

Nov. 29, 1949

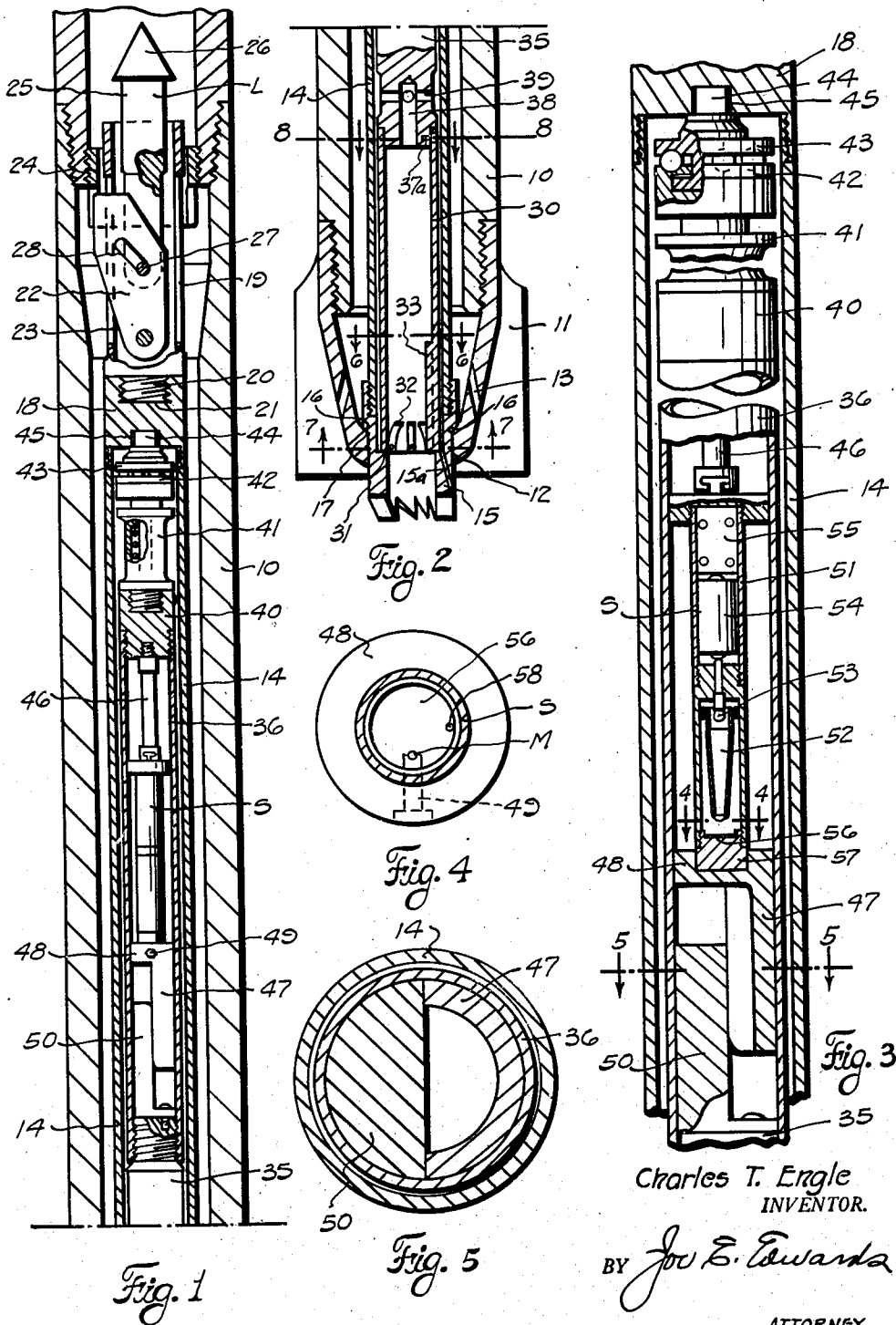
C. T. ENGLE

2,489,566

CORE ORIENTING APPARATUS

Filed Nov. 27, 1945

3 Sheets-Sheet 1



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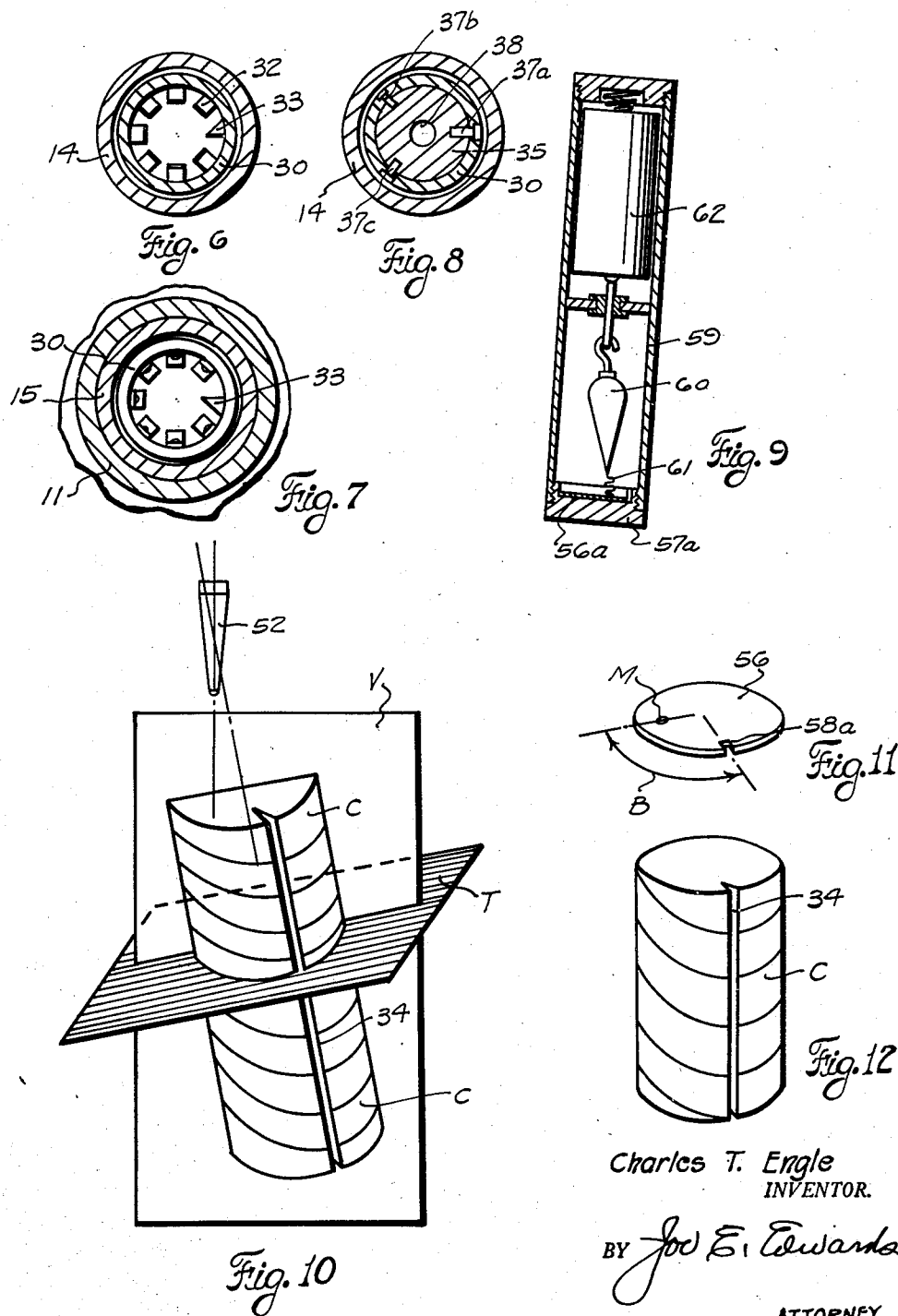
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CORE ORIENTING APPARATUS

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3 Sheets-Sheet 2



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CORE ORIENTING APPARATUS

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3 Sheets-Sheet 3

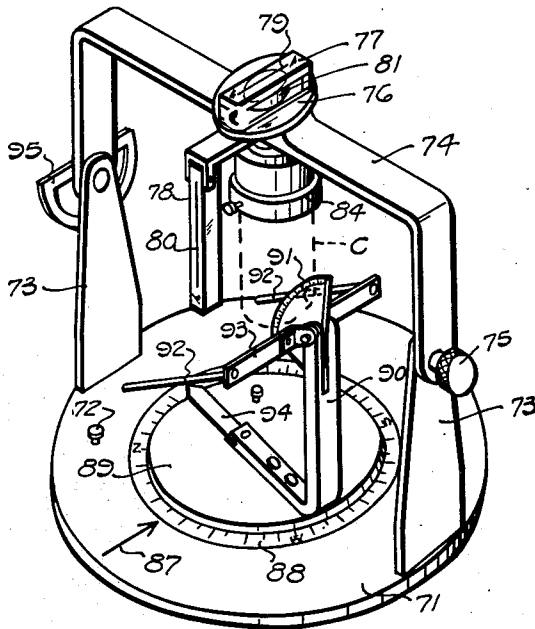


