Feb. 12, 1952 R. L. HENDRICKSON 2,585,386

METHOD AND APPARATUS FOR CORING WELLS

Filed June 26, 1947 3 Sheets-Sheet 1

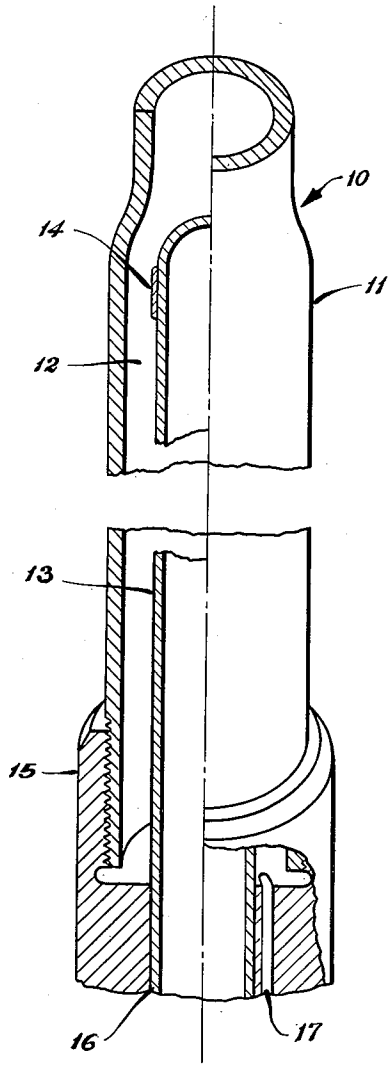


Fig. 1a

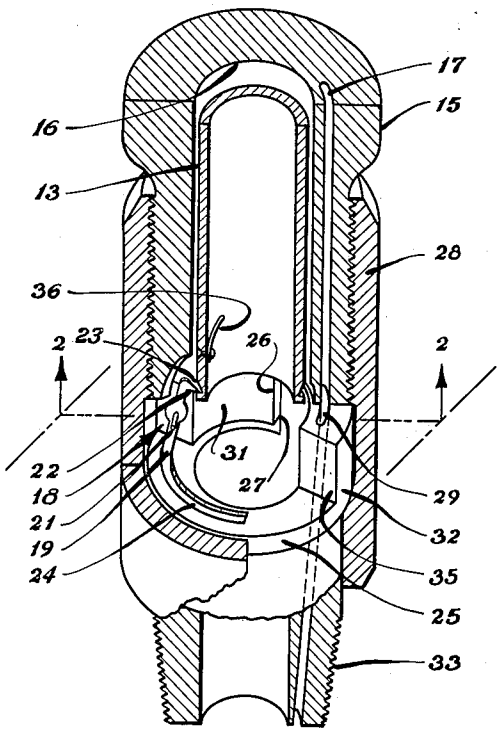


Fig. 1b

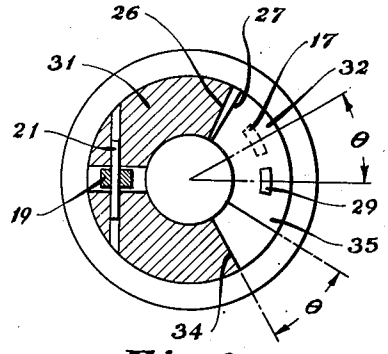


Fig. 2

Ralph L. Hendrickson
INVENTOR.

BY L. Goodwin
ATTORNEY

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METHOD AND APPARATUS FOR CORING WELLS

