June 18, 1968 J. S. BARTON 3,388,754

CORE BIT

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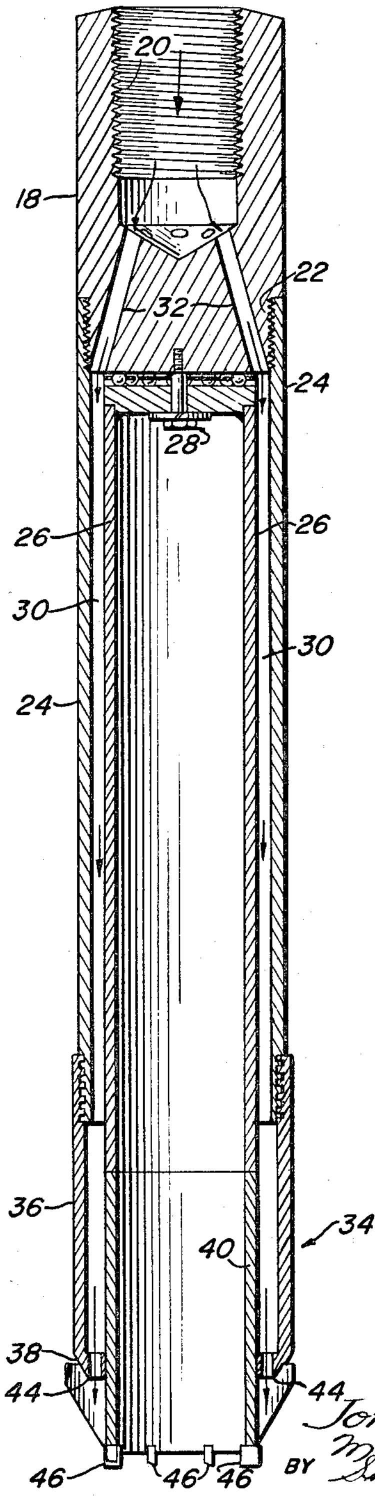