Fig. 13

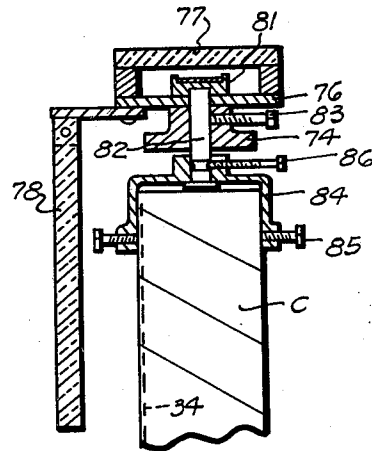


Fig. 15

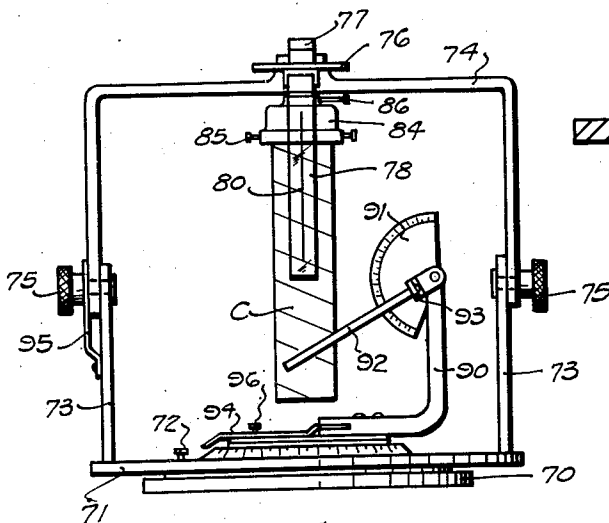


Fig. 14

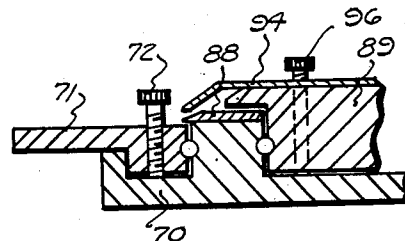


Fig. 16

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UNITED STATES PATENT OFFICE

2,489,566

CORE ORIENTING APPARATUS

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ware

Application November 27, 1945, Serial No. 631,052

20 Claims. (Cl. 255—1.4)

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This invention relates to new and useful improvements in core orienting apparatus.

