United States Patent [19]

Wolda

[11] **3,777,826**

[45] **Dec. 11, 1973**

[54] **FLUID RESPONSIVE CORE BARREL SYSTEM**

[75] Inventor: **Tiete Okke Wolda**, Orillia, Ontario, Canada

[73] Assignee: **Boyles Industries Limited**

[22] Filed: **Sept. 15, 1971**

[21] Appl. No.: **180,596**

[52] **U.S. Cl.** **175/46**, 175/246

[51] **Int. Cl.** **E21b 21/00**

[58] **Field of Search** 175/46, 246, 247, 175/245, 236

[56] **References Cited**

UNITED STATES PATENTS

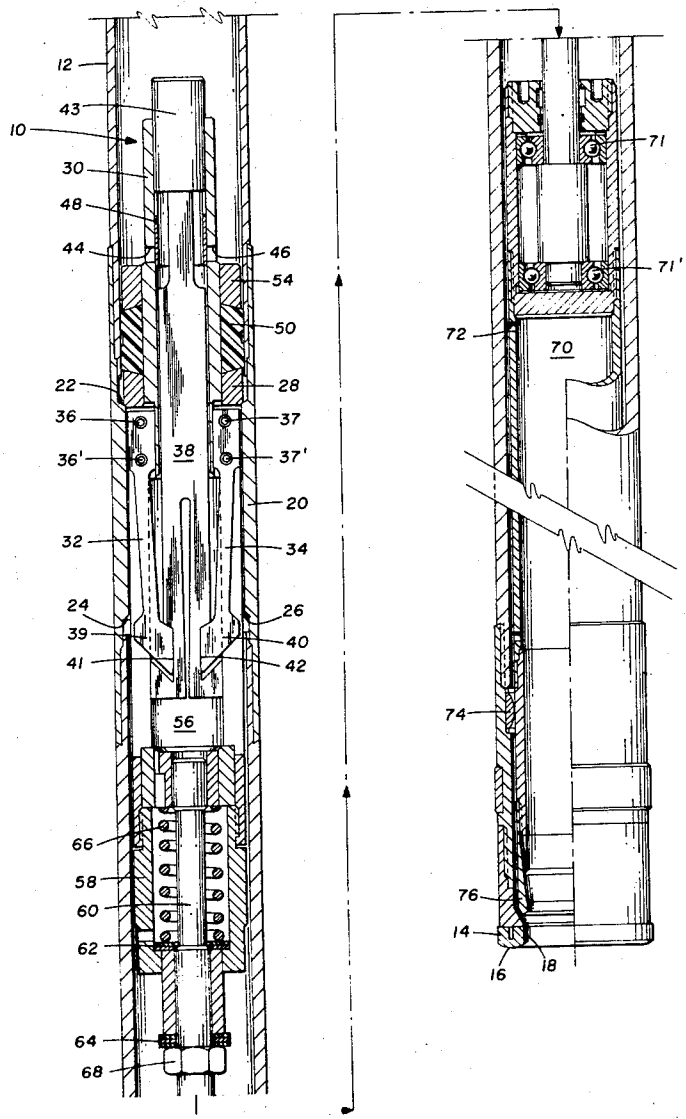
2,585,386	2/1952	Hendrickson	175/247 X
3,120,283	2/1964	Braun	175/246
3,292,717	12/1966	Hall et al.	175/46

Primary Examiner—Marvin A. Champion
Assistant Examiner—Richard E. Favreau
Attorney—Robert W. Mayer et al.

[57] **ABSTRACT**

An improved core barrel system including a single core sampling unit that may be used in up holes or down holes. The unit is pumped through a hollow drill string until a core container in the unit reaches the core receiving position proximate the coring bit, whereupon the unit produces a signal indicating that the unit is in the proper position. A pair of flexible and resilient latch fingers automatically move into latch seats in the drill string and drilling fluid is allowed to bypass the core sampling unit to the bit for the drilling of a core. The core container in the core sampling unit receives the core. When the core container is filled, a signal is produced that indicates the desired length of core sample has been obtained. The core sampling unit with the length of core sample in the core container automatically unlatches and the length of core is broken from the formation by pulling the drill string a short distance out of the hole. The core sampling unit is returned through the drill string by gravity in up holes or by reversing the fluid circulation in down holes and pumping the unit through the drill string.

