MULTI-START THREAD CONNECTION FOR DOWNHOLE TOOLS

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(57) ABSTRACT

An apparatus for transferring rotary power to a consumer in a wellbore includes a rotary power source positioned along a conveyance device and a drive train connected to the rotary power source. The drive train transfers torque from the rotary power source to a consumer. The drive train includes at least two torque transmitting members connected by a multi-start thread connection.
MULTI-START THREAD CONNECTION FOR DOWNHOLE TOOLS

BACKGROUND OF THE DISCLOSURE

[0001] Field of the Disclosure

This disclosure relates generally to oilfield downhole tools and more particularly to methods and devices for transferring rotary power to a consumer.

[0002] Description of the Related Art

To obtain hydrocarbons such as oil and gas, boreholes or wellbores are drilled by rotating a drill bit attached to the bottom of a BHA (also referred to herein as a “Bottom Hole Assembly” or “BHA”). The BHA is attached to the bottom of a drill string, which is usually either a jointed rigid pipe or a relatively flexible spoolable tubing commonly referred to in the art as “coiled tubing.” When jointed pipe is utilized, the drill bit is rotated by rotating the jointed pipe from the surface and/or by a mud motor contained in the BHA. In the case of coiled tubing, the drill bit is rotated by the mud motor. BHA’s, as well as other wellbore devices, may often incorporate equipment that require the transfer of rotary power from a generator to a consumer, e.g., from a drilling motor to a drill bit. The transfer of such rotary power often occurs across two or more torque transmitting elements such as shafts.

[0003] The present disclosure addresses the need for threaded couplings that provide enhanced torque transmitting capabilities during the transfer of rotary power between two or more torque transmitting elements.

SUMMARY OF THE DISCLOSURE

[0004] In aspects, the present disclosure relates to an apparatus for transferring rotary power to a consumer in a wellbore. The apparatus may include a conveyance device configured to be disposed in the wellbore; a rotary power source positioned along the conveyance device, the rotary power source generating a torque; and a drive train connected to the rotary power source, the drive train transmitting the torque from the rotary power source to a consumer. The drive train includes at least two torque transmitting members connected by a multi-start thread connection that has at least two helically wound intertwined threads.

[0005] Illustrative examples of some features of the disclosure thus have been summarized rather broadly in order that the detailed description thereof that follows may be better understood, and in order that the contributions to the art may be appreciated. There are, of course, additional features of the disclosure that will be described hereinafter and which will form the subject of the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] For detailed understanding of the present disclosure, references should be made to the following detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings, in which like elements have been given like numerals and wherein:

[0007] FIG. 1 illustrates a drilling system made in accordance with one embodiment of the present disclosure;

[0008] FIG. 2 illustrates a drilling motor assembly using one or more threaded couplings made in accordance with embodiments of the present disclosure;

[0009] FIG. 3A illustrates a two-start thread configuration in accordance with one embodiment of the present disclosure;

[0010] FIG. 3B illustrates an end view of a two-start thread configuration in accordance with one embodiment of the present disclosure;

[0011] FIG. 4 schematically illustrates an end view of a three-start thread configuration in accordance with one embodiment of the present disclosure.

[0012] FIG. 3B illustrates an end view of a two-start thread configuration in accordance with one embodiment of the present disclosure;

[0013] FIG. 4 schematically illustrates an end view of a three-start thread configuration in accordance with one embodiment of the present disclosure.

[0014] FIG. 3B illustrates an end view of a two-start thread configuration in accordance with one embodiment of the present disclosure;

[0015] FIG. 4 schematically illustrates an end view of a three-start thread configuration in accordance with one embodiment of the present disclosure.

[0016] FIG. 4 schematically illustrates an end view of a three-start thread configuration in accordance with one embodiment of the present disclosure.

[0017] FIG. 4 schematically illustrates an end view of a three-start thread configuration in accordance with one embodiment of the present disclosure.

[0018] FIG. 4 schematically illustrates an end view of a three-start thread configuration in accordance with one embodiment of the present disclosure.
The drive train 125 may have a greater or a fewer number of these torque transmitting members.

**[0018]** The drive train 125 can transmit torque from the motor 120 to the drill bit 62 (FIG. 1) using one or more threaded connections. These threaded connections may be used between the rotor 122, the universal joint (e.g., flex shaft) 126, and the drive shaft 128. In certain embodiments, the drive train 125 may also include a rotor adapter and bonnet (not shown) and a segmented drive shaft having upper and lower sections. Threaded connections may also be used to transmit torque along these components as well.

**[0019]** Referring to FIG. 3A, the threaded connection may include a pin end 150 and a box end 152 (shown in hidden lines). In a conventional manner, the pin end 150 has external threads and the box end 152 has internal threads (not shown). The pin end 150 and the box end 152 have abutting shoulders 154, 156, respectively. When the threaded connection is torqued up to a desired value when the pin end 150 and box end 152 are connected (i.e., made up), an axial loading occurs at the shoulders 154, 156. The ratio between a shoulder load and a make-up torque (MUT) depends on thread geometry. If the transmitted torque is higher than MUT, then the connection becomes over-torqued resulting in shoulder or pin damage.