This application is filed as a continuation-in-part of my co-pending application, Serial Number 565,775, filed November 29, 1944, now abandoned.

As is well known, it is desirable in the drilling of petroleum wells to determine the dip and strike of the sub-surface strata since this information is useful in ascertaining the location of the center of a "pool" or oil bearing sands. It has become the general practice to determine the dip and strike of the underground strata by cutting or "taking" a core or sample of the stratum and properly orienting said core to thereby gain the necessary information regarding the direction of inclination of earth strata contained in said core. The usual core-taking and orienting equipment involves use with a drill pipe, that is, said equipment must be lowered and raised by means of said drill pipe, with the result that the entire drill string must be lowered into position, then rotated or "spudded" in to "cut" the core, and then removed to bring said core to the surface. This type of equipment ordinarily utilizes a magnetic type of survey instrument for indicating inclination and direction, which indications are correlated in one manner or another with a suitable orienting mark on the core. The use of a magnetic survey instrument is disadvantageous since it requires a non-magnetic section of drill pipe immediately adjacent or surrounding the same.

Another type of apparatus also in general use is the removable core-taking equipment which is adapted to be lowered and withdrawn through the drill pipe. Such equipment is of decided advantage since removal of the entire drill string is not necessary to recover the core or sample. However, because of its particular construction, the removable core-taking equipment does not lend itself to orientation of the core taken thereby and up to the present time, orientation of cores obtained by such removable equipment, has been accomplished only through orientation of the entire drill string as the latter is lowered into the well bore.

It is one object of this invention to provide an improved apparatus for determining the correct orientation for a core taken in a bore hole, said apparatus being removable with respect to the drill pipe and having means for accurately orienting the core as it is actually cut or taken, whereby said apparatus combines all the advantages of both the usual removable core-taking

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ing equipment as well as those of the non-removable type of core orienting equipment.

An important object of the invention is to provide an improved core orienting apparatus which is adapted to be lowered within the drill pipe by dropping or by a wire line and which is arranged to be withdrawn from a drill pipe by means of a wire line or cable, said apparatus having means for mounting a well survey instrument therein, whereby an accurate orientation of the core may be carried out.

Still another object of the invention is to provide an improved core-receiving barrel having means for marking the core or sample received therein, said barrel having an extension or housing adapted to contain a well survey instrument, whereby the record obtained by said instrument may be correlated with the mark on said core to provide information regarding orientation thereof; said barrel and its extension being so constructed that said parts may be readily combined with the usual removable core-taking equipment without any appreciable variation or change in the latter.

A further object of the invention is to provide an improved core orienting apparatus, of the character described, wherein the inner core-receiving barrel is non-rotatable and also wherein the well survey instrument housing is connected to said non-rotatable barrel, whereby damage to the instrument mounted in said housing is obviated; the apparatus having improved means for accurately correlating the instrument record with the core-marking means within the core-receiving barrel, whereby positive orientation of the core is assured.

Still another object of the invention is to provide an improved apparatus, of the character described, having a simple means for marking the core when said core is taken so that the character of the mark itself will indicate which end of the core was uppermost when drilled from the formation.

A particular object of the invention is to provide a core-orienting apparatus including an improved reading device for accurately correlating the record obtained by the survey instrument, and the orientation mark on the core and also for efficiently determined the dip of the strata from the actual core or sample.

A still further object of the invention is to provide an improved reading or interpreting device which is constructed to receive the core or sample and which accurately reproduces or simulates the actual position which the core had in

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situ, whereby an accurate determination of dip and strike of the strata may be made.

The construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, wherein an example of the invention is shown, and wherein:

Figure 1 is a view partly in elevation and partly in section of an improved core-taking apparatus constructed in accordance with the invention and showing the apparatus mounted within a drill pipe,

Figure 2 is a continuation of Figure 1 and illustrating the drill and core-taking bits,

Figure 3 is an enlarged view partly in section and partly in elevation and illustrating the details of a well survey instrument used in conjunction with the core-taking barrel,

Figure 4 is an enlarged, horizontal, cross-sectional view taken on the line 4—4 of Figure 3,

Figure 5 is an enlarged, horizontal, cross-sectional view taken on the line 5—5 of Figure 3,

Figure 6 is an enlarged, cross-sectional view taken on the line 6—6 of Figure 2,

Figure 7 is an enlarged, horizontal, cross-sectional view taken on the line 7—7 of Figure 2,

Figure 8 is an enlarged, horizontal, cross-sectional view taken on the line 8—8 of Figure 2,

Figure 9 is a longitudinal sectional view of another type of well survey instrument which may be used in the apparatus,

Figure 10 is a diagrammatic view illustrating a core with its axis inclined at an angle from the vertical and also illustrating the position of the vertical plane in which the inclined axis of the core lies as well as the relative position of a transverse plane disposed substantially at right angles to the axis of the core,

Figure 11 is an isometric view of the record disk obtained by the well survey instrument,

Figure 12 is an isometric view of the core which is obtained and which is properly marked by the apparatus,

Figure 13 is an isometric view of an improved reading apparatus for determining the angle and direction of dip of the strata traversed by the core,

Figure 14 is a side elevation of said reading device,

Figure 15 is an enlarged, sectional detail of the record disk holder as well as the core holder of the reading device, and,

Figure 16 is an enlarged, sectional detail illustrating the mounting of the rotatable ring and rotatable table on the base of the reading device.

In the drawings, the numeral 10 designates a drill pipe or string which extends axially through the well bore (not shown). A drill bit 11 of any desired construction is connected to the lower end of the drill pipe or string and the body of said bit is substantially hollow with an axial opening 12 in its lower portion. The bit is provided with the usual circulating ports 13.

