A borehole tool for drilling in a formation is disclosed. The tool is of the type that incorporates a sphere for deploying cutting elements for hydraulically expanding the same for borehole enlargement during drilling. The tool conveniently includes a reset function where the cutting elements can be reset to a retracted position within the cutter housing. Advantageously the reset of the cutter elements is achievable by simply removing a cutting bit at the end of drill string and inserting the reset member in the form of a elongate rod through the end of the drill string to urge the sphere or ball back to the top of the drill string for retrieval and resetting the movable member which allows for fluid flow redirection within the cutter housing. The reset function can be achieved on site thus avoiding significant expenses and downtime typically associated with systems that cannot be reset onsite.
ABSTRACT

A borehole tool for drilling in a formation is disclosed. The tool is of the type that incorporates a sphere for deploying cutting elements for hydraulically expanding the same for borehole enlargement during drilling. The tool conveniently includes a reset function where the cutting elements can be reset to a retracted position within the cutter housing. Advantageously the reset of the cutter elements is achievable by simply removing a cutting bit at the end of drill string and inserting the reset member in the form of a elongate rod through the end of the drill string to urge the sphere or ball back to the top of the drill string for retrieval and resetting the movable member which allows for fluid flow redirection within the cutter housing. The reset function can be achieved on site thus avoiding significant expenses and downtime typically associated with systems that cannot be reset onsite.
EARTH BORING DEVICE AND METHOD OF USE

[FIELD OF THE INVENTION]

[0001] The present invention relates to an earth boring device and more particularly, the present invention relates to a method and apparatus for stabilizing a drill string during earth boring and expansion reaming.

[BACKGROUND OF THE INVENTION]

[0002] Drilling tools of all varieties are known in the art. One of the problems that has been pervasive in the solutions presented by the prior art relates to dependability of the tool and also expediency when resetting the reamer function once it has been deployed. As has been identified in the prior art, resetting the ball used to redirect the drilling fluid can be arduous and requires removal of the tool from within the formation partial disassembly and subsequent reassembly. All of these operations are time intensive and are therefore very costly in a drilling operation. The present invention seeks to mitigate the limitations with existing arrangements to provide a more effective drilling tool which may be easily and quickly reset in the field in order to keep things moving for maximum efficiency in a notoriously expensive operation.

[0003] Typical arrangements are used in drilling for oil and gas and may include a stabilizer and enlargement reamer. The stabilizer is used to prevent torsions and other forces from damaging or changing the direction of the string in use. The reamers are useful to enlarge the bore hole and are retractable within the body of the tool. Examples of such tools have been delineated in the prior art. An example of which is shown in United States Patent Publication No. US2012/0279784, the author which is Harvey et al. The technology relates to a slide reamer and stabilizer tool. The tool has reamer cartridges which can be removed and replaced with stabilizer cartridges having stabilizer inserts and hard faced stabilizer cones.

[0004] Turning to the expandable reamers, United States Patent No. 7,493,971, issued February 24, 2009 to Nevud et al. teaches a concentric expandable reamer. This is one of the earlier reaming arrangements which provides for movable arms deflectable radially outward from the reamer for borehole enlargement. A fairly complex mechanism is disclosed in the
patent and there is no discussion regarding resetting or repositioning of the movable arms in an expeditious manner.

[0005] Radford et al., in United States Patent No. 7,900,717, issued March 8, 2011, further advances the expandable reamer technology. In this arrangement a push sleeve is disposed in the inner bore of the body and is coupled to each one of the blades to effect axial movement along a track to an extended position responsive to exposure to a pressure or force of drilling fluid in the flow path of the inner bore. Similar to the Nevil et al. document, this document does not set forth any instruction regarding the reset of the blades.

[0006] Radford et al., further expands on the stabilizer with reamer elements in United States Patent No. 8,020,767, issued October 4, 2011. In this arrangement the blades may include at least one roller element for reaming a wellbore.


[0008] Despite the panacea of developments in this area of technology, there is a notable absence of expandable reamers with a reset function that can be expeditiously effected in the field. The present invention addresses the absence of the reset feature to present a more efficient arrangement.

[SUMMARY OF THE INVENTION]

[0009] One object of the present invention is to provide improved earth boring tool which may be expeditiously reset in the field with minimum downtime.

[0010] A second object of the present invention according to one embodiment is to provide a method of resetting an earth boring tool having a tubular body attached to a drill string, a drill bit disposed on an end thereof, expandable reaming elements for enlarging a bore hole, a movable member movable by fluid pressure within said tool to effect movement to a use position of said reaming elements and an actuating member for actuating said movable member,
comprising: providing a reset member; removing said drill bit to expose an opening in said tool; positioning said reset member within said opening of said tool; dislodging said actuating member from a seating within said tool; and resetting said blockage member to an initial position where said expandable reaming elements are retracted.

