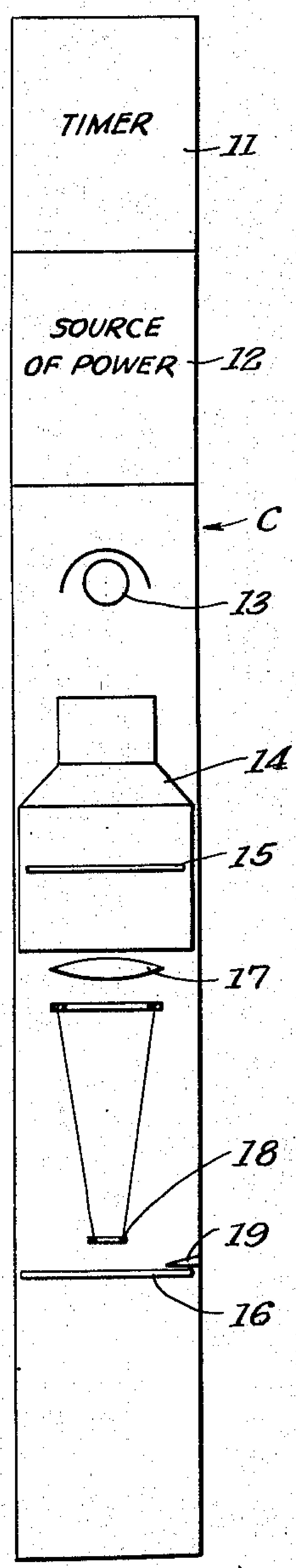

Fig. 3.

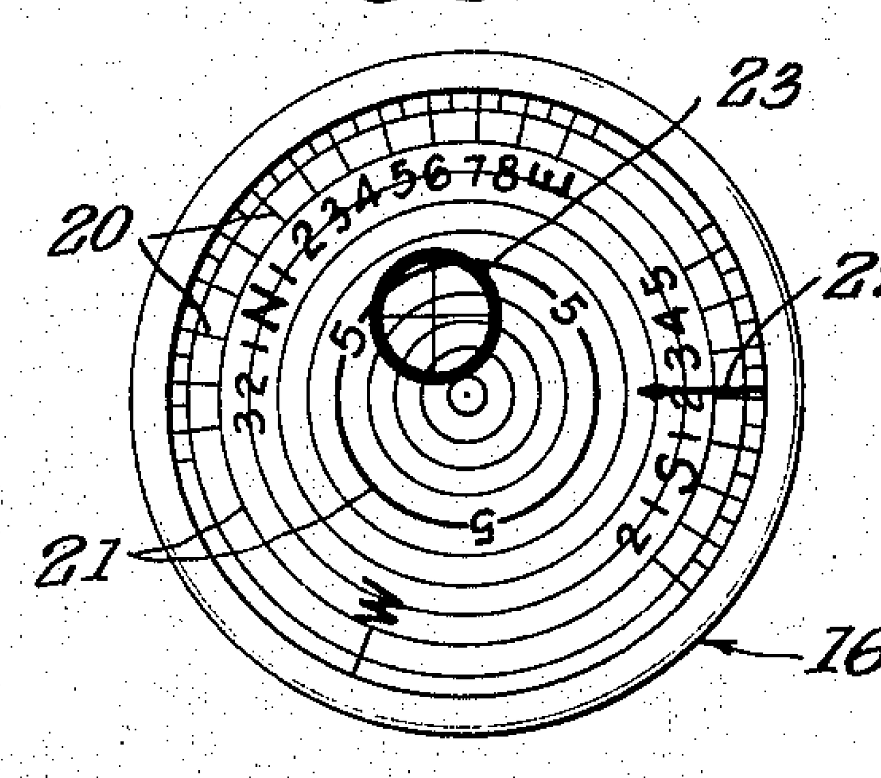

Fig. 4.

