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CORE BARREL

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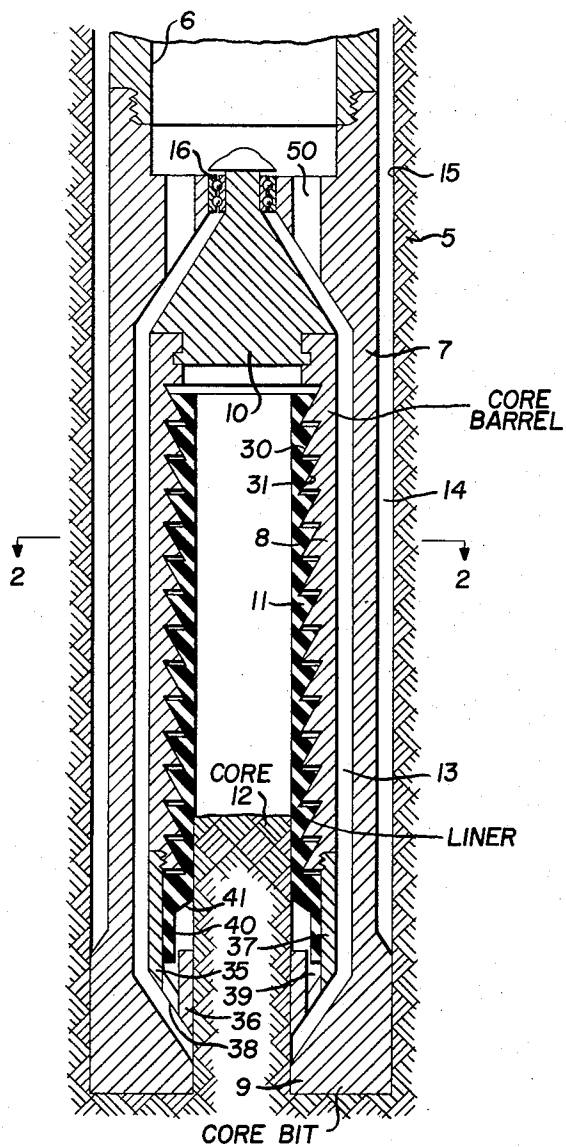


FIGURE 1

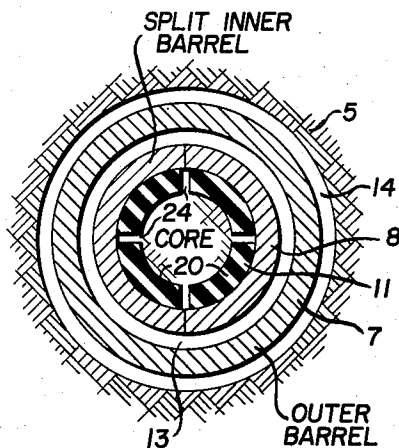


FIGURE 2

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CORE BARREL

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4 Claims. (Cl. 255—72)

The present invention generally concerns the coring of subterranean strata and is particularly directed toward coring operations that are involved in petroleum exploration and drilling procedures. The invention especially relates to a rotary coring apparatus in which the core barrel is of a type adapted to provide an improved sample of the formation which is cored.

Coring procedures and apparatus are well known as such in the art and are especially widely employed by petroleum producers. The data that are obtained from cores greatly assist such persons in their efforts to locate new oil reservoirs and to obtain increased amounts of oil from known reservoirs.

Several types of coring apparatus are employed in the art. The type of particular concern to the present invention is the rotary type which utilizes a ring-shaped cutting bit mounted on the lower end of a string of drill pipe. The bit may utilize a variety of cutting surfaces such as hardened steel teeth, diamond particles, various carbides, etc.

The coring bit is mounted on the lower end of an outer barrel member which in turn is connected to the aforementioned string of drill pipe. Disposed within the outer barrel member is a stationary inner barrel which is adapted to receive and hold a core sample after it has been cut by the bit. The combination of the inner barrel, the outer barrel, the bit and associated parts is conventionally referred to in the art in its entirety as a core barrel.

In order that the core remain within the inner barrel of a core barrel after a coring operation has been completed, the mouth or entrance to the inner barrel is conventionally provided with a device which is popularly known as a core catcher. A number of core catchers are available on the market but in general all of these devices utilize steel prongs or teeth which are spring loaded and which are continuously urged against the outer wall surface of the core. The prongs or teeth are so disposed in the entrance to the inner barrel that the core upon entering the barrel thrusts the prongs or teeth aside against the oppositely directed force of springs or the like. Thus, when a coring operation has been completed and the core separated from the sampled formation, the prongs or teeth by virtue of the force they exert upon the core act to retain the core within the core barrel.

