

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
19 October 2006 (19.10.2006)

PCT

(10) International Publication Number
WO 2006/109090 A2

(51) International Patent Classification:
E21B 17/05 (2006.01)

(21) International Application Number:
PCT/GB2006/001396

(22) International Filing Date: 18 April 2006 (18.04.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0507639.3 15 April 2005 (15.04.2005) GB

(71) Applicant (for all designated States except US): CALEDUS LIMITED [GB/GB]; 4 Rubislaw Terrace, Aberdeen, AB10 1XE (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): HOWLETT, Paul [GB/GB]; c/o Caledus Limited, 4 Rubislaw Terrace, Aberdeen, AB10 1XE (GB). BAIN, James [GB/GB]; 20 West Park Crescent, Inverbervie, Montrose, Angus, DD10 0TX (GB).

(74) Agent: KENNEDYS PATENT AGENCY LIMITED; 185 St. Vincent Street, Glasgow G2 5QD (GB).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

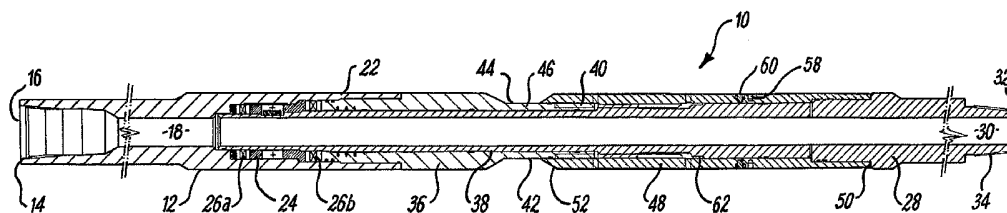
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DOWNHOLE SWIVEL SUB



(57) Abstract: A swivel sub for connection in a work string between a workstring and a downhole apparatus is disclosed. The sub has a first substantially cylindrical body, including a sleeve portion having one or more teeth and a second - substantially cylindrical body being partially located within the sleeve portion. The bodies are arranged to rotate relative to each other. A sliding sleeve, having one or more teeth arranged mutually engage with the first teeth is axially moveable between disengaged and engaged positions, in one embodiment by a pressure differential being created in the sub. Methods of running the tool are described, with particular application to setting and hanging of liners and screens. The invention also offers advantages for drilling applications.

WO 2006/109090 A2

1 Downhole Swivel Sub

2

3 The present invention relates to downhole tools for use
4 in the oil and gas industry and, in particular, to a
5 swivel sub suitable for use when running delicate screens
6 or liners into a wellbore, or in directional drilling
7 applications.

8

9 During completion of a oil or gas well, sand control
10 screens or liners are located in the wellbore. Typically
11 the screens and liners are lowered into the wellbore on a
12 workstring, but there is often insufficient workstring
13 down weight available to the driller to put the screens
14 into the well without rotating the string to break the
15 friction. Applying too much downhole weight can over-
16 compress the pipe below, thereby causing damage. It is
17 advantageous to rotate the workstring attached to the
18 screens or liners when inserting in high angle/ERD
19 (extended reach drilling) or tortuous wells due to the
20 fact that the associated drag of the friction is reduced
21 in the workstring, making it easier to observe and apply
22 the necessary measured down weight to aid getting sand
23 screens or liners to the planned depth. However, it is

1 often not desirable to rotate the screens or liners
2 (perhaps with delicate accessories) for fear of damage.
3 For example, if the screen or liner sticks, buckling can
4 occur as a result of the applied torque.

5

6 In directional drilling applications, using downhole
7 drilling motors or rotary steerable tools it will often
8 be necessary to selectively engage or disengage the main
9 drill string with drill bit to allow rotation independent
10 of the main drill string at times, and rotation with the
11 drill string at others.

12

13 US 5,394,938 describes a gravel pack screen wherein a
14 fluid permeable base pipe has a screen jacket rotatably
15 mounted thereon, so that the base pipe or drill-pipe
16 string can be rotated without imparting torque to the
17 screen jacket. Such an arrangement advantageously
18 prevents torque being applied to the screen, but has the
19 disadvantage that for certain applications it is useful
20 to be able to selectively impart full rotation to the
21 whole drill-pipe string, including the screens and
22 liners. For instance, it may be desirable to have an
23 ability to free a screen from a running tool by releasing
24 the running tool from the screen and rotating the running
25 tool, to prevent an unnecessary upward movement of the
26 screen during deployment.

27

28 US 5,323,852 discloses an auger gravel pack screen
29 connected to a drill-pipe string which includes a torque
30 limiting device to limit the maximum torque exerted on
31 the screen. While this arrangement prevents damage to
32 the screen from the over application of torque, the
33 device does not provide any selective application of

1 torque, as may be required for the release of running
2 tools, etc.

3

4 US 6,244,345 describes a lockable swivel apparatus
5 located above the rotary table, which allows an operator
6 to selectively rotate the drill string while a wireline
7 can be manipulated below. One disadvantage of this
8 swivel apparatus is that in order to unlock or disengage
9 the swivel, so that the parts can be relatively rotated,
10 weight must be set down on the drill string. This would
11 not be desirable in the use of sand screens or liners, as
12 the act of setting down weight on the sand screen or
13 liner may cause it to buckle and become damaged.

14

15 US 6,516,878 describes a tension swivel sub used for
16 cutting and removing sections of a wellbore casing. A
17 compression spring maintains a spear located below a
18 cutter into rotational engagement with the string, and
19 the spear is set against the casing below the cutter.
20 Tension is applied to overcome the compression spring and
21 disengage the spear from the string, so that the string
22 above the spear can be rotated. One disadvantage of
23 these tools is that they cannot be used on run in, as the
24 drill-pipe string below the sub must be held in place to
25 disengage the drill-pipe string and allow selective
26 rotation of the cutter above.

