Automated Pipe Tripping Apparatus and Methods

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a non-provisional application which claims priority from U.S. provisional application number 61/716,980, filed October 22, 2012.

Technical Field/Field of the Disclosure

[0002] The present disclosure relates generally to handling tubular strings on a drilling rig, and in particular to making up and breaking out tubular strings during a tripping in or tripping out operation.

Background of the Disclosure

[0003] In the oil and gas industry, wells are drilled into the earth to reach reservoirs of hydrocarbons buried deep within the ground. In drilling, servicing, and completing wellbores, so-called pipe strings are utilized. Pipe strings, including drill strings, casing strings, tool strings, etc. are made up of lengths of threadedly connected pipe sections joined end to end to reach the potentially great depths of wellbores. As an example, in a drilling operation, the drill string may include a bottomhole assembly (BHA) which may include a drill bit, mud motor, and a measurement while drilling (MWD) sensor array, as well as various other sensors, spacers and communications apparatuses.

[0004] As drilling progresses deeper into the Earth, lengths of drilling pipe are added at the top of the drilling string. Generally, two or three 30 foot lengths of drilling pipe are connected into so-called pipe stands prior to being added to the drilling string. The drilling rig hangs the drilling string on a pipe slips and disconnects the drilling string from the drawworks. The drilling rig lifts the next pipe stand above the drilling string with the drawworks and threadedly connects it to the drilling string using, in some instances, an automated or "iron" roughneck to, among other things, reduce personnel exposed to potentially dangerous environments on the drilling floor.

[0005] At times, the entire tubular string must be removed from the wellbore. Such a "tripping out" operation may be required if, for example, a drill bit breaks, a tool lowered into the wellbore must be returned to the surface, or a wellbore reaches its target depth. At times, the same or a new tubular string must be run back into the wellbore. Such a "tripping in" operation may, for

example, put the drill string with new drill bit back into the well, lower a downhole tool such as a packer, or insert a casing string into the wellbore to complete the well.

[0006] Since modern wells may become extremely deep, tripping out or tripping in operations may require a large number of threaded pipe joints to be disconnected (broken out) or connected (made up). Traditionally, the same drawworks, roughneck, and slips are used to make or break each connection. As the operation of a drilling rig can be extremely expensive, the need to trip in or trip out a tubular string may be a very costly operation. Additionally, damage may be caused to the wellbore simply by removing the tubular string from or inserting the tubular string into the wellbore. For instance, wellbore pressure may, in some circumstances, be rapidly increased or decreased by a rapid movement of a downhole tool. Commonly referred to as "swabbing", these pressure fluctuations may cause, for example, reservoir fluids to flow into the wellbore or may cause instability in a formation surrounding a wellbore.

Summary

[0006a] According to a first aspect of the present disclosure, there is provided a system, including: an outer frame, the outer frame including one or more vertical supports; an inner frame slidingly coupled to the outer frame and positioned to be moved vertically with respect to the outer frame, wherein the inner frame comprises a base disposed as a bottom portion of the inner frame; and an iron roughneck disposed in the inner frame and configured to make up or break out a threaded joint between a first tubular member and a second tubular member, wherein the iron roughneck is configured to be selectively movable between a first position above the base of the inner frame and a second position above the base of the inner frame.

[0006b] According to a second aspect of the present disclosure, there is provided a method, including: lifting a string at a relatively constant speed defining a tripping speed; moving an inner frame downward with respect to an outer frame to a first location; moving an iron roughneck relative to the inner frame into an upper position inside of the inner frame as the inner frame is moving downward with respect to the outer frame; moving the inner frame upwards relative to the outer frame at the tripping speed to align the iron roughneck with a threaded joint of the string; and breaking out the threaded joint with the iron roughneck.

[0006c] According to a third aspect of the present disclosure, there is provided an apparatus, including: an inner frame configured to be slidingly coupled to an outer frame, wherein the inner frame is configured to be moved vertically from a first position relative to the outer frame to a second position relative to the outer frame, wherein the inner frame comprises a base disposed as a bottom portion of the inner frame;

and an iron roughneck configured to be coupled to the inner frame, wherein the iron roughneck is configured to be movable between a first position above the base of the inner frame and a second position above the base of the inner frame, wherein the iron roughneck is configured to make up or break out members of a string, wherein the base comprises tripping slips disposed in the base of the inner frame, wherein the tripping slips are configured to selectively grip and support the string.

[0007] Disclosed herein is an automated pipe tripping apparatus. The automated pipe tripping apparatus may include an outer frame, the outer frame including one or more vertical supports; an inner frame, the inner frame slidingly coupled to the outer frame and positioned to be moved vertically by a lifting mechanism coupled between the inner and outer frames. The inner frame may include a tripping slips, the tripping slips positioned to receive a tubular member and selectively grip and support the tubular member; and an iron roughneck, the iron roughneck positioned above the tripping slips and positioned to receive the tubular member and make up or break out a threaded joint between a first and a second segment of the tubular member.

