June 22, 1954 J. N. GREGORY 2,681,795

SAMPLING SUB WITH REMOVABLE CUTTING COLLECTOR

Filed Aug. 14, 1950 2 Sheets-Sheet 1

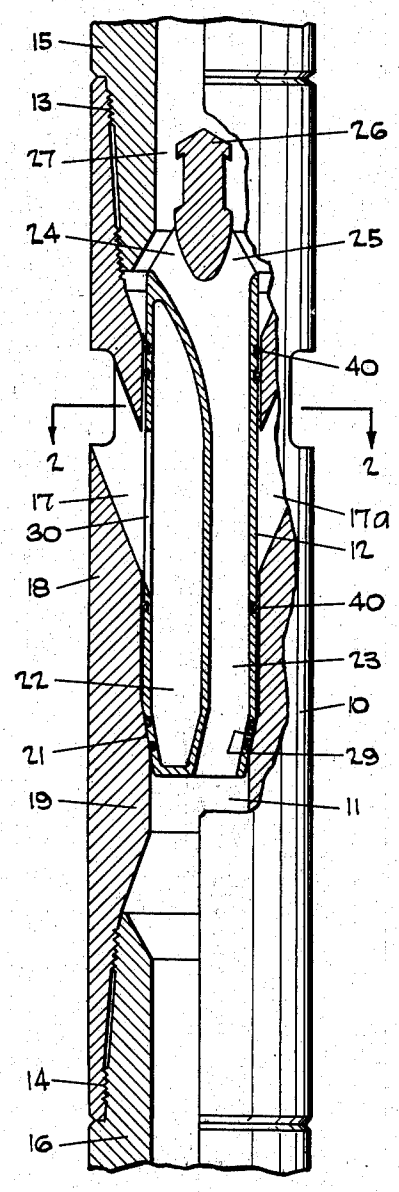


FIG. 1

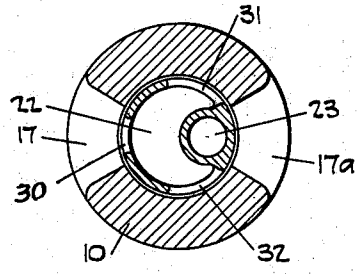


FIG. 2

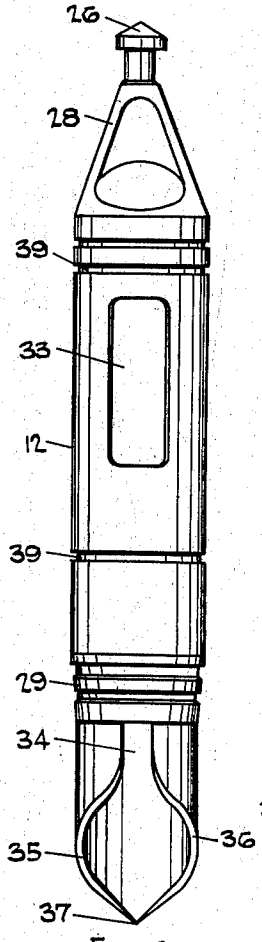


FIG. 3

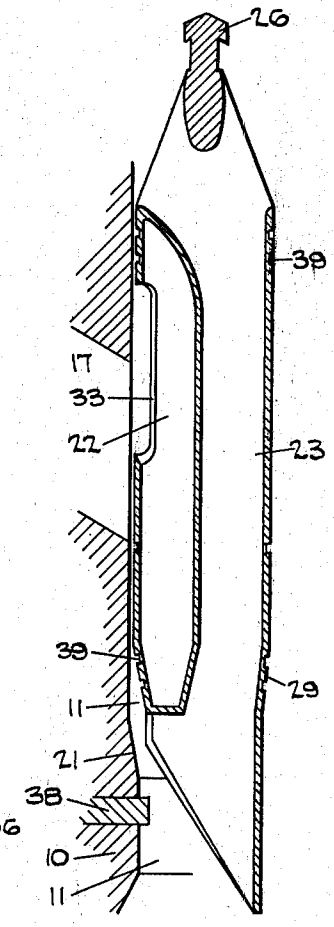


FIG. 4

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SAMPLING SUB WITH REMOVABLE CUTTING COLLECTOR

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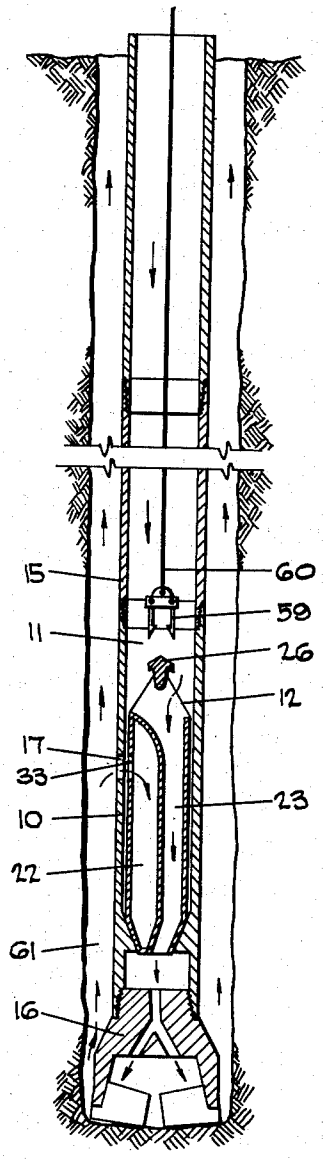


FIG. 5

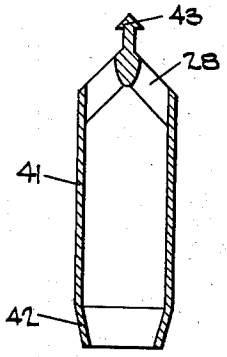


FIG. 7

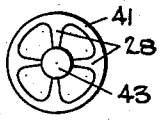


FIG. 8

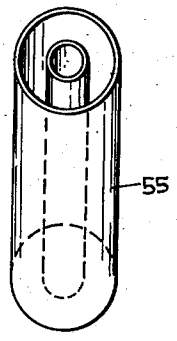


FIG. 9

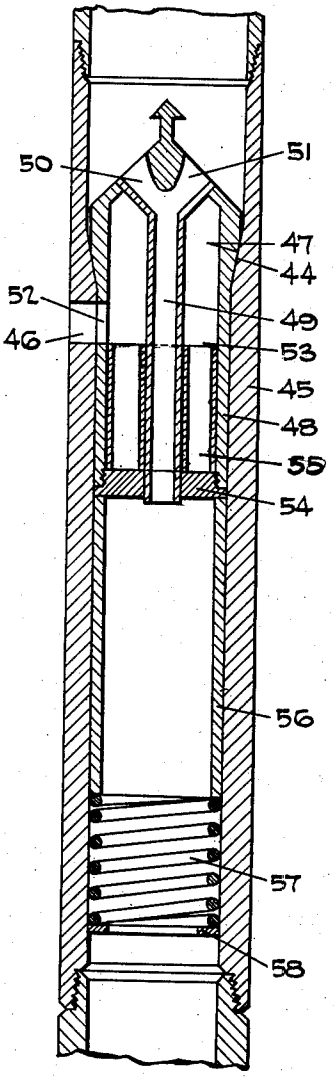


FIG. 6

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UNITED STATES PATENT OFFICE

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SAMPLING SUB WITH REMOVABLE CUTTING COLLECTOR

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9 Claims. (Cl. 255—1.4)

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The present invention relates to apparatus for drilling and logging wells and pertains more particularly to apparatus for collecting samples of formation cuttings from a stream of drilling fluid at a point near a drill bit during rotary drilling.

During well drilling operations, a well may be logged by studying the earth cuttings as they return to the top of the well in the circulating stream of drilling fluid. The fluid is either run through a screen upon which the cuttings are collected, or a sample of fluid is periodically taken from the drilling fluid stream, ditch or pit, and the cuttings contained therein are later separated from the fluid in a laboratory. The main disadvantages of collecting samples of bit cuttings at the top of the well is that the cuttings are generally small in size and have been contaminated by being carried in the stream of drilling fluid for as long as an hour or more. It is furthermore difficult to correlate the cuttings with the particular depths to which they belong.

Thus, in order to obtain relatively large, uncontaminated samples of the formation being traversed by a bore hole, it is generally necessary to resort to bottom-hole or side-wall coring. These methods of coring, while normally adequate, result in considerable lost operating time in that drilling operations must be stopped while a core is taken. Additionally, side-wall samples obtained by conventional apparatus are often inadequate for microfaunal determination because microfauna specimens occur in streaks which are often missed by taking spot core samples.

Sampling devices for obtaining bit cuttings from the bottom of a borehole have the common fault of being fixedly secured to the lower portion of a drill string, necessitating the shutting down of drilling operations and the raising of the entire drill string to the surface in order to remove the cuttings from the sampling device.

