March 8, 1955 R. D. WALKER 2,703,697

PROCESS AND APPARATUS FOR WELL CORING

Filed Dec. 15, 1950

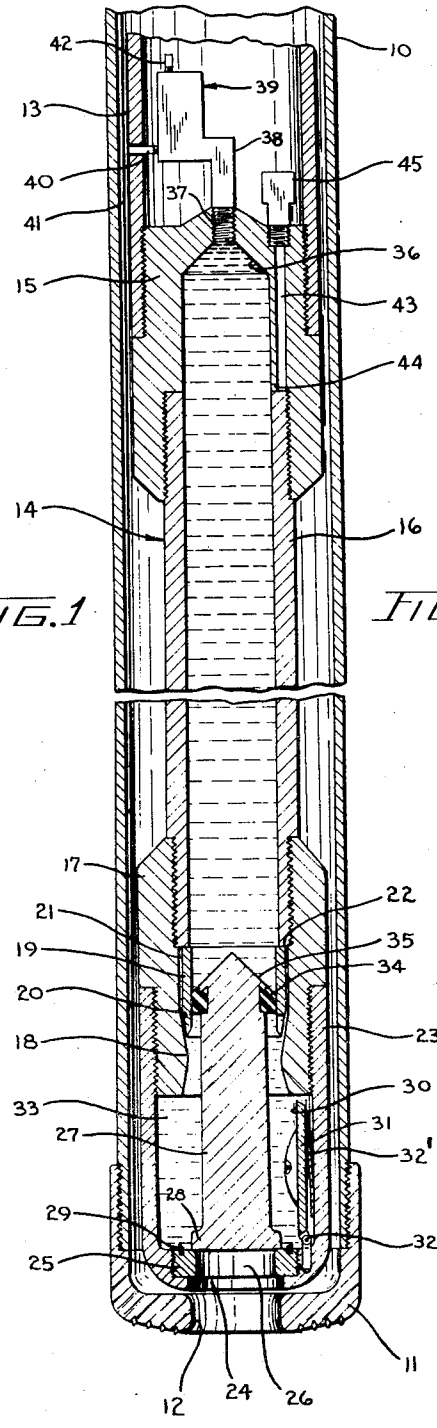


FIG. 1

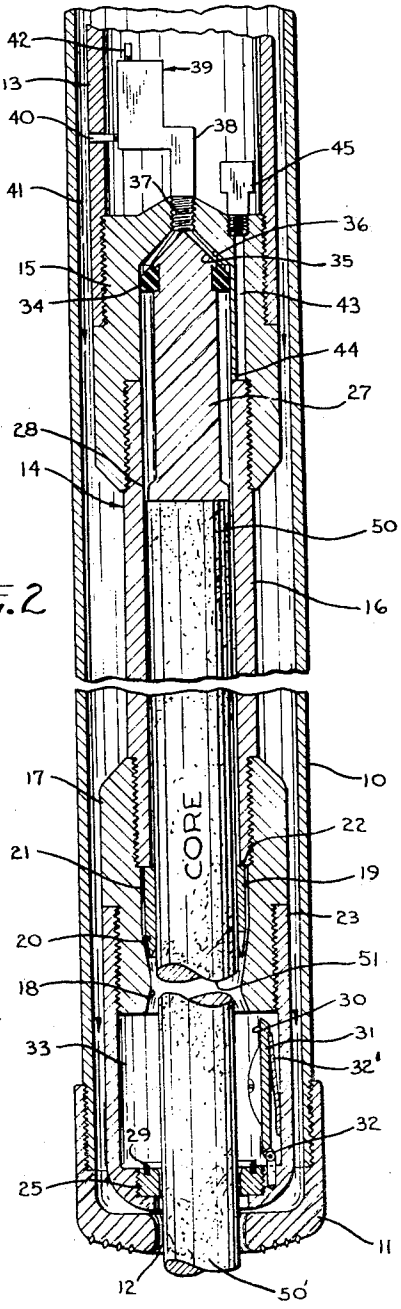


FIG. 2

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United States Patent Office 2,703,697 Patented Mar. 8, 1955

2,703,697

PROCESS AND APPARATUS FOR WELL CORING

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Application December 15, 1950, Serial No. 200,939

6 Claims. (Cl. 255—1.8)

This invention relates to a core extractor for use in the removal of samples of subterranean deposits. The invention also relates to a method of determining at the surface of the earth the extent to which a core has been cut and particularly when a certain length of core has been cut. The invention also relates to the preservation of cores and well fluids in unmodified state during their extraction from the well. The invention is particularly useful in drilling oil wells and it will be described in relation to that art, but it is equally useful whenever a subterranean deposit is to be sampled.