[0008] Disclosed herein is a method of removing a tubular member from a tubular string being removed from a wellbore. The tubular string may be made up of a series of threadedly connected tubular members. The method may include providing an automated pipe tripping apparatus. The automated pipe tripping apparatus may include an outer frame, the outer frame including one or more vertical supports; an inner frame, the inner frame slidingly coupled to the outer frame and positioned to be moved vertically by a lifting mechanism coupled between the inner and outer frames. The inner frame may include a tripping slips, the tripping slips positioned to receive a tubular member and selectively grip and support the tubular member; and an iron roughneck, the iron roughneck positioned above the tripping slips and positioned to receive the tubular member and make up or break out a threaded joint between a first and a second segment of the tubular member. The iron roughneck may be selectively movable in a vertical direction between a lower and an upper position by a roughneck lifting mechanism. The method may further include positioning the automated pipe tripping apparatus on a drilling floor of a drilling rig above the wellbore, the drilling rig including a drawworks, an elevator, an automated pipe handling device, and a drilling floor slips, the tubular string extending through the automated pipe tripping apparatus; lifting the tubular string with the elevator at a relatively constant speed defining a tripping speed; moving the inner frame downward; moving the iron roughneck into the upper position; moving the inner frame upwards at the tripping speed so that the iron roughneck is aligned with the threaded joint between the uppermost tubular member and the next tubular member; actuating the tripping slips; transferring the weight of the tubular string to the tripping

slips; breaking out the threaded joint with the iron roughneck; lifting the uppermost tubular member away from the iron roughneck; removing the uppermost tubular member from the elevator by the automated pipe handling system; moving the iron roughneck to the lower position; moving the elevator downward; moving the elevator upward at the tripping speed so that the elevator may attach to the tubular string; transferring the weight of the tubular string to the elevator; and releasing the tripping slips.

[0009] Disclosed herein is a method of adding a tubular member to a tubular string being inserted into a wellbore. The tubular string may be made up of a series of threadedly connected tubular members. The method may include providing an automated pipe tripping apparatus. The automated pipe tripping apparatus may include an outer frame, the outer frame including one or more vertical supports; an inner frame, the inner frame slidingly coupled to the outer frame and positioned to be moved vertically by a lifting mechanism coupled between the inner and outer frames. The inner frame may include a tripping slips, the tripping slips positioned to receive a tubular member and selectively grip and support the tubular member; and an iron roughneck, the iron roughneck positioned above the tripping slips and positioned to receive the tubular member and make up or break out a threaded joint between a first and a second segment of the tubular member. The iron roughneck may be selectively movable in a vertical direction between a lower and an upper position by a roughneck lifting mechanism. The method may further include positioning the automated pipe tripping apparatus on a drilling floor of a drilling rig above the wellbore, the drilling rig including a drawworks, an elevator, an automated pipe handling device, and a drilling floor slips, the tubular string extending through the automated pipe tripping apparatus, the tubular string gripped by the tripping slips; moving the inner frame downwards at a relatively constant speed defining a tripping speed; moving the elevator upward; attaching an additional tubular member to the elevator by the automated pipe handling system; moving the iron roughneck into the upper position; moving the elevator downward at a speed higher than the tripping speed until the lower threaded connector of the additional tubular member aligns with the upper threaded connector of the tubular string, then moving the elevator downward generally at the tripping speed; making up the threaded joint between the additional tubular member and the tubular string with the iron roughneck; transferring the weight of the tubular string to the elevator; releasing the tripping slips; moving the inner frame upwards; moving the iron roughneck into the lower position; moving the inner frame downwards at the tripping speed so that the iron roughneck is aligned with the upper threaded joint of the additional tubular member;

actuating the tripping slips; transferring the weight of the tubular string to the tripping slips; and releasing the additional tubular from the elevator.

[0010] Disclosed herein is an automated control system. The automated control system may include first code instructions that vary the speed of a tubular member moving into or out of a wellbore, the speed defining a tripping speed, the tripping speed varied in response to variations in pressure within the wellbore as measured by a pressure sensor at the end of the tubular member positioned within the wellbore.

Brief Description of the Drawings

[0011] The present disclosure is best understood from the following detailed description when read with the accompanying figures. It is emphasized that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

[0012] FIG. 1 is a perspective view of an automated pipe tripping apparatus consistent with embodiments of the present disclosure.

[0013] FIG. 2 is a cross-section view of the automated pipe tripping apparatus of FIG. 1.