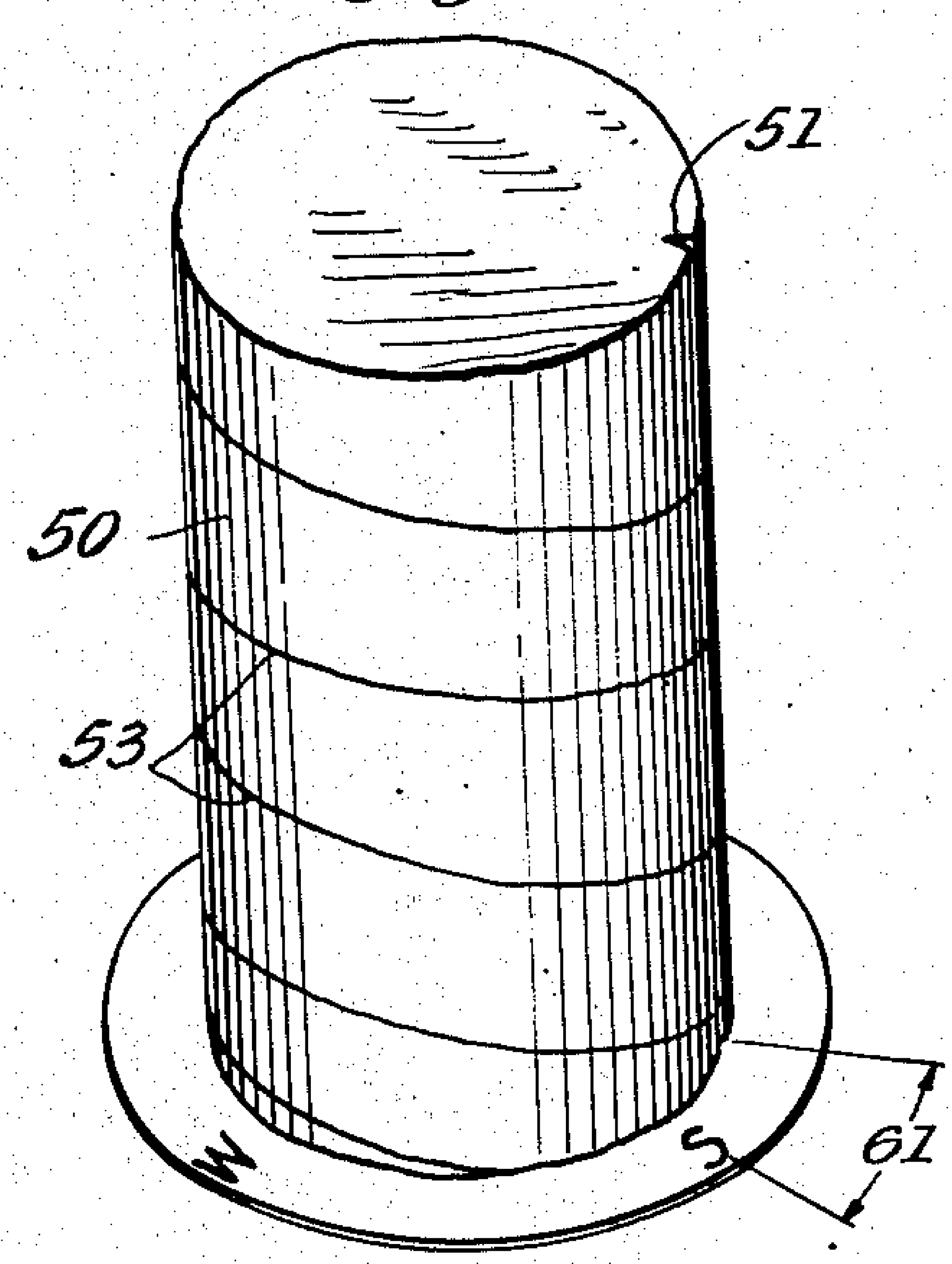

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Fig. 5.

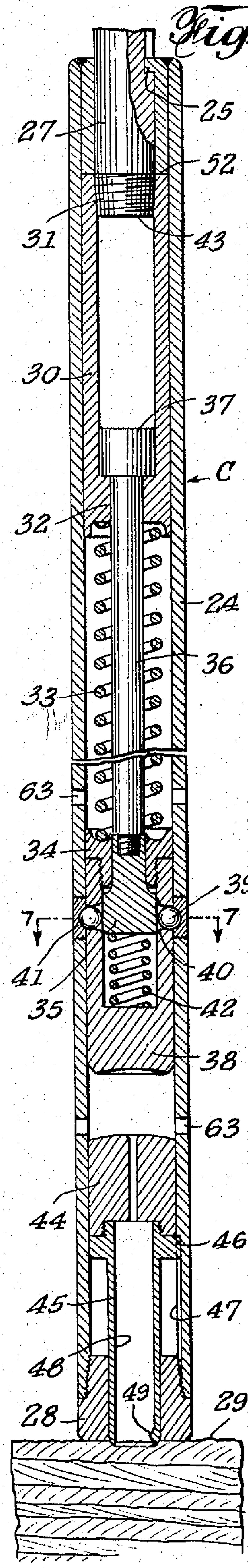

Fig. 6.

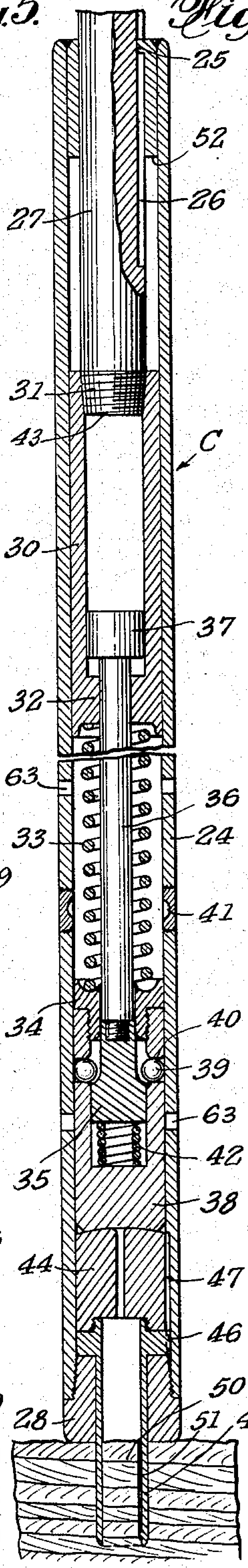

Fig. 7.

