

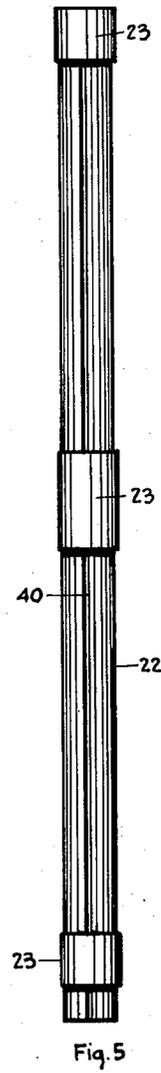
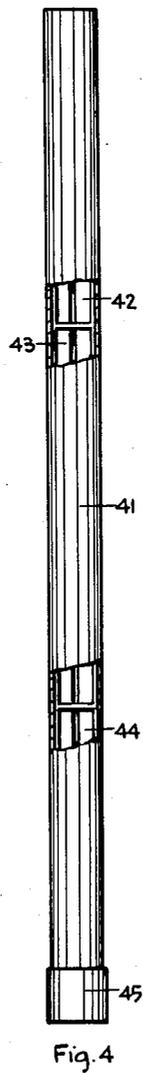
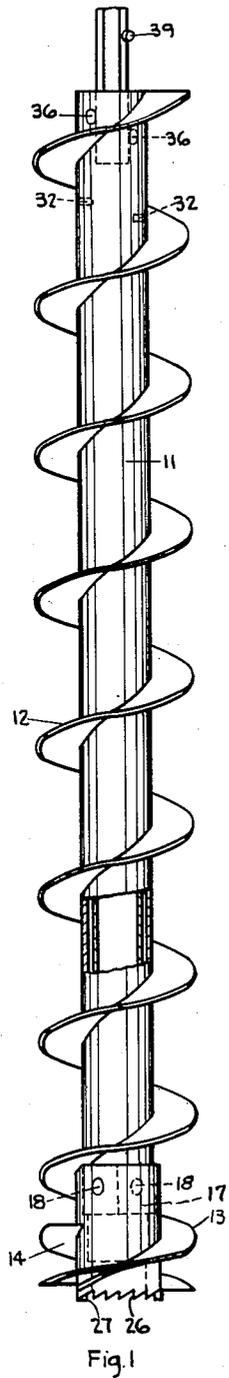
April 22, 1958