It is therefore a primary object of the present invention to provide apparatus for continuously obtaining samples of relatively large size bit cuttings from the circulating drilling fluid.

It is also an object of this invention to provide apparatus for continuously obtaining uncontaminated samples of earth or cuttings near the bottom of a borehole directly after they are washed away from the drill bit.

Another object of this invention is to provide a removable sampling device for continuously receiving bit cuttings in one portion of the device while permitting the flow of drilling fluid through another portion thereof.

These and other objects of this invention will

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be understood from the following description of the invention as shown in the accompanying drawing, wherein:

Figures 1 and 6 are views, partly in cross section, of two embodiments of the present apparatus, comprising a sampling device positioned in a special sub or section of a drill string.

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1.

Figure 3 is an elevation view of another embodiment of the present sampling device.

Figure 4 is a view in the longitudinal or vertical cross section of the device of Figure 3.

Figure 5 is a view, taken in cross section, illustrating the present sampling device and its associated sub positioned in a drill string at the bottom of a well borehole.

Figure 7 is a view in cross section of a sleeve adapted to be lowered into the special sub in place of a sampling device.

Figure 8 is a top view of the sleeve illustrated in Figure 7.

Figure 9 is an isometric view of one embodiment of a removable liner adapted to fit within the chamber of a sampling device.

Referring to Figure 1 of the drawing, the present sampling apparatus comprises an elongated tubular member 10 adapted to receive and anchor in its bore 11 a sampling device or cutting collector 12. The tubular member 10, otherwise known as a sub or short section of drill pipe or drill collar, is threaded at its upper and lower ends 13 and 14, respectively, whereby the upper end 13 may be connected to a section of drill string or a drill collar 15, as shown in Figure 5, and the lower end 14 may be connected to another section of the drill string or to a bit 16. The special sub 10 is preferably connected into the drill string 15 directly above a wall scraper or drill bit 16, as shown, but it is to be understood that the present sub may be connected between any two sections of the drill string.

The tubular member 10 is provided with one or more slots or ports 17 and 17a through the wall 18 thereof to permit earth cuttings to enter the bore 11. Preferably, the axis of the slot 17 slants downwardly to permit any cuttings entering the slot 17 to slide into the bore 11. However, the walls of the slot may have any other slant (or may extend horizontally, as shown in Fig. 5). Preferably, the slot 17 is located near the upper end of the sub 10 and may be of any size desired. However, the slot opening should have an area of several times the size of the cuttings which it is desired to collect.

The axial bore 11 may be of substantially the same diameter as the bore of the drill string 15 and has a constriction 19 which forms annular shoulder 21, beveled downwardly, whose function will be described hereinafter. Obviously, the shoulder 21, or an equivalent shoulder 44, may be located either above or below the slot 17 as shown in Figures 1 and 6, respectively.

The sampling device or cutting collector 12 comprises a cylindrical member containing a chamber 22 in which earth cuttings may be collected. The cross-sectional area of the chamber 22 generally constitutes a major portion of the cross-sectional area of the entire collector 12, as shown in Figure 2. Extending axially through the collector body 12 is a channel or by-pass conduit 23 through which a drilling fluid, passing downwardly through the drill string 15 (Fig. 5), may be delivered to the cutting tool 16 during drilling operations. The conduit 23 may be arranged in any desired manner within the collector body 12, either eccentrically as shown in Figures 1 and 2, or concentrically as shown in Figure 6. Also, if desired, the upstream end of the conduit 23 may have more than one inlet port, as shown at 24 and 25 in Figure 1.

The upper end of the collector body 12 is provided with an upwardly-extending fishing neck 26 which projects into the bore 27 of the drill string 15. The fishing neck 27 may be secured to the collector body 12 by a plurality of spaced lugs 28 as shown in Figure 8.

The outside wall of the collector body 12 is decreased in diameter along a portion thereof to form an annular shoulder 29 which engages and is supported by the shoulder 21 on the inner wall of the sub 10, thereby supporting the collector body 12 within the tubular member 10. The collector body 12 is also provided with one or more windows 30, 31 and 32 which are of such dimensions and are so disposed in the wall of the collector body 12 that at least one of them is always in register with at least one of the slots 17 and 17*a* in the sub 10 (Figures 1 and 2), whereby earth cuttings may pass through said slots and windows into chamber 22.