While the various presently known core catchers are moderately successful in retaining a core within a core barrel, all of these devices suffer from several shortcomings. First, they subject the core to unusual and highly concentrated lateral thrusts and therefore often cause the core to be fractured upon its entry into the core barrel. Second, they support the core at merely one position along its length with the result that the vibrations and movements that occur during a coring operation frequently cause additional fracturing and breakage of the core after it has entered the core barrel. Third, particles of the core or of the cuttings that are generated by the bit frequently become lodged within various parts

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of the core catcher with the result that the catcher fails to properly secure the core within the core barrel.

Accordingly, it is an object of the present invention to provide an improved coring apparatus in which a core is cut and introduced within a core barrel without subjecting the core to the forces that are generated by conventional core catchers. It is further an object of the invention to provide a coring apparatus in which the core barrel is adapted to support the core evenly along its entire length without exerting undue forces or thrusts upon the core.

These and other related objectives are attained in accordance with the invention by means of a coring apparatus which utilizes an improved type of core barrel. More specifically, the inner barrel of the core barrel is provided with a relatively soft inner sleeve member which extends substantially along the entire length of the inner barrel. The sleeve is furthermore of a character such that it is able to move both longitudinally and laterally with respect to the inner barrel. Thus, as a core enters the core barrel, the sleeve moves slightly upwardly and outward with respect to both the inner barrel and the sample; and upon completion of the coring operation the sleeve moves downward and inward of the inner barrel and thereby locks the core within the barrel.

The inner barrel sleeve is particularly characterized by possessing a relatively soft and smooth inner surface which has a radius of curvature substantially equal to that of the core. The sleeve is still further characterized by possessing a plurality of vertically spaced inclined shoulders on its outer surface which mesh with and rest upon similar shoulders that are formed on the inner surface of the inner barrel itself. As will be described and pointed out later in this description, these features of the apparatus enable the apparatus (1) to freely receive a core sample without subjecting the sample to undue lateral thrusts, and (2) to grip and support the core along substantially its entire length with a minimum of unit pressure.

The invention may be best understood by reference to the attached figures wherein:

Figure 1 illustrates in vertical cross-section an embodiment of the invention as it would appear during a coring operation.

Figure 2 is a sectional view taken along the lines 2—2 of Figure 1.

Turning first to Figure 1, it will be seen that there are illustrated therein a subterranean formation 5, the lower end of a string of drill pipe 6, an outer barrel 7, an inner barrel 8, a coring bit 9, swivel member 10, inner sleeve member 11 and core sample 12.

The string of drill pipe 6, the outer barrel 7 and the bit 9 may be of any conventional types that are generally employed in coring operations. For the sake of the present description, however, it will be assumed that bit 9 is a diamond type coring bit and that the coring head proper is provided with an annular passageway 13 which enables drilling mud to flow from the surface of the earth down through the drill pipe 6 to a point in the vicinity of the bit. It will further be assumed that a drilling fluid, if such is desired, flows from this point through the annular passageway 14 lying between the outer barrel 7 or the drill pipe 6 and the wall of the bore hole 15 back up to the surface of the earth. It may further be assumed that conventional drilling apparatus including mud pumps, drilling rigs, power sources, valves, and the like may be employed at the surface of the earth in combination with the invention.

With these assumptions in mind, attention is now directed toward a more detailed consideration of the inner barrel 8 and its inner sleeve member 11. Referring first to the inner barrel, it may be seen that this member is a

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substantially hollow cylinder which is secured at its upper end to the swivel member 10. Swivel member 10 in turn is supported from the outer barrel 7 and is freely movable with respect to the outer barrel by the provision of bearing 16.

The outer wall surface of the inner barrel 8 is relatively smooth, and the barrel itself may be constructed from any of the metals or alloys that are conventionally utilized in the fabrication of such members.

The inner surface of the inner barrel 8 is provided with a plurality of vertically spaced shoulders which are downwardly and inwardly inclined with respect to the inner barrel. The shoulders are furthermore arranged in a repeating fashion such that the upper and lower ends of each shoulder are vertically aligned with the upper and lower ends respectively of every other such shoulder. In other words, the shoulders form a pattern which might be referred to as a modified sawtooth arrangement.

While it is contemplated that the inner barrel 8 may be constructed as a single integral cylinder, it is preferred that it be split longitudinally to form at least two sections. Thus, it is particularly desirable that the barrel 8 be split into two halves as illustrated in Figure 2.