G. S. KUKUCHEK ET AL
EARTH CORING APPARATUS

2,831,659

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2 Sheets-Sheet 1



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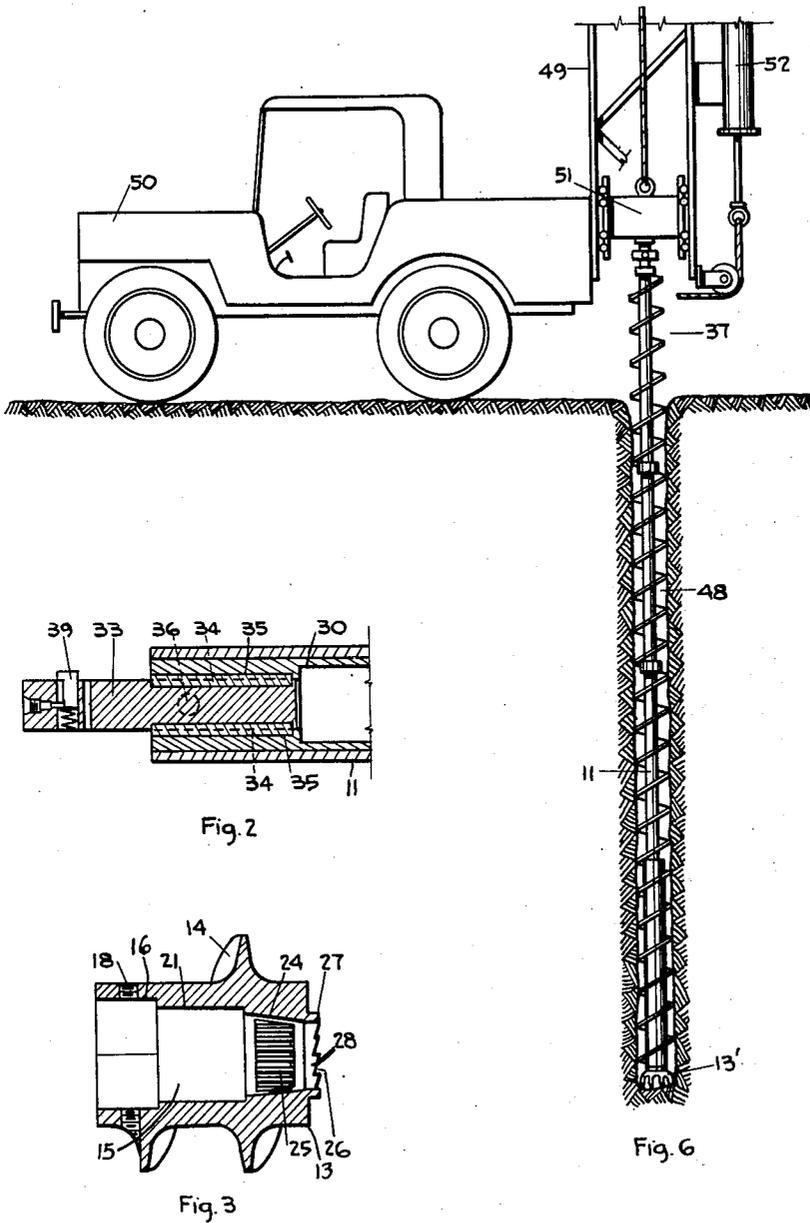
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EARTH CORING APPARATUS

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1 Claim. (Cl. 255—72)

This invention relates to an apparatus for boring holes in the earth and obtaining cores therefrom which does not require any circulating medium such as water or air. It pertains more particularly to an apparatus for boring holes to relatively shallow depths through formations which range from relatively soft and unconsolidated to those which are relatively hard and for obtaining core samples for stratigraphic control purposes.

In one phase of the exploration operations which are carried on in an attempt to locate oil and gas deposits, there has long been a need for a portable-type drilling and coring apparatus capable of obtaining core samples for locating lithologic contacts beneath soil covers and weathered zones as a part of a surface mapping program. Many mechanical methods have been used in the past to obtain stratigraphic and lithologic control samples. These methods ranged from shallow core holes drilled with small rotary drilling equipment to holes drilled by continuous coring equipment with diamond drilling tools, both types of equipment utilizing either air or water as a circulating medium.

The necessary earth samples used as control samples for normal field mapping operations may be obtained from sample depths ranging from the surface down to 50 feet. However, the terrain in many of the areas that are often studied is extremely rugged and often lacking in any source of water supply. Thus, the terrain requires that the sampling equipment be an extremely mobile piece of equipment with versatile drilling characteristics. In addition, it is necessary in conventional types of coring operations to provide a mobile water tank or air compressor for supplying the necessary air or water to be circulated in the borehole, which creates considerable practical difficulties.

It is, therefore, a primary object of the present invention to provide a portable and mobile drilling apparatus adapted to travel over rough terrain to obtain core samples beneath an unconsolidated soil cover or weathered layer.

Another object of this invention is to provide a drilling apparatus adapted to penetrate all types of formations, from soft to very hard, down to a depth of 50 feet or more.

A further object of this invention is to provide a drilling apparatus adapted to cut a core sample of at least 1 foot in length after the drill has penetrated the overburden or weather zone.

A still further object of the present invention is to provide a drilling apparatus adapted to convey cuttings of earth to the surface while taking a core without employing a fluid such as air or water for the purpose.

It is another object of this invention to provide an auger-type coring apparatus which does not require any circulating medium, thereby eliminating the need for water pumps, water storage tanks, or air compressors, which normally handicap the mobility of drilling units.

