

Top Drive Operated Casing Running Tool

FIELD OF THE INVENTION

[0001] The field of the invention is tools that assemble and deliver tubular strings into a borehole and more particularly top drive driven tools that allow circulation, makeup and movement of the string as it is assembled into the borehole.

BACKGROUND OF THE INVENTION

[0002] In the past manipulation, threading and circulation of casing or tubulars was done with a variety of tools such as fill up and circulation tools that featured a seal to the inside or the outside of the tubular to be able to pump fluid as the tubular string was lowered into the borehole or to initially fill that last segment that was added to the string before running in. Typically the handling of a joint to be added to a string was done with elevators and the threading was accomplished with tongs. Such tools are illustrated in USP 6578632; 5971079; 7028769; 7665515 and 6173777.

[0003] More recently systems have been developed that employ the top drive for rotation and axial movement of a tubular joint to be made up to an existing string and advanced into the borehole. These are rather complex devices that rely on cam pairs to convert rotation to axial movement of slips that cams the slips radially outwardly or inwardly to grip the inside or the outside of a tubular. They feature opposed cam pairs to allow slip actuation with bi-directional rotation and a lock position in between to allow for release. These designs are highly complex and expensive to produce and present complications that could require significant downtime for maintenance. The design is illustrated in in USP 8,424,939 and 7,909,120.

[0004] In a first embodiment of the present invention enables selective grip and release of a tubular joint to thread a connection and to rotate a string while facilitating release to get the next joint in the string connected. The device may include a lower end seal preferably in the form of a cup seal and slips in a housing that respond to axial movement of an actuating member. The actuating member is connected to a clutched drive that is engaged for power delivery and disengaged with set down weight from the top drive. Drive

rotation turns a thread that is engaged to the actuating member to move the actuating member axially in one of two opposed direction for radial extension or retraction of the slip segments. With the slips engaged the string can be rotated while lowered or lifted. With the string supported from the rig floor the top drive can radially allow the slips to retract with rotation. Those skilled in the art will have a better understanding of the present invention from the description of the preferred embodiment and the associated drawings while recognizing that the full scope of the invention is to be found in the appended claims.

[0005] In an alternative embodiment the components are rotationally locked to the housing of the tool as it is inserted into the casing as well as when weight is set down after the slips are extended to grab the casing. In between is a position that allows one or more parts to be rotated that engage with another part that is limited to axial movement so that a multi-ramped mandrel extends the slips to grip. When the slips are set with the needed torque the relatively rotating components are rotationally locked to the housing such that top drive rotation of the housing will turn the string rather than further trying to extend the slips, this avoiding potential damage to the casing from slip overextension.

SUMMARY OF THE INVENTION

[0006] A casing running tool is connected to a top drive with a clutch that operates with set down weight against a spring resistive force. Setting down weight with rotation in a first direction raises an actuation member that pushes the slips out radially. The weight of the string then keeps the slips in position so that the string can be picked up and the rig floor slips removed followed by lowering the string while circulating and rotating. With slips set inside the joint and the string hanging free rotating the top drive rotates the string as the string is lowered. With slips again supporting the string on the rig floor the top drive can be rotated in an opposed direction with weight set down to back off the slips and to remove it from the top joint.

[0007] In an alternative embodiment, spring loaded dogs can be attached to the housing to engage the casing internally or externally to facilitate extension or retraction of the slips that selectively grab the topmost of a string of casing. When the tool is suspended from the top drive, its components are

rotationally locked to facilitate insertion into the casing stand on top of a string being run in the hole. Some set down weight allows top drive rotation to move a multi-ramped mandrel axially because that mandrel is rotationally locked to the housing that is held fast by the spring loaded dogs bearing on the casing. Once the slips are extended with a specified torque applied from the top drive, further setting down weight locks the components and the housing so that applied rotation with setting down weight will turn the casing string but will not torque up the slips beyond their set position which could cause stress cracks to the casing. A return spring returns the components to a rotationally locked position with respect to the housing so the process can be repeated after the slips get retracted with rotation in an intermediate position between hanging and weight fully set down. Components can be rotationally locked when driving in the string into the borehole with backpressure from circulating fluid employed to hold the components in a rotationally locked relation so that the string can be manipulated as it is inserted without slip radial movement in opposed directions.

[0007a] According to a first aspect of the present invention, there is provided a top drive operated tubular running tool assembly, comprising: a housing supported by the top drive; a gear driven assembly in said housing to selectively transmit rotational input from the top drive and convert such rotation to axial movement of an actuator member operably linked to at least one slip for selective grip and release of a tubular by said slip; said selective transmission of rotational input comprises a clutch.