In oil well practice it is desirable to bring to the surface of the earth the core and accompanying fluids in the exact condition in which they occur, or at least without the loss of solids or fluids. It has been extremely difficult to accomplish this heretofore because the pressure deep in the well is greater than at the surface, volatile constituents are lost by evaporation as the core nears the surface, liquids drain away when the core is removed from the well, evaporation of those liquid ingredients which remain in the core occurs and the formation sometimes crumbles and loses its identity, and by the time the sample has reached the laboratory it bears but little relation to the structure and constitution that existed under the earth.

It is always hard to tell what is going on at the bottom of a drilled hole deep in the earth. Sometimes the core is powdered, crumbled or "drilled up" and does not enter the barrel. Sometimes when the barrel is lowered into the hole by a drill stem it strikes a bridge where the formation has caved a part way to the bottom, and the bridge enters the barrel and occupies a part of it, giving a false core.

It is an object of this invention to extract the core from a well in its original condition without any or with but little loss of constituents.

Another object is to inform the operators at the surface when core cutting begins, when a sufficient core has been cut, or when a formation has entered the barrel too soon, and to give other valuable information about the progress of the drilling.

Yet another object is to provide for the capture of volatile constituents and for their analysis without loss.

Other objects of the invention will be apparent to those skilled in the art or set forth from time to time in the part of the specification which follows.

The objects of the invention are accomplished, generally speaking, by displacing a recognizable substance into the well fluids progressively as the core is cut. As to apparatus, the invention is accomplished by the apparatus herein described and shown, which constitutes a preferred form of the invention.

In the drawings, Fig. 1 is a vertical sectional view through apparatus corresponding to the invention at the start of a coring operation;

Fig. 2 is a similar section near the end of a coring operation.

Referring now to Figs. 1 and 2, the apparatus comprises an outer barrel **10**, of metal which is lowered into the well and carries at its lower end a cutter **11** which is screw threaded onto the end of the outer barrel and which has an annular cutting face provided with a circular aperture **12** which receives the core. In cutting through rock, the annular cutter **11** powders the rock beneath it leaving an untouched core which gradually extends upwardly into the aperture **12**.

An inner barrel **13** carries at its lower end a cylinder **14** which comprises a head **15**, screw threaded into the barrel **13**, a tube **16** which is screw threaded into the head, a ring **17** which is screw threaded onto the tube **16** and is internally provided with an annular cam face **18**. A movable core breaker **19**, consisting of a metal ring which is split at its lower end, has an external cam surface **20** capable of cooperating with cam face **18**, and is loosely set in a widened portion **21** of the ring **17** just above the cam face **18**. In its upper position its end bears against the lower end of tube **16**. The core catcher **19** is made of spring steel, has a elementary slot, extending upward from its lower end, and is of less diameter than the core or the tube **16**. As the core advances it is gripped by the core breaker, which cannot, however, move upward past the shoulder **22** formed by the lower end of the tube **16**.

The ring **17** carries by screw threads the tubular end piece **23** which has at **24** an aperture slightly larger than aperture **12** in cutter **11**. The bottom valve seat **25** is screw threaded into a suitable seat above the aperture **24** and is provided with an aperture **26**, about equal in size to aperture **12**, which will accept the core as it is cut and advances into the cylinder **14**.