[0011] A further object of one embodiment of the present invention is to provide an earth boring tool, comprising: a tubular cutter housing having a plurality of retractable cutting elements retractably mounted within said housing; a piston housing connected to said cutter housing for housing a movable member coaxially mounted therein for axial movement within said cutter housing and said piston housing; a movable member disposed within said tool and movable from said cutter housing to said piston housing for redirecting fluid flow into said cutter housing to deploy said retractable cutting elements; an actuating member for positioning within said tool to actuate movement of said movable member to said piston housing; and reset means selectively positionable within said tool for retrieving said actuating member and repositioning said movable member from said piston housing to said cutter housing.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0012] Figure 1 is a view of the tool according to one embodiment of the present invention;

[0013] Figure 1A is a perspective enlarged view of the cutter housing of the tool;

[0014] Figure 1B is a longitudinal cross-section of an isolated section of the cutter housing shown in Figure 1A;

[0015] Figure 2 is a longitudinal cross-section view of the tool;

[0016] Figure 3 is a longitudinal cross-section view of the tool illustrating the actuating member as it is position within the tool;

[0017] Figure 4 is a longitudinal cross-section view of the tool illustrating the positioning of the actuating member in a position where the cutting elements are primed for deployment;

[0018] Figure 5 is a view similar to Figure 4 illustrating full deployment of the cutting elements and the positioning of the actuating member; and

[0019] Figure 6 is a view similar to Figure 5 illustrating the disposition of the reset member within the tool.
Similar numerals used in the Figures denote similar elements.

[DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS]

Referring now to the drawings and particularly Figure 1, numeral 10 generally denotes one embodiment of the earth boring tool. The tool includes, as is typical with these arrangements, a first stabilizing member 12 referred to in the art as a sub which is threadibly connected to the cutter housing 14. Extending coaxially and in threaded connection from the cutter housing 14 is a piston housing 16. One end of the piston 16 has a bottom sub 18, which has a threaded segment 20 for typically receiving a drill bit head (not shown).

Figures 1A and 1B illustrate greater detail concerning the cutter housing 14. As is evident from Figure 1A, the cutter housing 14 provides a plurality of helical flutes 16. The helices are disposed at an angle of 27.6° as a first possibility. It will be appreciated by those skilled in the art that this is an example of the invention. Between the flutes 16 are a plurality of raised segments 18 each having a plurality of apertures 20 extending therealong in equidistant relation. Referring to Figure 1B, each of the apertures 20 retains a piston 22 to which is connected a cutting element shown best in Figure 1. Each cutting element, in this example, includes a plurality of cutting buttons 24 which may be made of a sufficiently durable material such as tungsten carbide that is widely used for this purpose. As is evident from Figure 1B and equally true for the complete arrangement 10 a longitudinal shaft 26 extends through the entire cutter housing as well as all the elements connected thereto set forth regarding the discussion of Figure 1.

Turning now to Figure 2, shown as a longitudinal cross-section of the tool 10 the structural relationship of the individual members as discussed in Figure 1. The tool 10 in Figure 2 is depicted in a state where the cutting elements 22 is a retracted state within cutter housing 14. In this embodiment, there is an elongate member 26 disposed coaxially within cutter housing 14. The elongate member 26 is hollow and allows for fluid flow therethrough so that fluid can flow from sub 12 to sub 18 as is known in the art. The typical fluid is drilling mud well known to those skilled. The elongate member 26 is mounted for slidable movement within cutter housing 14 and extends substantially the full length of the housing 14. A terminal end 28 of member 26
provides a plurality of slots 30 the purpose of which will be discussed hereinafter. There are slots
30 which define a series of individual fingers 32. Elongate member 26 is more commonly
referred to as a collet sleeve in the art. The collet sleeve 26 at an opposed end from fingers 32,
referenced by numeral 34 includes a substantially frustoconical Conoco end portion, the purpose
of which will be discussed hereinafter. Collet sleeve 26 is movable within the tool 10 as
mentioned herein and previously by making use of an actuating member 36 shown in Figure 3.
The actuating member 36 comprises a sphere which is positionable within the tool in a position
as noted in Figure 3.

[0024] The purpose of the actuating member or sphere 36 as it will be referred to
hereinafter is to actuate movement of the collet sleeve 26 from the position shown in Figure 3
within cutting housing 14 to the second position shown in Figure 4, where the collet sleeve 26 is
disposed within piston housing 16. The mass of the sphere 36 is sufficient to move the collet
sleeve 26 into the position within piston housing 16. Once the sphere 36 is positioned as noted,
fluid flow and particularly drilling mud flow is altered within the tool such that the fluid builds
within cutter housing 14 to actuate the pistons 22 in order to urge the cutter elements 24
outwardly as shown in Figure 5 to a position where the cutter elements 24 extend outwardly from
the cutter housing 14 to result in borehole enlargement as is generally represented by reference
numeral 38.