Still another object of this invention is to provide a

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coring apparatus employing a core barrel from which soft formation cores can be readily removed without destruction of the core which often takes place in the present core barrels due to the adhesion of swelling types of formations to the inner surface of the core barrel.

A still further object of this invention is to provide a coring apparatus adapted to remove borehole cuttings or material sloughing off of the cut formation from the borehole during the coring operations so that a true representative sample of the bottom of the hole may be obtained.

These and other objects of this invention will be understood from the following description of the invention taken with reference to the drawing, wherein:

Figure 1 is a longitudinal view of a coring apparatus to be used with the present drilling equipment.

Figure 2 is a cross-sectional view of one end of the coring apparatus illustrated in Figure 1 showing one type of connecting means for securing the core barrel to a drill string.

Figure 3 is a longitudinal view in cross-section of one type of a core head or bit to be used with the coring apparatus of Figure 1.

Figures 4 and 5 illustrate two different types of inner core barrels adapted to be used with the present coring apparatus.

Figure 6 is a diagrammatical view illustrating the present drilling and coring apparatus mounted at the rear of a vehicle with the drill string and coring apparatus positioned in a borehole.

Referring to Figure 1 of the drawing, the coring device of the present invention comprises an elongated tubular body member 11 forming an outer core barrel, there being welded to or integrally formed on the outer surface of said body member 11 a continuous series of external cutting auger flights 12 extending helically throughout the entire length of the body member. A suitable coring bit 13 or 13', which may have auger flights 14 secured to its peripheral wall as a continuation of the auger flights 12 on the tubular body member 11, is adapted to be secured to the lower end of the body member 11.

As shown in Figure 3, the coring bit 13 has an axial bore 15 therethrough to allow a core being cut by said bit to enter the tubular body member 11 of Figure 1. The bore 15 of the bit 13 has sections of different shapes and diameters as shown. At 16, the bore is enlarged and is in the form of a hexagonal recess forming one portion of a hexagonal coupling for securing the coring bit 13 to the tubular member 11. The hexagonal recess 16 is adapted to receive therein the lower end of the tubular body member 11 which is also cut at 17 in a hexagonal form. Any other non-circular form of recess may be used whereby the coring bit 13 is suitably connected to the body member 11 so that one element does not rotate with relation to the other. The bit 13 may be secured to the body member 11 in any suitable manner as by means of recessed set screws 18.

Another portion 21 of the bore 15 is of a diameter sufficient to receive the end of an inner core barrel 22 (Figure 5) or the clamping means 23 surrounding said inner core barrel 22. The portion 24 of the bore 15 is tapered to contain a core catcher 25 which may be used, if desired, especially when drilling through hard formations. The cutting face of the bit 13 is provided with a suitable number of teeth 26 which may be hard-faceted with a tungsten carbide material. Preferably, the bit 13 is cast so that a tapered wear ring 27 is formed at the mouth of the core head for undercutting a core, i. e., cutting a core of a diameter smaller than the inner diameter of the inner core barrel 22 (Figure 5). The di-

iameter of the central opening 28 in the face of the coring bit is critical as this opening must be of a diameter slightly smaller than the inner diameter of the split inner core barrel 22, so that the core may readily enter the core barrel.

As shown in Figures 1 and 2, a sleeve 30 is secured within the bore of the tubular body member 11 in any suitable manner, as by means of a press fit, to form a stop for limiting the movement of the inner core barrel 22 (Figure 5) when it is inserted into the outer tubular body member 11 from the bit end thereof. One or more air holes 32 may be drilled through both the wall of the sleeve 30 and the wall of the body member 11 to permit the escape of air as a core enters the core barrel during coring operations. Secured within and closing the stop sleeve 30 at the end thereof is a male hexagonal shank 33 having one or more keys 34 adapted to register with and slide within keyways 35 formed in the stop sleeve 30 to prevent rotation of the shank within the sleeve. The hexagonal shank 33 is fixedly held within the sleeve 30 and is secured to the tubular body member 11 by socket set screws 36. The extending end of the hexagonal shank 33 is provided with a spring-loaded latching pin 39 adapted to automatically latch into a suitable recess (not shown) in another section of an auger flight drill string 37, as shown in Figure 6 of the drawing, when the male hexagonal shank 33 is inserted into a cooperating female hexagonal coupling on the drill string 37.