The improved core-taking apparatus includes an outer tubular casing 14 which has a tubular core bit 15 connected to its lower end. The core bit is provided with an external annular shoulder 16 which is arranged to engage an internal annular seat 17 formed within the drill bit 11 immediately above the axial opening 12 thereof and as is clearly shown in Figure 2 the core bit 15 projects below the main bit 11. The elongate

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tubular casing 14 extends upwardly through the drill pipe or string and has its upper end closed by a cap member or closure 18. A latching device L is arranged to thread into the top of the closure member 18 and said latching device includes an outer housing 19 which has a threaded pin 20 at its lower end. This pin is adapted to connect within a threaded socket 21 formed in the closure. A pivoted latch member or dog 22 is pivotally mounted within the housing 19 and is movable outwardly through a radial slot 23 formed in said housing. When the latch is in its extended position, as shown in Figure 1, the upper portion of said latch is engaged within a detent collar 24, which collar is suitably mounted within the drill pipe or stem 10. Thus, when the latch member 22 is in an outward or extended position, upward movement of the casing 14 and its core bit 15 is prevented.

For effecting retraction of the latch member 22 to an inner position which will permit removal of the tubular casing 14 and core bit 15, said latching device L is provided with an operating stem 25 which is formed with an enlarged head 26 at its upper end. The stem 25 extends downwardly within the tubular housing 19 of the latching device and has connection with the latch member 22 through a pin 27 and an inclined slot 28. It will be apparent that with the parts in the position shown in Figure 1, upward movement of the stem 25 will cause an inward swinging of the latch member 22 to move said member to its retracted position and thereby permit the tubular casing 14 and the core bit 15 to be removed from the drill pipe or string 10. Upward movement of the stem 25 may be accomplished by lowering a suitable tool (not shown) on a wire line or cable and engaging said tool with the head 26 of the stem. It is preferable to lower the casing 14 and bit by dropping the same into position but if desired, the removing tool may be utilized to lower the core bit into position within the drill string.

It might be noted that the removably mounted core bit, together with the particular latching device above described, have been in prior use in the taking of cores. However, this type of removable equipment has not heretofore been adapted for properly orienting the core taken thereby. Thus, the present invention is not to be limited to any particular latch arrangement nor to any specific type of core bit and those shown in the drawings are for purposes of illustration only.

In order to make possible the orientation of the core, an inner assembly is mounted within the tubular casing 14. This assembly includes a tubular core barrel 30 which is disposed within the lower portion of the casing 14 and which has its lower end supported on an internal shoulder 31 formed within the core bit 15. The lower end of the core barrel 30 is open and is provided with the usual core supporting spring fingers 32. In addition to the fingers 32 the bore of the core barrel 30 is provided with an elongate core marking element 33. This marking element is clearly shown in Figures 6 and 7 and has a general triangular shape in cross-section. As a core C enters the barrel 30, the side of said core is cut or marked by the element 33 to form a groove 34 (Figure 12) in said core, this groove being of the same shape in cross-section as the cross-sectional shape of the marking element. By making the core marking element of a particular shape, it is possible to readily determine which

end of the core is uppermost within the core barrel 30 and this is important in finally interpreting the information gained by recovering said core. Through the use of the particular marking element 33 it is not necessary to immediately mark the core as it is removed from the core barrel and proper interpretation of the core is assured.

The core barrel 30 has its upper end connected to a sub 35 (Figures 1 and 2) which sub has its upper end threaded into an inner barrel or tube 36. The lower portion of the sub 35 is connected to the core barrel 30 by means of pins 37a, 37b, and 37c, said pins each being of a different diameter, whereby the sub may be connected to the barrel in one position only. As illustrated in Figure 2, when the sub is connected to the barrel the pin 37a lies in the same vertical plane as the marking element 33 within the interior of the core barrel and due to the different diameters of the connecting pins, the pin 37a will always bear this same relationship to the marking element. The lower portion of the sub 35 has a vertical bore 38 therein and relief ports 39 extend from the upper end of this bore. The provision of the bore and ports 39 allow fluid which may accumulate in the barrel 30 to escape as the core enters said barrel. The fluid which escapes from the barrel flows into the annular space formed between the barrel and the tubular casing 14 and may escape from the lower end of the casing past the shoulder 31 which shoulder is not a ground seat but is merely a support for the lower end of the core barrel. If desired, inclined escape ports 15a may be drilled in the bit 15 (Figure 2) to further facilitate escape of the fluid from the annular space between said barrel and the tubular casing.

As explained, the sub 35 is connected to the core barrel 30 in a known relation with respect to the marking element 33, while its upper end is fastened to the lower end of the inner barrel or tube 36. The upper end of the tube or barrel is closed by a coupling member 40 and this coupling is connected to a telescoping sub 41 with a ball race 42. The upper portion 43 of the ball race has annular upstanding stud 44 which engages within an annular socket 45 provided in the underside of the head member or closure 18 of the outer casing 14. With this arrangement, when the assembly is in position within the drill string, a rotation of the drill string will be imparted to the outer casing 14 and its core drill 15 through the engagement of the detent collar 24 with the latching member 22. Thus, the outer drill bit 11 and the core bit 15 will be rotated upon rotation of the drill pipe or string 10. However, due to the ball race connection between the outer casing 14 and the inner barrel or tube 36 and its connected core barrel 30, the tube 36 of the core barrel will remain stationary while the drill pipe and outer casing 14 and core drill 15 may rotate. Thus, it will be apparent that upon rotation of the drill bit 11 and core bit 15, the core may enter the core barrel 30 which will be stationary while the core bit 15 is cutting said core. Although rotation of the drill bit and core bit is always carried out in the harder formations, it is noted that in soft formations the core bit 15 may be "spudded," that is, driven downwardly into such softer formation to cause a core to enter the barrel. Obviously, the core entering the barrel will be marked by the element 33.