16 Claims, 4 Drawing Figures



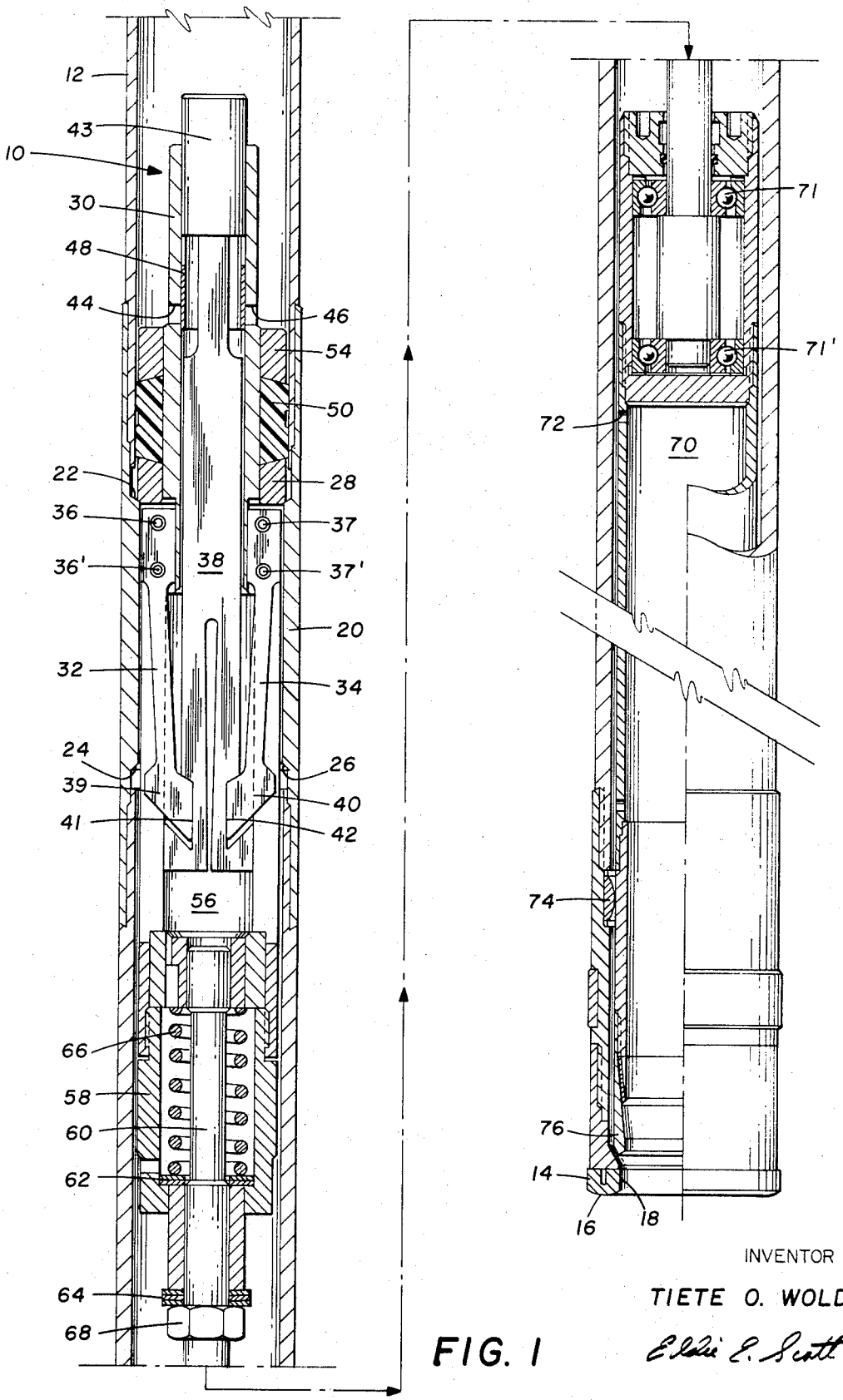


FIG. 1

INVENTOR

TIETE O. WOLDA

Eddie E. Scott

ATTORNEY

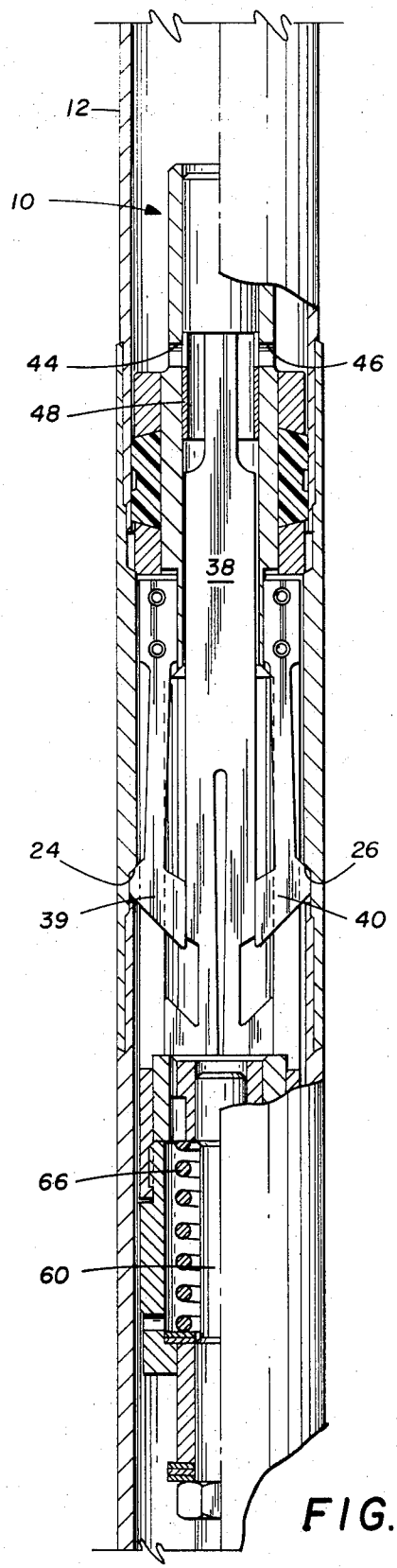


FIG. 2

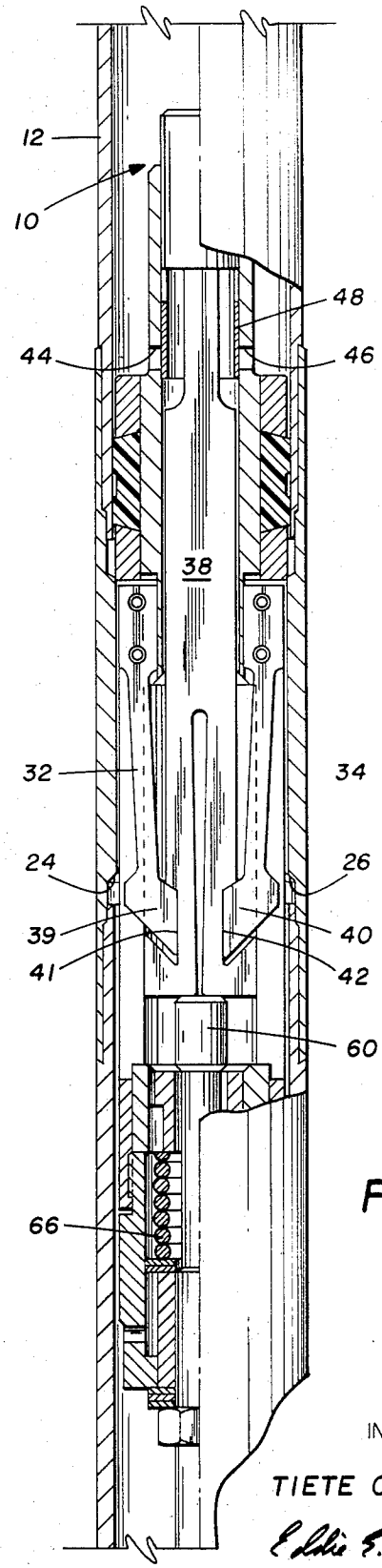


FIG. 3

INVENTOR
TIETE O. WOLDA
Eddie E. Scott
ATTORNEY

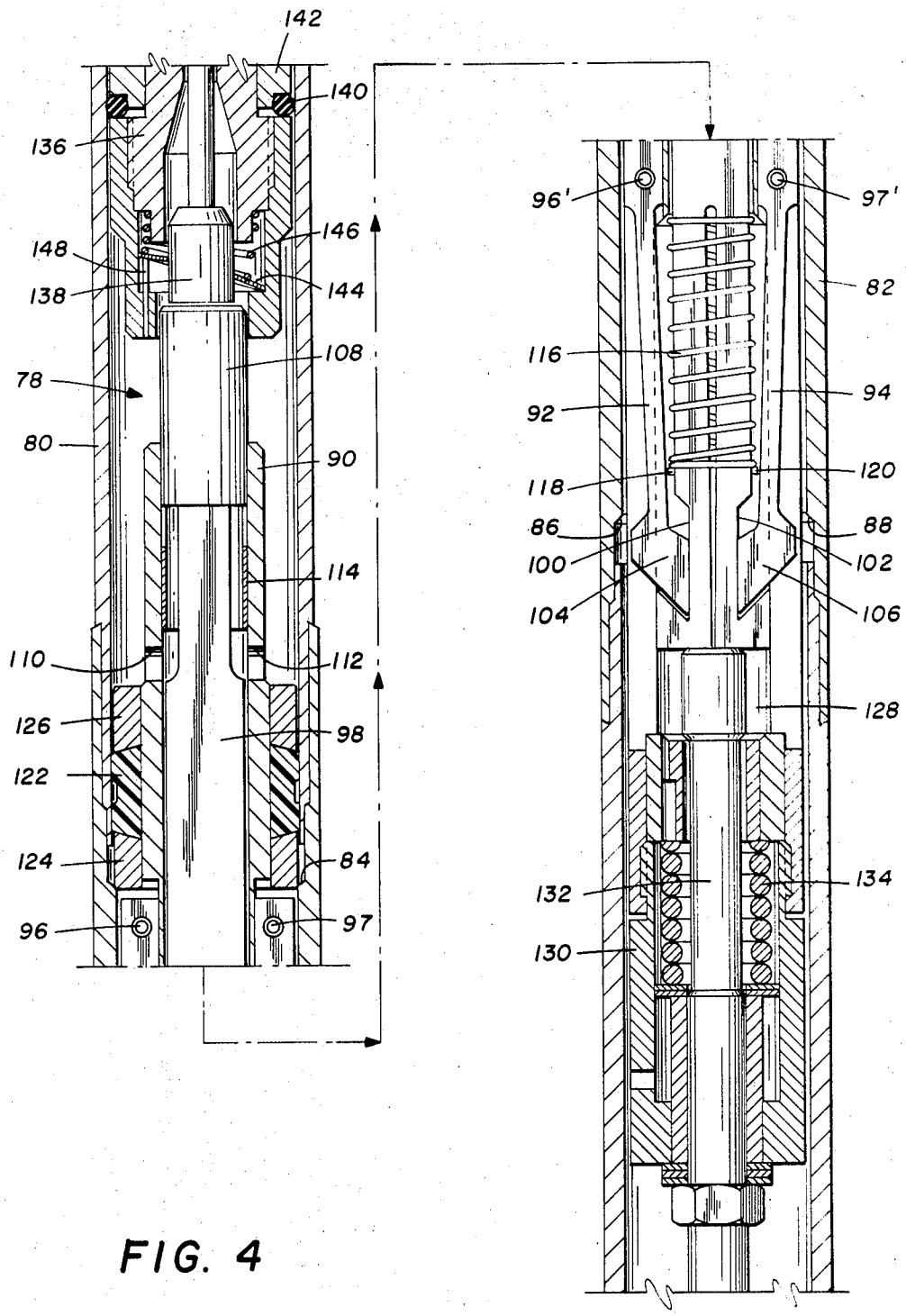


FIG. 4

INVENTOR
TIETE O. WOLDA
Eddie F. Scott
ATTORNEY

FLUID RESPONSIVE CORE BARREL SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to the art of core drilling and more particularly to a system for obtaining a core sample without removing the entire drill string from the borehole.

It is a common practice to take samples or cores of formations to obtain geological information. The cores may be obtained using a hollow rotary drill string or drill stem having a coring bit at the lower end and a core barrel unit positioned within the hollow rotary drill string adjacent the coring bit. In order to obviate the necessity of removing the entire drill string to obtain the core, core barrel units have been developed that may be transported through the drill string. The core barrel unit is moved into position at the inner end of the drill string adjacent the coring bit and locked to the drill string for the core receiving operation. Once the core receiving operation has been completed and the core has been broken, the core barrel unit is unlocked and transported to the outer end of the drill string.

In general, the core drilling operation may be categorized as up drilling or down drilling. The down drilling operation being a conventional drilling operation wherein drilling is downward from horizontal and up drilling being an operation wherein drilling is upward from horizontal such as drilling upward into the formation above a mine. Core drilling operations are often conducted in formations that contain water or other formation fluids and a drilling fluid is generally circulated through the drill string during the operation to cool the bit and flush cuttings and debris from the borehole. It is desirable to use a single core sampling unit for the entire core taking operation and the unit should be adaptable for use in either up holes or down holes. It can be appreciated that the unit must be extremely versatile to perform the required functions under such varying conditions.

Perhaps the single most important requirement of a core barrel system is that it be dependable. The system must operate positively each and every time even though it is subjected to the harsh environmental conditions of the drilling operation. The system should produce a signal when the core sampling unit is properly latched in the coring position to advise the drilling operator that he can begin drilling the core. If the unit is not latched, a signal should also be provided to advise the drilling operator that additional steps should be taken before he begins drilling the core.