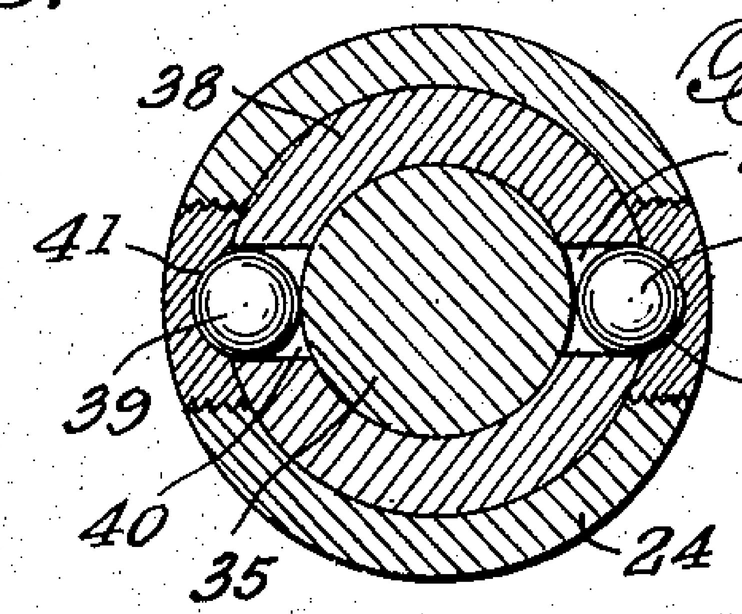

Fig. 8.

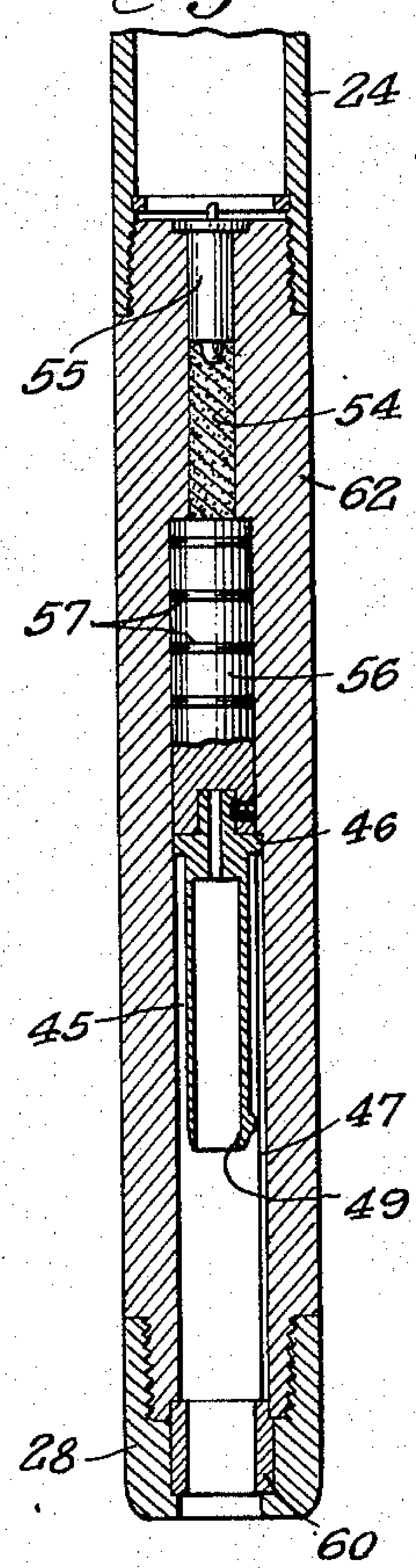

Fig. 9.