Fig. 1

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Fig. 2

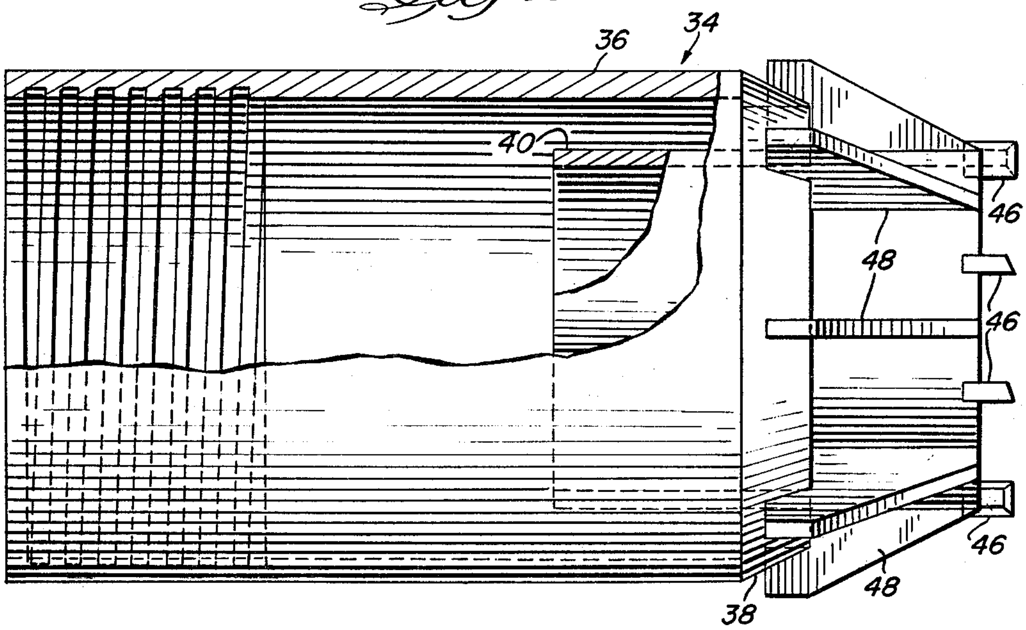


Fig. 3

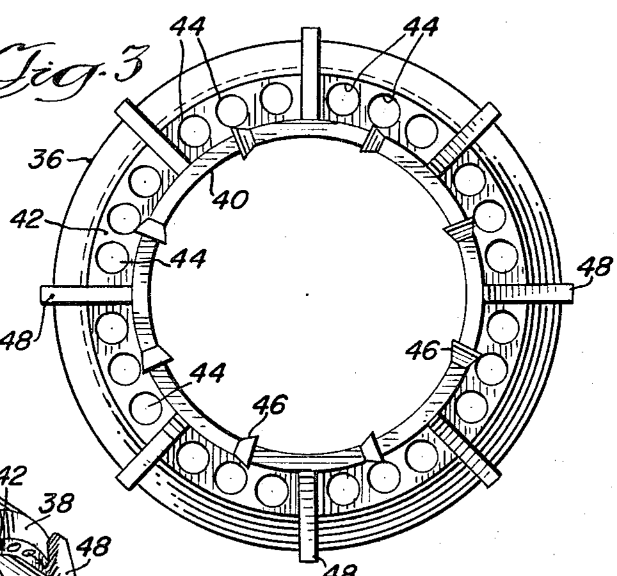
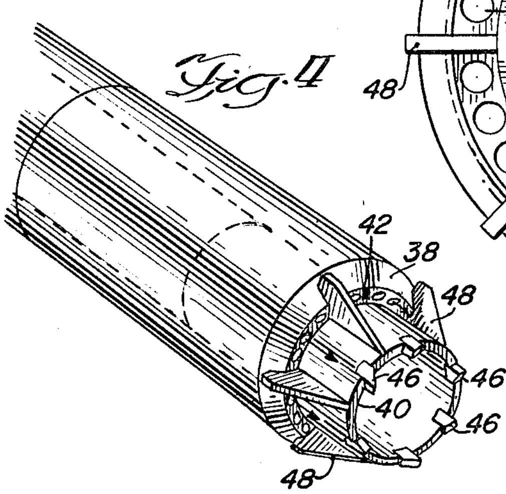


Fig. 4



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CORE BIT

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ABSTRACT OF THE DISCLOSURE

A core bit which is useful in rotary drilling for obtaining core samples. The bit includes an outer cylinder, which is tapered inwardly at the bottom; an inner cylinder the upper portion of which is within and concentric to the outer cylinder; a perforated spacer between the cylinders; cutting teeth on the bottom of and offset inwardly of the inner cylinder; and radial cutting blades extending from the inner cylinder to beyond the outer cylinder.

This invention relates to an improved core bit tool. In its more specific aspect, this invention relates to a rotary core bit tool of the type adapted for association with rotary drilling equipment and for yielding samples of the formation being drilled.

In rotary drilling operations, it is customary to employ a string of tubing which extends downwardly from the surface, the lower end of the tubing having a core barrel and drill bit attached thereto. The core barrel usually comprises inner and outer cylinders or barrels concentrically arranged to provide an annular space therebetween with a sample of the formation being drilled being collected in the inner barrel. A fluid, e.g. water, is pumped under pressure through the tubing string, the annular space formed by the inner and outer barrels, and finally through an appropriate opening or openings in the bottom of the drilling tool, the fluid serving to wash the trimmings away from the bottom of the well bore and flush them upwardly between the barrels and the outer surface of the drill hole to the surface where the trimmings are drained off.

A conventional core bit has a relatively large amount of frontal area which, during drilling, makes it difficult for the trimmings to pass the bit face. As a consequence, the penetration speed of the bit through the formation is reduced and water or other fluid is directed into the inner barrel which destroys or partially destroys the core sample.

It is known that the amount of trimmings which are removed during the drilling operation is directly proportional to the frontal area of the core bit. As the amount of trimmings increase, due to a large frontal area on a core bit, a higher fluid velocity is required to wash them to the surface of the hole. This requirement for increased fluid velocity not only necessitates increased power output from the power supply and pump, but the higher fluid velocity causes complete or partial destruction of the sample.

In securing samples of clay deposits, the recovery is affected by the peculiar deposition or formation of clay. In a clay formation, the moisture content varies considerably with the thickness of the clay stratum. Unusually thick or deep stratum frequently has a variable moisture progression that reverses itself from top to bottom. The first few feet of a thick stratum will have a high moisture content. As the drilling operation progresses further into the stratum, the moisture content gets lower such that the clay becomes extremely dry in the middle of the stratum. Then the moisture content of the clay increases as the drilling continues on to the bottom of the stratum. In the dry areas of such a thick stratum, core sample recovery with conventional bits is very poor to nonexistent. In exceptionally dry clay, the retention time of the bit

at any one location in the clay while coring with a conventional bit is too long. The dry clay is exposed to water for too long a period of time causing part of the core sample to expand and to be washed away before entering the core barrel. The remaining part of the core sample swells due to the water content and blocks the barrel before it is full thereby preventing further sampling. Moreover, in the core sample recovery of hard clay, conventional bits core too slowly and the sample is washed away before entering the sample barrel.