Turning next to the inner sleeve member 11, it will be observed that this member is constructed of a relatively soft material which is preferably flexible and resilient. Thus, this member may be conveniently constructed of vulcanized rubber which is preferably fabric reinforced. It may also be constructed of natural or synthetic resins, synthetic or natural rubber, wood, soft metals such as lead or babbitt, impregnated paper products, natural polymers such as gutta percha, etc. In some instances it may be desirable to have the member be laminated such that its inner surface is a relatively soft material while its outer surface is a hard material such as steel or the like.

In general, it follows that sleeve member 11 should be possessed of the following characteristics. First, it should be capable of ready radial movement such that it offers very little resistance to the entry of a core. Second, it should possess a relatively soft inner wall surface such that it molds itself readily around a core when compressed against the core.

As is particularly shown in Figure 2, sleeve member 11 preferably consists of a plurality of separate arcual sections of a cylinder which are arcually spaced from one another. Thus, in Figure 2 there are identified four sections 20, which are arcually separated by the openings 24. While the figure indicates the existence of four such sections, it will be appreciated that any number of sections from 2 or more may be used. In general, it is preferred that about 4 sections be employed.

Substantially the entire outer surface of the sleeve member 11 is provided with a plurality of vertically spaced shoulders which are inclined downwardly and inwardly with respect to the sleeve. In other words the shoulder members 31 of the sleeve member are of a number and character such that they mesh with and rest upon the shoulder members of the inner barrel. It follows, then, that the shoulder members of the sleeve 11 as well as of the inner barrel 8 should possess substantially the same length, slope, etc. With reference to these characteristics of these two sloped members, it is desirable that the members be inclined at an angle of about 30° to 60° with respect to the vertical and preferably about 45°.

In examining the apparatus of Figure 1, it will be apparent that means must be provided for retaining the sections of the sleeve member 11 flush against the inner surface of the inner barrel 8 as the apparatus is assembled and lowered into position for a coring operation. This relationship may be conveniently realized in several different ways, one particularly desirable way being that illustrated directly in the figure. Referring to the figure, it will be observed that inner barrel 8 is connected at its lower end to adaptor member 35 which consists of

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an outer ring 37 and an inner ring 36. The two rings are conveniently secured to one another and spaced by means of one or more rod members 38 disposed around the periphery of the adaptor. The inner and outer rings 36 and 37 are spaced from one another to form an annular opening 39 which may extend around the entire periphery of the adaptor.

The lower end of each section 20 is provided with an extension 40 which projects within an annular opening 39. Each extension 40 is provided with a shoulder 41 which engages the upper end of the inner ring 36 and thereby prevents the section from sliding down and out of the inner barrel. It follows that the shape of the extension 40 must be such as to not interfere with the desired relative movement between the shoulder members 30 and 31. Features such as this may be readily incorporated within the apparatus and will be apparent to those skilled in the art. Furthermore, it will be apparent that a variety of designs and devices may actually be utilized for retaining the sections 20 within their desired position within the inner barrel.

Having described the structural elements that are illustrated in Figures 1 and 2, attention is now directed toward a consideration of the manner in which this apparatus is operated. Thus, it will be assumed that the apparatus is employed in obtaining a core sample from a subterranean formation that lies beneath the bottom of a bore hole. Referring to the figures again, it will further be assumed that a bore hole 15 has been drilled down to formation 5 and that it is desired to obtain a core sample of this formation. Accordingly, a core head of the type illustrated in the figures is secured to the lower end of a string of drill pipe 6 and is thereafter lowered to the bottom of the bore hole 15. A suitable drilling fluid is thereafter circulated down through the drill pipe 6 and thence through the passageway 50 and the annular passageway 13 to the coring bit 9. From this point the drilling fluid flows up the annular space 14 to the surface of the earth.

Having established the circulation of drilling mud, rotation of the drill pipe 6, the attached outer inner barrel 7 and the coring bit 9 is commenced. The inner barrel 8 as well as the sleeve 11 are maintained stationary by virtue of the swivel connection 10 and its associated bearing 16.

As load is applied to the bit 9, the bit penetrates the formation 5 and drives core 12 upwardly into the inner barrel. It will be appreciated that the inner diameter of the cylinder effectively formed by the sleeve elements 20 is preferably such that it is no smaller than the diameter of the core which is cut by the bit 9. With this provision the core 12 freely enters the inner barrel 8 and moves the elements 20 upwardly and outwardly with respect to both the core and the inner barrel. In other words, the sleeve 11 and each element thereof expands and rises vertically by virtue of the sliding contact between the shoulders 31 and 30.