27

28 It is an object of the invention to provide a swivel sub
29 that overcomes at least one drawback or disadvantage of
30 prior art swivel subs.

31

32 It is an object of at least one embodiment the present
33 invention to provide a swivel sub which allows the

1 rotation of a drill-pipe string above the sub to be
2 selectively transmitted through the sub to downhole
3 apparatus, such as a screen, liner assembly, or drill bit
4 below.

5
6 It is a further object of at least one embodiment of the
7 present invention to provide a swivel sub wherein
8 relative rotation between the drill-pipe string above the
9 sub and downhole apparatus below the sub, such as a
10 screen, liner assembly or drill bit, can be achieved
11 without compression or tension at the sub.

12
13 It is a further object of at least one aspect of the
14 invention to provide a downhole swivel sub that meets the
15 objects above.

16
17 Additional aims and objects of the invention will become
18 apparent from the following description.

19
20 According to a first aspect of the present invention,
21 there is provided a swivel sub for connection in a work
22 string between a workstring and a downhole apparatus, the
23 sub comprising a first substantially cylindrical body,
24 including a sleeve portion having one or more first teeth
25 arranged thereon; a second substantially cylindrical body
26 being partially located within the sleeve portion and the
27 bodies being arranged to rotate relative to each other; a
28 sliding sleeve, including one or more second teeth
29 arranged thereon, to mutually engage with the first
30 teeth; the sliding sleeve being axially moveable between
31 a first position, wherein the first and second teeth are
32 disengaged and a second position, wherein the first and

1 second teeth are engaged; and means to engage the sliding
2 sleeve with the second cylindrical body.

3

4 The sliding sleeve may be operable to be engaged with the
5 second cylindrical body, or may be keyed with the second
6 cylindrical body.

7

8 Thus, with the sliding sleeve locked to the second body,
9 the sub may be arranged so that the teeth are locked in
10 either the engaged or disengaged position.

11

12 Preferably, the sliding sleeve is moved by virtue of a
13 pressure differential in the sub. The pressure
14 differential may be created by dropping a ball into a
15 ball seat of a downhole apparatus, such as a screen,
16 liner assembly, or drill bit located below the sub.

17

18 Alternatively, the sliding sleeve may be operated by a
19 hydraulic system. Optionally, the sliding sleeve may be
20 moved by a mechanical system.

21

22 In a first embodiment, the first cylindrical body is a
23 top sub, including means for connecting the top sub to a
24 workstring. The second cylindrical body may be an inner
25 mandrel including means for connecting the inner mandrel,
26 at a lower end, to a downhole apparatus. The downhole
27 apparatus may be apparatus for running or hanging a liner
28 or screen. Alternatively, the downhole apparatus is
29 directional drilling apparatus.

30

31 Preferably, the first and second bodies include central
32 bores therethrough, such that the sub has a central bore
33 running axially therethrough. This arrangement allows

1 wireline and other tools to be located through the sub,
2 and also allows for circulation fluids, etc., through the
3 sub and the drill-pipe string, if desired.

4

5 Preferably a bearing sleeve is located between the first
6 and second bodies to provide smooth rotation relative to
7 each other.

8

9 Preferably, the sub includes at least one shear pin which
10 connects the sliding sleeve to the second cylindrical
11 body.

12

13 More preferably, the sliding sleeve includes at least one
14 locking dog. In this way, an initial pressure
15 differential will cause the shear pin to shear and the
16 sliding sleeve will move, such that the first and second
17 teeth move axially with respect to each other. The
18 locking dog can then engage the sliding sleeve with the
19 second cylindrical body to lock the sub in either of the
20 first or second positions.

21

22 In a preferred embodiment, the sub is initially set in
23 the first position, wherein the sliding sleeve is held to
24 the second cylindrical body with the first and second
25 teeth disengaged. In this arrangement, the second
26 cylindrical body can rotate with respect to the first
27 cylindrical body. If the first cylindrical body is
28 connected to a drill-pipe string, this arrangement allows
29 the drill-pipe string to be rotated while apparatus
30 attached to the second cylindrical body will be held
31 stationary. By the application of differential pressure,
32 the shear pin may shear and the sliding sleeve will move
33 axially over the second body until the locking dog

1 engages the sliding sleeve in a second position. The
2 second position has the first and second teeth engaged,
3 and thus rotation of the drill-pipe string and the first
4 cylindrical body will cause the second cylindrical body
5 to rotate with the first cylindrical body.

6

7 Optionally, a drop ball seat may be located within the
8 sub, in order to provide means for creating a pressure
9 differential in the sub.

10

11 Preferably, a spring is located between the first
12 cylindrical body and the sliding sleeve. In this way,
13 the sleeve can be biased toward the first or the second
14 position.

15

16 Advantageously, the sliding sleeve may incorporate an
17 index sleeve. In this way, a pin and groove arrangement
18 can allow the sliding sleeve to selectively rotate around
19 the second body, and move axially so that the sub can be
20 selectively engaged or disengaged any number of times.

21

22 According to a second aspect of the present invention,
23 there is provided a method of running a downhole
24 apparatus into a wellbore, the method comprising the
25 steps of:

26

- 27 (a) locating a swivel sub between a workstring and
28 a downhole apparatus;
- 29 (b) running the workstring into the wellbore while
30 rotating the workstring;
- 31 (c) creating a pressure differential in the swivel
32 sub to switch the sub between a first position,
33 in which the workstring rotates relative to the

1 downhole apparatus and a second position in
2 which the workstring and at least a portion of
3 the downhole apparatus rotate together.