In another embodiment of the present invention (Figures 3 and 4), the sub 10 and the cutting collector 12 may be provided with a single slot 17 and a single window 33, respectively. When a cutting collector 12 is provided with a single window 33, it is necessary to provide suitable orienting means for aligning the collector 12 within the sub 10 so that the windows of each are in register. Hence, the body of the cutting collector 12 may be provided with a longitudinal slot or keyway 34 from which diverging shoulders 35 and 36 slant downwardly and meet at a point 37. An alignment pin or key 38 is fixedly mounted in the sub body 10 so that it projects horizontally a short distance into the bore 11 thereof. As the collector 12 is lowered into the sub body 10, the projecting pin 38 will engage a point on either shoulder 35 or 36. Thereupon, the pin 38 will ride up the shoulder 35 or 36 and cause the collector 12 to rotate in the bore of the sub 10 until the pin 38 and slot 34 are in vertical alignment. In this position the windows 17 and 33 in the sub 10 and collector 12, respectively, are in register.

In order to secure a more fluid tight seal between the cutting collector 12 and the inner wall of the sub 10, one or more annular grooves 39 (Fig. 1) may be cut or formed in the outer surface of the collector 12 to accommodate rings 40 of any suitable packing material. Generally, however, an adequate seal is provided at the point where the two shoulders 21 and 29 are in contact.

During drilling operations when no sampling of cuttings is desired, the cutting collector 12 may be removed and replaced with a suitable plug or closure means for closing the slots 17 and 17*a* in the sub, whereby a drilling fluid being circulated down the drill string 15 will not by-pass the bit and flow out the slots 17 and 17*a*. As shown in Figures 7 and 8, one embodiment of a slot closure means may comprise a tubular member or closure sleeve which is decreased in diameter near the lower end thereof to form an annular shoulder 42 which is adapted to engage the shoulder 21 on the inner wall of the sub 10 (Fig. 1). The length of the tubular member 41 is such that the top of said member extends above the slots 17 and 17*a*, effectively closing them. The upper end of the closure sleeve 41 is provided with a fishing neck 43 secured thereto by a plurality of spaced lugs 28.

It is realized that various changes and modifications may be made in the elements described herein without departing from the principles of this invention. Another embodiment of the invention is illustrated in Figure 6. Here, a seating shoulder 44 is provided on the inner wall of the sub 45 above a slot 46 in the wall thereof, rather than below the slot as shown in the embodiment of Figure 1. At the same time, a cooperating shoulder 47 is formed near the top of a cutting collector 48 rather than near the bottom thereof. This arrangement permits an effective seal to be formed between the sub 45 and collector 48 above the slot 46, thus eliminating the rings of packing 38, shown in Figure 1.

The cutting collector 48 is provided with an axial fluid by-pass 49 having two inlet ports 50 and 51. Thus, an annular collecting chamber 53 is formed within said collector 48. Cuttings enter the chamber 53 through a window 52 in the wall of the collector 48. The bottom of the chamber 53 is closed by a removable plate 54 which is secured in any suitable manner, as in screw-threaded engagement, to the bottom of the collector 48. By removing the plate 54, the collected cuttings may be readily removed from the chamber 53. If desired, the collector may be equipped with a removable liner 55 (Fig. 9), having an open top and a closed lower end. The liner is formed of a thin material shaped to fit within the annular chamber 53. While a thin metallic liner 55 may be used, it is preferably made of a transparent plastic material whereby the different layers of cuttings, collected from the various strata traversed by the drill bit, may be visually inspected before removing them from the liner. The layers of cuttings in the liner 55 will be arranged in the inverse order in which the strata are penetrated.

For closing the slot 46 in the sub 45 when the cutting collector 48 is removed therefrom, the sub is provided with a slidable sleeve 56 mounted above a compression spring 57 in the bore of said sub 45. The spring 57 is limited in its downward movement by a holding ring 58 which is fixedly secured, as by welding, to the inner wall of the sub 45. As the cutting collector 48 is lowered into the sub 45, the weight of the collector 48 forces the sleeve 56 downwardly to compress the spring as illustrated in Figure 6. Upon removal of the collector 48, the spring 57 forces the sleeve upwardly until it is positioned opposite the slot 46, effectively closing it.