This invention has its purpose to provide a core bit tool which provides superior core sample recovery and relatively fast penetration speed in all types of clay. Further, with my new and novel invention, core samples of increased length can be recovered as compared to the length of samples presently secured with conventional core bits.

In general, the core bit tool of my invention comprises an outer cylindrical member tapered inwardly at its lower end, and an inner cylindrical member partially disposed within and substantially co-axial with the longitudinal axis of the outer cylindrical member. A perforated spacer ring connects the outer and inner barrel members. The end of the inner barrel member which is not disposed within the outer member is provided with a plurality of cutting teeth which are offset to the inside of the inner barrel member. A plurality of regularly spaced, radially disposed cutting blades are mounted on the sides of the inner and outer barrels and are tapered inwardly, desirably from the end of the blade which is located on the outer barrel to the remaining blade end disposed on the inner barrel. In operation, the bit penetrates the formation being drilled and cuts a core sample which is recovered from the inner cylinder or barrel, as described hereinbelow in greater detail.

Reference is now had to the following detailed description, and to the accompanying drawings, in which:

FIGURE 1 is a vertical sectional view showing the core bit with associated equipment for recovering a core sample;

FIGURE 2 is a longitudinal view partly in cross-section of a core bit drawn to scale and constructed in accordance with the invention;

FIGURE 3 is an end view of the core bit of FIGURE 2; and

FIGURE 4 is a perspective view of the core bit shown as connected with associated equipment.

In conventional drilling operations, a drill string of tubing (not shown) extends from the surface through the well bore in the formation being drilled. Auxiliary equipment, at the surface, such as a rotary table for transmitting rotary motion to the core bit, is employed for drilling and for circulating water or other flushing fluid under pressure through the string. Rotary head **18** is provided with a socket having an internally threaded bore **20** for coupling with the lowermost drill tube of the string. The opposite end of head **18** has a stud portion **22** that is externally threaded for coupling with outer longitudinal barrel **24**.

Concentrically arranged within the outer barrel **24** is an inner core barrel **26** which is suspended from the rotary head **18** by suitable bolt and bearing means indicated generally at **28**. Barrel **26** is spaced from outer barrel **24** to provide annular passage **30**. In this manner, inner core barrel **26** is maintained in a non-rotatable position. Rotary head **18** is provided with fluid ducts **32** which communicate with annular passage **30** and which open to the socket to provide communication with the drill tubing.

The drill bit, indicated generally at **34** is connected to the bottom of the outer barrel **24**. As illustrated in the drawings, the drill bit comprises an outer cylindrical member 36 which is threaded at one end for threadable engagement with the bottom of outer barrel 24 while the remaining end is tapered inwardly at 38 for a short portion along the length of member 36. Inner cylindrical member 40 is partially disposed within and substantially co-axial with outer cylindrical member 34. It is desirable that the inner cylindrical member 40 have the same diameter as the inner core barrel 26 such that upon connection of the core bit with outer barrel 24, the adjacent ends of the inner cylindrical member and the inner core barrel are in an abutting engagement. Spacer ring 42 connects the inner and outer cylindrical members, and has a plurality of holes 44 equi-distant from each other. Water pumped from the surface, under pressure, will flow through ducts 32, annular passage 30 and out of the holes 44 located in the spacer ring 42.

In the core bit, the end of inner cylindrical member 40, which is positioned outside of outer cylindrical member 36, is provided with a plurality of cutting teeth 46. The cutting teeth are offset to the inside in order that the core which is cut during a drilling operation is slightly smaller than the diameter of the inner core barrel 26. Cutting blades 48, typically eight in number, are mounted on the sides of the inner and outer cylindrical members, the blades being positioned on the outer cylindrical member 36 just above the position of the tapered end where they extend down to the end of the inner cylindrical member 40 which is located outside of member 36. Cutting blades 48 are spaced equally about the outer wall surface of the inner cylindrical member and have a sharp inward taper along the outer edge of the blade going from the end of the blade located on the outer cylindrical member to the remaining end disposed on the inner cylindrical member. The taper of the cutting blades is designed so that the water flowing through the holes in the perforated spacer ring will be commensurate with the amounts of cuttings to be removed from a particular position on the various blades. More specifically, more water will be available at the end of a blade 48 closest to member 36 than will be present at the opposite end of the blade which merges into member 40.