4

5 The method may comprise the additional steps of rotating
6 the workstring with the swivel sub in the first position
7 such that the workstring rotates relative to the downhole
8 apparatus.

9

10 The method may comprise the additional step of rotating
11 the workstring with the swivel sub in its second position
12 such that the workstring and at least a portion of the
13 downhole apparatus rotate together.

14

15 The method may include the step of dropping a ball
16 through the workstring to land on a ball seat and create
17 the pressure differential.

18

19 The method may further include the step of locking the
20 sub in the second position.

21

22 The method may further include the step of creating a
23 further pressure differential to relocate the sub into
24 the first position and rotating the workstring relative
25 to the downhole apparatus.

26

27 The downhole apparatus may comprise a running or setting
28 tool. Preferably, the portion which rotates with the
29 workstring is the running or setting tool.

30

31 In one embodiment, the downhole apparatus comprises a
32 running or setting tool for a liner or screen.

1 Alternatively, the downhole apparatus comprises
2 directional drilling equipment.

3

4 According to a third aspect of the invention, there is
5 provided a method of running a downhole apparatus into a
6 wellbore, the method comprising the steps of:

7

- 8 (a) locating a swivel sub between a workstring and
9 a downhole apparatus;
- 10 (b) running the workstring into the wellbore while
11 rotating the workstring;
- 12 (c) creating a pressure differential in the swivel
13 sub to switch the sub between a first position,
14 in which the workstring rotates relative to the
15 downhole apparatus and a second position in
16 which the workstring and at least a portion of
17 the downhole apparatus rotate together.

18

19 The method may comprise the additional step of rotating
20 the workstring with the swivel sub in the first position
21 such that the workstring rotates relative to the downhole
22 apparatus.

23

24 The method may comprise the additional step of rotating
25 the workstring with the swivel sub in its second position
26 such that the workstring and at least a portion of the
27 downhole apparatus rotate together.

28

29 The method may include the step of dropping a ball
30 through the drill-pipe string in order to create the
31 pressure differential.

32

1 Further, the method may include the step of creating a
2 further differential pressure to switch the sub back to
3 the first position and rotating the drill-pipe string and
4 downhole apparatus together.

5

6 Preferably, the steps can be repeated any number of
7 times, so that the sub may be cycled between the first
8 and second positions.

9

10 According to a fourth aspect of the invention there is
11 provided a method of running downhole apparatus into a
12 wellbore, the method comprising the steps of:

13

14 (a) locating a swivel sub between a workstring and
15 the downhole apparatus;

16 (b) rotating the workstring with the swivel sub in
17 an engaged position, such that the workstring
18 rotates with the downhole apparatus;

19 (c) running the apparatus on the workstring into a
20 wellbore, while rotating the workstring and the
21 apparatus;

22 (d) creating a pressure differential in the swivel
23 sub, such that the sub switches to a disengaged
24 position, such that the workstring can be
25 rotated relative to the downhole apparatus.

26

27 The method may comprise the additional step of rotating
28 the workstring relative to the downhole apparatus.

29

30 The method may comprise the additional steps of creating
31 a further differential pressure to switch the sub back to
32 the engaged position, and; rotating the workstring and
33 downhole apparatus together.

1

2 According to a fifth aspect of the present invention,
3 there is provided a swivel sub for connection in a work
4 string between a drill-pipe string and a screen or liner
5 assembly, the sub comprising a first substantially
6 cylindrical body, including a sleeve portion having one
7 or more first teeth arranged on a surface thereof; a
8 second substantially cylindrical body being partially
9 located within the sleeve portion and the bodies being
10 arranged to rotate relative to each other; a sliding
11 sleeve, including one or more second teeth arranged on a
12 surface thereof, to mutually engage with the first teeth;
13 the sliding sleeve being axially moveable between a first
14 position, wherein the first and second teeth are
15 disengaged and a second position, wherein the first and
16 second teeth are engaged; and means to lock the sliding
17 sleeve to the second cylindrical body.

18

19 According to a sixth aspect of the invention there is
20 provided a method of running a screen or liner into a
21 wellbore, the method comprising the steps:

22

- 23 (a) locating a swivel sub between a drill-pipe
24 string and a liner or screen assembly;
- 25 (b) rotating the drill-pipe string with the swivel
26 sub in a first position, such that the drill-
27 pipe string rotates relative to the assembly;
- 28 (c) running the drill-pipe string into the wellbore
29 while rotating the drill-pipe string;
- 30 (d) creating a pressure differential in the swivel
31 sub to switch the sub into a second position,
32 such that the drill-pipe string and at least a
33 portion of the assembly rotate together; and

1 (e) rotating the drill-pipe string and the portion
2 of the assembly.

3

4 According to a seventh aspect of the present invention,
5 there is provided a method of running downhole apparatus
6 into a wellbore, the method comprising:

7

8 (a) locating a swivel sub between a drill-pipe
9 string and the downhole apparatus;

10 (b) rotating the drill-pipe string with the swivel
11 sub in a first position, such that the drill-
12 pipe string rotates with the downhole
13 apparatus;

14 (c) running the apparatus on the drill-pipe string
15 into a wellbore, while rotating the drill-pipe
16 string and the apparatus;

17 (d) creating a pressure differential in the swivel
18 sub, such that the sub switches to a second
19 position, such that the drill-pipe string can
20 be rotated relative to the downhole apparatus;
21 and

22 (e) rotating the drill-pipe string relative to the
23 downhole apparatus.

24

25 Preferred embodiments of the fifth to seventh aspects of
26 the invention may include features of the embodiments of
27 the first to fourth aspects of the invention.