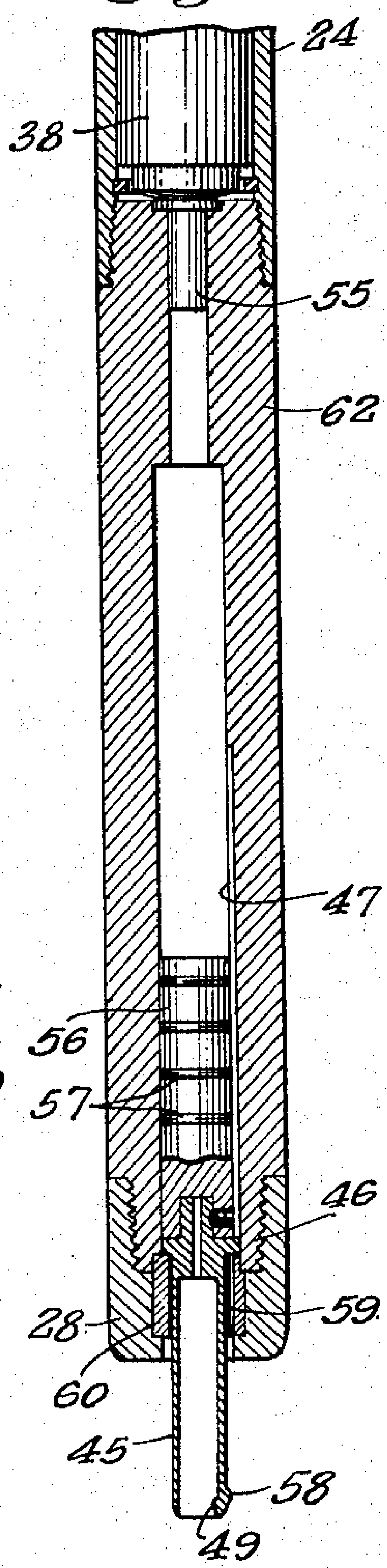

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Fig. 10.

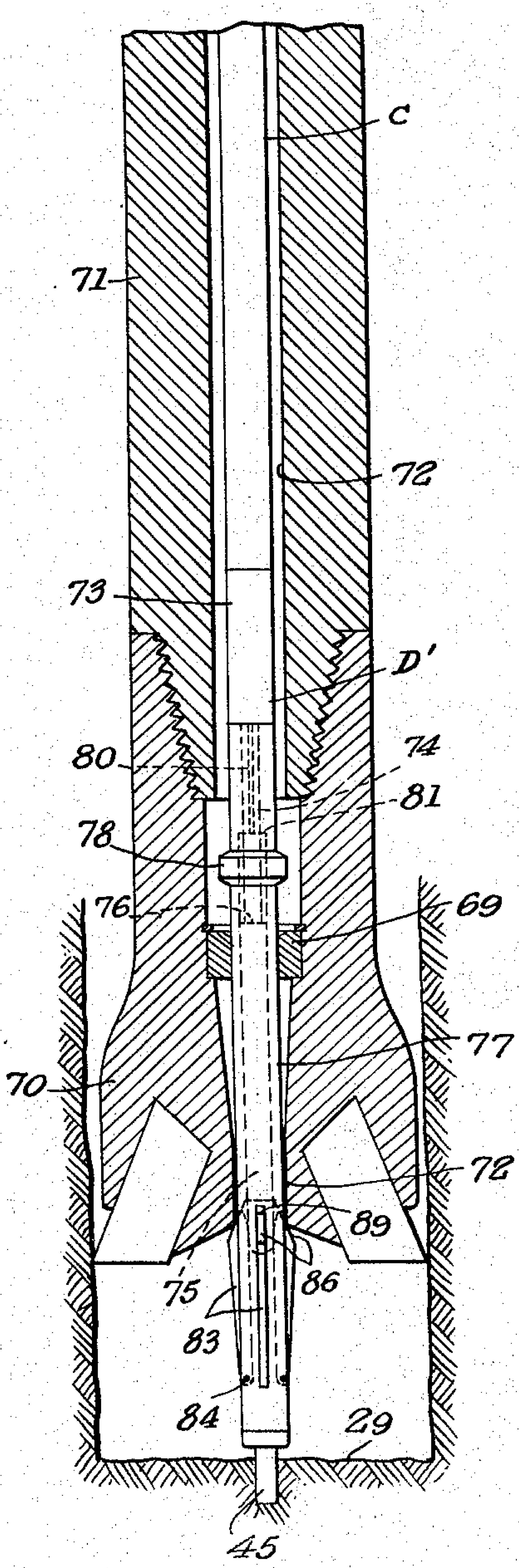


Fig. 11.

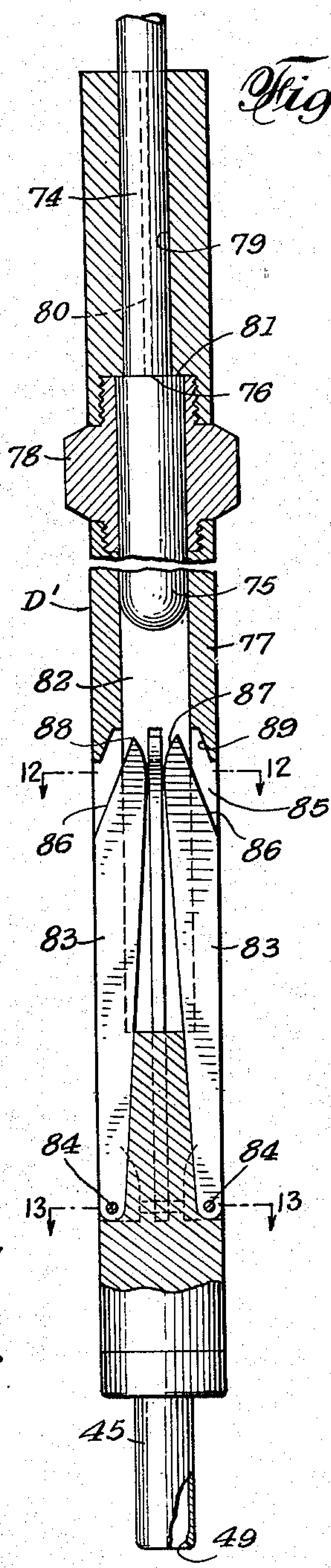


Fig. 12.