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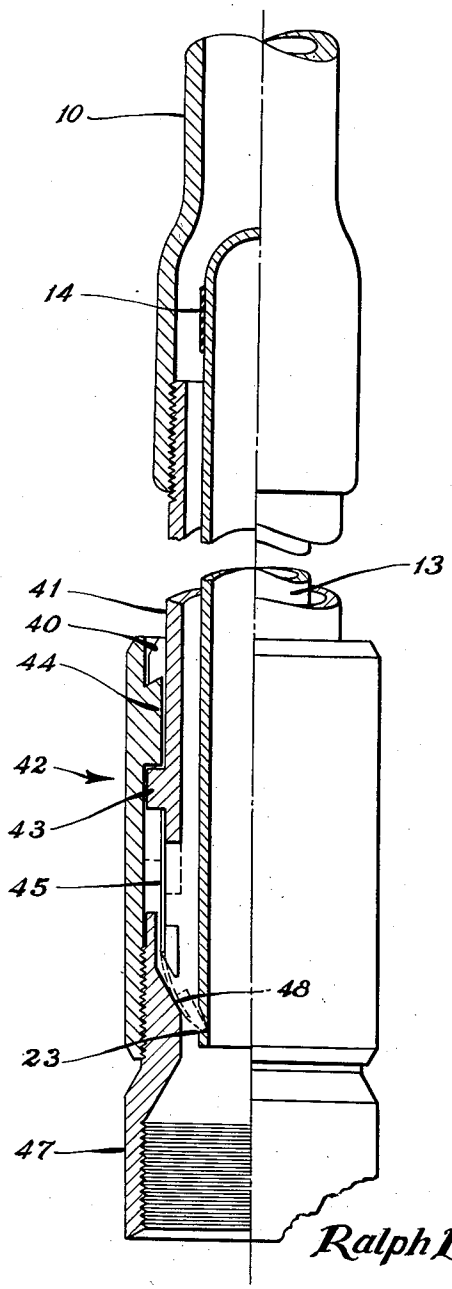


Fig. 3

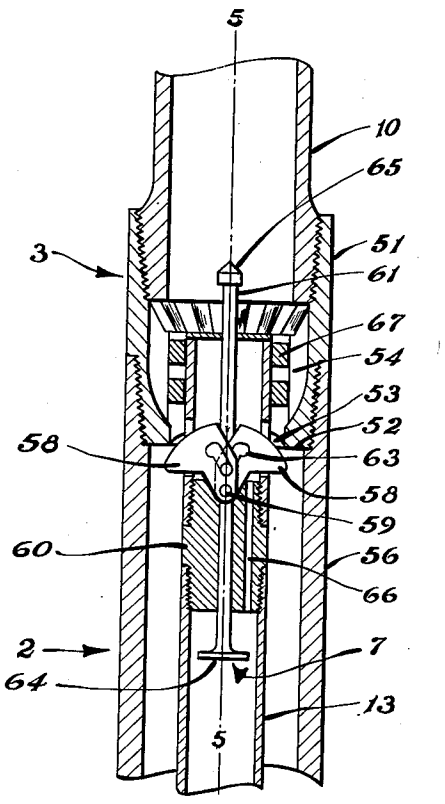
Ralph L. Hendrickson
INVENTOR.

BY L. Goodwin
ATTORNEY

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METHOD AND APPARATUS FOR CORING WELLS

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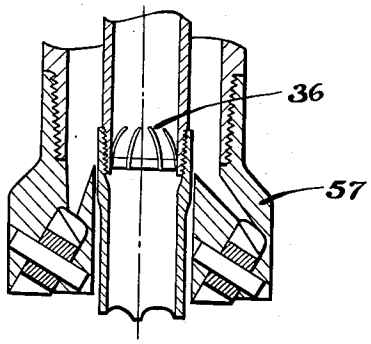


Fig. 4

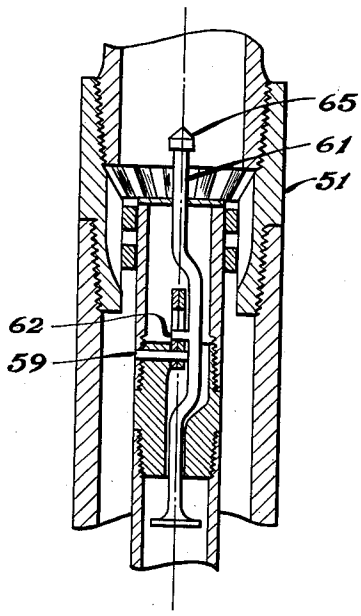


Fig. 5

Ralph L. Hendrickson
INVENTOR.