A channel must be opened through the unit to allow fluid to pass to the bit during the drilling of the core. Once the core container is filled, the core sampling unit should provide a signal to the operator indicating that the required core sample has been obtained. The core sampling unit must be automatically unlatched from the coring position at the inner end of the drill string and transported to the outer end of the drill string.

DESCRIPTION OF THE PRIOR ART

The prior art core barrel systems have various procedures for transporting the core barrel unit through the drill string. One of the basic core barrel units is lowered into position by a lowering device connected to a wireline. The lowering device disengages the core barrel unit and is retracted. After the core barrel unit has received the desired core sample, a retriever connected to a cable is lowered into the drill string and attached to the unit. The retriever with the core barrel unit in tow is removed from the drill string by drawing on the cable. Another of the basic core barrel systems includes a core barrel unit that is transported through the drill string by fluid pressure from the circulating fluid. The core barrel unit must form a fluid seal with the drill string to allow the fluid pressure of the circulating fluid to act upon the core barrel unit and move it through the drill string.

In U. S. Pat. No. 3,066,748 to J. R. Doherty, patented Dec. 4, 1962, a pumpable core sampling apparatus is shown. A disc on the core sampling apparatus allows it to be pumped into position. After the desired core sample has been obtained, the apparatus is returned by reversing the flow of the fluid medium so that the apparatus and its associated parts can be brought to the surface of the drilling assembly whereby the core sample can be removed and studied or used for any desired purpose.

In U. S. Pat. No. 3,120,282 to A. F. Pickard, patented Feb. 4, 1964, a wireline core barrel is shown that can be hydraulically transported to the bit end of the drill string. The system includes a core barrel inner tube assembly for obtaining a core, an overshot assembly for retracting said core barrel inner tube assembly from the bit end of the drill stem and an overshot release assembly for unlatching the overshot assembly from the core barrel inner tube assembly so that the overshot assembly may be retracted separate from the core barrel inner tube assembly. The core barrel inner tube assembly is provided with means that will allow the fluid for hydraulically propelling it into position to pass through the core barrel inner tube assembly and circulate around the drill bit during the drilling operation.

SUMMARY OF THE INVENTION

The present invention provides a core barrel system that can be used for both up drilling and down drilling. The system includes a single sampling unit that will latch positively into the coring position in the drill string for the core receiving operation and will automatically unlatch when the desired core sample has been obtained. Drilling fluid may be circulated past the unit during the core taking operation. A movable latch on the unit engages a latch seat on the drill string to connect the unit to the drill string during the core taking operation. Once the core sampling unit's core sample container has received the desired core sample, the movable latch is disengaged from the latch seat by a latch actuator in the unit. The core sampling unit includes a seal element that forms a fluid seal with the drill string. A fluid bypass channel is provided to allow drilling fluid to bypass the unit during the core receiving operation and a valve element in the channel allows the channel to be closed to facilitate transportation of the unit through the drill string by fluid pressure.

It is therefore an object of the present invention to provide a core barrel system that can be used for both up drilling and down drilling.

It is a further object of the present invention to provide a core sampling unit that will latch positively in the coring position.

It is a still further object of the present invention to provide a core barrel system that will provide a signal

indicating that the core sampling unit is latched in position for taking a core sample.

It is a still further object of the present invention to provide a core sampling unit that will remain positively latched in position during the core receiving operation.

It is a still further object of the present invention to provide a core sampling unit with a channel for passing fluid by the unit during the core receiving operation.

It is a still further object of the present invention to provide a core sampling unit that will produce a signal indicating that the desired core sample has been obtained.

It is a still further object of the present invention to provide a core sampling unit that will automatically unlatch when the desired core sample has been obtained.

It is a still further object of the present invention to provide a core sampling unit that can be transported through the drill string by fluid pressure.

It is a still further object of the present invention to provide a core sampling unit that can be transported through a drill string to the coring position and withdrawn through the drill string from the coring position without the use of separate transporting units.

It is a still further object of the present invention to provide a core barrel system with relatively few moving parts.

It is a still further object of the present invention to provide a core barrel system that has greater strength and durability than those of the prior art.

It is a still further object of the present invention to provide a core barrel system that is relatively simple and is less expensive to manufacture than those of the prior art.

It is a still further object of the present invention to provide a core barrel system that is easy to service and maintain.

It is a still further object of the present invention to provide a core barrel system that is resistant to corrosion and will operate effectively in the drilling environment.

The above and other objects and advantages will become apparent from a consideration of the following detailed descrip-tion when taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a core sampling unit constructed in accordance with the present invention positioned in a drill string with the latch fingers of the unit opposite latch seats in the drill string.

FIG. 2 shows the upper portion of the core sampling unit shown in FIG. 1 with the latch fingers of the unit latched in position in the latch seats in the drill string.

FIG. 3 shows the upper portion of the core sampling unit shown in FIGS. 1 and 2 after the desired core sample has been obtained and the latch fingers have been automatically unlatched.

FIG. 4 is another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings and in particular to FIG. 1, a core sampling unit generally designated by the reference number **10** is shown positioned within a hollow rotary drill string **12.** The rotary drill string **12** consists of a series of sections of hollow drill pipe connected together to form a drill string. For example, the drill string **12** may be made up of a series of sections of threaded drill pipe connected together end to end. A coring bit **14** is connected to the end of the rotary drill string **12.** The coring bit **14** includes a circular cutting face **16** and a central opening **18.** The cutting face **16** may include any of the cutting structures known in the art, such as diamonds impregnated in a metal matrix. As the drill string **12** and core bit **14** are rotated, the cutting face **16** serves to disintegrate the formations and form a borehole. The central opening **18** in core bit **14** allows a core to build up in the center of the drill string during the drilling operation. In order to obtain geological information about the formation, a section of the core is withdrawn from the borehole using the core barrel system of the present invention.

