Title: BOREHOLE CUTTER RETENTION AND FASTENING/Locking SYSTEM

Abstract: A borehole reaming cutter retention and fastening/locking system enable field replacement of borehole reaming cutter assemblies utilized in infrastructure emplacement horizontal drilling (HDD) applications. The borehole reaming cutter assembly retention/fastening system can withstand borehole drilling forces without the necessity of permanent welding, thereby allowing cutter interchangeability/replacement in the field. The borehole retention assembly shape and design, coupled with the fastening/locking mechanism design, may be robust enough to replace permanent welding and may allow field cutter interchangeability and replacement. Current designs and devices utilize permanent welding of component/cutter assemblies, thereby requiring workshop/welding construction and deconstruction to enable the interchangeability and replacement of cutter assemblies.
BOREHOLE CUTTER RETENTION AND FASTENING/LOCKING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present invention claims the benefit of priority to U.S. provisional patent application number 61/480,587, filed April 29, 2011.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to a borehole reaming cutter retention and fastening/locking system and, more particularly, to a borehole reaming cutter retention and fastening/locking system that enables field replacement of borehole reaming cutter assemblies utilized in infrastructure emplacement horizontal drilling (HDD) applications.

[0003] Typical borehole reaming cutter assemblies use permanent welding of components and cutter assemblies, thereby requiring workshop welding for construction. Complex deconstruction procedures are required to enable the interchangeability and replacement of cutter assemblies. Otherwise, the user must use a whole new cutter and assembly.

[0004] As can be seen, there is a need for a borehole reaming cutter assembly that enables field replacement of cutter assemblies.

SUMMARY OF THE INVENTION

[0005] In one aspect of the present invention, a cutter retention system comprises a leg adapted to receive a cutter at a first end thereof, the leg having threads at a second, opposite end thereof; a receptacle adapted to receive the leg; a recess in a first end of the receptacle adapted to receive the second end of the leg; at least one receptacle locking mechanism on a
second, opposite end of the receptacle; and a fastener adapted to fit into the recess and threadingly engage the threads of the leg.

[0006] In another aspect of the present invention, a cutter retention system comprises a leg adapted to receive a cutter at a first end thereof, the teg having threads at a second, opposite end thereof, the leg having a conical shape from the first end to the threads; a receptacte, the receptacle having a hollow, conical inside shape corresponding to the conical shape of the leg; a recess in a first end of the receptacle adapted to receive the second end of the leg; at least one receptacle locking mechanism on a second, opposite end of the receptacte; a leg locking mechanism on a first end of the leg; and a fastener adapted to fit into the recess and threadingly engage the threads of the leg.

[0007] In a further aspect of the present invention, a borehole reaming cutter assembly comprises a borehole reaming cutter; a leg adapted to receive the borehole reaming cutter at a first end thereof, the leg having threads at a second, opposite end thereof, and the leg having a conical shape from the first end to the threads thereof; a receptacle, the receptacle having a hollow, conical inside shape corresponding to the conical shape of the leg, the receptacle adapted to permit the leg to fit inside the receptacle; a recess in a first end of the receptacle adapted to receive the second end of the leg; at least one receptacle locking mechanism on a second, opposite end of the receptacle; and a fastener adapted to fit into the recess and threadingly engage the threads of the leg.

[0008] These and other features, aspects and advantages of the present invention will become better understood with reference to the following drawings, description and claims.
BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 shows a perspective view of a borehole reaming cutter assembly according to an exemplary embodiment of the present invention;

[0010] Figure 1A shows an exploded view of a cutter retention system according to an exemplary embodiment of the present invention;

[0011] Figure 1B shows a cross-sectional view taken along line 1-1 of Figure 1A;

[0012] Figure 2A shows a perspective view of the cylinder receptacle used in the cutter retention system of Figure 1A;

[0013] Figure 2B shows an end view of the cylinder receptacle used in the cutter retention system of Figure 1A;

[0014] Figure 2C shows a cross-sectional view taken along line 3-3 of Figure 2B;

[0015] Figure 2D shows a side view of the cylinder receptacle used in the cutter retention system of Figure 1A;

[0016] Figure 3A shows a side view of the assembled cutter retention system of Figure 1A;

[0017] Figure 3B shows a cross-sectional view taken along line 3-3 of Figure 3A;

[0018] Figure 4 shows a side view of a cutter assembly inserted into the cutter retention system of Figure 1A;

[0019] Figure 5A shows a side view of the fastener of the cutter retention system of Figure 1A;

[0020] Figure 5B shows an end view of the fastener of the cutter retention system of Figure 1A; and

[0021] Figure 5C shows a cross-sectional view taken along line 5-5 of Figure 5A.
DETAILED DESCRIPTION OF THE INVENTION

[0022] The following detailed description is of the best currently contemplated modes of carrying out exemplary embodiments of the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention, since the scope of the invention is best defined by the appended claims.