BY L. Goodwin
ATTORNEY

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METHOD AND APPARATUS FOR CORING WELLS

Ralph L. Hendrickson, Hobbs, N. Mex., assignor to Stanolind Oil and Gas Company, Tulsa, Okla., a corporation of Delaware

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14 Claims. (Cl. 255—1.4)

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This invention pertains generally to sampling sub-surface formations by coring. More particularly, it deals with an improvement in the art of sampling formations at the bottom of a hole by employing reverse-circulation drilling to cut the core and circulate it to the surface in a core barrel.

As used herein "direct circulation" refers to circulation of the drilling fluid downwardly in the drill pipe in a drilling well and upwardly in the well outside the drill pipe. "Direct-circulation drilling" is defined as drilling which is carried on while the fluid is in direct circulation. Conversely, "reverse circulation" as used herein refers to circulation of drilling fluid upwardly in the drill pipe in a drilling well and downwardly in the well outside the drill pipe. "Reverse-circulation drilling" is therefore drilling which is carried on while the fluid is in reverse circulation.

In the art of sampling deep subterranean formations by circulating cores to the surface in the drilling fluid, two general methods have been practiced. In one a core barrel is employed adjacent the bit, and in the other the core fragments are transmitted to the surface through the drill pipe directly as the cores are cut and broken off.

In the former method a core barrel is pumped to the bottom by direct circulation and held in position contiguous to the drill bit, as a general rule by the pressure of the drilling fluid, while the core is cut and deposited in the barrel. Constricted ports are provided around the core barrel which by the pressure drop of the fluid tend to hold the barrel in position at the bit where it receives the cores as they are cut. When the barrel is full of cuttings or cores, reverse circulation is employed to transmit the barrel containing the cuttings or cores to the surface in the drilling fluid. This method of coring has many advantages over previous methods of coring in which all of the drill pipe had to be retracted in order to recover the core. However, many of the limitations of the earlier practices are retained in this method. For example, the washing action of the drilling fluid which tends to dissipate the core also tends to prevent the core particles from entering the barrel, due to the use of direct-circulation drilling, and accordingly a recovery of as low as 10–30 per cent of the core is not uncommon, especially where the formation cored is relatively porous.

The second general method of coring formations employs reverse-circulation drilling either with or without a core barrel not only for cutting the core but also for removing it to the surface through the drill pipe. This method is an improvement upon the previously described method in that the recovery is increased by the tendency

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of the crumbled core particles to be removed with the core. In the case of coring by reverse circulation without a core barrel, I have found that many difficulties are encountered in that the small core particles and cuttings tend to rise in the drill pipe at different rates, depending upon size and shape of the particles. There is a tendency for two particles or a fragment and a full-diameter core to pass in the drill pipe and to wedge therein and plug the drill pipe. Furthermore, such cores are invariably broken in random lengths, and certain lengths cannot be transmitted in the fluid through the drill pipe without also wedging and plugging the drill pipe and consequent loss of time, etc. In the case of coring by reverse circulation with a core barrel, many of the disadvantages of the previously described processes have been overcome. For example, the per cent core recovery is substantially increased and the plugging of the drill pipe as previously described is completely avoided. However, even in this improved process considerable drilling time is lost in recovering the core barrel after the core has been cut and deposited in the barrel. Prior to my invention it has been necessary to stop drilling and lower an unlatching mechanism to the barrel and then either lift the barrel or circulate the barrel to the surface.

It is, therefore, an object of this invention to provide an improved method for coring a subterranean formation. Another object of this invention is to provide a method of coring subterranean formations wherein a core barrel is employed during reverse-circulation drilling, and wherein such core barrel and core are removed from the drill pipe by reverse-circulation drilling. It is another object to provide an improved coring device which can be circulated down the drill pipe and latched in position adjacent the drill bit to take a sample of the formation during reverse-circulation drilling, and, after taking such sample, which can be released without discontinuing drilling operations and lowering a tool into the drill pipe to release and/or lift the core barrel. It is another object of this invention to provide a latching and releasing means for holding a core barrel in position adjacent the bit of a drilling device, the latching and releasing means being adapted to remote control whereby the drill stem does not have to be removed from the hole or a releasing tool otherwise lowered into the drill pipe to retrieve the core or core barrel. Further objects and advantages of this invention will be apparent from the following description taken with the drawings in which:

Figure 1 is a view with a fragmentary central longitudinal section through the lower portion of a drill stem equipped with and showing a form of apparatus used in my invention;

Figure 2 is a transverse section on the plane 2—2 of Figure 1 showing certain operational features of one embodiment apparatus employed in my invention;

Figure 3 is a view partly in section and Figure 4 is a sectional view of apparatus according to my invention, employing alternative principles for latching the core barrel adjacent the bit and releasing the core barrel; and

Figure 5 is a fragmentary longitudinal section taken on plane 5—5 of Figure 4 showing certain operational features of that apparatus.