In operation, the string of tubing, core barrels and core bit are assembled with the drilling being effected by suitable drive means generally located on the surface. During the course of the drilling operation, water is pumped through the string and rotary head 18 and is directed through annular passage 30 where it exits through discharge holes 44 in spacer ring 42. The trimmings are washed or flushed upwardly away from the bottom of the bore hole in the space between core barrel 24 and the outer surface of the drill hole and ultimately to the surface where they are drained off. As outer barrel 24 and core bit 34 rotate, the inner barrel 26 remains stationary and slides down over the core sample being produced, protecting it from water and trimmings. The bit penetrates the formation being drilled, trims around or cuts the core and directs the trimmings away from the bottom of the hole with the aid of water. After a sample has been taken, the assembly of string, barrels and bit are removed from the bore and disassembled. Generally, the core bit is first removed from the outer core barrel after which the outer barrel is disassembled from rotary head 18. Next, rotary head 18 is removed from the inner core barrel 26 thereby leaving the inner barrel open at both ends. A ramrod or other suitable means is utilized to push the core sample free from barrel 26. Subsequently, the barrel and auxiliary equipment can be reassembled, if desired, for another sampling operation.

The improved core bit of my invention permits extremely fast penetration speed on drilling a particular formation. Faster penetration reduces the core exposure to water thereby minimizing the washing away of the core sample. Also, the core barrel is filled before expansion of the sample can occur and block the barrel. Because of these features achieved with my new and novel invention, it is now possible to employ longer core barrels in sampling operations than presently utilized which results in considerable reduction in time and expense as the number of drill runs required with the longer core barrel is substantially reduced as compared to the number of sampling runs presently required with substantially shorter core barrels. For example, with conventional core bits, a typical core sample recovered for a drill run in dry clay or hard clay is approximately 3 feet. With the core bit of the instant invention, an inner core barrel of 10 to 15 feet can be employed and consequently the core sample recovered when sampling hard or dry clay is approximately the same length.

Moreover, the core bit of this invention penetrates all types of clay, including hard clay and dry clay, at high penetration speeds. As a consequence, less power is required to operate the drilling equipment for coring or sampling.

Moreover, the core bit disclosed herein has substantially reduced the undesirable rotational drag found in core bits presently employed due to the fact that all nonfunctional frontal area has been substantially eliminated. The taper of the blades 48 serves to provide a minimum amount of water exposure to the core sample as well as a minimum amout of water at the bottom of the drill holes. Further, the taper in cutting blades 48 decreases the rotational drag or torque of the core bit over that presently found when conventional bits are employed thereby decreasing the amount of power needed to operate the drill.

Cutting blades 48 are made to extend slightly beyond the diameter of the core bit, as seen, for example, in FIGURES 2 and 3. This extension of the blades is desirous because it allows cuttings or trimmings to quickly escape upwardly so the core bit will not become clogged. In addition, the tapered or beveled face of the outer cylindrical member also permits the trimming to escape quickly and further, beveled face 36 assists in reducing drag.

When extremely fast penetration speed is desired by using down pressure on the core bit, the tapered or beveled face 38 forces the cuttings to the outside and away from the bit preventing a build-up of cuttings around the bit and core barrel.

By reason of my new and novel invention, core drilling is accomplished more economically and at approximately twice the speed as compared to conventional core bits. Further, the core bit disclosed and claimed herein reduces substantially the number of sampling runs ordinarily required as a good sample can now be obtained on the first run. This invention is adaptable for use on all types and sizes of core barrels and rotary drills that use fluid pressure, e.g., water, to flush or wash cuttings out of the drill hole.

The core bit of my invention is made preferably of stock steel of no special hardness except for the cutting blades 48 which are made of a special grade of carbide which has a special grain structure to maintain a high transverse rupture strength exhibiting an excellent resistance to wear and shock. The blades are of the type manufactured by the Adamas Carbide Corporation, Kenilworth, N.J. The make-up and dimensions for the core bit may vary depending upon the particular application, but a typical core bit has and over-all length of 7⅜ inches measured from the edge of the cutting teeth 46 to the edge of the threaded end of cylinder 24. The outside diameter of outer member 36 is 3¾ inches. The length of the outer cylindrical member of the core bit is 5⅞ inches having an inside diameter of 3½ inches, and the length of inner member 40 is 3⅛ inches having an inside diameter of 2¼ inches. The taper 38 at the lower end of the cylindrical member is about 25°. The cutting teeth are ⅜ inch by ¼ inch having a 25° upward taper along the horizontal plane when the bit is positioned as seen in FIGURE 1. The teeth extend 1/16 inch beyond the inside diameter of the inner cylindrical member. The cutting blades are 1 9/16 inches in over-all length, and for a substantial portion of that length are provided with a taper in the range of 25–30° and preferably 25° along the outer cutting edge. Each blade 48 extends about 1/16 inch beyond the outside diameter of the outer cylindrical member. In the spacer ring, three holes are provided between each cutting blade 48, the individual holes being about 1/4 inch in diameter. A core bit of this size can utilize a core barrel of 10 to 15 feet in length thereby making it possible to recover a core sample of comparable length.