A go-devil **27**, which may also be called a ram or piston is provided with a base **28** which rests, in its retracted position, upon the upper face of valve seat **25**. The base **28** is circular and is received within a sealing ring **29** provided with a knife edge for cooperation with the lower face **30** of a flapper valve **31** which is pivoted at **32** beside the valve seat **25**. A spring **32'** loads the flapper valve **31** toward closed position. A kind of enlarged chamber **33** is provided in the lower end of the cylinder beneath the ring **17**. At its upper end the go-devil is provided with a rubber ring **34** which acts to seal the interior of the cylinder so that it can contain liquid whenever it is desired to give visual information to the operator at the surface concerning the progress of cutting or the breaking of the seal of the cylinder on the way down.

The upper end **35** of the go-devil and the upper face of resilient ring **34** are conical and conform to the conical face **36** in the head **15**. At the upper point of the cone **36** is an opening **37** into which is screw threaded a pipe **38** leading to relief valve **39** which has an outlet **40** discharging into a space **41** between the inner and outer barrels. The relief valve **39** is of adjustable type having a set screw **42** which sets the pressure at which relief occurs. Valves of this type are known and need no detailed description.

The wall of the head is bored at **43** to a distance below the position occupied by the ring **34** in its upper position and at that level is connected by a port **44** with the interior of the cylinder **14**. A tap valve **45** is provided at the outlet of the bore **43**. The base of the go-devil is of such size as to permit fluid to travel past it in the cylinder. When the cylinder is at the surface of the ground its fluids may be drawn off through the tap valve into suitable sealable containers for analysis.

When the apparatus is at work the drill **11** cuts the core and the core advances through apertures **12**, **24** and **26** against the bottom of the go-devil, which is forced upwardly against the liquid within the cylinder, which is expelled progressively as the core advances. The liquid in the cylinder is of some type readily recognizable when it reaches the surface and it enters the space between the two barrels and is carried upward by the fluids under pressure which enter that space between the lower end of end piece **23** and drill **11**. When the go-devil reaches its uppermost position it seals the relief pipe **37** and the telltale liquids cease to travel to the surface with the rising fluids. This is accomplished in the following way.

Before the apparatus is lowered into the well for coring the cylinder **14** is filled with a recognizable liquid such as ink, a water soluble dye, or an oil soluble dye, the liquid being forced into the cylinder **14** under a pressure exceeding the pressure at the bottom of the hole. This is accomplished by first determining the pressure at the bottom of the hole, either by interpolation from the weight of the drilling fluid at the surface, or by availing oneself of known methods for determining that pressure at the bottom of the hole. That internal pressure is maintained by the setting of the adjustable relief valve, and seals the lower end of the cylinder by pressing the base **28** against its seat and by expanding the ring **34** against

the wall. The ring 34 may be cupped or provided with an annular slot opening upward to increase this sealing effect if desired. The apparatus is then lowered into the well. The colored liquid fills the inner barrel from the lower end of the go-devil to the valves at the top. When the seal at the bottom is broken, as by an obstruction on the way down, or by entry of the core at the bottom, colored fluid flows out the bottom hole into the mud and is carried up to the surface, informing the operator of the obstruction, if the color appears too soon, or of the cutting and progress of the core into the barrel. As the coring operation proceeds the go-devil moves up the barrel until its top ring seals the barrel above the core catcher, and thereafter the colored fluid is all expelled upwardly through the relief valve, in proportion to the advance of the core into the barrel. The go-devil is shown in Fig. 2 without an extended base, is forced upward and eventually into the sealing position of the cooperating valve seats 35, 36. At that time, the teletale fluid has been expelled, except for a small residue in the relief valve itself and in the tap valve bore, and the core 50 has been received in the cylinder and gripped by the core breaker 19. When the inner barrel is lifted, the core breaker 19 remains fixed to the core (assuming a solid core), bringing the cam surface 20 against the cam face 18 and constricting the ring 19 upon the core, which breaks at a point generally indicated by line 51. The apparatus may now be removed from the well and as it rises, the ffapper valve 31 follows the end of the core stub 50' downward until it makes sealing engagement with the ring 29. The internal pressure in cylinder 50 is equal to that at the bottom of the hole, but as the cylinder is drawn upward the surrounding pressure decreases so that the interior pressure is greater than the exterior pressure and maintains the go-devil 27 and the valve 31 in tightly sealed condition. At the surface the compressed fluids and volatiles are drawn off through the tap valve 45, releasing the interior pressure, whereupon the core may be removed. This removal is best accomplished by unscrewing the tube 16 from the ring 17. The core is slightly less in diameter than the tube 16, in the modification shown in the drawing, and slides out readily, still having its original structure and composition except for the volatiles which have already been captured. This core can immediately be subjected to deep freezing, or to preservation in other and less efficient ways.