28

29 Embodiments of the present invention will now be
30 described by way of example only, with reference to the
31 following drawings, of which:

32

1 Figure 1 is a cross-sectional view through a swivel sub
2 according to a first embodiment of the present invention,
3 in an unlocked configuration;

4

5 Figure 2 is a cross-sectional view through the sub of
6 Figure 1 in a second, locked configuration;

7

8 Figure 3 is a sectional view through the Line A-A of
9 Figure 2; and

10

11 Figure 4 is a schematic view of a swivel sub according a
12 further embodiment of the present invention.

13

14 Reference is initially made to Figure 1 of the drawings,
15 which illustrates a swivel sub, generally indicated by
16 reference numeral 10, according to the first embodiment
17 of the present invention. Sub 10 comprises a first
18 cylindrical body 12 having at an upper end 14, a box
19 section 16 for connecting the body 12 to a drill-pipe
20 string (not shown). The body 12 includes a bore 18
21 therethrough and at a lower end 20 there is provided a
22 sleeve 22 extending from the body 12. Located within the
23 sleeve 22 is a bearing sleeve 24 which includes bearings
24 26a,b to provide a rotational coupling to anything placed
25 adjacent to the bearing sleeve 24.

26

27 Located within the bearing sleeve 24 and thus
28 rotationally coupled to it, is an inner mandrel 28.

29 Inner mandrel 28 is a cylindrical body having a central
30 bore 30 located therethrough. At an upper end 32, distal
31 to the bearing sleeve 24, is a pin section 34 for
32 connecting the sub to a downhole apparatus (not shown).

33

1 Attached to the sleeve 22 is a locking sleeve 36 which
2 may form part thereof. The locking sleeve 36 abuts an
3 outer surface 38 of the mandrel 28. Locking sleeve 36 is
4 preferably screwed to the sleeve 22 and has at an upper
5 end 40 a narrowed portion 42 which has, on its outer
6 surface 44, six teeth 46a-f, as illustrated in Figure 3.

7

8 Located on the outer surface 38 of the mandrel 28 is a
9 sliding sleeve 48. The sliding sleeve 48 is arranged to
10 travel longitudinally on the inner mandrel 28. Its
11 passage is restricted by an abutment face 50 on the
12 mandrel 28 and by engagement with the teeth 46 on the
13 locking sleeve 36. At an upper end 52 of the sliding
14 sleeve, arranged on an inner surface 54 thereof, are
15 located six teeth 56a-f, as illustrated in Figure 3.
16 Teeth 46, 56 are sized so that they can engage with each
17 other when axially brought together.

18

19 Located around the sliding sleeve 48 are six shear pins
20 58. The shear pins 58 are equidistantly spaced around
21 the sleeve 48, passing through apertures in the sleeve 48
22 into the inner mandrel 28. Thus, the sliding sleeve 48
23 is fixed to the inner mandrel 28.

24

25 In a first configuration, as shown in Figure 1, the shear
26 pins 58 fix the sliding sleeve 48 to the mandrel 28. The
27 sliding sleeve 48 is located against the abutment face
28 50. The teeth 46, 56 are disengaged with the upper end 52
29 of sleeve 48 being clear of the teeth 46 on the locking
30 sleeve 36 though there is still provided a small overlap
31 to assist in positioning the sleeves on the sub 10. Also
32 located on the sleeve 48 is a locking dog 60. This is a

1 sprung pin which is biased towards the inner mandrel 28.
2 In this embodiment, the dog 60 is compressed.
3
4 Reference is now made to Figure 3 of the drawings, which
5 illustrates the sub 10 of Figure 1, in a second
6 configuration. In Figure 3, shear pins 58 have been
7 sheared and the sliding sleeve 48 has been moved up so
8 that the teeth 46, 56 are completely engaged. The
9 locking dog 60 is now located over a recess 62 on the
10 inner mandrel 28. The dog 60 expands to locate a pin
11 into the recess 62. With the pin located in the recess
12 62, the sliding sleeve 48 is prevented from movement.
13 The locking sleeve 36, through engagement with the
14 sliding sleeve 48, is now locked to the inner mandrel 28.
15
16 In use, sub 10 is connected to a drill-pipe string via
17 the box section 16. A liner or screen is attached via a
18 liner hanging tool or running tool onto the pin section
19 34 at the lower end 32 of the sub 10. The sliding sleeve
20 48 is arranged in the configuration shown in Figure 1,
21 that is the sleeve is pulled back against the abutment
22 face 50 and the shear pins 58 are mounted through the
23 sleeve 48 into the inner mandrel 28. In this
24 configuration the sub is unlocked and the teeth 46, 56
25 are clear of each other and disengaged. The inner
26 mandrel 28 is now only connected to the top sub 10 via
27 the bearing sleeve 24. In this way, the body 12 and the
28 mandrel 28 can rotate independently of each other.
29
30 When run in a wellbore, the drill-pipe string at the
31 upper end 14 of the sub 10 can be rotated, while the
32 liner connected to the inner mandrel 28 can remain
33 stationary. No torque will be imparted onto the liner,

1 as it is all borne by the bearing sleeve 24. Further
2 rotation of the drill-pipe string above the sub is
3 achieved without tension or compression on the sub. This
4 means that once the screen or liner is at total depth
5 (TD), the drill string can continue to be rotated during
6 circulation to aid in hole displacement, and cuttings or
7 debris removal without fear of imparting rotation or
8 torque below.