The core drilling operation may be conducted either up or down from the horizontal and including drilling at any inclination. For example, the core drilling operation may be conducted from the surface by drilling downward into the formations or the core drilling operation may be conducted upward into the formations above a mine. Rotary drilling equipment (not shown) is positioned at the face of the formations through which the drilling operation is to proceed. The rotary drilling equipment supplies both rotary and thrust forces to the drill string and may consist of any of the various rotary drilling machines known in the art. The core drilling operation requires a fluid circulation system for cooling the bit and flushing the cuttings and debris from the borehole. The fluid circulation system includes a hydraulic pump (not shown) connected to the drill string **12.** The hydraulic pump circulates drilling fluid through the interior of the drill string **12** across the face **16** of the coring bit **14** and upward in the annulus between the borehole wall and the exterior surface of the drill string.

In order to obtain a sample of the formations, the core sampling unit **10** is positioned in the outer end of the hollow drill string and transported through the drill string to a position at the inner end of the drill string adjacent the coring bit **14.** The outer end of the drill string is defined as the end near the face of the formations through which the drilling operation is to proceed and the inner end of the drill string is defined as the end with the coring bit. Once the unit **10** is in place and firmly connected to the drill string **12,** drilling fluid must be allowed to bypass the unit **10** to cool the coring bit **14** and flush cuttings and debris from the borehole. After the required core sample has been obtained, the unit **10** must unlatch and be returned through the drill string to obtain the core sample.

The drill string **12** includes a latch and landing shoulder section **20** that is similar to the other sections of the drill string but includes an internal shoulder **22** and a pair of latch seats **24** and **26.** The core sampling unit **10** has been positioned within the drill string **12** and transported through the drill string **12** until a landing ring **28** on the unit **10** has contacted the internal shoulder **22** on the latch and landing shoulder section **20** preventing further movement of unit **10** and suspending the core sampling unit **10** in proper position for receiving a core.

The upper portion of the unit **10** consists of a cylindrical tubular housing **30** somewhat smaller in diameter than the interior of the drill string **12.** A pair of latch fingers **32** and **34** are rigidly affixed to the tubular housing **30** by four mounting pins **36, 36'** and **37, 37'.** The latch fingers **32** and **34** are constructed of a flexible and

resilient material such as spring steel. The latch fingers 32 and 34 are shown in their relaxed position in FIG. 1 allowing the unit 10 to be transported through the drill string.

An actuator 38 is positioned within the tubular housing 30 and adapted to slide therein from a first position where latch elements 39 and 40 on the ends of the latch fingers 32 and 34 respectively fit in recesses 41 and 42 in the side of the actuator 38 to a second position wherein the latch elements 39 and 40 of the latch fingers are forced outward into the latch seats 24 and 26. When the latch elements 39 and 40 are in the latch seats 24 and 26, the latch fingers are in a stressed condition and are held from springing out of the latch seats 24 and 26 into a relaxed condition by the actuator 38. The latch seats 24 and 26 and the latch fingers 32 and 34 cooperate to connect the cylindrical tubular housing 30 of the core sampling unit 10 firmly to the drill string 12.

The upper end of the actuator 38 is connected to a solid cylinder 43 that fits within the tubular housing 30 and closes it upper end. The cylinder 43 and the actuator 38 slide freely within the tubular housing 30 from the said first position to said second position. Actuator 38 has a rectangular cross section throughout its length, thereby leaving a fluid passageway between the wall of cylindrical tubular housing 30 and the surface of actuator 38. A pair of holes 44 and 46 are located in the side of tubular housing 30 to allow fluid from within the drill string 12 to flow through the core sampling unit 10. A valve element 48 is affixed to actuator 38 and moves with actuator 38 to block fluid in the first actuator position or allow fluid to pass in the second actuator position. In the position shown, the actuator is in the first position and valve element 48 blocks the fluid passage.

A ring-shaped packing rubber 50 is mounted on the exterior of tubular housing 30 and provides the core sampling unit 10 with an enlarged diameter to form a fluid seal with the wall of the drill string 12. Adjustment of the size of the enlarged diameter provided by the packing rubber 50 may be accomplished with the landing ring 28 positioned below the packing rubber 50 and a threaded packing nut 54 positioned above packing rubber 50. The packing rubber 50 is squeezed between packing nut 54 and landing ring 28 and the amount of expansion may be varied by adjusting the packing nut 54. The landing ring 28 also forms a landing shoulder on the core sampling unit 10 and coupled with the packing rubber 50 and packing nut 54 provides a cushioning effect when the unit 10 lands upon landing shoulder 22 on the drill string 12.

A pair of elongated extensions 56 of the tubular housing 30 (one on each side of the actuator 38) connect the upper portion of the unit 10 with a spring and spindle housing 58. Positioned within the spring and spindle housing 58 and adapted to slide therein is an elongated spindle 60. Two sets of washers 62 and 64 are affixed to the spindle 60 with washers 62 being inside of housing 58 and washers 64 being outside of housing 58. A spring 66 is positioned within the housing 58 surrounding spindle 60 thereby urging the spindle 60 into its lowest position. The length of stroke of the spindle 60 may be adjusted by a lock nut 68 that engages a threaded portion of spindle 60. A core sample container 70 is rotatably connected to the lower portion of spindle 60. Bearings systems 71 and 71' facilitate rotation of the core container 70. Thus, the core container 70 rotates freely relative to the tubular housing 30 and upward pressure on the core sample container 70 will produce upward movement of spindle 60 acting against the force of spring 66.

The core sample container 70 is positioned adjacent the coring bit 14 during the core receiving operation. A hole 72 in the upper end of the core container 70 allows fluid to exit from the container 70 as the container is filled with the length of core sample and a stabilizer ring 74 holds the core sample container 70 in the proper position for receiving the core as it is drilled. A core lifter 76 in a core lifter case is connected to the lower end of core sample container 70 and serves to retain the core sample within container 70 throughout the core sampling operation.