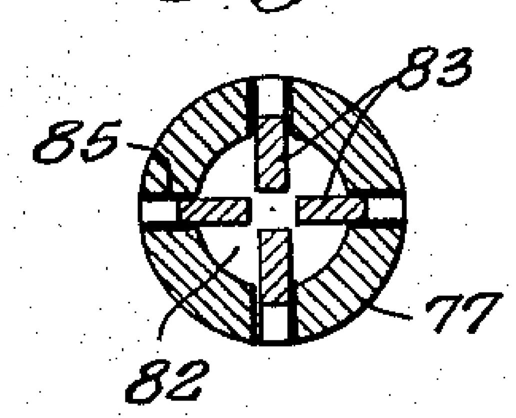
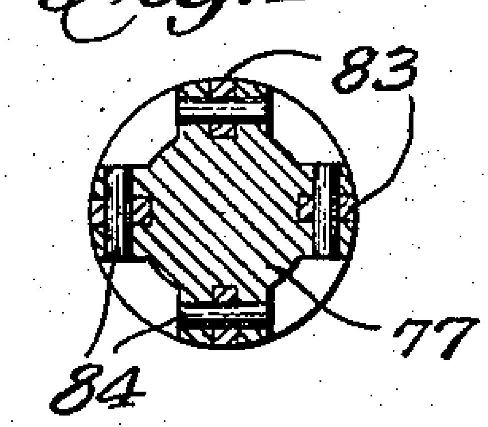


Fig. 13.



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UNITED STATES PATENT OFFICE

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CORE-SAMPLING TOOL

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Application August 20, 1949, Serial No. 111,371

3 Claims. (Cl. 255—1.4)

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This invention relates to a tool that is adapted to be run into a well bore or the like for the purpose of removing a sample core from the bottom of the bore.

The primary object of the invention is to provide a tool, as indicated, that extracts a sample core which is so oriented with the cardinal points of the compass that the formation, the angle, and the direction of angle of the bedding layers thereof can be readily determined.

Another object of the invention is to provide a core-sampling tool that is adapted to have a diametral size enabling running the same to the bottom of a hole through the bore of a string of drill pipe or through casing, said tool, of course, being adapted to be run into an open hole.

Another object of the invention is to provide an oriented core-sampling tool that provides a record of the relationship of the orientation mark on the sample core and the cardinal points of the compass, and also, if any, of the degree of inclination of the well bore and the direction of said inclination with respect to the compass.

A further object of the invention is to provide a tool, as indicated, that embodies novel impact means of taking the sample core, the same being automatic upon engagement of the end of the tool with the bottom of the well bore.

A further object of the invention is to provide a core-sampling tool adapted to be run down through the axial bore of a drill string and beyond the bit on the end of said string and to so co-act with said bit as to receive the full weight of the drill string, whereby said tool, under force of said weight, is pressed into the formation at the bottom of a well hole.

The invention also has for its objects to provide such means that are positive in operation, convenient in use, easily installed in a working position and easily disconnected therefrom, economical of manufacture, relatively simple, and of general superiority and serviceability.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. However, the drawings merely show and the following description merely describes embodiments of the present invention, which are given by way of illustration or example only.

Fig. 1 is a small scale elevational view, partly broken, showing a core-sampling tool according to the present invention.

Fig. 2 is an enlarged schematic view of the preferred form of orienting recording section of said tool.

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Fig. 3 is a further enlarged face view of a record produced in the orienting recording section.

Fig. 4 is a perspective view of a sample core and indicating how the same may be associated with a compass-point-marked card or sheet to re-orient said core with the cardinal points of the compass so as to have a visual revelation of the angle and direction of angle of the bedding formation at the bottom of the bore from which said core is taken.

Fig. 5 is a longitudinal sectional view of one form of sample-taking impact section before the same is tripped.

Fig. 6 is a similar view of said section after tripping and taking of a sample core.

Fig. 7 is an enlarged cross-sectional view as taken on line 7—7 of Fig. 5.

Fig. 8 is a longitudinal sectional view showing a modification of the lower end of the impact section before the same is operated.

Fig. 9 is a similar view of said section after operation.

Fig. 10 is a longitudinal sectional view of the lower end of a well-drilling bit and a third form of sample-taking tool in operative combination.

Fig. 11 is an enlarged longtiudinal and partly broken sectional view of the tool shown in Fig. 1 in the condition the parts assume during passage through the drill bit and its string.

Figs. 12 and 13 are cross-sectional views as taken on the respective lines 12—12 and 13—13 of Fig. 11.