**[0020]** In embodiments, the threaded connections of the drive train 125 (FIG. 2) may use a multi-start thread to reduce the induced shoulder load for a given torque. Reducing the shoulder load may increase the torque capacity of the connection and may therefore avoid the necessity of a double shouldering of a connection. An additional advantage is the faster make and break of long thread cylindrical connections like at the bonnet of a motor. A traditional thread, which is a single start thread, has one helically wound thread. A multi-start screw has two or more intertwined threads. The FIG. 3A thread embodiment has two intertwined threads, 158 and 159. The intertwined threads may be helically wound threads. In these screw configurations, the effective pitch is equal to the pitch of a standard thread multiplied by the number of starts.

**[0021]** It should be understood that the drill bit is only one illustrative consumer of rotary power. Other consumers include, but are not limited to, underreamers, reamers, pipe cutting tools, etc.

**[0022]** The number of thread starts may vary depending on application. Thus, the ratio between a make-up torque and a break out torque may also vary significantly. FIG. 3B shows an end view of a two-start thread that has intertwined threads, 158, 159. FIG. 4 show the end view of a three start threads having three intertwined threads, 160, 162, 164. While only up to three thread starts are shown, the number of thread starts may be even higher. The ultimate number of thread starts is reached for an infinite pitch resulting in a pure spline connection. For a relatively high number of thread starts (e.g., five or more depending on pitch and diameter), a potential loss of self locking capability may be addressed with supplemental locking features. Nevertheless, these relatively high thread starts may still be able to transmit bending loads and apply a pre-load (clamping force) on components.

**[0023]** The foregoing description is directed to particular embodiments of the present disclosure for the purpose of illustration and explanation. It will be apparent, however, to one skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope of the disclosure. It is intended that the following claims be interpreted to embrace all such modifications and changes.

What is claim is:

1. An apparatus for transferring rotary power to a consumer in a wellbore, comprising:
   - a conveyance device configured to be disposed in the wellbore;
   - a rotary power source positioned along the conveyance device, the rotary power source generating a torque; and
   - a drive train connected to the rotary power source, the drive train transferring the torque from the rotary power source to a consumer, wherein the drive train includes at least two torque transmitting members connected by a multi-start thread connection.

2. The apparatus of claim 1, wherein the multi-start thread connection is formed at a pin and box connection between the at least two torque transmitting members.

3. The apparatus of claim 1, wherein a number of starts of the multi-start thread connection is selected to increase torque capacity of a connection between the at least two torque transmitting members relative to a single start thread connection.

4. The apparatus of claim 1, wherein the rotary power source is a drilling motor.

5. The apparatus of claim 1, wherein the consumer is a drill bit.

6. The apparatus of claim 1, wherein at least one of the two torque transmitting members is one of: (i) a rotor, (ii) flex shaft, and (iii) a drive shaft.

7. The apparatus of claim 1, wherein the conveyance device is a drill string.

8. The apparatus of claim 1, wherein the multi-start screw has at least two intertwined helically wound threads.

9. A method for transferring rotary power to a consumer in a wellbore, comprising:
   - disposing a conveyance device in the wellbore, the conveyance having a rotary power source generating a torque; and
   - transferring torque from the rotary power source using a drive train, wherein the drive train includes at least two torque transmitting members connected by a multi-start thread connection.

10. The method of claim 9, wherein the multi-start thread connection is formed at a pin and box connection between the at least two torque transmitting members.

11. The method of claim 9, wherein a number of starts of the multi-start thread connection increases torque capacity of a connection between the at least two torque transmitting members relative to a single start thread connection.

12. The method of claim 9, wherein the rotary power source is a drilling motor, the consumer is a drill bit, and wherein at least one of the two torque transmitting members is one of: (i) a rotor, (ii) flex shaft, and (iii) a drive shaft.

13. The method of claim 9, wherein the multi-start screw has at least two intertwined threads.

14. A system for transferring rotary power to a consumer in a wellbore, comprising:
   - a drill string conveyed into the wellbore; and
   - a bottomhole assembly connected to the drill string, the bottomhole assembly including:
     - a drilling motor energized by a drilling fluid circulated in the wellbore; and
a drive train connected to the rotary power source, the drive train transferring the torque from the rotary power source to a consumer, wherein the drive train includes a multi-start thread formed at a pin and box connection between at least two torque transmitting members.

15. The system of claim 14, the at least one of the two torque transmitting members include a rotor, a flex shaft, and a drive shaft interconnected to one another.

16. The system of claim 14, wherein the number of starts of the multi-start thread is selected to reduce the transmitted torque to a value lower than the make-up torque.

17. The system of claim 14, wherein the multi-start screw has at least two intertwined threads.

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