As explained, the core will be marked as it

moves upwardly within the core barrel by the elongate marking element 33. However, at the time that the core is being cut, the particular position of the marking element 33, with reference to compass direction, is not known and in order to properly orient the core, this position must be ascertained. In order to make it possible to determine the compass position of the marking element 33 as it marks said core, a well survey instrument S is mounted within the inner barrel or tube 36. This instrument is suitably suspended within the barrel or tube by a shock absorber rubber 46, which rubber is attached to the coupling member 40 at its upper end and to the instrument S at its lower end. In order to properly orient the instrument S within the barrel or tube 36, an orienting member or leg 47 is connected to the lower end of the instrument by means of a collar 48 which is made integral with the upper end of said member. The collar encircles the lower end of the instrument S and is secured thereto by a suitable bolt 49. The orienting member or leg 47 is arcuate or semi-circular in cross-section, as is clearly shown in Figure 5, and this leg is adapted to co-act with an upstanding orienting member or extension 50 which is secured to the upper end of the connecting sub 35. The extension 50 is connected to the sub 35 in a known relation to the connecting pin 37a which connects the lower portion of the sub to the core barrel 30. As illustrated, the orienting extension 50 on the sub 35 is diametrically opposite the connecting pin 37a which as has been stated lies in the same vertical plane as the elongate marking element 33 within the core barrel. Since the sub is always connected to the core barrel in this manner, the orienting extension 50 is always located diametrically opposite the elongate marking element 33 which marks the core. Thus, when the instrument S is inserted within the barrel, the orienting leg or member 47 connected to said instrument is always located in the same vertical plane as the marking element 33. Therefore, the instrument S is at all times oriented with respect to the marking element 33 which marks the core as it moves upwardly into the core barrel 30.

The particular well survey instrument S is subject to variation and as shown in Figure 3 is the usual type of inclination indicator. As shown, this instrument includes an outer housing 51 having a plumb bob 52 mounted for universal movement therein. A light bulb 53 is supplied with current from a dry cell battery 54 and the flow of current to said bulb is controlled by a suitable timing mechanism 55. The plumb bob overhangs a record disc 56 which is carried in a record disc holder 57 and said holder forms the lower end of the instrument. The holder 57 is secured within the collar 48 of the orienting member or leg 47. The record holder is provided with an orienting pin 58, which pin is located in a known relation with respect to the fastening bolt 49, whereby the orienting pin 58 of the record holder will be in a known position with respect to the orienting member 47. Since, as has been explained, the orienting member or leg 47 of the instrument S is in a known relation with respect to the marking element 33, it becomes obvious that the orienting pin 58 of the record holder is also in a known position with respect to the core marking element 33. As illustrated the orienting pin 58 lies in the same vertical plane as the marking element 33 and

the orienting member or leg 47. Thus, when the record is made by the survey instrument, said record appears on the record disc 56 and is made in definite relation to the marking element 33 which marks the core.

The operation of the well survey instrument S is obvious. The plumb bob 52 will, of course, seek the low side of the well bore and when the timing mechanism 55 closes the circuit, a light beam will be projected through the tubular plumb bob 52 and onto the record disc which is light sensitive. The projection of this beam of light will form a mark or dot M on said record disc and this mark will be representative of the low side of the well bore.

As pointed out other types of survey instruments may be employed and in Figure 9 a modified form of an inclination indicator is shown. This instrument includes an outer casing 59 having a plumb bob 60 mounted therein. A record disc 56a is mounted in a holder 57a below said plumb bob. The lower end of the plumb bob is provided with a marking device 61 which is preferably in the form of a bent or undulated spring wire 61, the lower end of which will always be in contact with the record disc 56a. The disc 56a is chemically treated so that it will react to an electrical current passing down through the wire 61 to the holder 57a. Current for this purpose is supplied from a battery 62 mounted in the upper end of the instrument.

Both of the well survey instruments which have been illustrated are, of course, inclination indicators and provide a record of the low side of the well bore. The particular compass direction of the low side is known to the operator since it is usual practice to survey the well bore for its particular direction of inclination as said well bore is drilled. However, if the apparatus is to be used in a well in which no previous survey has been made, a directional type of survey instrument may be run to determine the direction of inclination of said bore prior to the running of the present core-taking equipment.

In the operation of the invention, the drill pipe is within the well bore while drilling there-of progresses. When it is desired to obtain or recover a core, the apparatus including the outer casing 14 and core bit 15, as well as the inner assembly which includes the inner barrel 36 and the core barrel 30 is lowered into position preferably by dropping the same downwardly through the pipe; however, if desired, said inner assembly may be lowered by means of a wire line or cable attached to the upper end of the latching device L. Lowering of the apparatus causes the core bit 15 to seat within the drill bit 11 and at this time the latch member 22 moves outwardly into engagement with the detent collar 24. Thus, the drill pipe or string 10 is coupled through the latch member 22 with the outer casing 14 and core bit 15. The timing mechanism 55 of the well survey instrument S is also previously set to permit lowering of the apparatus into position and to allow drilling of the major portion of the core before the recording mechanism of said instrument is operated. Thus, after the core taking apparatus has been lowered into position and a drilling operation carried out, the well survey instrument operates to record the direction of the low side of the well bore on the record disc 56. If desired, the timing mechanism could be set so as to permit the core to be drilled and to enter the core barrel 30 after the record of

the direction of the low side of the well bore is made.