9

10 If rotation of the liner hanger or setting tool is
11 required, a differential pressure is induced within the
12 sub 10. This can be done by dropping a ball from the
13 surface of the wellbore through the bores 18 and 30 of
14 the sub, and into a ball seat. The ball seat may be
15 mounted in the inner mandrel 28 or, alternatively, it may
16 be located in the liner hanging tool or running tool
17 mounted on the pin 34 of the inner mandrel 28. On
18 passing a ball into the bore 30, fluid can be circulated
19 through the bore 30 to induce a pressure build up within
20 the sub 10, pressure outside the sub on the sliding
21 sleeve 48 will induce movement in the sleeve 48.
22 Sufficient force of the movement will break the shear
23 pins 58, allowing the sleeve 48 to move.

24

25 Sleeve 48 will move towards the upper end 14 of the sub
26 10. As the sleeve 48 moves, the teeth 56 pass between
27 the teeth 46 on the locking sleeve 36. The engagement of
28 the teeth 46,56 causes the sleeves 36, 48 to couple until
29 the locking pin 60 reaches the recess 62, whereupon
30 movement of the sliding sleeve 48 is then prevented. In
31 this position, teeth 46, 56 are fully engaged and the
32 sliding sleeve 48 is locked to the inner mandrel 28.
33 Torque now imparted from the drill-pipe string will cause

1 rotation of the body 12 and the locking sleeve 36. By
2 virtue of the engagement of the teeth 46,56, the sliding
3 sleeve 48 will be forced to rotate with the body 12. As
4 the sliding sleeve 48 is locked to the inner mandrel 28,
5 the inner mandrel will now also rotate with the body 12,
6 thus the entire sub 10 will rotate with the drill string.

7
8 This feature can be considered an emergency device that
9 can be used to help screen deployment running tools that
10 perhaps will not release easily. Having an ability to
11 rotate the running tools to free them from the running
12 assembly, may prevent the unnecessary upward movement of
13 the screens or liner once deployed. The lock-up feature
14 could also be necessary if hydraulically tools were
15 required to be released by their emergency release
16 features, i.e., through left-hand rotation, as is the
17 case for some liner hanger tools used for screen
18 deployments.

19
20 In the embodiment shown, a predetermined differential
21 pressure at the sub of around 2,500psi is required to
22 disengage the sliding sleeve and cause movement into the
23 locked position. The differential pressure can be
24 achieved by pushing up against a ball on a shearable ball
25 seat. It could also be applied by running a retrievable
26 plug to a profile at the bottom of the sub 10. The
27 retrievable plug would be inserted through the bores 18
28 and 30 of the sub 10.

29
30 Reference is now made to Figure 4 of the drawings which
31 shows a swivel sub generally indicated by reference
32 numeral 110, according to a further embodiment of the
33 present invention. Like parts to those of the swivel sub

1 10 shown in Figures 1 to 3, have been given the same
2 reference numeral with the addition of 100. The
3 embodiment in Figure 4 is similar to the swivel sub 10 of
4 Figures 1 to 3, but comprises two additional features.
5 The first of these is the incorporation of a spring 70
6 located between the sleeves 136 and 148. A first end 72
7 of spring 70 is located within a recess 74 in the upper
8 face 152 of the sliding sleeve 148. An opposing end 76
9 of the spring 70 is located in a recess 78 within a
10 portion 80 of a locking sleeve 136, behind the teeth 146.

11

12 In use, when the differential pressure increases
13 sufficiently to shear the shear pin 158, the sleeve 148
14 will move over the sleeve 136 for the teeth 146, 156 to
15 engage. As the sleeve 148 moves, the spring 70 is
16 compressed. As long as the differential pressure is
17 maintained, the sleeve 148 will remain over the teeth 146
18 and the sub 110 will rotate in its entirety. Release of
19 the differential pressure will cause the sleeve 148 to
20 drop so that it falls back to the abutment face 150. On
21 reaching the abutment face 150, the sub 110 is now
22 disengaged and the body 112 connected to the drill-pipe
23 string can be rotated relative to the inner mandrel 128.

24

25 It will be appreciate that merely by varying the
26 differential pressure across the sub 110, the sub 110 can
27 be moved from the engaged to disengaged position any
28 number of times. The sub 110 therefore has an advantage
29 over the sub 10, in that it can be used repeatedly.
30 However, the sub 10 has the advantage that it can be
31 locked in either position.

32

1 A further feature which may be added to the sub 110 is
2 the incorporation of an index sleeve 82. The index
3 sleeve 82 forms a portion of the inner mandrel 128 and
4 comprises a continuous groove 86 machined
5 circumferentially around the outer surface 138 of the
6 mandrel 128. Located on the inner surface 154 of the
7 sliding sleeve 148 is a pin 84. Although only one pin is
8 illustrated, it will be appreciated that a number of pins
9 may be used to increase the stability of the sub 110 and
10 distribute the loading on the sub 110 in use. Pin 84
11 locates in the groove 86. Groove 86 is a typical J-slot
12 arrangement which is circumferentially arranged around
13 the inner mandrel 128.

14

15 In use, the pin 84 is initially located in a first slot
16 and by varying the differential pressure on the sub 110
17 and via the bias on the spring 70, the pin 84 is moved
18 around the groove 86. It can be appreciated that the pin
19 84 may be arranged on the sleeve 48, while the groove 86
20 is arranged on the inner mandrel 128. The arrangement of
21 the J-slots would then be repositioned accordingly.

22

23 The principal advantage of the present invention is that
24 it provides a swivel sub which allows a workstring to be
25 rotated above the sub, while a downhole apparatus, such
26 as a screen, liner assembly, or drill bit below the sub
27 is not affected by the rotation or torque.

28

29 A further advantage of the present invention is that it
30 provides a swivel sub, wherein the rotational coupling
31 can be selectively deployed so that, if necessary, the
32 torque can be imparted through the sub.