The structural details of one embodiment of a core sampling unit constructed in accordance with the present invention having been described, the operation of the unit will now be considered with reference to FIGS. 1, 2 and 3. The unit 10 is placed inside the outer end of the rotary drill string 12 and moved into the core receiving position adjacent the coring bit 14. The packing rubber 50 provides a fluid seal between the tubular housing 30 and the interior of the drill string 12 and the holes 44 and 46 are blocked by the valve element 48 when the actuator 38 is in the first position with the latch fingers 32 and 34 in the relaxed position. The core sampling unit 10 may be pumped into the core receiving position by the pressure of fluid acting on the unit 10 and moving from the outer end of the drill string 12 to the inner end of the drill string 12. The packing rubber 50 serves as a cushion to absorb shock when the unit 10 lands upon the landing shoulder 22. Since the landing ring 28 is not affixed to the tubular housing 30, the shock from the core sampling unit 10 striking the landing shoulder 22 is transmitted to the rubber packing 50.

When the unit 10 lands upon the landing shoulder 22, the actuator 38 is in the first position as shown in FIG. 1 and the latch fingers 32 and 34 are in a relaxed condition with the latch elements 39 and 40 in recesses 41 and 42 and away from the wall of the drill string 12. Since the unit 10 completely blocks fluid flow thorugh the drill string with the actuator 38 in the first position wherein valve 48 blocks holes 44 and 46, pumping after the unit 10 has landed in the core receiving position will cause a rapid buildup of pressure in the drill string. This buildup of pressure advises the operator that the core sampling unit 10 is located adjacent the coring bit 14. The fluid pressure will continue to rise until a sufficient force is applied to the exposed portions of cylinder 43 and actuator 38 to force actuator 38 downward and overcome the resistance of latch fingers 32 and 34. Once the required pressure is reached, the force on actuator 38 moves the latch elements 39 and 40 outward into the latch seats 24 and 26, thereby bending and stressing latch fingers 32 and 34. The amount of fluid pressure, i.e., the force on cylinder 43 and actuator 38 required to deform latch fingers 32 and 34, is a function of the inclination of the actuator surface engaging the latch fingers and their material strength. The latch fingers 32 and 34 are not stressed or bent beyond their elastic limits and will spring back to their relaxed position once actuator 38 is returned to the first position. With the actuator 38 in the second position as shown in FIG. 2, the latch elements 39 and 40 are in the latch

seats 24 and 26 and the valve element 48 has moved away from holes 44 and 46 thereby allowing fluid in the drill string 12 to circulate through the core sampling unit 10 and the pressure of fluid in the drill string drops. The operator will notice the decrease in pressure and know that it is time to begin drilling the core. Therefore, the core barrel system of the present invention will provide a predetermined pressure signal indicating latching of the core sampling unit. If the latch elements 39 and 40 do not latch in place, the pressure increases beyond a predetermined pressure value and the operator knows that the core sampling unit 10 is not latched in place and can take proper action.

With the unit 10 locked in the core receiving position adjacent the coring bit 14 as shown in FIG. 2, the core taking operation is ready to proceed. The drill string 12 is rotated and a length of core begins to build up through the center opening 18 of the coring bit 14 and into the core container 70. The fluid in the core container 70 is forced upward and will exit through the hole 72 into the drill string 12. Drilling fluid is circulated through the drill string 12 and core sampling unit 10 during the coring operation to cool the coring bit 14 and flush drill cuttings and debris from the well bore. The latch elements 39 and 40 are locked in the latch seats 24 and 26 and the core container 70 is held firmly in position for receiving the core.

When the core container 70 is completely filled with a length of core, an upward force is applied to the core container 70. This upward force is transmitted to spindle 60 causing it to move upward until it contacts the lower end of actuator 38. Actuator 38 is moved upward until the valve element 48 is again in a position blocking holes 44 and 46. This prevents fluid from bypassing the core sampling unit 10 and a pressure signal is transmitted to the operator. Since the actuator 38 has been returned to the first actuator position, the latch elements 39 and 40 move out of latch seats 24 and 26 and into the recesses 41 and 42 in the actuator 38 as shown in FIG. 3. With the latch fingers 32 and 34 in their relaxed position, the core sampling unit 10 is ready to be transported through the drill string 12. The length of core is broken from the formation by lifting the drill string 12 a short distance in the borehole. The core lifter 76 and the core lifter case grip the length of core and the core lifter 76 and the core lifter case move relative to the drill string until they contact the drill string 12 at the coring bit 14. Upward force is then transmitted through the drill string 12 and core lifter 76 directly to the length of core and the length of core is broken from the formation. Thus, the core sampling unit 10 has automatically unlatched from the core taking position once the desired length of core has been received. The valve element 48 has been moved to a position blocking holes 44 and 46, the length of core has been broken from the formation and the unit 10 may be transported to the outer end of the drill string 12 by reversing circulation of the fluid. Fluid is pumped down through the annulus between the outer surface of the drill string 12 and the borehole and upward through the opening 18 in the drill bit 14. The fluid continues through the center of the drill string 12 and acts on the core sampling unit 10. The unit 10 is thereby moved along the drill string 12 from the inner end to the outer end. In up holes, the unit 10 may be transported from the inner end of the drill string to the outer end by draining the fluid from the drill string below the unit 10 and allowing gravity to move the core sampling unit to the outer end of the drill string.

Under certain circumstances, it may be desirable to retrieve the core sampling unit by an overshot or retriever. In down holes under certain circumstances, it may be undesirable to reverse the circulation of the drilling fluid to pump the core sampling unit to the outer end of the drill string. Reversing circulation of the drilling fluid may cause the borehole to cave in and/or result in drill cuttings and debris being forced upward into the interior of the hollow drill string thereby damaging certain elements of the drilling system. Certain core drilling operations include a high risk of the sampling unit becoming lodged in the drill string and it may be desirable to be able to withdraw the core sampling unit by means other than pumping the unit out of the drill string. An embodiment of the present invention that includes an element on the upper end of the core sampling unit for connecting the unit to an overshot or retriever device is shown in FIG. 4. The core sampling unit, generally designated by the reference number 78, is shown positioned in a hollow rotary drill string 80. The hollow rotary drill string includes a latch and landing shoulder section 82 with an internal shoulder 84 and a pair of latch seats 86 and 88.

