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APPARATUS FOR OBTAINING UNALTERED CORES

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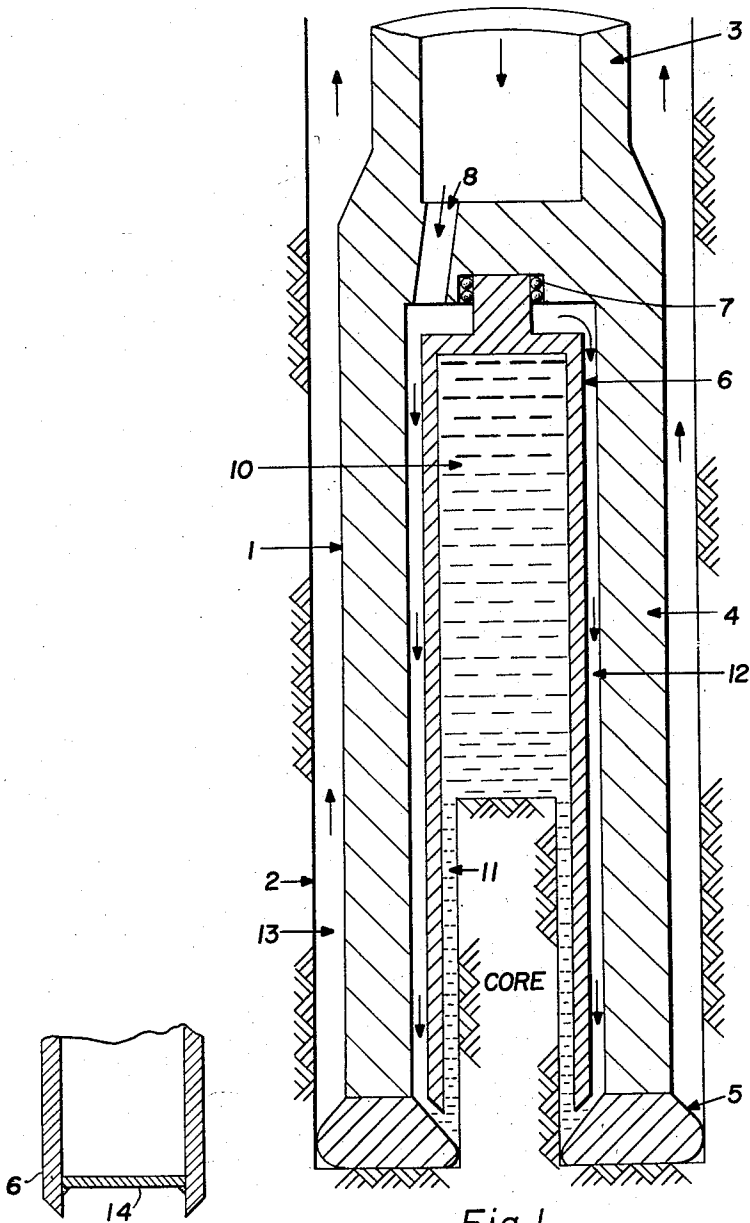


Fig. 1

Fig. 2

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APPARATUS FOR OBTAINING UNALTERED CORES

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The present invention is concerned with an improved method for obtaining uncontaminated cores from subterranean formations. The invention is more specifically concerned with a method and apparatus for obtaining an uncontaminated core sample from formations containing hydrocarbon constituents at the bottom of a bore hole or well which penetrates the earth's substrata. The method and apparatus are particularly characterized by the fact that the core sample may be obtained without employing drilling mud which on occasions tend to seriously contaminate and thus impair the value of the core sample. The method and apparatus are further characterized by the fact that the core sample may be continuously maintained under substantially ambient formation conditions; and that the core is sealed immediately after it is cut, thus preventing the loss of connate fluids therefrom. The invention is especially adapted for the coring of formations that are non-flowing and are open to the atmosphere.

One problem that is encountered in the search for oil is that of obtaining reliable samples of oil bearing formations that lie beneath the surface of the earth. The problem has become one of particular importance in view of the ever increasing use of secondary recovery methods for obtaining additional oil from subterranean oil reservoirs that have ceased primary production. It is essential, before initiating a secondary recovery procedure in any such reservoir, to have as much information as possible about the structure, the fluid content, the pore volume, the permeability, etc. of the reservoir. Such information is extremely valuable in determining whether the reservoir formation is susceptible to successful exploitation using secondary recovery techniques and just which particular techniques should preferentially be utilized.