33

1 A yet further advantage of the present invention is that
2 it provides a swivel sub in which relative rotation
3 between the workstring above and downhole apparatus, such
4 as a screen, liner assembly, or drill bit below the sub,
5 can be achieved without compression or tension at the
6 sub.

7

8 It will be appreciated that while the terms 'upper' and
9 'lower together with 'top' and 'bottom' have been used
10 within this specification, they are relative terms and
11 the sub could find equal application in deviated or
12 horizontal wellbores.

13

14 Various modifications may be made to the invention herein
15 described without departing from the scope thereof. For
16 instance, although the change in differential pressure
17 has been described by the action of a ball landing on a
18 shearable ball seat or by running of a retrievable plug
19 to a profile at the bottom of the sub, the movement of
20 the sliding sleeve can also be effected by the
21 application of hydraulics on the surface, or indeed by
22 other mechanical means. Additionally, the embodiments
23 described show a sub wherein the drill-pipe string can
24 rotate relative to apparatus connected at the base of the
25 sub during run-in, the sub could equally be set such that
26 the sub is locked to provide through rotation during run-
27 in, and then unlocked in a position in the wellbore.
28 This feature may be suitable for the operation of
29 hydraulic tools located at the base of the sub.

1 Claims

2

3 1. A swivel sub for connection in a work string
4 between a workstring and a downhole apparatus, the
5 sub comprising a first substantially cylindrical
6 body, including a sleeve portion having one or more
7 first teeth arranged thereon; a second
8 substantially cylindrical body being partially
9 located within the sleeve portion and the bodies
10 being arranged to rotate relative to each other; a
11 sliding sleeve, including one or more second teeth
12 arranged thereon, to mutually engage with the first
13 teeth; the sliding sleeve being axially moveable
14 between a first position, wherein the first and
15 second teeth are disengaged and a second position,
16 wherein the first and second teeth are engaged; and
17 means to engage the sliding sleeve with the second
18 cylindrical body.

19

20 2. The swivel sub as claimed in Claim 1 wherein the
21 sliding sleeve is operated by a hydraulic system.

22

23 3. The swivel sub as claimed in Claim 1 or Claim 2
24 wherein the sliding sleeve is moved by virtue of a
25 pressure differential in the sub.

26

27 4. The swivel sub as claimed in Claim 3 wherein the
28 pressure differential is created by dropping a ball
29 into a ball seat of a downhole apparatus located
30 below the sub.

31

32 5. The swivel sub as claimed in Claim 1 wherein the
33 sliding sleeve is moved by a mechanical system.

- 1
- 2 6. The swivel sub as claimed in any preceding Claim
3 wherein the first cylindrical body is a top sub,
4 including means for connecting the top sub to a
5 workstring.
6
- 7 7. The swivel sub as claimed in any preceding Claim
8 wherein second cylindrical body is an inner mandrel
9 including means for connecting the inner mandrel, at
10 a lower end, to a downhole apparatus.
11
- 12 8. The swivel sub as claimed in Claim 7 wherein the
13 downhole apparatus is apparatus for running or
14 hanging a liner or screen.
15
- 16 9. The swivel sub as claimed in Claim 7 wherein the
17 downhole apparatus is directional drilling
18 apparatus.
19
- 20 10. The swivel sub as claimed in any preceding Claim
21 wherein the first and second bodies include central
22 bores therethrough, such that the sub has a central
23 bore running axially therethrough.
24
- 25 11. The swivel sub as claimed in any preceding Claim
26 wherein a bearing sleeve is located between the
27 first and second bodies to provide smooth rotation
28 relative to each other.
29
- 30 12. The swivel sub as claimed in any preceding Claim
31 wherein the sub includes at least one shear pin
32 which connects the sliding sleeve to the second
33 cylindrical body.

1

2 13. The swivel sub as claimed in any preceding Claim
3 wherein the sliding sleeve includes at least one
4 locking dog.

5

6 14. The swivel sub as claimed in Claim 13 wherein the
7 locking dog is adapted to engage the sliding sleeve
8 with the second cylindrical body to lock the sub in
9 either of the first or second positions.

10

11 15. The swivel sub as claimed in any preceding Claim
12 wherein the sub is initially set in the first
13 position, wherein the sliding sleeve is held to the
14 second cylindrical body with the first and second
15 teeth disengaged.

16

17 16. The swivel sub as claimed in any preceding Claim
18 wherein a drop ball seat is located within the sub,
19 in order to provide means for creating a pressure
20 differential in the sub.

21

22 17. The swivel sub as claimed in any preceding Claim
23 further comprising biasing means for biasing the
24 sliding sleeve toward the first or the second
25 position.

26

27 18. The swivel sub as claimed in Claim 17 wherein the
28 biasing means is a spring.

29

30 19. The swivel sub as claimed in any preceding Claim
31 wherein the sub incorporates an index sleeve.