When the record is made subsequent to cutting the core, the drill pipe is rotated to cut the core and then drilling is stopped to allow the apparatus to remain stationary and at rest until the record is made; then to assure that the core does not break off, the drill pipe or string is again rotated to impart rotation to the outer casing 14 and the core bit 15 to drill an additional few inches of core. Because of the ball race connection between the outer casing 14 and the inner barrel 36, said inner barrel which houses the instrument S, as well as the core barrel 30, is held stationary due to the frictional engagement of the spring fingers 32 with the core within the core barrel. Therefore as the outer casing and core bit are rotated to cut additional core, the barrel 30 remains non-rotatable and as said core enters said barrel it is marked by the marking element 33.

After the core has been taken and the instrument operated, a suitable removing tool (not shown) is lowered by means of a wire line or cable and is engaged with the head 26 of the stem 25 of the latching device L. An upward pull on the stem will retract the latching element 22 and will permit the entire assembly to be removed from the drill string. The core C which has been taken and which is shown in Figures 10 and 12, as well as the record disc 56 are then removed from the apparatus.

As explained, the record disc 56 has been marked by an indentation 58a caused by the orienting pin 58 and this indentation was in true vertical alignment with the groove 34 cut in the core by the marking element 33 at the time that the mark M representative of the low side of the hole was made. Since the direction of inclination of the well bore is known, the compass direction of the mark M which represents the low side of the well bore is also known. Thus, it is only necessary to determine the angle indicated by B in Figure 10 to determine the compass direction of the groove or mark 34 on the core C. This may be done in any desired manner. The position of the mark M with respect to the center of the disc 56 will indicate the degree of inclination of the well bore at the point that the core is taken and thus by knowing the degree of inclination of the core and also knowing the direction of the groove 34 on the core C, the angle of the bedding planes on said core may be accurately determined. With this information the angle and direction of dip of the strata traversed by said core may be readily ascertained.

Figure 10 clearly illustrates the manner in which the core may be accurately oriented. The core C is shown as slightly inclined from a vertical plane and the plumb bob 52 is diagrammatically shown to indicate the vertical plane. The plumb bob indicates the vertical plane identified by V which passes through the axis of the well bore. The traverse plane T which is disposed substantially perpendicular to the axis of the well bore is also illustrated in this view. Thus, it will be seen that at the time that the record of the low side of the well bore is made, the core C is in a position inclined from the vertical and is marked by the groove 34. In order to determine the compass direction or azimuthal position of the groove 34, it is only necessary to determine the angle between the vertical plane represented by the mark M and the

vertical plane through which the mark 34 passes.

Although the determination of the azimuthal position of the groove 34, as well as the angle of the bedding planes on said core, may be determined in any desired manner, it is desirable to utilize the improved reading device illustrated in Figures 12 to 16. This device includes a base 70 having an outer ring 71 rotatable around its peripheral portion. A set screw 72 may be employed to lock the ring 71 in any desired position. Diametrically opposite upright standards 73 extend upwardly from the ring 71 and a U-shaped bracket or support 74 has its ends pivotally secured to the upper ends of the standards 73. The bracket 74 may be frictionally locked in various angular positions with respect to the vertical standard 73 by hand operated friction nuts 75. At the center of the bracket 74 is a supporting plate 76 which is secured to said bracket. This supporting plate carries a horizontal transparent aligning member 77 and also carries a vertical transparent aligning bar 78. The horizontal member 77 has a reference line 79 displayed thereon while the aligning bar 78 has a similar index line 80 imprinted thereon. A record disc holder 81 for receiving the record disc 56 is secured to the upper end of a shaft 82 which is rotatable within the bracket 74 and also within the supporting plate 76. A set screw 83 which is threaded through the bracket 74 is adapted to engage the shaft 82 to lock the same in various adjusted positions. A recessed core holder 84 is mounted on the lower end of the shaft 82 and the upper end of the core C is arranged to be inserted therein and clamped by suitable retaining screws 85. The core holder 84 is adjustable rotatably on the shaft 82 and is locked in adjusted positions by a set screw 86.

In interpreting the core, the record disc 56 having the indentation 58a and the mark M thereon is inserted within the holder 81 of the reading device, while the core C has its upper end inserted into the core holder 84 and retained therein by the screws 85. The indentation 58a of the record disc 56 is aligned with the index line 79 of the horizontal aligning member 77, this being accomplished by rotating the shaft 82 and its holders 81 and 84. After this alignment is made the set screw 83 is tightened to maintain the indentation 58a aligned with the index line 79. The set screw 86 is then loosened and the core holder 84 rotated to align the groove 34 in the core with the index line 80 of the aligning bar 78, after which the set screw 86 is again tightened. The index lines 79 and 80 of the two aligning members 77 and 78 are located in the same vertical plane and thus the groove 34 on the core may be accurately aligned with the indentation 58a of the record disc. It will be remembered that at the time that the record was made by the survey instrument and the core was taken within the well bore, the groove 34 and the indentation 58 were in the same vertical plane and thus this condition is reproduced in the reading device.

After proper vertical alignment of the core groove 34 and the indentation 58a is made, the set screw 83 is loosened and the entire assembly is rotated so that the mark M on the disc is aligned with the index 79 of the horizontal member. The set screw 83 is then tightened. The index lines 79 and 80 lies in the same vertical plane as an indicating arrow 87 which is displayed on the upper surface of the supporting ring 71 which carries the bracket and, therefore,

when the mark M on the disc is in alignment with the index 79, it is also in alignment with the indicating arrow 87. At this time the indentation 58a on the disc and the groove 34 in the core lie in the same vertical plane since they had been previously adjusted to do so.