[0023] Broadly, an exemplary embodiment of the present invention provides a borehole reaming cutter retention and fastening/locking system enabling field replacement of borehole reaming cutter assemblies utilized in infrastructure emplacement horizontal drilling (HDD) applications. The borehole reaming cutter assembly retention/fastening system can withstand borehole drilling forces without the necessity of permanent welding, thereby allowing cutter interchangeability/replacement in the field. The borehole cutter retention assembly shape and design, coupled with the fastening/locking mechanism design, may be robust enough to replace permanent welding and may allow field cutter interchangeability and replacement.

[0024] The cutter retention system design and shape, according to exemplary embodiments of the present invention, may spread the borehole drilling forces evenly across a large surface area. This retention system may impart robust cutter assembly holding power, thereby relieving drilling stresses from the rear fastening/locking mechanism. A rear dual fastening/locking mechanism may provide cutter assembly fastening/locking redundancy. The cutter leg assembly is adapted to mate to the cutter leg receptacle and the fastening /locking mechanism may be integrally designed for proper retention without requiring weld attachment. The machined male cutter assembly leg shape is adapted to mate to the machined female receptacle shape thereby equally spreading the loading forces circumferentially. This may relieve borehole drilling stresses upon
the rear fastening/locking mechanism, thereby not requiring physical welding attachment to offset these borehole drilling forces. This permits field interchangeability/replacement of borehole cutting assemblies.

[0025] Referring to Figures 1, 1A, 1B, 3A and 3B, a cutter retention system 10 may include a leg 12 for receiving a cutter 20 (see Figure 4), a receptacle 14 for receiving the leg 12 and a fastener 16 for connecting the leg 12 in the receptacle 14. In some embodiments, one end of the leg 12 may have threads mating with threads of the fastener 16. The leg 12 may fit entirely inside of the receptacle 14. In some embodiments, a retainer 18 may be disposed between the fastener 16 and the receptacle 14. The fastener 16 may fit into a recess 14-2 in the receptacle 14. The retainer 18 may help retain the fastener 16 on the leg 12. The retainer 18 may be, for example, a washer, a lock washer, a star washer, or the like. The receptacle 14 may have a hollow interior designed in a conical shape. The leg 12 may have an exterior conical shape matching the hollow interior shape of the receptacle 14.

[0026] When the leg 12 is inserted into the receptacle 14, a space 22 may remain in between the leg 12 and the receptacle 14. Also, a space 24 may remain after the fastener 16 is secured to the threaded end of the leg 12. Further tightening of the fastener 16 may reduce the spaces 22, 24 and cause radial compression of the receptacle 14 against the leg 12. This radial compression force may help secure the cutter 20 inside the leg 12.

[0027] As shown in Figures 2A through 2D, the receptacle 14 may include at least one locking mechanism 14-1 for receiving and rotationally locking the cutter 20. The locking mechanism 14-1 may include a pair of ridges for mating with corresponding indents in the leg 12.

[0028] Referring to Figure 4, the cutter 20 is shown installed in the leg 12. As can be seen, a locking mechanism 12-1 may have a radius of curvature, such as a radius of curvature of about .125. The locking
mechanism 12-1 may align with the locking mechanisms 14-1 of the receptacle 14 for securing the cutter 20.

[0029] Referring to Figures 5A through 5C, the fastener 16 is shown, according to an exemplary embodiment of the present invention.

[0030] While the figures show specific dimensions for the various components of the cutter retention system 10, these dimensions should not be viewed as limiting. Variations of these sizes may result in a cutter retention system 10 that may be larger or smaller, but, nonetheless, is within the scope of the present invention.