At any time during drilling operations, when a drill string 15 (Fig. 5) is made up, the special

sub 10 may be connected into the spring, preferably directly above the bit 16. When no bit cuttings are being collected, the slot 33 may be closed by the sleeve 41 (Fig. 7) which may be dropped or lowered down the drill string 15 and into the sub 10. Before taking samples of the cuttings, a suitable fishing device 59 (Fig. 5) is lowered on a cable 60 into contact with the fishing head 43 (Fig. 7). The fishing device 59 latches onto the head 43 and the sleeve 41 is withdrawn from the well on the end of the cable.

The cutting collector 12 is then lowered by cable or dropped through the drill string 15 and into position in the sub 10, as shown in Figure 5. If a cable 60 is employed to lower the collector 12, the cable is withdrawn to the surface before drilling operations are resumed. Drilling fluid being circulated down the drill string 15 passes through the fluid by-pass 23 in the collector 12, through the bit 16, and up the annular passageway 61 between the drill string 15 and the wall of the borehole.

The present cutting collector 12 operates on the principle that the velocity of the circulating fluid rising in the annular passageway 61 is reduced when the fluid passes the slots 33 and windows 17 in the sub 10 and collector 12, respectively. The resulting decrease in the circulating fluid velocity together with the turbulence created by the slots reduces the carrying power of the circulating fluid. The earth cuttings, especially the larger and more desirable ones, are thrown out of the mud stream and into the chamber 22 of the collector 12. The collected cuttings may be raised to the surface of the well along with the collector 12, by a fishing tool 59 at the end of a cable 60, in a manner similar to that described above for removing a sleeve 41.

I claim as my invention:

1. Apparatus for collecting earth cuttings from mudflush circulating in a borehole, comprising in combination a tubular member adapted to be connected into a drill string, radial port means in the walls of said tubular member opening from the outside to the bore therethrough, an elongated cylindrical container snugly fitting slidably within said bore, means within said bore for anchoring said container within said bore, a first axially-elongated chamber in said container, said chamber opening at both axial ends thereof to the space within the drill string to either side of said container, a second axially-elongated chamber in said container closed at its lower end and to the space within said drill string, and radial window means opening to said second chamber through the walls of said container near the upper end thereof, said window means being adapted to register with the port means of said tubular member when said container is anchored within said tubular member and being of a size to permit earth cuttings to enter said container and settle to the closed lower end thereof.

2. Apparatus for collecting earth cuttings from mudflush circulating in a borehole, comprising in combination a tubular member adapted to be connected into a drill string, radial port means in the walls of said tubular member opening from the outside to the bore therethrough, an elongated cylindrical container snugly fitting slidably within said bore, means formed on the inner wall of said bore and the outer wall of said container for anchoring said container within said bore, a first axially-elongated chamber in said container, said chamber opening at both axial ends thereof to the space within the drill string to either side of said container, a second axially-elongated chamber in said container closed at its lower end and to the space within said drill string, removable plate means forming the lower closure of said chamber, and radial windows opening to said second chamber through the walls of said container near the upper end thereof, said windows being adapted to register with the ports of said tubular member when said container is anchored within said tubular member and being of a size to permit earth cuttings to enter said container and settle to the closed lower end thereof.

3. Apparatus for collecting earth cuttings from mudflush circulating in a borehole, comprising in combination a tubular member adapted to be connected into a drill string, radial port means in the walls of said tubular member opening from the outside to the bore therethrough, an elongated cylindrical container snugly fitting slidably within said bore, means formed on the inner wall of said bore and the outer wall of said container for anchoring said container within said bore, a first axially-elongated chamber in said container, said chamber opening at both axial ends thereof to the space within the drill string to either side of said container, a second axially-elongated chamber in said container closed at its lower end and to the space within said drill string, radial windows opening to said second chamber through the walls of said container near the upper end thereof, said windows being adapted to register with the ports of said tubular member when said container is anchored within said tubular member and being of a size to permit earth cuttings to enter said container and settle to the closed lower end thereof, and removable liner means carried within the lower end of said container means below the windows thereof.

4. Apparatus for collecting earth cuttings from mudflush circulating in a borehole, comprising in combination a tubular member adapted to be connected into a drill string, substantially radial port means in the walls of said tubular member opening from the outside to the bore therethrough, an elongated cylindrical container snugly fitting slidably within said bore, means formed on the inner wall of said bore and the outer wall of said container for supporting said container within said bore, a first axially-elongated chamber in said container, said chamber opening at both axial ends thereof to the space within the drill string to either side of said container, a second axially-elongated chamber in said container closed at its lower end and to the space within said drill string, radial windows opening to said second chamber through the walls of said container near the upper end thereof, said radio windows being of a size to permit earth cuttings to enter said container and settle to the closed lower end thereof, and registering first and second guide means, said first means being carried by said cylindrical container and said second means being carried by the tubular member, whereby the engagement of said first and second guide means upon the sliding of said container within the bore of said tubular member moves said container to a position wherein the windows thereof register with the ports of said tubular member.