[0007b] According to a second aspect of the present invention, there is provided a top drive operated tubular running tool assembly, comprising: a housing supported by the top drive; a gear driven assembly in said housing to selectively transmit rotational input from the top drive and convert such rotation to axial movement of an actuator member operably linked to at least one slip for selective grip and release of the tubular by said slip; said selective transmission of rotational input comprises a clutch; said clutch is biased to a first position where rotation of the top drive will not move said actuator member axially.

[0007c] According to a third aspect of the present invention, there is provided a top drive operated tubular running tool assembly, comprising: a

housing supported by the top drive; an assembly in said housing to selectively transmit rotational input from the top drive and convert such rotational input to movement of an actuator member operably linked to at least one slip for selective grip and release of a tubular by said slip; said assembly selectively locking said actuator from relative movement with respect to the housing.

[0007d] According to a fourth aspect of the present invention, there is provided a method of using a tubular running tool for assembling a string and running the string into a subterranean location, comprising: supporting a running tool at a surface location; providing at least one slip on said running tool to selectively engage and release the tubular upon movement of an actuator with respect to a housing of said running tool; mechanically selectively disabling said actuator from moving with respect to said housing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 shows the device in the run in position;

[0009] FIG. 2 is the view of FIG. 1 with weight set down before the spring is compressed;

[0010] FIG. 3 is the view of FIG. 2 with the spring compressed just before rotation that will extend the slips;

[0011] FIG. 4 shows the actuating member having moved up as a result of rotation that sets the slips;

[0012] FIG. 5 shows the slips extended on the multiple ramps of the actuating member;

[0013] FIG. 6 is a close up showing three of four slips in the set position;

[0014] FIG. 7 is the view of FIG. 6 with the slips in the retracted position;

[0015] FIG. 8 is a detailed view of the spline inside the housing wall which acts as a rotational lock when there is no set down weight from the top drive;

[0016] FIG. 9 is a section view of an alternative embodiment shown in the suspended position and inserted into the casing;

[0017] FIG. 10 is the view of FIG. 9 with weight set down to then allow slip extension with rotation;

[0018] FIG. 11 is the view of FIG. 10 after rotation that has extended the slips against the casing; and

[0019] FIG. 12 is the view of FIG. 11 showing setting down weight after setting the slips to allow pushing on the casing string and rotated when running in the casing without further extending the slips.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] Referring to FIG. 1 a top drive **TD** is schematically illustrated as supporting a top sub **3** at threads **30**. The top sub **3** is rotationally locked to driving nut **1** that is captured above shoulder **32** leaving an exposed annular surface **34** on which spring **5** exerts an upward force. Driving nut **1** is rotationally locked to top sub **3** with locking balls **9** although other ways to rotationally lock can be used. Drive nut **1** has an exterior gear pattern or splines **36** that in the FIG. 1 position are engaged with an internal gear or splines **38** on driven nut **2** and with splines **39** on an interior wall of the housing **7** when subjected to the force of spring **5**. Splines **39** are best seen in FIG. 8 when the driving gear **1** is pushed down to expose splines **39**. Driven nut **2** is mounted to rotate in housing components **6** and **7**. Driven nut **2** is connected to actuator **10** at thread **40** such that rotation of the driven nut **2** by driving nut **1** through meshed splines **36** and **38** result in axial translation of actuator **10** into or out of the coils of spring **5**. As better seen in FIG. 5 ramps **42** on actuator **10** engage a parallel pattern of inclined ramps **44** on slip segments **11** that are mounted for radial extension into casing **14** for contact with the interior of a casing joint **48** that is shown in FIG. 6. A flow passage **51** leads to outlets **55** for circulating fluid as the casing string is lowered into a borehole. A cup seal **12** has a downward orientation to hold pressure in the casing string **14** with returns coming back to the surface outside the casing string **14**.

[0021] To make the actuator **10** move axially, weight is set down with the top drive **TD** pushing the ring **50** against the top **52** of the driving nut **1**, as shown in FIG. 2. Further setting down weight compresses spring **5** and moves the splines **36** out of splines **39** and only into splines **38** to create meshing engagement as shown in FIG. 3. Note that in this position the actuator **10** is

about even with the spring support surface **54**. At this point rotation of the top drive **TD** in one direction raises actuator **10** which pulls ramps **42** axially which results in radial movement of the slip segments **11** out until the wickers or grip profile **56** engages the tubular **14** on surface **48**. With the slips segments **11** wedged into the tubular **14**, the top drive **TD** is raised up so that the support slips in the rig floor that support the balance of the string below the tubular just threaded to the string, can be removed so that the top drive **TD** with slip segments **46** engaged to the tubular **48** now supports the string but splines have reengaged due to the return force of spring **5** and the fact that weight is no longer being set down as the entire string is hanging on the slip segments. At this point the splines on the driving nut **1** are engaged to splines **39** on the upper housing **7** so that top drive **TD** rotation simply turns the housing **6, 7** and with it the slip **11** that is secured to the housing **6, 7**. The top drive **TD** can be turned in either direction with the string weight hanging without risk of release of the slips. The driller can watch the weight indicator to determine that the hanging condition of the string is maintained before operation of the top drive **TD** in rotation.