By this invention the previously described processes or methods have been improved by employing reverse-circulation drilling, not only to cut the core and deposit it in the barrel, but also to circulate the core to the surface in a barrel without substantial loss of drilling time. Improved apparatus is also provided to release the core barrel remotely when a desired amount of core has been cut. Inasmuch as drilling may proceed during the time the core is being removed, considerable drilling time as well as the cores are saved by this invention.

Referring now to Figure 1, the lower end of a drill pipe 10 is illustrated to show generally the location of the novel apparatus employed in the operation of this invention. The remainder of the drill pipe, including a core catcher at the surface, can be standard equipment such as shown in U. S. Patent 2,135,737 Stokes, and so for clarity is not shown or described here. A drill-pipe enlargement 11 is provided at the lower end of drill pipe 10 providing a fluid passage 12 between core barrel 13 and the enlargement 11. As explained in greater detail hereinafter, this passage provides means for fluid to bypass the core barrel during the time that a core is being cut and deposited in the core barrel 13. This core barrel 13 has an external diameter nearly equal to the internal diameter of drill pipe 10, whereby fluid circulation in the drill pipe tends to move the core barrel by piston action. Sealing means such as rubber ring 14, cups, or the like, however, may be attached to the core barrel 13 to provide a better seal between the core barrel and the drill pipe, thus tending to produce a more positive piston action in the core barrel. A special collar 15 is attached to the lower end of enlargement 11. This collar preferably has an internal bore 16 which has substantially the same diameter as the external diameter of core barrel 13. The special collar is also provided with a fluid passage 17, the function of which will be explained in greater detail hereafter. A latching device 18 is provided at the lower end of the special collar 15. This latching device is adapted to hold core barrel 13 in position adjacent the bit while the core is being cut even though the fluid is being circulated upwardly in the drill pipe. The latching device consists of a latch 19 which rotates on pin 21. This pin in turn is anchored in the special collar 15 as shown more clearly in Figure 2. The latch is provided with a hook 22 which is adapted to engage the core barrel in a groove 23, thus holding the core barrel in position. The latch is actuated by a variable-diameter groove or cam 24 in the body of valve 25 as shown. When drill pipe 10 is turned rotated clockwise looking down from the surface whereby shoulder 26 on special collar 15 contacts the shoulder 27 on valve 25, latch 19 takes the position shown in groove 24. That is, the hook 22 engages groove 23 holding the core barrel 13 in the position shown. Valve 25 is held in position adjacent special collar 15 by a sleeve 28 in such a manner that fluid passage 29 in the valve is in alignment with fluid passage 17 of special collar 15. Special collar 15 and valve 25 are each provided with projections 31 and 32, respectively, which prevent rotation except over a small angle θ, as shown in Figure 2. When projection 31 is moved by the clockwise rotation of the drill pipe, shoulder 26 engages shoulder 27 of the projection 32, tending to drive the bit, which is attached to the valve by threads 33. At the same time ports 29 and 17 are brought into communication whereby fluid passes freely through the communicating ports.