[0025] As is well observed in the art, once the cutting elements 24 have been deployed
by the force of the drilling mud, they cannot be retracted or reset without extensive effort. The
problem in the art is that the entire drill string must be removed from within the formation in
order to remove the tool and manually reset the cutting elements 24. This presents a financial
burden in terms of the downtime that is required to remove the drill string and the cutter housing
from the tool, reset the cutting elements and subsequently reassembling the components so that
the string can be reinserted into the formation to continue drilling without borehole enlargement
until such time as the enlargement aspect is required. This is something that plagues the industry
and contributes to the excessive costs associated with drilling.

[0026] By the instant technology, this significant drawback is mitigated. It has been
found that the cutting elements 24 can be reset, i.e. retracted within cutting housing 14 in a fairly
straightforward manner. Reference is now made to Figure 6 where the tool is one again in

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longitudinal cross-section and where there is disposed a reset member 38 through the tool and specifically through sub 18 and piston housing 16. In order to insert the reset member in the later mentioned elements, the cutting but (not shown) is removed and the reset member 38 inserted therethrough to urge against sphere 36. Upon application of sufficient force to reset member 38, the sphere can be moved through cutter housing 14 along with collet sleeve 26 to return to the position within cutting housing 14 where the cutter elements 24 are returned to their retracted position. In the embodiment shown in Figure 6, the elongate reset member 38 is shown in the example as a rod having a free end 40 which can be useful to receive an impact force with for example a hammer to dislodge sphere 36 and collet sleeve 26 back to the start or initial position for subsequent deployment when desired by the user.

[0027] By this method, significant time is saved as the tool can be reset in the field at the drilling location without having to disassemble each segment and subsequently transporting the cutter housing, etc. off site for reset.
We Claim:

1. An expandable reamer apparatus for subterranean drilling, comprising:
   
a tubular body having a longitudinal axis and a trailing end for connecting to a drill string;

   a drilling fluid flow path extending through said tubular body;

   fluid pressure actuable cutting members movable from a storage position retracted within said tubular body to a use position extending outwardly of said tubular body for expanding the diameter of a borehole;

   a drilling fluid flow redirection member movably mounted within said tubular body from a first position proximate said cutting members to a second position distal from said cutting members to facilitate drilling fluid flow redirection whereby fluid pressure is sensed by said cutting members for movement to said use position; and

   an actuator for actuating movement of said fluid flow redirection member.

2. The apparatus as set forth in claim 1, further including a reset member for resetting the position of said drilling fluid flow redirection member from said second position to said first position.

3. The apparatus as set forth in claims 1 or 2, wherein said drilling fluid flow redirection member movable within said tubular body from said first position to said second position comprises a collet sleeve.

4. The apparatus as set forth in claim 3, wherein said collet sleeve is coaxially positioned within said flow path of said tubular body.

5. The apparatus as set forth in claims 3 or 4, further including a housing to receive and retain said collet sleeve in said second position.

6. The apparatus as set forth in claim 4, wherein said housing includes stop means for setting the maximum movement distance of said collet sleeve within said housing.
7. The apparatus as set forth in claim 5, wherein said housing is positioned within said tubular body in coaxial disposition therewith and spaced inwardly from an inside wall of said body to define a second fluid path.

8. The apparatus as set forth in claim 7, wherein said housing is fixedly secured within said tubular body.

9. The apparatus as set forth in claims 7 or 8, wherein said housing has opposed ends, one end of said ends being threadably engaged with an inside wall of said tubular body, other said end being connected to a positioning member secured between said tubular body and said housing.

10. The apparatus as set forth in claim 9, wherein said positioning member includes a plurality of radially oriented apertures spaced outwardly from said housing and in fluid communication with said fluid path.

11. The apparatus as set forth in any one of claims 4 through 10, wherein said collet sleeve has opposed ends each having proximal thereto on an outside wall seals for providing sealing between said outside wall and the inside wall of said housing.

12. The apparatus as set forth in claim 11, wherein said seal comprise O-rings.

13. The apparatus as set forth in claims 11 or 12, wherein one end of said opposed ends of said collet sleeve includes a plurality of spaced apart fingers extending from said end.

14. The apparatus as set forth in claim 13, wherein other said end of said collet sleeve includes a seating.

15. The apparatus as set forth in any one of claims 1 through 14, wherein said actuator comprises a sphere movable within said fluid flow path.