The tool that is shown in Fig. 1 comprises four essential sections, a loading section A, a jars section B, an orienting and recording section C, and an impact and core-taking section D, arranged one below the other in the order named and suspended from a cable or wire 10 whereby said tool is lowered into a well bore either in an open hole, through a lining casing, or through a drilling string, as the case may be.

The loading section A may be of any suitable length, and, so that the same may have sufficient weight for operating the impact section D, is preferably comprised of sections of tubing and/or sinker bars sufficient in number to provide the desired weight.

The jars section B may be generally conventional and is provided primarily to insure careful withdrawal of the tool from the hole after the sample core is taken. Instead of an inordinately strong pull, by means of the jars, short upward tugs on cable 10 will result in progressive taps that will loosen the core in a safe and careful manner.

The orienting and recording section C may be any of the well known time or gravity actuated mechanisms if the hole has appreciable inclination, or a magnetic directional surveying device if the hole has less than two degrees of inclination. Section C, per se, does not constitute a part of the present invention. However, such a section, in operative combination with all or some of the other sections of the tool, contemplates one novel phase of the present tool.

Figs. 2 and 3, for reasons of clarity, illustrate the essential features of a preferred form of orienting and recording section. As shown in the schematic form of Fig. 2, said section comprises a timer, such as a time clock 11, a source of power such as dry cell batteries 12, a light source 13, camera means 14, a magnet 15 adapted to be photographed by the camera on a card 16, a suitable optical system 17, an inclination indicating ring 18, and an orientation point or index 19, said camera being adapted to also photograph said ring and index on card 16. As a result, card 16, which is initially blank, but light sensitive, has photographed thereon compass marks 20, a series of concentric rings 21 representing one degree angles of inclination relative to the center of the card, an image 22 of index 19, and an image 23 of ring 18. It is immaterial at what angular disposition index 19 is with respect to the cardinal points of the compass 15 since the latter constitutes a fixed reference by means of which the angular position of index 19 is determined. In the example shown in Fig. 3, the image 22 of index 19 is shown at 21° E. of S.

Any inclination of the hole is shown by image 23 which will fall off the center since ring 18 is freely suspended. As shown, the inclination on the example is some three and one-half degrees and the direction of the inclination is 44° E. of N. Any time after the sample is taken by operation of the impact section, section C may simultaneously record the above-outlined orientation of the tool relative to the compass, and the angle and direction of the hole.

As indicated, the above-described orientation section C may vary. The one described will provide all the needed information regarding the angle and orientation of the hole. In instance where some of this information is already known, section C may incorporate only such means as will complete the needed information.

The impact and core-taking section D that is shown in Figs. 5, 6 and 7 comprises an outer tube 24 which is provided with a key 25 engaged in a slot 26 in an extension 27 of section C. Thus, sections C and D are held against relative rotation while they may move relatively longitudinally. The bottom of tube 24 is provided with a fitting 28 adapted to engage the bottom of the hole 29, while the tool is being lowered and enabling the weight of section A to further depress extension 27 and a hollow barrel 30 threadedly connected to said extension at 31. Said barrel has a bottom wall 32 which constitutes the upper abutment for a compression spring 33. The lower abutment for said spring comprises a flange 34 on a plug 35. The latter is provided with an upwardly extending stem 36 which extends into barrel 30 and terminates in a head 37 normally resting on bottom wall 32 of said barrel. It will be evident that the weight on extension 27 and barrel 30 will effect compression of spring 33 when fitting 28 bottoms and providing that flange 34 is held against downward movement.

To this end, the flange 34 is affixed to a ram or percussion element 38 which is locked in place as by, at least, two detent balls 39 in transverse passages 40 in said ram, said balls engaging in hardened seats 41 provided in tube 24 and retained therein by plug 35. A coil spring 42 normally supports said plug so that the same retains a position between the balls whereby the ram 38 is locked and the spring 33 is enabled to be compressed, as above indicated.

The first portion of the downward movement of barrel 30 stores energy in spring 33. Then, as this movement continues, the bottom face 43 of extension 27 engages head 37 to move stem 36 and plug 35 down against the light force of spring 42. Said plug will thus be removed from between the balls 39. The force of spring 33 is now enabled to urge said balls inwardly out of their seats 41 to, thereby, free the ram 38, which, under power from spring 33, is propelled downward with considerable force.

Below the ram 38 and guided in tube 24, there is provided a unit that comprises a piston 44 that is adapted to be struck by the ram, and a core-taking tube 45 removably connected to said piston. Said tube 45 is guided in fitting 28 and is adapted to be retracted thereinto as in Fig. 5.

According to the present invention, tube 45 is non-rotationally held in tube 24 by a key projection 46 thereon and a key slot 47. Also, the bore 48 of tube 45, at or near its bottom end, is provided with a correlating device such as a knife-like projection 49 or anything that will similarly mark or scribe a core sample 50 with a longitudinal mark, line, etc. 51 when the force of ram 38 has projected tube 45 into the bottom 29 as indicated in Fig. 6.

While key 46 and keyway 47 need not have any special orientation with index 19, projection 49 is so positioned as to be exactly aligned with said index or at a known angle thereto so that definite relationship between the index and the projection is known. Said key and keyway insure retention of such correlation.