The upper portion of the core sampling unit 78 consists of a cylindrical tubular housing 90 somewhat smaller in diameter than the interior of the drill string 80. A pair of latch fingers 92 and 94 are rigidly affixed to the tubular housing by four mounting pins 96, 96' and 97, 97'. The latch fingers 92 and 94 are constructed of a flexible and resilient material such as spring steel. A movable actuator 98 is positioned within the tubular housing 90 and adapted to slide relative to the housing 90. The actuator 98 includes a pair of recesses 100 and 102 that receive the latch elements 104, 106 of the latch fingers 92 and 94. The length of the recesses 100 and 102 is longer than the length of the latch elements 104,106 thereby allowing the actuator 98 to slide relative to the latch fingers 92 and 94 when the latch elements 104 and 106 are in the recesses. The significance of this movement will become apparent as this description proceeds. The actuator 98 and the latch fingers 92 and 94 function in a manner similar to that of the embodiment shown in FIGS. 1, 2 and 3. When the actuator 98 is moved downward, the latch elements 104 and 106 are moved outward into the latch seats 86 and 88. When the latch elements 104 and 106 are in the latch seats 86 and 88, the latch fingers are in a stressed condition and are held from springing out of the latch seats 86 and 88 by the actuator 98. The latch seats 86 and 88 and the latch fingers 92 and 94 cooperate to connect the cylindrical tubular housing of the unit 78 firmly to the drill string during the core receiving operation.

The upper end of the actuator 98 is connected to a solid cylinder 108 that fits within the tubular housing 90 and closes its upper end. The cylinder 108 and the actuator 98 slide freely within the tubular housing 30. Actuator 98 has a rectangular cross section throughout its length, thereby leaving a fluid passageway between the wall of the cylindrical tubular housing 90 and the surface of the actuator 98. A pair of holes 110 and 112 are located in the side of tubular housing 90 to allow fluid from within the drill string 80 to flow through the core sampling unit 78. A valve element 114 is affixed to the actuator 108 and moves with actuator 108 to ei-

ther block or open a passage through the holes **110** and **112.** When the actuator **98** is moved to its lowest position, the valve element **114** is in a position blocking the holes **110** and **112** and the latch elements **104** and **106** have been forced outward into the latch seats **86** and **88** and out of the recesses **100** and **102.** When the actuator **98** is moved upward, the latch elements **104** and **106** spring back into the upper portion of the recesses **100** and **102.** When the actuator **98** is in this position, the valve element **114** is still in a position blocking the holes **110** and **112.** A spring **116** is positioned around the actuator **98** with its upper end against the bottom of the tubular housing **90** and its lower end connected to the actuator **98** by a pair of pins **118** and **120.** The spring **116** urges the actuator **98** downward relative to the tubular housing **90** so that the latch elements **104** and **106** remain in the upper portion of recesses **100, 102** and the valve element **114** remains in a position blocking the holes **110** and **112.** This allows the core sampling unit **78** to be pumped through the drill string **80** in either direction. The actuator **98** can be moved upward against the force of the spring **116** thereby allowing the latch elements **104** and **106** to slide to the lower portion of the recesses **100** and **102** and the valve **114** to move upward above the holes **110** and **112,** thereby opening a fluid passage through the unit **78.** This operation will be discussed subsequently.

A ring shaped packing rubber **122** is mounted on the exterior of tubular housing **90** and provides the unit **78** with an enlarged diameter to form a fluid seal with the wall of the drill string **80.** Adjustment of the size of the enlarged diameter provided by the packing rubber **122** may be adjusted by a backup ring **124** positioned below the packing rubber **122** and a threaded packing nut **126** positioned above packing rubber **122.** The packing rubber **122** is squeezed between packing nut **126** and backup ring **124** and the amount of expansion may be varied by adjusting the packing nut **126.** The backup ring **124** forms a landing shoulder on the core sampling unit **78** and coupled with the packing rubber **122** and packing nut **126** provides a cushioning effect when the unit **78** lands upon the internal shoulder **84** on the drill string **80.**

A pair of elongated extensions **128** of the tubular housing **90** (one on each side of the actuator **98**) connect the upper portion of the core barrel **78** with a spring and spindle housing **130.** The spring and spindle housing **130** is constructed in the same manner as the spring and spindle housing shown in FIGS. **1, 2** and **3.** A spindle **132** positioned within the spring and spindle housing **130** connects the upper portion of the core sampling unit **78** to a core sample container (not shown). The core sample container is constructed in the same manner as that shown in FIG. **1** and is rotatably connected to the spindle **132.** When the core container has received the desired length of core sample, it will begin moving upward relative to the tubular housing **90** forcing spindle **132** upward against the force of spring **134.** The upper end of the spindle **132** contacts the lower end of the actuator **98** and moves the actuator **98** upward, allowing the latch elements **104** and **106** of the latch fingers **92** and **94** to spring back into recesses **100** and **102.** The latch element **114** has meanwhile moved into a position blocking the holes **110** and **112.** The spring **116** keeps the valve element **114** in a position blocking the holes **110** and **112** thereby allowing the core sampling unit **78** to be pumped to the outer end of the drill string **80** if desired. However, if it is desirable to retrieve the core sampling unit **78** by a wireline, a retriever **136** can be moved into position grasping a gripping element **138** connected to the cylinder **108** that is affixed to the upper end of the actuator **98.**

The retriever **136** is connected to a cable (not shown) and is adapted to be transported through the drill string **80.** An O-ring seal **140** is positioned around the body of the retriever **136** and moved into a sealing position by a movable element **142** on the retriever body **136.** The O-ring seal **140** forms a fluid seal with the drill string **80** and the retriever **136** may be pumped into contact with the core sampling unit **78.** When the retriever **136** is pulled upward, the movable element **142** moves relative to the body **136** of the retriever and the O-ring seal **140** contracts, allowing fluid to bypass the retriever **136.** A latching washer **144** is positioned in the lower end of the retriever **136.** A spring **146** urges the latching washer **144** downward. A pin **148** holds one side of the latching washer **144** against the downward force of the spring **146.** The gripping element **138** moves through the central opening of latching washer **144** when the retriever **136** contacts the core sampling unit **78.** The latching washer **144** is canted on the gripping element **138** and a firm engagement is established between the retriever **136** and the unit **78.** The core sampling unit **78** may then be drawn upward by the cable (not shown). The upward pull on the cable is transmitted through the retriever **136,** the gripping element **138** and the cylinder **108** to the actuator **98.** This causes the actuator **98** to move upward against the force of spring **116** and the gripping elements **104** and **106** move to the lower portion of the recesses **100** and **102.** The valve element **114** is moved upward above the holes **110** and **112,** thereby forming a passage through the core sampling unit **78** and allowing fluid standing in the drill string **80** to bypass the retriever **136** and core sampling unit **78.**