[0031] It should be understood, of course, that the foregoing relates to exemplary embodiments of the invention and that modifications may be made without departing from the spirit and scope of the invention as set forth in the following claims.
What is claimed is:

1. A cutter retention system comprising:
   - a leg adapted to receive a cutter at a first end thereof, the leg having threads at a second, opposite end thereof;
   - a receptacle adapted to receive the leg;
   - a recess in a first end of the receptacle adapted to receive the second end of the leg;
   - at least one receptacle locking mechanism on a second, opposite end of the receptacle; and
   - a fastener adapted to fit into the recess and threadingly engage the threads of the leg.

2. The cutter retention system of claim 1, including a leg locking mechanism on a first end of the leg.

3. The cutter retention system of claim 2, wherein the receptacle locking mechanism aligns with the leg locking mechanism.

4. The cutter retention system of claim 1, wherein the fastener is a nut.

5. The cutter retention system of claim 1, wherein the receptacle has a hollow, conical interior.

6. The cutter retention system of claim 5, wherein the leg has a conical exterior shape adapted to fit into the hollow, conical interior of the receptacle.
7. The cutter retention system of claim 1, wherein the leg is adapted to fit entirely inside of the receptacle.

8. The cutter retention system of claim 1, including a retainer disposed between the fastener and the receptacle.

9. The cutter retention system of claim 1, wherein the leg is adapted to fit inside of the receptacle such that a space remains between the leg and the receptacle when the leg is placed inside the receptacle.

10. A cutter retention system comprising:
    a leg adapted to receive a cutter at a first end thereof, the leg having threads at a second, opposite end thereof, the leg having a conical shape from the first end to the threads;
    a receptacle, the receptacle having a hollow, conical inside shape corresponding to the conical shape of the leg;
    a recess in a first end of the receptacle adapted to receive the second end of the leg;
    at least one receptacle locking mechanism on a second, opposite end of the receptacle;
    a leg locking mechanism on a first end of the leg; and
    a fastener adapted to fit into the recess and threadingly engage the threads of the leg.

11. The cutter retention system of claim 10, wherein the leg is adapted to fit entirely inside of the receptacle.

12. The cutter retention system of claim 10, including a retainer disposed between the fastener and the receptacle.
13. The cutter retention system of claim 10, wherein the leg is adapted to fit inside of the receptacle such that a space remains between the leg and the receptacle when the leg is placed inside the receptacle.

14. The cutter retention system of claim 10, wherein the receptacle locking mechanism aligns with the leg locking mechanism.

15. The cutter retention system of claim 10, wherein the fastener is a nut.

16. A borehole reaming cutter assembly comprising:
   a borehole reaming cutter;
   a leg adapted to receive the borehole reaming cutter at a first end thereof, the leg having threads at a second, opposite end thereof, and the leg having a conical shape from the first end to the threads thereof;
   a receptacle, the receptacle having a hollow, conical inside shape corresponding to the conical shape of the leg, the receptacle adapted to permit the leg to fit inside the receptacle;
   a recess in a first end of the receptacle adapted to receive the second end of the leg;
   at least one receptacle locking mechanism on a second, opposite end of the receptacle; and
   a fastener adapted to fit into the recess and threadingly engage the threads of the leg.

17. The borehole reaming cutter assembly of claim 16, including a leg locking mechanism on a first end of the leg.

18. The borehole reaming cutter assembly of claim 17, wherein the receptacle locking mechanism aligns with the leg locking mechanism.
19. The borehole reaming cutter assembly of claim 16, including a retainer disposed between the fastener and the receptacle.

20. The borehole reaming cutter assembly of claim 6, wherein the leg is adapted to fit inside of the receptacle such that a space remains between the leg and the receptacle when the leg is placed inside the receptacle.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B23B 31/00 (201.01)
USPC - 175/325.1

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - B23B 5/22, 5/34, 31/00, 31/02, 41/00, 41/02, 51/12; E21B 10/00, 41/00 (201.01)
USPC - 175/308, 309, 320, 325.1, 325.2, 325.4, 331

Documentation searched to the extent that such documents are included in the fields searched.

Electronic database other than minimum documentation to the extent that such documents are included in the fields searched

PatBase

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>Y</td>
<td>US 5,342,155 A (HARROUN) 30 August 1994 (30.08.1994) entire document</td>
<td>8, 12, 19</td>
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Further documents are listed in the continuation of Box C.

Date of the actual completion of the international search
15 December 2011

Date of mailing of the international search report
6 DEC 2011

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