The taking of the core sample is automatic, since only continued lowering of the tool is all that is necessary to first bottom the tool, then release the ram, and finally project the core tube into the bottom.

When the tool is to be extracted from the hole, the first pull on cable 10 will cause wall 32 to engage head 37 and exert a lift on ram 38 by means of the interengagement of plug 35 and balls 39. This lift continues until said balls arrive opposite seats 41 and fall thereinto releasing the plug for further upward movement while locking the ram. Then, as barrel 30 engages stop abutment 52 carried by tube 24, an upward force is imparted to the latter. Since tube 45 is firmly imbedded in the formation of hole bottom 29, the jars section now becomes effective to gently create a series of removal taps by alternately slacking off and pulling on cable 10. When the tool is completely withdrawn, fitting 28 is removed so that tube 45 and its piston can be extracted from tube 24. Now, said tube and piston can be separated and the sample core 50 of the formation pushed out of the former.

Of course, removal of the tool destroys any relationship that the core had with the well bottom, but such relationship is readily re-established by consulting the record on card 16, since the line 51 on said core was coordinated with image 22 when the core was taken. It will be evident that the strata of the core 50 as indicated by lines 53, when said core is associated with a compass card, as in Fig. 4, so that line 51 has the same relationship thereto as has index image 22, are reoriented with the points of the compass. Now, the angle and the direction of the strata can readily be determined to give geological information that is accurate.

The modification of Figs. 8 and 9 employs an explosive charge 54 which, through the medium of firing mechanism 55, is percussed by ram 38, to propel a piston 56 that carries a tube 45 similar to that shown in Figs. 5 and 6. Said piston is sealed to retain the expanding gases of explosion by O-rings 57. Here, also, tube 45 is held against rotation relative to tube 24. In addition, said tube is provided with an outwardly directed projection 58 that cuts a line or groove 59 in a copper or other soft metal ring 60 through which the tube moves when propelled. This line 59 may be used to check the initial correlation with index 19 and if such correlation has been disturbed during operation, a suitable correcting factor would be introduced in the angular dimension 61 (Fig. 4).

Since the forces of explosive 54 are equal in all directions, the modification preferably entails terminating tube 24 short of the end of section D and housing the above-described elements in a strong unit 62 capable of withstanding the forces of explosion.

Since the tool may be lowered into water or other fluid, displacement of the same is afforded through openings 63 in tube 24. Also, air cushions are, thereby, eliminated.

Since section C depends for its proper function on the magnetic position of magnet 15, the barrel 64 therefor is made of a non-magnetic metal so as not to interfere with said magnet. "K-Monel" has been found satisfactory for this purpose.

The modification of Figs. 10 to 13 contemplates utilizing the weight of a drilling string, rather than an impact, for embedding the core-taking tube 45 in the bottom 29 of the hole. Such a tool may be used where the formation is sufficiently penetrable by such a weight.

Fig. 10 illustrates a conventional hole-boring bit 70 connected on the lower end of a drilling string 71. In the usual manner, a longitudinal passage 72 extends through the string and bit, being normally used for passing flushing fluid down into the hole. Bit 70 is provided with a stop or slush ring 69, the same constituting a shoulder used for other purposes.

Instead of section D, above described as an impact section, the present modification comprises a section D^1 designed for operative inter-engagement with bit 70 to utilize the weight of said bit and of the drill string 71.

The upper end of section D^1 comprises a fitting 73 removably affixed to the lower end of section C. A lower extension 74, of smaller diameter than said fitting, extends downward and terminates in a plunger 75, there being a shoulder 76 where extension 74 and plunger 75 meet. The lower end of section D^1 comprises an elongated unit 77 which, near its upper end, is provided with an enlarged shoulder 78 of a diametral size to freely move in passage 72.

Unit 77, above shoulder 78, is provided with a bore 79 for extension 74 and a key 80 is provided to hold said extension and unit 77 against relative rotation while one moves axially relative to the other. Bore 79 terminates in an internal shoulder 81 for shoulder 76 of plunger 75 and, below shoulder 81, a bore 82 to telescopically accommodate said plunger, is provided.

Intermediate shoulder 78 and the lower end of unit 77, the latter mounts at least two opposed, or, as shown, two pairs of opposed dogs 83 that are hinged to unit 77 at their bottom ends, as on pins 84 and extend upward in slots 85 provided in said unit. Each dog, at its upper end, is provided with an outer downwardly and outwardly sloping edge 86 and with an inner opposed convexly curved edge 87. The upper ends 88 of said dogs are retained by abutments 89 from completely leaving slots 85, being capable of movement from an inner position entirely within the outer surface of unit 77 to an outer position where edges 86 (as in Fig. 10) protrude beyond said outer surface and beyond the diameter of that portion of bore 72 that is formed in bit 70.

Tube 45 is carried by the lower end of unit 77 in a manner comparable to that described in the earlier forms of the invention.