32

- 1 20. A method of running a downhole apparatus into a
2 wellbore, the method comprising the steps of:
3
- 4 (a) locating a swivel sub between a workstring and
5 a downhole apparatus;
 - 6 (b) running the workstring into the wellbore while
7 rotating the workstring;
 - 8 (c) creating a pressure differential in the swivel
9 sub to switch the sub between a first position,
10 in which the workstring rotates relative to the
11 downhole apparatus and a second position in
12 which the workstring and at least a portion of
13 the downhole apparatus rotate together.
14
- 15 21. The method as claimed in Claim 20 comprising the
16 additional step of rotating the workstring with the
17 swivel sub in the first position such that the
18 workstring rotates relative to the downhole
19 apparatus.
20
- 21 22. The method as claimed in Claim 20 or Claim 21
22 comprising the additional step of rotating the
23 workstring with the swivel sub in its second
24 position such that the workstring and at least a
25 portion of the downhole apparatus rotate together.
26
- 27 23. The method as claimed in any of Claims 20 to 22
28 comprising the additional step of dropping a ball
29 through the workstring to land on a ball seat and
30 create the pressure differential.
31

- 1 24. The method as claimed in any of Claims 20 to 23,
2 further including the step of locking the sub in the
3 second position.
4
- 5 25. The method as claimed in any of Claims 20 to 24
6 wherein step (c) is repeated so that the sub is
7 cycled between the first and second positions.
8
- 9 26. The method as claimed in any of Claims 20 to 25
10 wherein the downhole apparatus comprises a running
11 or setting tool.
12
- 13 27. The method as claimed in Claim 26 wherein the
14 portion which rotates with the workstring is the
15 running or setting tool.
16
- 17 28. The method as claimed in Claim 26 or Claim 27
18 wherein the downhole apparatus comprises a running
19 or setting tool for a liner or screen.
20
- 21 29. The method as claimed in any of Claims 20 to 25
22 wherein the downhole apparatus comprises directional
23 drilling equipment.
24
- 25 30. A method of running a downhole apparatus into a
26 wellbore, the method comprising the steps of:
27
- 28 (a) locating a swivel sub between a workstring and
29 a downhole apparatus;
30 (b) rotating the workstring with the swivel sub in
31 a first position, such that the workstring
32 rotates relative to the downhole apparatus;

- 1 (c) running the workstring into the wellbore while
2 rotating the workstring;
- 3 (d) creating a pressure differential in the swivel
4 sub to switch the sub into a second position,
5 such that the workstring and at least a portion
6 of the downhole apparatus rotate together.
7
- 8 31. The method as claimed in Claim 30 further including
9 the step of rotating the workstring and the portion
10 of the downhole apparatus.
11
- 12 32. The method as claimed in Claim 30 or Claim 31
13 further including the step of creating a further
14 pressure differential to relocate the sub into the
15 first position and rotating the workstring relative
16 to the downhole apparatus.
17
- 18 33. A method of running downhole apparatus into a
19 wellbore, the method comprising the steps of :
20
- 21 (a) locating a swivel sub between a workstring and
22 the downhole apparatus;
- 23 (b) rotating the workstring with the swivel sub in
24 an engaged position, such that the workstring
25 rotates with the downhole apparatus;
- 26 (c) running the apparatus on the workstring into a
27 wellbore, while rotating the workstring and the
28 apparatus;
- 29 (d) creating a pressure differential in the swivel
30 sub, such that the sub switches to a disengaged
31 position, such that the workstring can be
32 rotated relative to the downhole apparatus.
33

1

2 34. The method as claimed in Claim 33 further comprising
3 the step of rotating the workstring relative to the
4 downhole apparatus.

5

6 35. The method as claimed in Claim 33 or Claim 34
7 further including the steps of creating a further
8 differential pressure to switch the sub back to the
9 engaged position, and; rotating the workstring and
10 downhole apparatus together.

11

12 36. A swivel sub for connection in a work string between
13 a drill-pipe string and a screen or liner assembly,
14 the sub comprising a first substantially cylindrical
15 body, including a sleeve portion having one or more
16 first teeth arranged on a surface thereof; a second
17 substantially cylindrical body being partially
18 located within the sleeve portion and the bodies
19 being arranged to rotate relative to each other; a
20 sliding sleeve, including one or more second teeth
21 arranged on a surface thereof, to mutually engage
22 with the first teeth; the sliding sleeve being
23 axially moveable between a first position, wherein
24 the first and second teeth are disengaged and a
25 second position, wherein the first and second teeth
26 are engaged; and means to lock the sliding sleeve to
27 the second cylindrical body.

28

29 37. A method of running a screen or liner into a
30 wellbore, the method comprising the steps:

31

32 (a) locating a swivel sub between a drill-pipe
33 string and a liner or screen assembly;

- 1 (b) rotating the drill-pipe string with the swivel
2 sub in a first position, such that the drill-
3 pipe string rotates relative to the assembly;
4 (c) running the drill-pipe string into the wellbore
5 while rotating the drill-pipe string;
6 (d) creating a pressure differential in the swivel
7 sub to switch the sub into a second position,
8 such that the drill-pipe string and at least a
9 portion of the assembly rotate together; and
10 (e) rotating the drill-pipe string and the portion
11 of the assembly.

12

13 38. A method of running downhole apparatus into a
14 wellbore, the method comprising:

15

- 16 (a) locating a swivel sub between a drill-pipe
17 string and the downhole apparatus;
18 (b) rotating the drill-pipe string with the swivel
19 sub in a first position, such that the drill-
20 pipe string rotates with the downhole
21 apparatus;
22 (c) running the apparatus on the drill-pipe string
23 into a wellbore, while rotating the drill-pipe
24 string and the apparatus;
25 (d) creating a pressure differential in the swivel
26 sub, such that the sub switches to a second
27 position, such that the drill-pipe string can
28 be rotated relative to the downhole apparatus;
29 and
30 (e) rotating the drill-pipe string relative to the
31 downhole apparatus.