[0022] It should be noted that spring **5** is optional and the same result can be obtained by moving a precise distance in either or both opposed directions with the top drive to get the desired engagement that allows slip extension or tubular rotation with the weight of the string hanging off the top drive as well as the release of the slips from the string when needed.

[0023] In order to release from the string **14** after filling and circulating through the string **14** as it is advanced into the borehole, slips on the rig floor (not shown) are set to support the string **14** from the rig floor and allow weight to be set down by lowering the top drive **TD** so that the FIG. 3 position is resumed. At this point the top drive **TD** is made to rotate driving nut **1** and the driven nut **2** in the opposite direction than the direction that set the slip segments **46** to make the actuator **10** move back axially in a downhole direction to allow the slip segments to radially retract. When the actuator **10** moves down it will pull the slip segments **46** inward for a grip release.

[0024] Those skilled in the art will appreciate that spring **5** can take different forms such as a sealed volume with compressible gas inside or a stack of Bellville washers for example. The top sub **3** can be a guide for the

axial movement of the actuator **10** while conducting flow through the cup seal **12**. The rotational lock with balls **9** can be splines or other structures. The design is simple and can be built economically for reliable operation. Setting down weight allows extension or retraction of the slips when accompanied by rotation from the top drive. Without setting down weight and rotating the top drive with the slips extended the tubular supported by the slips turns in tandem with the housing **6,7** and the slips **11** that is non-rotatably attached to it.

[0025] Referring now to FIGS. 9-12 similar parts will have the same number as the above described embodiment. FIG. 9 shows the tool inserted into the tubular **14** to the point of the travel stop **200** being positioned just above the top **202** of the tubular **14**. Actuator **10** is in a down position so that the slips **11** are retracted. Spring **18** pushes up on driving nut **1** which is rotationally locked at splines **39** to the housing **7**. Drag block housing **120** is attached to housing **7** and has drag blocks **121** biased by springs **122** against the outer wall **204** of the tubular **14**, which can be the topmost stand of a string of casing being run in or removed into or from a borehole that is not shown. Alternatively housing **120** can be inserted into the tubular **14** while still mounted to the housing **7** so that the inside wall **206** can be contacted by the drag blocks **121**. The force of springs **122** on drag blocks **121** hold the housing **7** as the top sub **3** is put into position to rotate by a downward force to release from driving nut **1** as shown in FIG. 2. This setting down weight compresses spring **5** to release parts for relative rotation as a kind of clutch. The top sub **3** in the FIG. 10 position will turn in tandem with driving nut **1** and driven nut **2** and relative to the housing **7**. That rotation raises the actuator **10** that is rotationally locked but axially movable due to the presence of thread **208**. As the actuator **10** rises the ramps **42** push out the slips **11** against the tubular **14** until the needed grip torque is sensed at the top drive that is not shown. Further setting down weight on top sub **3** will engage splines **101** and **102** so that all the parts **1, 2** and **3** are again locked to the housing **7** which means they all turn together and further force to extend the slips against the tubular **14** is precluded. This avoid overstressing the tubular **14** after setting the slips in it during efforts to advance the tubular string and rotate it to advance the string into a borehole should there be some resistance to running in the hole such as a deviation, or hole partial collapse or other reasons to resist the advancement

of the string associated with tubular **14**. FIG. 12 shows advancing and rotating the string in a manner that will not further extend the slips **11** when setting down weight.

[0026] Those skilled in the art will appreciate that the drag blocks help to hold the housing fixed with respect to the tubular **14** so as to overcome friction in thread **208** when the slips **11** are extended by rotation of parts **1**, **2** and **3** in tandem to raise the actuator **10** to extend slips **11**. For insertion in FIG. 9, the spring **5** insures that the parts in the housing **7** are locked to it so none of the parts relatively rotate. With some set down weight a second position is assumed where the drag blocks hold the housing **7** to the tubular **14** as items **1**, **2** and **3** rotate together relative to the actuator **10** that cannot rotate but can move axially due to thread **208**. The slips now can be extended with the top drive to the required torque. Setting down weight further to a third position again locks items **1**, **2** and **3** to the housing **7** so that rotating housing **7** will just rotate the tubular **14** without extending or retracting the slips **11**. Picking up allows spring **18** to get the parts **1**, **2** and **3** back to their original positions in FIG. 9.