When a sample core is to be taken by a tool embodying section D^1, drill string 71 is lifted to raise bit 70 from the bottom 29 of the hole a distance somewhat greater than the distance between dog ends 88 and the lower end of tube 45. The tool is then lowered through bore 72. If, during the lowering, dogs 83 fall outward, it is immaterial since said dogs trail and will merely slide along the wall of bore 72. During this condition (Fig. 11) plunger 75 is retracted since unit 77 is suspended from shoulder 76.

When shoulder 78 encounters stop or slush ring 69, the downward movement of unit 77 is arrested but with assurance that dogs 83 are now wholly below the lowermost part of bit 70. Lowering of the tool, except unit 77, continues until fitting 73 abuts the upper end of said unit. This last portion of the tool movement brought plunger 75 down into bore 82 and between the opposite edges 87 of dogs 83 to hold said dogs outwardly projected. At this time, the bottom of tube 45 is still above the hole bottom 29.

Now, both the drill string 71 and the tool are lowered together. When tube 45 encounters the hole bottom 29, this downward movement of unit 77 is arrested. The drill string continues down effecting separation of shoulder 78 and stop ring 69. Then, as the bottom of bit 70 engages the outwardly projected sloping edges 86 of dogs 83, the entire weight of the drill string and bit is borne by unit 77. This great weight of many tons is sufficient to cause tube 45 to penetrate into the bottom formation 29 of the well bore. Since unit 77 is keyed to fitting 73 and the latter fixed, although removably, to section C, projection 49 of said tube will be oriented radially with the instrumentalities within said section as hereinabove described.

Removal of the tool is simple. String 71 is just lifted off the dogs and shoulder 78 used to dislodge tube 45 from the bottom formation. Then, the tool is raised to effect withdrawal of plunger 75 from between the dogs. After shoulders 76 and 81 are re-engaged, the tool can be drawn to the surface, edges 86 of the dogs merely camming inward past the abutments formed by the lower end of the bit and the bottom face of stop ring 69.

In this form of the invention, the jar section B is unneeded and may be omitted, since the drill string is used instead for dislodging the tool.

While the invention that has been illustrated and described is now regarded as the preferred embodiments, the construction is, of course, subject to modifications without departing from the spirit and scope of the invention. It is therefore not desired to restrict the invention to the particular forms of construction illustrated and described, but to cover all modifications that may fall within the scope of the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. A core-sampling tool comprising two telescopic units one above the other, the lower of said units having an axial bore, a plunger carried by the upper unit and movable therewith in said bore upon telescopic movement of the units, a set of upwardly directed dogs carried by said lower unit and pivotally connected at their lower ends to said lower unit and having upper weight-bearing shoulders, said set of dogs, from a normal position retracted on their pivots within the outer surface of the lower unit and, in part, within the mentioned bore of said unit, being adapted to be moved by the mentioned plunger to a projected position wherein said shoulders are beyond the outer surface of said lower unit, and a sample-taking tube carried by said lower unit at the lower end thereof and impressible into a hole formation upon weighting of said dog shoulders, said shoulders of the set of dogs being outwardly and downwardly sloped from their upper ends to constitute cams which, when weighted, urge said set of dogs to move to retracted position upon withdrawal of the plunger from between them.

2. A core-sampling tool for operative engagement within the axial passage of a boring bit on the lower end of a drill string, there being an upwardly facing abutment in said passage, said tool comprising two telescopic units one above the other slidingly extending in said passage, the lower of said units having an axial bore, a plunger carried by the upper unit and movable therewith in said bore upon telescopic movement of the units, a set of upwardly directed dogs carried by said lower unit adjacent the lower end thereof and pivotally connected at their lower ends to said lower unit and having upper shoulders

adapted to be engaged by the lower end of the bit and to bear the weight of said bit and drill string, said set of dogs, from a retracted position within the passage in the bit and, in part, within the bore of the lower unit, being adapted to be moved by the mentioned plunger to a projected position engaged by the lower end of the bit, a sample-taking member extending from the lower end of the lower unit and impressible into a hole formation formed by said bit by the weight of the bit and drill string on said set of dogs, and a downwardly facing abutment on said lower unit and spaced above the upper ends of the set of dogs to be above the upwardly facing abutment in said passage, the spacing between the abutment on the lower unit and the set of dogs being such that, when the two abutments are engaged, the set of dogs is disposed below the bottom of the bit.

3. A core-sampling tool according to claim 2: said shoulders on the set of dogs being outwardly and downwardly sloped from their upper ends to constitute cams, the weight of said bit and drill string, upon withdrawal of the plunger from between the set of dogs, engaging said cams to force the dogs to retracted position enabling withdrawal of the tool and the sample taken thereby from operative engagement with the bit and drill string.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,489,566	Engle	Nov. 29, 1949
2,491,682	Muhlbach	Dec. 20, 1949
2,509,833	Rolshausen et al.	May 30, 1950
2,528,981	Stokes	Nov. 7, 1950
2,541,785	Smith	Feb. 13, 1951

FOREIGN PATENTS

Number	Country	Date
7,107	Great Britain	1900