When a sufficient amount of core has been collected in core barrel 13, the core barrel is remotely released. As used in this specification and the appended claims "remotely released" means that the core barrel which is latched in position adjacent the bit to receive the core is unlatched or released by the action of the drill pipe or the core and specifically excludes the use of actuating means inserted into the drill pipe and lowered to the core barrel to release any latching means employed for holding the core barrel adjacent the bit during reverse-circulation drilling. The drill pipe is rotated counter-clockwise, bringing shoulder 34 of projection 31 into contact with shoulder 35 of projection 32. That is, there is relative rotation between the drill pipe and the bit through an angle θ, which at the same time rotates port 29 with respect to port 17 through an angle θ as shown in Figure 2, thereby closing this fluid passage. By this same relative rotation latch 19 is moved by cam 24 disconnecting hook 22 from groove 23 and releasing core barrel 13. Inasmuch as reverse-circulation drilling is employed to cut the core, the fluid movement in the drill pipe 10 now tends to raise the core barrel in drill pipe 10. Means are, as stated above, provided at the surface for catching this core barrel and unloading same. Drilling may obviously proceed as usual even though the core barrel has been removed. When the core has been removed from core barrel 13, the barrel may again be inserted into the drill pipe 10 and pumped into position at or adjacent the bit by circulating fluid down the drill pipe, i. e., by direct circulation. When the core barrel is in position, the drill pipe may again be rotated in reverse temporarily and then turned clockwise to move upper special drill collar 15 with respect to valve 25 and latch core barrel 13 into position as shown. While I have shown in this embodiment only one fluid passage comprising ports 29 and 17, it is obvious that two or more such fluid passages could be provided and also that two or more latching devices could be provided. I have found also that a core catcher 36 may be employed to some advantage in some cases.

The embodiment of this invention as shown in Figure 3, like that embodiment shown in Figure 1, is directed to a device for holding a core barrel in position adjacent a bit during the time that a core is being cut by reverse circulation. Means are also provided for remotely releasing the core barrel, thus saving valuable drilling time. In this embodiment the core barrel is held in position merely by the weight on the drill pipe 10. At the lower end of the drill pipe a spline 40 between mandrel 41 and sleeve 42 permits longitudinal motion of the drill pipe 10 relative to the sleeve 42 and the bit without permitting rotation therebetween. A shoulder 43 on mandrel 41 is adapt-

ed to engage the projecting grooves 44 of spline 40 to lift the bit, etc. One or more flexible spring catches 45 are connected to the mandrel 41 for the purpose of holding core barrel 13 down against the upward force of the drilling fluid.

In operation, the core barrel 13 is introduced into the drill pipe 10 at the surface and pumped by direct circulation through the drill pipe into the position shown. Before drilling is commenced and the circulation of the fluid is reversed, however, the drill pipe 10 is lowered until the bit strikes the bottom of the hole. As the weight of the drill pipe is applied to the bit which is connected to collar 47, spring catches 45 are deflected radially inward by the inclined surface 48, thus latching in groove 23 of core barrel 13 as shown in invisible outline. Inasmuch as the weight is maintained on the drill pipe during drilling, a core barrel is held in position by these spring catches 45 until it is desired to release the core barrel. At this time the drill pipe 10 is raised slightly to extend this latching mechanism and withdraw springs 45 from the groove 23 and to release the core barrel, which may then be circulated to the surface in the drilling fluid.

Turning now to the description of a third embodiment of apparatus which may be employed in this invention, I have shown in Figures 4 and 5 means adapted to latch and unlatch remotely a core barrel in position adjacent a bit. In this embodiment, however, the core barrel is latched in position automatically and unlatched by the action of the core after a predetermined amount of core has been cut and circulated into the core barrel. More specifically, in this apparatus the drill pipe 10 is screwed into a collar 51 having fluid passages or grooves 54. This collar includes at its lower end a shoulder 52, which not only provides means for latching the barrel in position but also produces a restricted fluid passage 53. This restricted fluid passage, as described more fully hereinafter, produces a pressure drop in the drilling fluid sufficient to lift core barrel 13 when the barrel is unlatched and the fluid is circulated upwardly in the drill pipe. A drill bit 57 may be attached to the lower end of drill collar 56 according to usual practice.