Adjacent the rotatable ring 71 is a compass rose ring 88 which is secured to the base 70 of the reading device. Inside of the ring 88 is a turntable 89 which carries an angular bracket 90. A quadrant 91 is secured to the upper end of the upright arm of the bracket 90. Measuring rods 92 are carried by supporting arms 93 which are pivotally secured to the upper end of the bracket 90 and the arms 93 are movable to various angular positions with respect to the quadrant 91. The lower leg of the bracket 90 carries a pointer 94 which overlies the compass rose ring 88.

In using the reading device the core C is mounted within the holder 84 and the record disc 56 is mounted in the holder 81. The aligning members 77 and 78 are employed to accurately locate the groove 34 of the core and the indentation 58a of the record disc in the same vertical plane. After this alignment is carried out, the set screw 86 is tightened to lock the core and the record disc in this aligned position. The set screw 83 is then loosened and the record disc and core are rotated as a unit to align the mark M on the record disc 56 with the index line 79 of the horizontal aligning member 77. Since the index line 79 is in the same vertical plane as the indicating arrow 87 of the rotatable base ring 71, it will be apparent that the mark M, which is representative of the low side of the hole is aligned or in the same vertical plane as the arrow 87. The frictional lock nuts 75 are then loosened and by means of a quadrant 95 mounted on one of the standards 73 the bracket 74 is inclined from a vertical position to an angular position in accordance with the angle of deviation of the bore hole. Thus, the core which is held in the holder 84 of the bracket is inclined to the same position which it had in the well bore at the time that it was cut or drilled out. The base ring 71 is then rotated to rotate the indicating arrow 87 in the same compass direction as the low side of the well bore. The set screw 72 then locks the outer ring 71 in this position and obviously at this time the core C has assumed a position within the reader which is the exact duplication of its position within the well bore at the time that it was drilled. The bracket 90 which is mounted on the turntable 89 may then be properly rotated to place the aligning rods 92, one on each side of the core. A set screw 95 may then be utilized to lock the turntable and bracket in adjusted position. By manipulating the rods 92 on their pivotal connection with the bracket 90 the angle of the bedding planes in the core may be accurately determined. Thus, accurate information as to the angle of dip is obtained. The indicating pointer 94 which is secured to the bracket 90 will, of course, give the information as to the direction of dip.

The reading device is accurate and very simple in its operation. The important feature of the device is the fact that it accurately duplicates the position which the core had during the actual drilling out of said core. Means is provided for accurately orienting said core and for de-

termining the angle of the various bedding planes.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. The combination with the tubular drill pipe having an internal seat at its lower portion and also having a drill bit at its lower end, of a core-taking apparatus including, an outer barrel adapted to detachably connect the drill pipe, means for detachably connecting the outer barrel with the drill pipe whereby said outer barrel is rotatable with the drill pipe, an inner non-rotatable core-receiving barrel located within the outer barrel, means for rotatably supporting the upper end of the inner barrel within the outer barrel, said inner barrel having a marking element therein for marking the core as it enters said barrel, a survey instrument mounted in the upper portion of the inner barrel, and co-acting means on said instrument and within said inner barrel for orienting the instrument with respect to the marking element whereby the record made by said instrument is made in a predetermined relationship to the mark on the core to permit subsequent orientation of said core.

2. The combination with the tubular drill pipe having a drill bit at its lower end, of a core-taking apparatus including, an outer barrel, detachable means for connecting the outer barrel with the drill pipe whereby said outer barrel may be movable and rotatable with the drill pipe, a core cutting element on the lower end of the outer barrel, an inner non-rotatable core-receiving barrel having a lower open end located within the outer barrel and having a marking element therein for marking the core as it enters said barrel, a survey instrument mounted in the upper portion of the inner barrel, coacting means on said instrument and within said inner barrel for orienting the instrument with respect to the marking element whereby the record made by said instrument is made in a predetermined relationship to the mark on the core to permit subsequent orientation of said core, and means for shock mounting the survey instrument within the inner barrel to prevent damage thereto during lowering and raising of the apparatus and during the drilling operation.

3. The combination set forth in claim 1, wherein the detachable connecting means comprises a latch on the upper end of the outer barrel and a co-acting recess on the drill pipe, said means being operable by a wire line or cable, whereby the core-taking apparatus may be removed from the drill pipe by means of said wire line or cable.

4. The combination as set forth in claim 1, wherein the survey instrument is an inclination indicator, whereby the record made thereby is representative of the low side of the well bore.

5. A core-taking and orienting apparatus adapted to be operated within a drill pipe, including, an outer barrel, a latching mechanism connected to the upper end of said barrel for removably connecting the outer barrel to the drill pipe, whereby rotation of the pipe imparts rotation to the barrel, means for supporting the outer barrel within the drill pipe, a core bit on

the lower end of the outer barrel, an inner barrel within said outer barrel and extending substantially throughout the length thereof, said inner barrel having its lower end open for receiving a core, a marking element within the bore of the inner barrel for marking the core as it enters said barrel, a ball race connection between the upper end of said inner barrel and the outer barrel, whereby said inner barrel may remain stationary when the the outer barrel rotates, a well survey instrument within the upper portion of the inner barrel, and means for orienting said survey instrument within said inner barrel, whereby the record made by said instrument is made in a predetermined relationship to the marking element within the lower portion of the barrel.

6. A core-taking and orienting apparatus adapted to be operated within a drill pipe including, an outer barrel, a latching mechanism connected to the upper end of said barrel for removably connecting the outer barrel to the drill pipe, whereby rotation of the pipe imparts rotation to the barrel, an inner barrel within said outer barrel and extending substantially throughout the length thereof, said inner barrel having its lower end open for receiving a core, a marking element within the bore of the inner barrel for marking the core as it enters said barrel, a ball race connection between the upper end of said inner barrel and the outer barrel, whereby said inner barrel may remain stationary when the outer barrel rotates, a well survey instrument within the upper portion of the inner barrel, means for orienting said survey instrument within said inner barrel, whereby the record made by said instrument is made in a predetermined relationship to the marking element within the lower portion of the barrel, and a core-taking bit mounted on the lower end of the outer barrel.