In line with the growing emphasis on secondary recovery programs, many petroleum producers are conducting extensive analyses of old reservoirs and fields that have lost their reservoir pressures and have been abandoned. In an effort to evaluate these old reservoirs and fields, and in order to determine whether a secondary recovery procedure can be successfully applied to them, the producers are conducting extensive testing programs. One technique has been to drill and sample the bottoms or side walls of old wells that were originally producing wells associated with a reservoir or field. However, in many instances the samples derived by this technique are not truly representative of the field or reservoir as a whole. This is due in part to the fact that it is very difficult to determine the true fluid content of reservoir rock. Accordingly, it has become more and more the established practice to drill entirely new holes from the earth's surface down to an oil bearing formation and to obtain samples of the formation directly from these new holes. Conventional drilling and coring methods such as rotary and cable tool have been employed for this purpose. In all of these types of drilling it is conventional to use air or gas or at least a small amount of drilling

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mud, water or other drilling fluid in the bottom of the hole.

However the presence of the drilling mud, water or other drilling liquid in a hole still constitutes an undesirable feature when sampling a reservoir of the type described for the reason that the hydrostatic pressure and wetting effects of even this small amount of liquid seriously interferes with the reliability of the core samples that are obtained. It is accordingly an object of the present invention to provide an apparatus and method for obtaining reservoir core samples wherein the samples need not be subjected to a drilling liquid of any kind. It is a further object of the invention to provide means for coring a formation in such a manner that the core sample suffers little exposure to material that may be a source of contamination. It is a particular object of the present invention to provide means for isolating a core sample within the coring apparatus so that connate fluids are sealed within the sample. It is further a particular object of the invention to provide a coring method and apparatus wherein a core sample is sealed as it is cut to protect it from contaminating substances.

These objectives are realized in accordance with the present invention by the utilization of a core drill assembly that is at least partially filled with a core sealing agent and which is arranged to receive the core. As the core is cut by the core bit and enters the core barrel, the sealing agent is displaced and is extruded and distributed over the outer surface of the core. The sealing agent acts to seal the pores of the core sample and thereby prevents fluids from escaping from the sample. The film of sealing agent additionally prevents contaminating substances from penetrating within the sample. As a core sample is cut by the coring apparatus, the sample forces its way into the core barrel with the result that sealing agent is displaced or extruded from within the core barrel and is deposited over the outer surface of the core sample.

The present invention may be more fully understood by reference to the drawing in which:

Fig. 1 illustrates a longitudinal section of one embodiment of a coring apparatus; and,

Fig. 2 illustrates a frangible disc in the lower portion of the inner core barrel of the apparatus shown in Fig. 1.

Referring specifically to the drawing, a core barrel assembly 1 is shown disposed in the bottom of bore hole 2 in the earth's substrata. The core barrel assembly is attached by suitable means to the lower end of tubing or drill pipe 3. The core barrel assembly comprises an outer cylindrical element 4 which is attached at one end to the lower end of the drill stem and contains at its lower edges suitable cutting bit elements such as cone elements 5. The core assembly also contains an inner core receiving barrel 6 which is preferably rifled on the inner bore to prevent sticking of sealing material which is positioned within the inner barrel. The inner barrel is swiveled at bearing 7 so as the drill stem 3 rotates along with the outer barrel 4 the inner core receiving barrel will remain stationary. In accordance with one preferred adaptation of the present invention the sealing material within the inner barrel is sealed by means of a frangible disc 14 positioned at its lower end.

Thus, as a coring operation starts, the outer core barrel will rotate and cut an annulus about the core as it along with the non-rotating inner core receiving barrel will move downwardly. In accordance with a preferred adaptation of the invention the viscous material placed within the core receiving barrel is maintained in position by a frangible disc 14. As the core assembly moves downwardly the frangible disc will be fractured and the viscous material 10 within the core receiver will be forced or extruded into the area 11 between the core and the inner

surface of the core receiving barrel. Under certain circumstances it may be desirable to circulate mud downwardly in the drill stem 3 through port 8 and downwardly in the area 12 between the inner core receiving barrel and the outer rotating core cutting barrel. This circulating mud will move through suitable ports in the bit and upwardly in the area 13 between the rotating outer barrel and the bore hole wall. However, in most instances it is desirable not to circulate mud but to secure and seal off the core without its use.