The latching devices in this case are associated with the core barrel 13 and consist of two or more latches 58 which are adapted to seat on shoulder 52 to hold the core barrel in position. These latches are rotatably mounted on a pin 59 which is anchored into the core barrel head 60. The latches are urged outwardly by springs or by the weight of trigger 61 through pin 62, which operates in the cams 63 of the latches. A force on the bottom shoe 64 of trigger 61 tends to raise the trigger, contract the latches, and permit the core barrel to move upwardly. Trigger 61 may be raised by either a core striking the shoe 64 or by a fishing device which may latch on fishing spear 65. This fishing spear is provided, however, for use only in an emergency and is not generally employed to unlatch the core barrel, inasmuch as drilling would necessarily have to be discontinued during the time the latching and unlatching device is in the drill pipe. A perforation 66 through the core barrel head 60 provides means for displacing fluid in the barrel ahead of the core and equalizes the pressure on both sides of the head whereby the trigger will not be released prematurely by fluid pressure. In this embodiment core drilling may proceed using reverse circulation of the fluid until the top of the core strikes shoe 64. At this time the trigger 61

is raised, contracting latches 58 and permitting the core barrel to rise by the fluid pressure drop through constricted fluid passage 53 into the drill pipe. This core barrel could also be raised into drill pipe 10 by the force of the cores. Under any circumstance, when the core barrel is displaced into the drill pipe, cups 67 or other packing means seal the annular space between the drill pipe and the core barrel, causing the core barrel to rise in the drill pipe in the manner of a piston to the surface. The core is thus automatically retrieved when the core barrel is full of core, and no time is lost in the drilling operation by lowering an unlatching means into the well.

It may be seen, therefore, that my invention may be practiced with a number of devices embodying generally a core barrel which may be latched in position adjacent the bit to receive the cores during reverse-circulation drilling, and means for remotely releasing the core barrel without materially interrupting drilling operations. The invention should therefore not be construed to be limited to the specific devices disclosed, but only by the scope of the appended claims.

I claim:

1. The method of taking core samples of formations being penetrated by a bit including the steps of flowing a core barrel by direct circulation to a position adjacent the bit, releasably latching said core barrel adjacent said bit, cutting a core and collecting said core in said core barrel while maintaining reverse-circulation drilling, releasing said core barrel and flowing said core barrel containing said sample to the surface of the earth while continuing said reverse-circulation drilling.

2. In a method of taking core samples during drilling operations, the improvement comprising circulating a core barrel to a point adjacent the drilling zone, releasably latching the core barrel in position in the drill stem within the drilling zone, cutting a core sample while maintaining reverse-circulation drilling and displacing said core sample into said core barrel by reverse circulation, remotely releasing said core barrel, and circulating said core barrel containing said core sample to the mouth of the well.

3. A method of sampling formations penetrated by a drill bit comprising the steps of circulating a core barrel to a point adjacent to said drill bit by direct circulation, releasably anchoring said core barrel at said point, establishing reverse-circulation drilling, taking a sample of said formation while conducting said reverse-circulation drilling, remotely releasing the core barrel containing said sample while continuing the reverse-circulation drilling, and flowing said core barrel to the surface by continuing said reverse circulation drilling.

4. In a method of sampling the subterranean formations penetrated by a bit at the end of a drill stem wherein the sample as it is cut is displaced into a core barrel, the improvement comprising maintaining said core barrel in position adjacent the bit during reverse-circulation drilling and remotely releasing said core barrel whereby said sample may be delivered to the surface without materially interfering with drilling operations.

5. A method of sampling the formations penetrated by a bit at the end of a drill stem comprising positioning a core barrel adjacent said bit, cutting a sample of said formation and displacing it into said core barrel by reverse-circu-

lation drilling, remotely releasing said core barrel containing said sample, and raising said core barrel through said drill stem by reverse circulation of the drilling fluid.

6. A method of sampling the formations penetrated by a bit at the end of a drill stem comprising passing a core barrel by direct circulation through said drill stem to a position adjacent said bit, maintaining said core barrel in said position, cutting a sample of said formation and displacing it into said core barrel by reverse-circulation drilling, remotely releasing said core barrel containing said sample, and raising said core barrel through said drill stem by reverse circulation of the drilling fluid.

7. A method of sampling formations penetrated by a bit at the end of a drill stem comprising lowering a core barrel through said drill stem to a position adjacent said bit, rotating said drill stem in one direction to latch said core barrel in said position, cutting a sample of said formation and displacing it into said core barrel by reverse-circulation drilling, rotating said drill stem in the opposite direction to release said core barrel containing said sample and raising same through said drill stem by reverse circulation of the drilling fluid.