5. Apparatus for collecting earth cuttings from mudflush circulating in a borehole, comprising in combination a tubular member adapted to be connected into a drill string, substantially radial port means in the walls of said tubular

member opening from the outside to the bore therethrough, an elongated cylindrical container snugly fitting slidably within said bore, first shoulder means formed on the inner wall of said bore, second shoulder means formed on the outer wall of said container, said first and second shoulder means contacting each other for supporting said container within said bore, a first axially-elongated chamber in said container, said chamber opening at both axial ends thereof to the space within the drill string to either side of said container, a second axially-elongated chamber in said container closed at its lower end and to the space within said drill string, radial windows opening to said second chamber through the walls of said container near the upper end thereof, said radio windows being of a size to permit earth cuttings to enter said container and settle to the closed lower end thereof, and registering pin and guide means, one of said means carried by the tubular member and the other by the container means, whereby the engagement of said guide means with said pin means upon the entry of said container into the bore of said tubular member causes said container to rotate until the windows thereof are in register with the ports in said tubular member.

6. Apparatus for collecting earth cuttings from circulating drilling fluid in a well borehole during drilling operations, said apparatus comprising, in combination, a tubular sub adapted to be connected into a drill string, said sub having port means through the wall thereof, a projecting shoulder arranged on the inner wall of said sub, container means insertable into said bore of said tubular sub to engage the projecting shoulder thereof and withdrawable upwardly therefrom, said container means forming an elongated chamber closed at the upper and lower ends, open window means through the wall of said member near the upper end thereof, said window means being at least partially in register with said port means of said sub and being of a size to permit earth cuttings to enter said container means and settle to the closed lower end thereof, and conduit means extending through said chamber opening to the spaces above and below the ends thereof.

7. The combination of a tubular sub, having port means through the wall thereof and internally projecting shoulder means, with a sample collecting device adapted to be dropped into the bore of said sub and seat on said projecting shoulder, said device comprising a closed elongated cylindrical container having radial window means near the upper end thereof in register with said port means in said sub, said window means being of a size to permit earth cuttings to enter said container and settle to the closed lower end thereof, and fluid conduit means in communication with the bore of said sub above and below container extending through said container.

8. Apparatus for collecting earth cuttings from mudflush circulating in a borehole, said apparatus comprising, in combination with a tubular member adapted to be connected into a drill string and having radial port means in the walls thereof opening from the outside to the bore of said tubular member, an elongated cylindrical container snugly fitting slidably within said bore, means formed on the inner wall of said bore and the outer wall of said container for supporting said container within said bore, a first axially-elongated chamber in said container, said chamber opening at both axial ends thereof to the space within the drill string to either side of said container, a second axially-elongated chamber in said container closed at its lower end and to the space within said drill string, and radial window means opening to said second chamber through the walls of said container near the upper end thereof, said window means being adapted to register with the port means of said tubular member when said container is anchored within said tubular member and being of a size to permit earth cuttings to enter said container and settle to the closed lower end thereof, and tubular sleeve means fitting slidably within the bore of said tubular member to close the radial port means thereof when said container is withdrawn therefrom, said cylindrical container and tubular sleeve being alternatively insertable into the core of said tubular member.

9. Apparatus for collecting earth cuttings from mudflush circulating in a borehole, comprising in combination a tubular member adapted to be connected into a drill string, radial port means in the walls of said tubular member opening from the outside to the bore therethrough, tubular sleeve means slidably mounted in the bore of said tubular member, spring means supported within the bore of said tubular member for normally urging said sleeve means to a position closing said radial port means, an elongated cylindrical container fitting slidably within said bore, said container being adapted to depress said tubular sleeve means and open said port means, means formed on the inner wall of said bore and the outer wall of said container for supporting said container within said bore, a first axially-elongated chamber in said container, said chamber opening at both axial ends thereof to the space within the drill string to either side of said container, a second axially-elongated chamber in said container closed at its lower end and to the space within said drill string, and radial window means opening to said second chamber through the walls of said container near the upper end thereof, said window means being adapted to register with the port means of said tubular member when said container is anchored within said tubular member and being of a size to permit earth cuttings to enter said container and settle to the closed lower end thereof.

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