Thus as the core moves upwardly within the inner barrel the sealing material is extruded around the core as it enters the barrel. Excess sealing material is removed through the ports of the bit and flows into area 13.

While a frangible disc has been described with respect to the drawing, it is to be understood that the sealing material may be made sufficiently viscous so as not to be flowable but which can be extruded as the core receiving barrel moves downwardly in the annulus about the core. It is also within the scope of the present invention to use as a sealing agent a very highly viscous membrane at the lower end of the inner core prior to coring and to have this high viscous membrane of sufficient thickness serve to hold in place a less viscous and thermo setting sealing material.

Insofar as the choice of sealing agent is concerned, it is necessary that this material flow readily under the ambient conditions that prevail during a coring operation and that it be substantially chemically inert toward the apparatus as well as toward the core sample. While it is not essential that the sealing agent be non-wetting, it is preferred that it be so, so that it would not have a tendency to stick to, or penetrate the core sample. It is additionally preferred that the agent possess lubricating qualities so as to reduce the amount of friction that customarily exists between the core and the inner core barrel. It is further preferred that the agent be substantially chemically inert toward the drilling fluid as well as toward water and the hydrocarbons that are present within the core sample.

In addition to the above characteristics, it is desirable that the sealing agent be of a character to form a film over the surface of a core sample which effectually seals off the surface of the sample. Suitable sealing materials may for example be a lubricant which has a viscosity of 1,000 centistokes or higher and a specific gravity of 1 or greater. Other suitable sealing agents are for example polymeric silicones having a viscosity above 1,000 centistokes and thermo plastic materials such as polyvinyl chloride. Other suitable materials are for example thermo plastic materials such as polyesters: reaction product of adipic acid and hexamethylene diamine, reaction product of ethylene glycol and maleic anhydride, and reaction product of ethylene glycol and phthalic anhydride.

Still other suitable materials are thermo setting materials such as condensation product of cresol and formaldehyde, condensation product of furfural, and condensation product of adipic acid and glycerol. It is within

the concept of the present invention to use as sealing materials low melting metallic alloys such as alloys of lead, bismuth, tin and the like.

In general the material may be a time-setting plastic so chosen that with a reasonable weight on the bottom after coring the plastic would set up and positively encase the core. The material may be of a thermo plastic type which will solidify on cooling. The cooling may be accomplished by either coring with a hot tool or chilling after operation at ambient temperature.

A particularly desirable adaptation of the apparatus of the present invention is to use a material in the core receiving barrel that is frangible. Thus when the core receiving barrel is removed it can be readily broken to secure a sealed core which may be handled as desired.

While not illustrated in the drawing, it is to be understood that conventional core catchers and break off devices as well as conventional seal off devices such as described in U. S. Patents 2,343,805 and 2,216,962 may be employed in conjunction with the present invention.

Having described the invention, it is claimed:

1. A core barrel for securing an uncontaminated core which comprises an outer barrel adapted to be positioned at the lower end of a string of drill pipe, a coring bit connected to the lower end of said outer barrel, an inner core receiving barrel disposed within said outer barrel, swivel means supporting said inner barrel from said outer barrel and adapted to provide relative rotational movement between said barrels, the outer surface of said inner barrel being spaced from the inner surface of said outer barrel and defining an annular space therebetween, the internal diameter of said inner barrel being slightly greater than the diameter of a core cut by said coring bit, said inner core barrel containing a liquid viscous core sealing agent capable of forming a film over said core and means for retaining the sealing agent within said core barrel.

2. An apparatus as defined in claim 1 including a frangible disc sealing the entrance to said inner barrel and adapted to be broken by the entrance of a core into said inner barrel.

3. An apparatus as defined in claim 1 including a conduit providing fluid communication between the interior of said drill string and the annular space between said inner and outer barrels.

4. An apparatus as defined in claim 1 in which the sealing agent is a time-setting plastic.

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