8. A method of sampling subterranean formations penetrated by a bit at the end of a drill stem in the process of rotary drilling, comprising lowering a core barrel through said drill stem to a position adjacent said drill bit, cutting a sample of said formation and displacing it into said core barrel, releasing said core barrel by raising said drill stem, and raising said core barrel through said drill stem by reverse circulation of the drilling fluid.

9. A method of sampling formations penetrated by a bit at the end of a drill stem in the process of rotary drilling, comprising lowering a core barrel through said drill stem to a position adjacent said bit, lowering said drill stem to latch said core barrel in said position, cutting a sample of said formation and displacing it into said core barrel by reverse-circulation drilling, raising said drill stem to release said core barrel containing said sample, and raising said core barrel containing said sample through said drill stem by reverse circulation of the drilling fluid.

10. In an apparatus for sampling the formations penetrated by a bit at the end of a rotary drill stem comprising a core bit attached to the lower end of said drill stem to cut a core, a core barrel, a latch for said core barrel at the lower end of said drill stem adjacent said bit, said latch being operable to hold said core barrel at the lower end of said drill stem during reverse circulation drilling; and means for remotely actuating said latch to release said core barrel whereby said core barrel may be lowered through said drill stem and latched in position adjacent said bit by direct circulation during the process of reverse-circulation drilling, and said core barrel containing said sample may be raised hydraulically through said drill stem without materially interfering with drilling operations.

11. An apparatus for sampling formations penetrated by a bit at the end of a rotary drill stem comprising means to latch said core barrel in position adjacent said bit by rotation of said drill stem in a clockwise direction, means to cut a sample of said formation and displace it into said core barrel, and means to release said latching means by rotating said drill stem in a counterclockwise direction whereby said formations may be sampled by reverse circulation drilling and said core barrel containing said sample may be raised to the surface through said drill stem by reverse circulation of the drilling fluid.

12. An apparatus for sampling formations penetrated by a bit at the end of a rotary drill stem comprising a core barrel, a latch adapted to hold said core barrel in position adjacent said bit, cam means adapted to actuate said latch by relative rotation between said drill stem and said bit, a fluid by-pass around said core barrel, a valve in said fluid passage operated by said relative rotation, said valve being adapted to open and said latch being adapted to close by rotation of said drill stem in a first direction, and said valve being adapted to close and said latch being adapted to unlatch when said drill stem is turned opposite to said first direction, whereby said core barrel is retained adjacent said bit during reverse-circulation drilling and is remotely released by rotation of said drill stem to permit said core barrel to be raised through said drill stem to the surface by piston action during reverse circulation of the drilling fluid.

13. An apparatus for sampling formations penetrated by a bit at the end of a drill stem comprising a core barrel, means adapted to latch said core barrel in position adjacent said bit when the weight of said drill stem is placed upon said bit, means to cut a sample of said formation and displace it into said core barrel, unlatching means adapted to release said core barrel from said position by removing the weight of said drill stem from said bit, whereby said core barrel may be lowered to and latched in said position, said sample may be cut by reverse-circulation drilling, and raised to the surface through said drill stem by reverse circulation without materially interfering with drilling operations.

14. In an apparatus for sampling subterranean formations penetrated by a bit at the end of a drill stem comprising a core barrel, said core barrel defining a recess therein, a mandrel connected to the lower end of said drill stem, a sleeve connected to said bit and slidably disposed about said mandrel, projections on said mandrel and on said sleeve adapted to permit limited relative longitudinal movement and to prevent relative rotation between said mandrel and said sleeve, spring catches associated with said mandrel, said catches being adapted to be displaced radially by said sleeve into said recess to hold said core barrel when said mandrel and said sleeve are in a compressed position, whereby said catches are released remotely by raising said drill stem to permit said core barrel to be raised through said drill stem by reverse circulation of said drilling fluid.

RALPH L. HENDRICKSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
473,910	Bullock	May 3, 1892
2,068,762	Pennington	Jan. 26, 1937
2,135,737	Stokes	Nov. 8, 1938
2,277,989	Kinnear	Mar. 31, 1942