[0027] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below:

We claim:

1. A top drive operated tubular running tool assembly, comprising:
a housing supported by the top drive;
a gear driven assembly in said housing to selectively transmit rotational input from the top drive and convert such rotation to axial movement of an actuator member operably linked to at least one slip for selective grip and release of a tubular by said slip;
said selective transmission of rotational input comprises a clutch.
2. The assembly of claim 1, wherein:
said gear driven assembly converts rotational input from the top drive into axial movement of said actuator member using a threaded connection therebetween.
3. The assembly of claim 1, wherein:
said gear driven assembly is selectively rotationally locked to said housing under the force of a bias.
4. The assembly of claim 1, wherein:
said actuator member drives said slip exclusively in a radial direction.
5. The assembly of claim 1, wherein:
said at least one slip has an elongated shape with a plurality of driven ramps that are in alignment with a plurality of driving ramps on said actuator member.
6. A top drive operated tubular running tool assembly, comprising:
a housing supported by the top drive;
a gear driven assembly in said housing to selectively transmit rotational input from the top drive and convert such rotation to axial movement of an actuator member operably linked to at least one slip for selective grip and release of the tubular by said slip;
said selective transmission of rotational input comprises a clutch;
said clutch is biased to a first position where rotation of the top drive will not move said actuator member axially.
7. The assembly of claim 6, wherein:
said bias is overcome with set down weight on a driving gear that at least in part acts as said clutch.
8. The assembly of claim 6, wherein:

said bias is accomplished with a coiled spring.

9. The assembly of claim 6, wherein:

axial movement of said driving gear against said bias maintains engagement with a driven gear for tandem rotation while disengaging said driving gear from said housing.

10. The assembly of claim 9, wherein:

rotation of said driven gear drives said actuator member axially.

11. The assembly of claim 10, wherein:

said driven gear is operably connected to said actuator member by a thread.

12. The assembly of claim 11, wherein:

said actuator member drives said slip exclusively in a radial direction.

13. The assembly of claim 12, wherein:

said at least one slip has an elongated shape with a plurality of driven ramps that are in alignment with a plurality of driving ramps on said actuator member.

14. The assembly of claim 12, further comprising:

a top sub adapted to be connected to the top drive and rotationally locked to said driving gear.

15. The assembly of claim 14, wherein:

said driving gear and driven gear are rotationally locked to said housing under a force provided by said biasing.

16. The assembly of claim 15, wherein:

said driving gear is released from being rotationally locked to said housing with a set down force that overcomes said biasing.

17. The assembly of claim 16, wherein:

said slip retains the tubular with said slip extended when the weight of said tubular is supported by said extended slip such that rotation of said housing by the top drive rotates the tubular.

18. The assembly of claim 14, wherein:

said top sub comprises a passage therethrough that acts as an axial movement guide for said actuator member;

said actuator member has an actuator passage therethrough so that there is flow communication through said passages in said top sub and said actuator member.

19. A top drive operated tubular running tool assembly, comprising:
a housing supported by the top drive;
an assembly in said housing to selectively transmit rotational input from the top drive and convert such rotational input to movement of an actuator member operably linked to at least one slip for selective grip and release of a tubular by said slip;
said assembly selectively locking said actuator from relative movement with respect to the housing.
20. The tool assembly of claim 19, further comprising:
a drag block assembly mounted to said housing for selective contact with the tubular to hold said housing against rotation as said assembly is rotationally unlocked from said housing and rotated by said top drive.
21. The tool assembly of claim 19, wherein:
said assembly comprises an actuator that is movable axially.
22. The tool assembly of claim 21, wherein:
said actuator is engaged to a rotating component of said assembly by a thread.
23. The tool assembly of claim 22, wherein:
rotation of said rotating component in opposed directions moves said actuator axially in opposed directions using said thread.
24. The tool assembly of claim 23, wherein:
said drag block assembly maintaining said housing stationary as said rotating component is rotated by overcoming frictional forces in said thread.
25. The tool assembly of claim 24, wherein:
said rotating component further comprises a top sub driven by the top drive that selectively engages said actuator to preclude movement of said slip as weight from the top drive is set on said top sub and a rotational force is applied to said top sub by the top drive.
26. The tool assembly of claim 25, wherein:
a return spring is compressed to engage said top sub with said actuator.
27. The tool assembly of claim 26, wherein:

setting down top drive weight on said top sub and against said return spring to a point short of engaging said actuator allows said top sub to rotate a driving and driven nuts in tandem with respect to said housing that is held by said drag blocks to the tubular.

28. The tool assembly of claim 27, wherein:

said thread is located on said driven nut.

29. The tool assembly of claim 28, wherein:

said at least one slip comprises a plurality of slips driven by said actuator on a series of multiple ramp surfaces.