16. The apparatus as set forth in claim 15, wherein said sphere is adapted to be seated within said collet sleeve at an opposed end thereof to prevent passage of said sphere through said sleeve.
17. The apparatus as set forth in anyone of claims 9 through 16, wherein adjacent said one end of said housing, said housing includes a plurality of apertures there through.

18. The apparatus as set forth in claim 17, wherein said apertures comprise generally elliptically shaped apertures in spaced relation about the housing.

19. The apparatus as set forth in anyone of claims 3 through 18, wherein said tubular body includes an upper sub, a cutter housing, a piston housing and a bottom sub commonly connected and having a drilling fluid flow path there through.

20. The apparatus as set forth in anyone of claims 1 through 19, wherein said cutter housing retains said fluid actuated cutting members.

21. The apparatus as set forth in claim 20, wherein said piston housing includes said drilling fluid flow redirection member and said housing coaxially mounted therein.

22. The apparatus as set forth in any one of claims 19 through 21, wherein said cutter housing includes retainer means for retaining said collet sleeve in said first position.

23. The apparatus as set forth in claim 22, wherein said retainer means is releasably engageable with said collet sleeve.

24. The apparatus as set forth in claim 23, wherein said retainer means is releasably engageable with spaced apart fingers of said collet sleeve.

25. The apparatus as set forth in any one of claims 2 through 24, wherein said reset member comprises an elongate member.

26. The apparatus as set forth in claim 25, wherein said elongate member is configured for insertion through said tubular body for contact with said drilling fluid flow redirection member to effect movement from said second position to said first position.

27. The apparatus as set forth in claims 25 or 26, wherein said elongate member comprises a rod.

28. The apparatus as set forth in claim 27, wherein said rod includes boss means for engagement with said fluid flow redirection member internally thereof.
29. The apparatus as set forth in claims 27 or 28, wherein said boss means is configured to engage an abutment within said fluid flow redirection means.

30. The apparatus as set forth in any one of claims 19 through 29, in combination with a drill string.

31. The apparatus as set forth in any one of claims 19 through 30, in combination with a drill bit.

32. The apparatus as set forth in any one of claims 19 through 31, in combination with a drill string and a drill bit.

33. A method for reaming a borehole in a subterranean formation, comprising:

   positioning an expandable reaming apparatus within a subterranean formation, said reaming apparatus having having a tubular body, a drilling fluid flow path extending through said tubular body, fluid pressure actuable cutting members movable from a storage position retracted within said tubular body to a use position extending outwardly of said tubular body for expanding the diameter of a borehole;

   introducing drilling fluid into said reaming apparatus;

   redirecting said drilling fluid flow in said reaming apparatus with a redirection member movably mounted within said tubular body from a first position proximate said cutting members to a second position distal from said cutting members to facilitate drilling fluid flow redirection whereby drilling fluid pressure is sensed by said cutting members for movement to said use position; and

   reaming a borehole in said subterranean formation by rotation and displacement of the reamer apparatus within said subterranean formation.

34. The method as set forth in claim 33, further including the step of introducing an actuator into said drilling fluid flow path for actuating movement of said fluid flow redirection member.

35. The method as set forth in claims 33 or 34, further including the step of resetting the position of said fluid flow redirection member from said second position to said first position.
36. The method as set forth in claim 35, wherein resetting said position comprises forcing said fluid flow redirection member back into said first position by mechanical means.

37. The method as set forth in claims 35 or 36, wherein resetting said position comprises forcing said fluid flow redirection member back into said first position by manual means.

38. The method as set forth in anyone of claims 35 through 37, further including releasably locking said fluid flow redirection member into said first position.

39. A method for reaming a borehole in a subterranean formation, comprising:

   positioning an expandable reaming apparatus within a subterranean formation, said reaming apparatus having a tubular body, a drilling fluid flow path extending through said tubular body, fluid actuated cutting members movable from a storage position retracted within said tubular body to a use position extending outwardly of said tubular body for expanding the diameter of a borehole;

   redirecting drilling fluid flow with a fluid flow redirection member operatively positioned with the flow path to pressurize an internal volume of said tubular body adjacent said cutting members to effect movement of said cutting members to said second position; and

   reaming a borehole in said subterranean formation by rotation and displacement of the reamer apparatus within said subterranean formation.

40. The method as set forth in claim 39, further including the step of resetting the position of said fluid flow redirection member from said second position to said first position.

41. The method as set forth in claim 40, wherein resetting said position comprises forcing said fluid flow redirection member back into said first position by mechanical means.

42. The method as set forth in claim 41, wherein resetting said position comprises forcing said fluid flow redirection member back into said first position by manual means.