The coring operation is continued until the desired amount of core is lodged within the core barrel. At this point rotation of the bit is ceased and the circulation of mud may be discontinued. It will be appreciated that the core may be separated from the underlying formation by any convenient and conventional procedure. For example, it may be separated by rotating the apparatus with no load on the bit. The normal play and vibration associated with the apparatus under this condition is generally sufficient to part a core.

Once having separated the core 12 from the formation 5, the entire apparatus is lifted from the bottom of the bore hole. Simultaneously, each element 20 of the sleeve 11 slides downwardly and inwardly by virtue of the shoulders 30 and 31 until they engage the core 12. It will be observed that the amount of force which is exerted in this way upon the core is derived substantially

entirely from the weight of the core itself. Furthermore,

it will be observed that the lateral thrust on the core is distributed substantially evenly over the entire surface area of the core.

Once the elements 20 have engaged the core, the entire apparatus including the core may be lifted from the bore hole and subsequently handled as desired.

At this point it will be realized that the foregoing description and figures are intended to illustrate merely a preferred embodiment of the invention and that the invention is not to be limited by the particular features or forms of apparatus that are illustrated. In other words, it is contemplated that numerous variations and modifications of the foregoing apparatus may be employed without departing from the spirit or scope of the invention. For example, it is considered that the sleeve member 11 may comprise more than four sectional elements and furthermore may be formed of a wide variety of suitable materials. Again, the use of the apparatus is not to be limited by any particular drilling mud. Instead, it is considered that the apparatus may be employed with gasiform or liquid drilling fluids and that it may utilize any of the conventional bits that are employed in coring operations.

It will also be appreciated that the various parts of the apparatus may be chamfered, beveled or tapered as desired to provide increased freedom of movement and minimization of plugging. Thus, the elements 20 that are illustrated in Figure 2 may have their corners beveled so that particles of rock or cuttings do not lodge between the elements. These and other modifications will be readily apparent to persons skilled in the art.

What is claimed is:

1. An improved coring apparatus comprising an outer barrel, a coring bit disposed at the lower end of said outer barrel, an inner core receiving barrel disposed within said outer barrel, a swivel connection adapted to support said inner barrel within said outer barrel and to provide relative rotational movement between said barrels, a plurality of vertically spaced downwardly and inwardly inclined shoulders on the inner wall surface of said inner barrel, a generally cylindrical soft resilient sleeve member disposed within said inner barrel and extending substantially throughout the length of said inner barrel, the inner wall surface of said sleeve member having a radius of curvature substantially equal to the radius of curvature of a core cut by said coring bit, a plurality of vertically spaced, inwardly and downwardly inclined shoulders on the other wall surface of the sleeve mem-

ber, each shoulder on the sleeve member resting upon a separate shoulder of the inner barrel and being slidable thereon.

2. An improved coring apparatus adapted for use at the lower end of a string of well pipe which comprises in combination an outer barrel; an inner core receiving barrel disposed within said outer barrel; a swivel connection supporting said inner barrel from said outer barrel and providing relative rotational movement between said barrels; a coring bit at the lower end of said outer barrel; a plurality of vertically spaced, downwardly and inwardly inclined shoulders extending circumferentially around the inner wall surface of said inner barrel; a plurality of relatively soft arcual sections of a hollow cylinder disposed within said inner barrel, said sections extending the length of and being supported from said inner barrel to define a sleeve member; the inner wall surface of each section having a radius of curvature substantially equal to the radius of a core cut by said coring bit; a plurality of vertically spaced downwardly and inwardly inclined shoulders on the outer wall surface of each said section adapted to mesh with and rest upon the shoulders on said inner barrel.

3. In a coring apparatus including an outer barrel attachable at its upper end to the lower end of a string of drill pipe and a coring bit attachable to the lower end of the outer barrel, the improvement which comprises an inner barrel disposed within said outer barrel and supported therefrom by a swivel adapted to provide relative rotational movement between the barrels, a plurality of vertically spaced downwardly and inwardly inclined shoulders on the inner wall surface of said inner barrel, a sleeve having a smooth soft inner surface disposed within and extending substantially the length of the inner barrel, said sleeve having an internal diameter no smaller than the diameter of a core cut by the bit, a plurality of vertically spaced, inwardly and downwardly inclined shoulders on the outer wall surface of the sleeve member resting upon corresponding shoulders of the inner barrel in a slidable relation.

4. An apparatus as defined in claim 3 in which the sleeve comprises a plurality of longitudinal sections.

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