As stated above, the inner core barrel 22 (Figure 5) is adapted to fit within the bore 31 of the body member 11. It has been found in coring operations that when pressures on certain types of formations are relieved during the taking of a core, the core extracted from the formation often expands and becomes wedged within the barrel of the coring apparatus. In the present coring apparatus, the inner core barrel 22, which may be made of stainless steel, is provided with a longitudinal slot in the wall thereof throughout its entire length. It has been found that if the inner core barrel is made of a thin flexible material provided with a longitudinal slot 40, the slot 40 permits opening the inner core barrel sufficiently to remove a core therefrom with ease without destruction of the core. When cores are taken from hard formations, little swelling of the cores takes place and they may be readily extracted from the inner core barrel 22. However, when coring formations contain swelling clays, the split inner core barrel 22 is normally provided with one or more clamps 23 which may be in the form of short, rigid tubular sleeve sections which surround the split core barrel 22 and are mounted thereon before the inner core barrel is inserted into the tubular member 11.

In some cases, the clamp surrounding the split inner core barrel may take the form of an elongated tubular section 41 (Figure 4), especially when the split inner core barrel is formed of more than one section, for example, three sections, 42, 43 and 44, as shown in Figure 4. A three-section split inner core barrel, as shown in Figure 4, may make handling of some types of cores much simpler, especially when it is desired to remove soft formation cores which otherwise may jam in the inner core barrel. To facilitate removal of the three split core barrels 42, 43 and 44 from the tubular clamp means 41, the inner surface of the tubular clamp 41 or the outer surfaces of the core barrels 42, 43 and 44 may be lubricated in any suitable manner, as by oil or grease. Since soft cores stick readily within the split core barrels, it is not necessary to use a core catcher 25 (Figure 3) in the coring bit for coring soft formations. If desired, the lower end of the tubular elongated clamp 41 may be provided with a sleeve 45 affixed to the outside of the clamp. If a core catcher 25 (Figure 3) is used, it may bear against the sleeve 45 and the end of tubular clamp 41 during coring operations. If no sleeve 45 is used,

the core catcher 25 will operate substantially as well by bearing against the lower end of the tubular clamp 41.

In operation, while drilling through soft formations, one or more slotted inner core barrels 42, 43 and 44 (Figure 4) are inserted in the tubular clamp 41 which, in turn, is inserted in the bore 31 of the tubular body member 11 of Figure 1. The tubular body member 11 is then closed by connecting the coring bit 13 over its lower end by means of the recessed set screws 18.

Prior to coring the desired formation with the above-described core barrel and bit, a borehole 48 (Figure 6) is drilled vertically through the unconsolidated material or overburden which covers the formation to be cored. For drilling shallow holes of from 0 to 80 feet in terrain which is often rough and lacking in available water for use as a drilling fluid, it has been found that an auger-type boring apparatus such as illustrated in Figure 6 of the drawing is most suitable. The mobile drilling apparatus may be of a conventional type as manufactured by Mobile Drilling, Inc., of Indianapolis, Indiana, and may comprise a stationary mast 49, about 8½ feet high, which is fixedly mounted on the rear of a small truck 50. A rotary or turntable 51 is mounted for vertical movement within the mast 49 for rotating an auger-type drill string 37 connected thereto in either a clockwise or a counterclockwise direction at speeds at from 10 to 300 R. P. M. A suitable drill bit is connected to the lower end of the drill string. The turntable 51 is powered by the truck engine through a power take-off (not shown). Vertical movement of the turntable 51 is effected by means of a hydraulic cylinder 52 having a 5 foot piston stroke for lifting and lowering the turntable and drill string 37 during coring operations. A hydraulic pump (not shown), driven by the truck engine, is capable of supplying fluid to the cylinder at a maximum pressure of 1500 p. s. i.