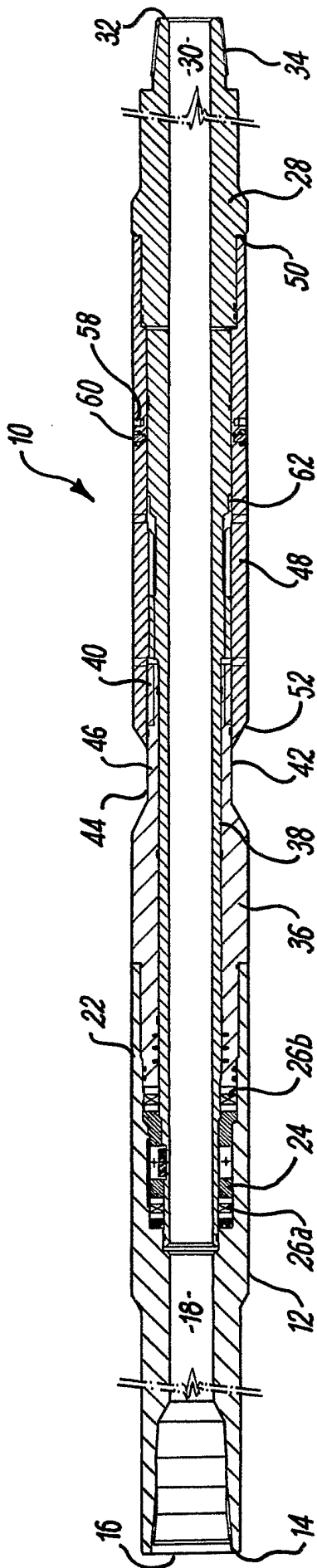


FIG. 1

1/2

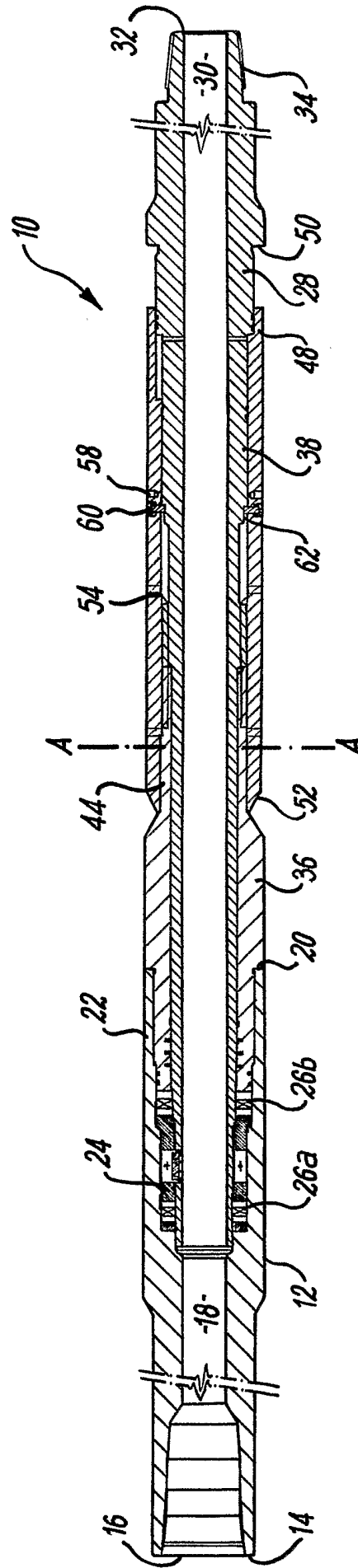


FIG. 2

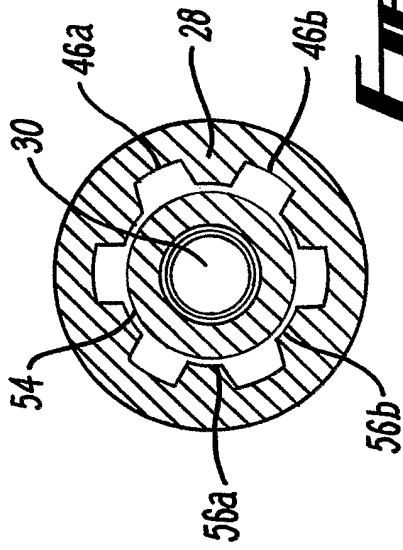


FIG. 3

2/2

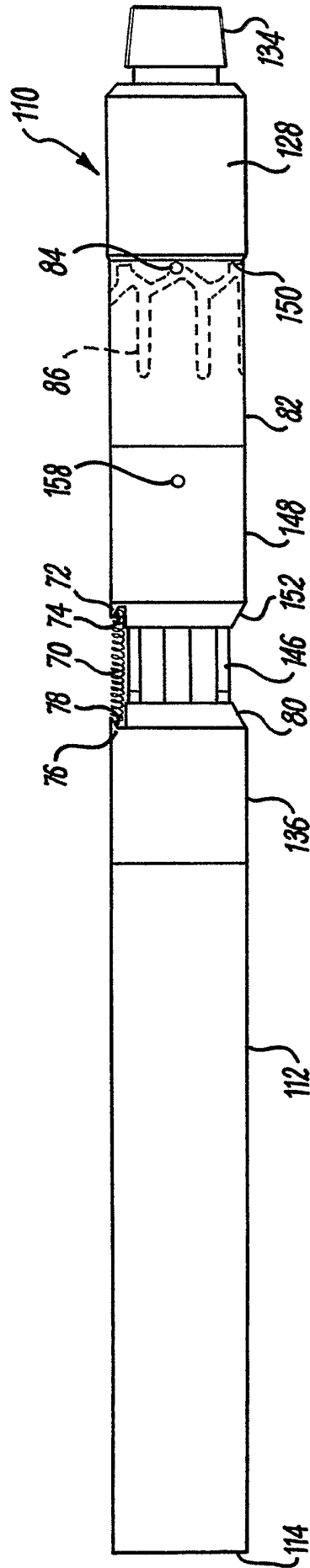


FIG. 4