[0014] FIGS 3-8A depict operations consistent with a tripping in operation consistent with embodiments of the present disclosure.

[0015] FIGS. 9-12A depict operations consistent with a tripping out operation consistent with embodiments of the present disclosure.

Detailed Description

[0016] It is to be understood that the following disclosure provides many different embodiments, or examples, for implementing different features of various embodiments. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

CLAIMS

1. A system, comprising:

an outer frame, the outer frame including one or more vertical supports;

an inner frame slidingly coupled to the outer frame and positioned to be moved vertically with respect to the outer frame, wherein the inner frame comprises a base disposed as a bottom portion of the inner frame; and

an iron roughneck disposed in the inner frame and configured to make up or break out a threaded joint between a first tubular member and a second tubular member, wherein the iron roughneck is configured to be selectively movable between a first position above the base of the inner frame and a second position above the base of the inner frame.

2. The system of claim 1, comprising a roughneck lifting mechanism coupled to the iron roughneck, wherein the roughneck lifting mechanism is configured to selectively move the iron roughneck between the first position above the base of the inner frame and the second position above the base of the inner frame.

3. The system of claim 1, comprising tripping slips disposed in the base of the inner frame, the tripping slips configured to receive the tubular member and selectively grip and support at least one of the first tubular member and the second tubular member.

4. The system of claim 3, wherein the iron roughneck is positioned above the tripping slips in the inner frame.

5. The system of claim 1, comprising a lifting mechanism coupled to the inner frame and configured to selectively move the inner frame with respect to the outer frame.

6. The system of claim 5, wherein the lifting mechanism comprises one of one or more hydraulic pistons, jack screws, racks and pinions, cable and pulley, or travelling block.

7. The system of claim 1, wherein the iron roughneck comprises:

fixed jaws configured to grip and prevent rotation of the first tubular member; and

makeup/breakout jaws configured to grip the second tubular member and impart a high-torque low-speed rotation on the second tubular member.

8. The system of claim 7, wherein the iron roughneck comprises a pipe spinner configured to impart a high-speed, low-torque rotation on the second tubular member.

9. The system of claim 1, comprising a tubular filling apparatus positioned to fill at least one of the first tubular member and the second tubular member with drilling fluid.

10. The system of claim 1, comprising a control system configured to control a lifting mechanism to selectively move the inner frame with respect to the outer frame or control a roughneck lifting mechanism configured to selectively move the iron roughneck between the first position above the base of the inner frame and the second position above the base of the inner frame.

11. The system of claim 1, comprising a control system configured to control movement of the inner frame with respect to the outer frame or control movement in the vertical direction of the iron roughneck between the first position above the base of the inner frame and the second position above the base of the inner frame.

12. The system of claim 1, wherein the first tubular member and the second tubular member comprise a portion of a drill string, a casing string, a tool string, or a riser string.

13. A method, comprising:

lifting a string at a relatively constant speed defining a tripping speed;

moving an inner frame downward with respect to an outer frame to a first location;

moving an iron roughneck relative to the inner frame into an upper position inside of the inner frame as the inner frame is moving downward with respect to the outer frame;

moving the inner frame upwards relative to the outer frame at the tripping speed to align the iron roughneck with a threaded joint of the string; and

breaking out the threaded joint with the iron roughneck.

14. The method of claim 13, comprising:

transferring weight of the string to tripping slips; and

lifting an uppermost member of the string away from the iron roughneck.

15. The method of claim 14, comprising moving the iron roughneck from the upper position inside of the inner frame to a lower position inside of the inner frame.

16. The method of claim 15, comprising:

moving an elevator upward at the tripping speed in conjunction with attaching the elevator to the string;

transferring the weight of the string to the elevator; and

releasing the tripping slips from the string.

17. The method of claim system of claim 13, wherein breaking out the threaded joint comprises breaking out a portion of a drill string, a casing string, a tool string, or a riser string.

18. An apparatus, comprising:

an inner frame configured to be slidingly coupled to an outer frame, wherein the inner frame is configured to be moved vertically from a first position relative to the outer frame to a second position relative to the outer frame, wherein the inner frame comprises a base disposed as a bottom portion of the inner frame; and

an iron roughneck configured to be coupled to the inner frame, wherein the iron roughneck is configured to be movable between a first position above the base of the inner frame and a second position above the base of the inner frame, wherein the iron roughneck is configured to make up or break out members of a string, wherein the base comprises tripping slips disposed in the base of the inner frame, wherein the tripping slips are configured to selectively grip and support the string.

19. The apparatus of claim 18, wherein the outer frame does not completely encompass the inner frame.

20. The apparatus of claim 19, wherein the outer frame comprises a rail coupled to a top drive rail.