An advantage of the invention is in the information which is given to the operator concerning what is going on underground. If any obstructions such as a bridge unseals the barrel at the lower end of the go-devil colored fluid escapes past the bottom of the go-devil into the mud or liquid, appearing at the surface and warning the operator, enabling him to take steps for the correction of the situation. If, for some reason, the core does not enter the barrel, its failure is signalled to the operator by the failure of color to appear at the surface, in the well fluids, when it should. When the core cutting is proceeding regularly the fluid is expelled through the relief valve regularly and the well fluids are thus regularly colored, informing the operator of the fact. When the core has filled the barrel no further colored material is discharged into the well fluids and the operator is informed of the completion of the operation by the arrival of the well fluids, which have previously been colored, at the surface in uncolored condition.

The drilling apparatus has the further advantage that it retains in the barrel well fluids existing at the core level, and which are frequently as important as the solids in the core or more, so, the barrel being sealed against the escape of these fluids when the core is broken. These fluids, or some of them, may be liquid under the pressure pertaining at the bottom of the well but gaseous at surface pressure. This invention prevents the escape of those gases and provides for their capture through the draw-off valve that opens into the side of the cylinder below the upper sealing ring of the go-devil, in its upper position. After reducing the internal pressure in the draw-off valve the core or other liquid constituents can be removed and preserved by freezing or by insertion in a sealable receptacle and all parts of the core may thus be forwarded together to the laboratory for analysis.

The device protects the apparatus against uselessly continuing the coring operation after the core has filled the inner barrel.

As many apparently widely different embodiments of the present invention may be made without departing from the spirit and scope thereon, it is to be understood that the invention is not limited to the specific embodiments.

What is claimed is:

1. A core extractor adapted to take samples of subterranean structure comprising an outer barrel, a drill attached thereto circumscribing a passage for a core, an inner barrel comprising a cylinder spaced from the outer barrel having an opening for the core cut by the drill, a go-devil piston adapted to close the opening in the cylinder and having sealing contact with the wall thereof, a valve seat on the upper end of the go-devil piston, a cooperating valve seat at the upper end of the cylinder circumscribing an outlet to the space between the barrels provided with a relief valve, valved outlet means connecting the cylinder with the interior of the inner barrel, a core catcher at the lower end of the cylinder, and valve means to close the inner barrel below the core catch.

2. A core extractor adapted to take samples of subterranean structure comprising a cylinder filled with colored liquid, a relief valve closing the upper part of said cylinder, a go-devil closing an aperture at the lower end of the cylinder and having means to seal the cylinder, and core cutting means operatively associated with said cylinder below said aperture and having a core-receiving aperture aligned with the go-devil.

3. In core drilling of a well from which fluids flow while drilling, the method of indicating at the top of the well, the entrance of a core into the drill tool at a subterranean part of said well that comprises releasing an inidcator fluid from the drill tool into the fluids flowing from said well as such core enters the drill, and determining the existence of such core cutting by testing the well fluids flowing from the top of the well.

4. In the method of claim 3, stopping the release of the indicator fluid into the well fluid upon termination of the advance of the core into the drill tool.

5. A core extractor adapted to take samples of subterranean structure comprising a cylinder containing an indicator liquid, said cylinder being sealed at one end by a go-devil piston, and at the upper end by a release valve means opening in response to pressure inside the cylinder, annular core cutting means operatively associated, and aligned axially with the cylinder and go-devil piston, said valve means operating as pressure is generated by advance of the go-devil piston to release the indicator liquid as the core is cut, and means to seal both ends of the cylinder when the core has been cut.

6. The core extractor of claim 5 in which the cylinder has internal means loosely supporting, for limited motion along the core, a split core gripping sleeve having an external cam, said internal means comprising a cooperating cam operable to compress the split sleeve.

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