7. An apparatus as set forth in claim 5, wherein the well survey instrument is an inclination indicator, whereby the record made thereby is representative of the low side of the well bore in which said apparatus is lowered.

8. An apparatus as set forth in claim 5, wherein the orienting means is a longitudinal element mounted within the inner barrel in a known relationship to the marking element, and a longitudinal orienting leg secured to the instrument and adapted to co-act with the element to position the instrument in a known relationship to said element.

9. A core orienting apparatus adapted to be operated within a drill pipe including, an outer barrel, means at the upper end of the outer barrel for detachably connecting said barrel to the drill pipe, whereby movement of said pipe imparts rotation to said barrel, means for supporting the outer barrel within the drill pipe, a hollow core bit attached to the lower end of said outer barrel, a non-rotatable inner barrel, within the outer barrel, the lower end of said inner barrel being open and adapted to receive a core as the core bit cuts the formation upon downward movement of the outer barrel and drill pipe with respect to the formation, a marking element within the lower portion of said inner barrel for marking said core as it enters the barrel, and a well survey instrument mounted within the non-rotatable inner barrel in a known relationship to the marking element, whereby the record made by said instrument is made in a known relationship to the mark on said core to permit subsequent orientation of said core.

10. An apparatus as set forth in claim 9, wherein the well survey instrument is an inclination indicator, whereby the record made thereby is representative of the low side of the well bore.

11. An apparatus as set forth in claim 9, wherein the marking element within the inner barrel is of a predetermined configuration to mark said core in a predetermined manner and thereby indicate the uppermost end of the core.

12. A core orienting apparatus adapted to be operated within a drill pipe including, an outer barrel, means at the upper end of the outer barrel for detachably connecting said barrel to the drill pipe, whereby rotation of said pipe imparts rotation to said barrel, a hollow core bit attached to the lower end of said outer barrel, a non-rotatable inner barrel within the outer barrel, the lower end of said inner barrel being open and adapted to receive a core as the core bit cuts the formation upon rotation of the outer barrel and drill pipe, a marking element within the lower portion of said inner barrel for marking said core as it enters the barrel, a well survey instrument mounted within the inner barrel, an orienting member secured within the inner barrel in a known angular radial position with relation to the marking element, and an orienting leg secured to the instrument and adapted to co-act with the orienting member to position the instrument in a known relation with respect to the marking element, said orienting leg and member being arranged to engage each other upon insertion of the instrument within the inner barrel and being readily separable upon removal of said instrument from said barrel.

13. The combination with a tubular drill pipe having a drill bit at its lower end, of a core-taking apparatus having means for detachably connecting said apparatus within said drill pipe, whereby the apparatus may be manipulated by means of said pipe, said apparatus including, a core-receiving barrel at the lower portion of the apparatus for receiving a core, a marking element within the core-receiving barrel for marking said core as it enters said barrel, an inclination indicating means mounted in the upper portion of the apparatus and having an indicating record, and means for locating said indicating record in a known angular relationship to the marking element, whereby when the indicating means is actuated to record the inclination and low side of the well bore within which the apparatus and drill pipe are disposed, said indication is made in a predetermined known relationship to the marking element to permit the core to be oriented.

14. The combination as set forth in claim 13, wherein the inclination indicating means includes a gravity responsive element which will fall towards the low side of the well bore.

15. The combination with a removable core-taking apparatus adapted to be latched within a drill pipe and having a tubular core-receiving barrel, of a marking element within the bore of the core barrel for marking the core which enters said barrel, an inclination indicating means mounted within the apparatus and having a record member, and means for mounting the record member in a known relationship to the marking element whereby the inclination indication made on said record when the inclination indicating means is actuated is in a known angular rela-

tionship to the marking element within the bore of the core barrel.

16. The combination as set forth in claim 15, wherein the inclination indicating means includes a gravity responsive indicator, and means for recording the position of said indicator on the record member.

17. A removable core-orienting apparatus adapted to be operated within a drill pipe including, an outer barrel member, means for detachably connecting the outer barrel member to the drill pipe when said member is disposed in the lower portion of said pipe whereby the barrel member may be moved relative to a sub-surface formation by manipulating the drill pipe, a core bit on the lower portion of the barrel member adapted to cut a core when the barrel member is moved into the sub-surface formation, an inner core-receiving barrel within the outer barrel and having an open lower end for receiving a core cut by the core bit, a marking means within the bore of the inner barrel for marking a core which enters said inner barrel, and a well survey instrument mounted in the apparatus above the core-receiving barrel in a known relationship to the marking element within said core-receiving barrel, whereby the record made by said instrument is made in a known relationship to the mark on said core to permit subsequent orientation of said core.

18. An apparatus as set forth in claim 17, together with retrieving means adapted to be lowered on a wire line and engaged with the detachable connecting means for disconnecting said means and retrieving the core-orienting apparatus through the drill pipe.

19. An apparatus as set forth in claim 17, together with retrieving means adapted to be lowered on a wire line and engaged with the detachable connecting means for disconnecting said means and retrieving the core-orienting apparatus through the drill pipe, the well survey instrument comprising an inclination indicator whereby the record made thereby is representative of the low side of the well bore.

20. The combination as set forth in claim 13, together with retrieving means adapted to be lowered on a wire line and engaged with the detachable connecting means which connects the apparatus within the drill pipe for disconnecting said detachable connecting means and for retrieving the core-taking apparatus through the drill pipe.

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