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a system for obtaining a core sample that includes a hollow string extending into a bore hole, a coring bit connected to said drill string and a latch seat in said drill string; a core sampling unit comprising:

a sampling unit body;

a core sample container connected to said body;

at least one flexible and resilient latch finger carried by said body for selectively connecting said body to said latch seat in said drill string, said at least one flexible and resilient latch finger including a movable latch element adapted to move into or out of said latch seat;

actuating means carried by said body for contacting said at least one flexible and resilient latch finger and moving said latch element into said latch seat thereby bending and stressing said at least one flexible and resilient latch finger and for moving said latch element out of said latch seat thereby allowing said at least one flexible and resilient latch finger to return to an unstressed condition; and

means connected to said core sample container for contacting said actuating means and causing said actuating means to move the latch element from said latch seat when said core sample container has received the core sample thereby allowing said at

least one flexible and resilient latch finger to return to an unstressed condition.

2. The system of claim 1 including a seal element mounted on said body that form a fluid seal between said body and said drill string, a fluid passage through said body to allow fluid to flow through said body and valve means in said fluid passage for blocking and unblocking the fluid passage.

3. A system for obtaining a length of core sample from a formation that is penetrated by a borehole with a hollow string extending into the bore hole wherein the hollow string includes a coring bit connected to the drill string and a latch seat on the drill string, comprising:

a core sampling unit that will fit within said drill string;

means for moving said core sampling unit through the hollow drill string to a positIon proximate the coring bit;

at least one flexible and resilient latch finger in said core sampling unit for latching the unit to said drill string;

actuating means carried by said sampling unit for contacting said at least one flexible and resilient latch finger, bending and stressing said at least one flexible and resilient latch finger and latching the core sampling unit to said drill string;

a core sample container connected to said core sampling unit for receiving a length of core sample;

means responsive to the core sample container being filled with said length of core sample for contacting said actuating means and causing said actuating means to disconnect said core sampling unit from said drill string; and

means for moving said core sampling unit, said core sample container and said length of core sample through said drill string to obtain the length of core sample.

4. The system of claim 3 including means for providing a signal if the core sampling unit fails to latch to the drill string.

5. The system of claim 3 including means for providing a signal indicating that the core sample container has been filled with said length of core sample.

6. The system of claim 3 including means for providing a signal indicating that the core sampling unit is latched to the drill string.

7. The system of claim 6 including means for providing a channel to pass fluid by the core sampling unit when the core sample container is receiving said length of core sample.

8. The system of claim 7 wherein said means for latching said core sampling unit to said drill string includes a movable latch element adapted to move into or out of said latch seat.

9. The system of claim 8 wherein said means responsive to the core sample container being filled by said length of core sample includes a latch actuator that causes said latch element to move out of said latch seat when said core sample container is filled with said length of core sample.

10. A core sampling unit for obtaining a core sample from a formation penetrated by a bore hole by the core sampling unit being transported through a holloW drill string that extends into the bore hole until it reaches a coring bit at the end of the drill string and is latched to a latch seat on the drill string during the drilling of a core and is returned through the drill string to obtain the core sample, comprising:

a sampling unit body;

a core sample container connected to said body, said core sample container including an internal cavity for receiving core sample;

at least one flexible and resilient latch finger carried by said body for selectively connecting said body to said drill string, said at least one flexible and resilient latch finger including a movable latch element adapted to move into or out of said latch seat;

actuating means carried by said body for contacting said at least one flexible and resilient latch finger and selectively moving said latch element into said latch seat thereby bending and stressing said at least one flexible and resilient latch finger or moving said latch element out of said latch seat thereby allowing said at least one flexible and resilient latch finger to return to an unstressed condition; and

means connected to said core sample container for contacting said actuating means thereby causing said actuating means to move the latch element out of said latch seat when the core sample has filled the cavity in the core sample container thereby allowing said at least one flexible and resilient latch finger to return to an unstressed condition.

11. The core sampling unit of claim 10 including a seal element on said sampling unit body that forms a fluid seal be-tween said body and said drill string, a fluid passage through said body to allow fluid to flow through said body and valve means in said fluid passage for blocking and unblocking the fluid passage.

12. The core sampling unit of claim 11 including means connected to said sampling unit body for moving said valve means to block said fluid passage when the sampling unit body is being transported through the drill string and for unblocking said fluid passage when the sampling unit body is connected to the drill string.

13. The core sampling unit of claim 12 including means on said sampling unit body for connecting a retriever to the body and means for moving said valve means to unblock said fluid passage when the core sampling unit is being retrieved.

14. The core sampling unit of claim 13 wherein said at least one flexible and resilient latch finger includes an upper portion rigidly affixed to the sampling unit body with the remainder of said finger extending toward said core sample container.

15. The core sampling unit of claim 14 wherein said valve means is connected to said actuating means and wherein said sampling unit body includes a spring connected to said actuating means for maintaining the actuating means and the valve means in a position where the valve means blocks said fluid passage thereby allowing the core sampling unit to be transported through the drill string by fluid pressure.

16. The core sampling unit of claim 15 wherein said means for connecting a retriever to the sampling unit body is affixed to the actuating means and acts against said spring to move the actuating means and the valve means to a position where the valve means unblocks said fluid passage when the core sampling unit is being retrieved.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,777,826 Dated December 11, 1973

Inventor(s) Tietie Okke Wolda

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 2, line 2, change "form" to -- forms --.

Signed and sealed this 16th day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.

3