The foregoing description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. A core bit adapted for use in sampling operations, said bit comprising:
an outer cylindrical member tapered inwardly at its lower end;
an inner cylindrical member partially disposed within, and substantially co-axial with said outer member;
a perforated spacer member connecting said inner and outer members in spaced relationship;
cutting means located on the end of said inner member which is disposed outside of said outer member wherein said cutting means are offset to extend inwardly of said inner member;
cutting blade means radially disposed about the outer wall surfaces of said inner member, said blade means extending substantially from said taper of said outer member to said end of said inner member which is located outside of said outer member; and
wherein the upper end of said blade means disposed on said taper of said outer member extends slightly beyond the periphery of said outer member.

2. A core bit adapted for use in clay sampling operations, said bit comprising:
an outer cylindrical member having two ends and an outer wall surface which is tapered inwardly at one of said ends;
an inner cylindrical member co-axial with and partially disposed within said outer member;
a perforated spacer ring positioned near the tapered end of said outer member, said spacer ring connecting said inner and outer members whereby an annular space is formed along a portion of the length of said outer wall surface of said inner member and said inner surface of said outer member;
teeth means located on the end of said inner member which is disposed outside of said outer member, said teeth means being offset to the inside of said inner member; and
at least one cutting blade disposed on said inner and outer members, the outer exposed cutting edge of said blade tapering inwardly moving from that portion of said blade on said outer member to that portion of said blade on said inner member wherein said blade extends radially outwardly beyond the outer wall surface of said outer cylindrical member.

3. A core bit in accordance with claim 2 wherein the inward taper of said cutting blade is about 25°–30°.

4. Apparatus for core drilling and clay sampling comprising:
a rotary head for attachment to the lower end of a drill string;
outer and inner barrels mounted to said rotary head and arranged to define an annular space therebetween, said inner barrel having two ends, the upper end of which is joined to said head for non-rotatable disposition;
means for establishing fluid communication between said rotary head and said annular space;
an outer cylindrical member for attachment to the lower end of said outer barrel and tapered inwardly for a small portion of the length of the outer wall of said outer member adjacent to its lower end;
an inner cylindrical member partially disposed within and substantially co-axial with said outer cylindrical member, the upper end of said inner cylindrical member which is disposed within said outer member being in substantial abutting relationship with said lower end of said inner barrel;
a spacer ring connecting said inner and outer cylindrical members in spaced relationship, said ring having a plurality of holes;
cutting teeth located on the end of said inner cylindrical member which is disposed outside of said outer cylindrical member; and
a plurality of cutting blades radially disposed about the outer wall surface of said inner cylindrical member, extending from said taper on said outer cylindrical member to the end of said inner cylindrical member which is located outside of said outer member.

5. Apparatus for core drilling and clay sampling comprising:
a rotary head for attachment to the lower end of a drill string;
outer and inner barrels mounted to said rotary head and arranged to define an annular space therebetween, said inner barrel having two ends, the upper end of which is joined to said head for non-rotatable disposition;
means for establishing fluid communication between said rotary head and said annular space;
an outer cylindrical member for attachment to the lower end of said outer barrel and tapered inwardly for a small portion of the length of the outer wall of said outer member adjacent its lower end;
an inner cylindrical member partially disposed within and substantially co-axial with said outer cylindrical member, the upper end of said inner cylindrical member which is disposed within said outer member being in substantial abutting relationship with said lower end of said inner barrel;
a perforated spacer member connecting said inner and outer cylindrical members in spaced relationship;
cutting teeth located on the end of said inner cylindrical member which is disposed outside of said outer cylindrical member;
a plurality of cutting blades radially disposed about the outer wall surface of said inner cylindrical member, extending from said taper on said outer cylindrical member to the end of said inner cylindrical member which is located outside of said outer member.

6. The apparatus as described in claim 5, wherein said cutting teeth are offset to extend inwardly of said inner member.

7. The apparatus as described in claim 5, wherein the upper end of said cutting blades extend slightly beyond the periphery of said outer member.

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