After 4 feet of hole has been drilled by the auger-type drill string 37, the drill string 37 is disconnected from the turntable 51 and another 4 foot section of drill string having auger flights thereon is connected to the top of the drill string already in the hole and to the turntable. After an other 4 feet of hole has been drilled, another section of drill string is added. Additional 4 foot sections of auger flight drill string are added until a hole of a desired depth has been drilled. By use of a drill string having auger flights thereon, cuttings are returned to the surface without employing a drilling fluid. After the hole has been drilled it may be cleaned out, if necessary, by any suitable type of bailer.

With the hole cleaned, the auger flight drill string 37 is again lowered into the borehole 48. This time, the first or lowermost section of the drill string 37 having bit 13 attached thereto comprises the tubular body member 11 (Figure 1) containing the split inner core barrel 22 or a series of split inner core barrels 42, 43 and 44, as previously described. When the drill bit has reached the bottom of the borehole, the upper end of the drill string is engaged by the turntable 51 which is then rotated while being lowered through its 5 foot stroke to cut up to a 4 foot core from the bottom of the borehole. During cutting operations, cuttings are being removed to the top of the borehole by the auger flights so that the core obtained is a true representative sample of the bottom of the borehole and does not comprise compacted cuttings from the bottom of the hole.

After the core has been cut, the entire auger flight drill string is removed from the borehole 48 and the tubular coring apparatus 11 is disconnected therefrom. The bit 13 is detached from the end of the tubular body member 11 and the split type core barrel is extracted from the bore 31 of said body member. Normally, the split inner core barrel can be readily removed from the bore of the tubular body member 11, as the bearing force of the metal inner split core barrel on the metal body member 11 is considerably less than that of the

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dirt-metal frictional force obtaining when no inner split core barrel is used. If a clamp 23 (Figure 5) or a clamp 41 (Figure 4) surrounds the split inner core barrel, the clamp 23 or the end of the clamp 41 extends into the enlarged bore section 21 of the bit 13 (Figure 3). Thus, after the bit 13 has been removed, the exposed clamp 23 may be grasped by hand or by a suitable wrench and the split core barrel and its clamps pulled from the bore of the tubular body member 11. In extreme cases of sticking of a split core barrel within the body member 11, set screws 36 and the hexagonal shank 33 may be removed from the other end of the tubular body member 11 so that a rod or other cylindrical body can be inserted into the bore of the tubular body member 11 from the other end to force the split core barrel and its core therefrom.

After the split inner core barrel 22 (Figure 5) has been removed from the core of the tubular body member 11 having clamps 23 which are used to prevent expansion of the split inner core barrel 22 in the body member 11, the clamps 23 or the elongated tubular clamp 41 is first removed from the split inner core barrel 22. The longitudinal slot 40 in the inner core barrel 22 is then expanded either by hand or a suitable wedge-shaped tool and the core contained within the inner core barrel is easily removed by pushing it out one end.

We claim as our invention:

For use with a drilling apparatus having an auger type drill string, a coring apparatus comprising a tubular body member secured to the lower end of said drill string, spring-loaded coupling means affixed to the upper end of said tubular body for securing said body to said

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drill string, auger flights carried outwardly on said tubular body throughout its entire length, a core barrel adapted to receive an earth core, said core barrel being of thin flexible sheet metal and having a longitudinal slot throughout its entire length, rigid tubular clamp means surrounding said slotted core barrel and to prevent radial expansion of said barrel as a core is forced thereinto, said clamp means being of a diameter to fit slidably within said tubular body member, and a coring bit secured to the lower end of said tubular body member and adjacent the end of said slotted core barrel, said coring bit having an axial opening therein of a diameter less than the inner diameter of said slotted core barrel double auger flights being formed on the outer surface of said bit, and an interior shoulder formed within said bit for seating the core barrel.

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