The sealing elements are required to be regularly replaced to maintain an effective seal. The replacement of the sealing element results in a loss of rig drilling time and poses safety issues to rig personnel.

MPD systems have proven effective in different well types including vertical, horizontal, deviated and unconventional well designs in offshore and onshore environments. Typically drill strings are required to be strong and flexible to allow drilling of horizontal, highly deviated and long reaching bores.

Summary of the invention

Aspects of the invention are defined in the independent claims. Some optional features of the invention are defined in the dependent claims.

There is need for a drill pipe apparatus which addresses one or more of the problems associated with known prior art systems, including those identified above.

It will be seen that it is possible to provide a drill pipe apparatus for managed pressure drilling which prevents or mitigates wear of annular seals or seal elements.

It is further possible to provide a method of performing managed pressure drilling in deviated or horizontal wells which mitigates the frequency with which annular seals or seal elements are worn and require replacement.

According to a first exemplary arrangement, there is provided a managed pressure drilling system for use in managed pressure drilling operations, the system comprising:
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members arranged in at least a first drill string section and a second drill string section;
wherein each drill pipe members comprises a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and
a tubular body between the first and second tool joints having a tubular body outer diameter,

wherein the first tool joint outer diameter and second tool joint outer diameter are larger than the tubular body outer diameter in each of the drill pipe members in the first drill string portion;

body (such as having an upset), this may facilitate the drilling of wells that deviate from the vertical while maintaining a robust effective seal around a surface of the second drill string section.

The second drill string section may be configured to be located in a substantially vertical portion or section of the wellbore bore in a well, riser, liner and/or casing. The second drill string section may be configured to be located in a substantially non-horizontal or non-deviated portion or section of the wellbore bore in a well, riser, liner and/or casing.

The first drill string section may be connected to a drill bit. The first drill string section may be configured to be located in a substantially non-vertical portion or section of the wellbore to allow the drill bit connected at a lower end of the first drill string section to drill in a deviated or horizontal well. The first drill string section may be configured to be located in a deviated or substantially horizontal portion or section of the wellbore. The first drill string section may be configured to be located in a substantially S-shaped portion or section of the wellbore.

The rotating sealing device may be a surface pressure control device such as a rotary control device (RCD). The rotary control device may comprise at least one sealing element configured to contact, form and/or maintain a fluid seal against at least one drill pipe member in the second drill string section or a part of at least one drill pipe member in the second drill string section. The RCD may contact an outer surface of a part of the second drill string section to form a seal.

The second drill string section may have a generally smooth surface without any protruding or irregular surfaces from tool joints, upsets and/or drill collars. The continuous outer surface diameter of the second drill string section along its longitudinal length may enable sealing elements in an RCD to maintain a robust effective seal around a surface of the second drill string section. The continuous outer surface diameter of the second drill string section along its longitudinal length may enable sealing elements in an RCD to maintain a robust effective seal around a surface of the second drill string section as the second drill string section is raised and/or lowered through the RCD.

By providing a second drill string section with flush tool joints, the second drill string section or part thereof may be moved through the RCD and/or through the sealing element

The first drill string section may be located further downhole than the second drill string section. The first drill string section may be a lower drill string section. The second drill string section may be an upper drill string section.

A third or further drill string section may be connected to the second drill string section. The third or further drill string section may comprise a plurality of drill pipe members having first tool joint with a first tool joint outer diameter, a second tool joint having a second tool joint outer diameter; and a tubular body between the first and second tool joints having a tubular body outer diameter. The first tool joint outer diameter and second tool joint outer diameter of the third or further drill string may be larger than the tubular body outer diameter of the drill pipe member in the third or further drill string section.

Alternatively, the first tool joint outer diameter and the second tool joint outer diameter of the third or further drill string may be substantially the same diameter as the tubular body outer diameter in each drill pipe members. A third or further drill string section may have an outer diameter that is substantially uniform along its longitudinal length.

According to a second exemplary arrangement, there is provided a managed pressure drilling system for use in managed pressure drilling operations, the system comprising:
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members wherein each drill pipe member has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and
a tubular body between the first and second tool joints having a tubular body outer diameter;
wherein the first tool joint outer diameter, the second tool joint outer diameter and the tubular body outer diameter are substantially the same; and
wherein the rotating sealing device is configured to form a fluid seal against the drill string.

The rotating sealing device may be configured to form a fluid seal against at least part of a drill pipe member of the drill string. The rotating sealing device may be configured to operate in annular wellbore fluid pressures in the range of 2000 psi to 10000 psi.

The rotating sealing device may be a rotary control device (RCD). The rotary control device may comprise at least one sealing element configured to form and maintain a fluid

seal against at least one surface of the drill string. The at least one sealing element may be configured to form and maintain a fluid seal against at least one part of the drill string.

The drill string may be an upper drill string section. The drill string may be connectable to a lower drill string connected to a drill bit. The drill string may be configured to connected to a lower drill string. The lower drill string may be configured to be connected to a drill bit at one end.

The lower drill string may comprise a plurality of drill pipe members wherein each drill pipe member has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and
a tubular body between the first and second tool joints having a tubular body outer diameter; wherein the first tool joint outer diameter and the second tool joint outer diameter of the lower drill string may be larger than the tubular body outer diameter.

Alternatively the first tool joint outer diameter and/or the second tool joint outer diameter may be smaller than the tubular body outer diameter in the lower drill string.

The drill string may be connectable to an upper drill string. The drill string may be configured to connected to an upper drill string. The upper drill string may be configured to be connected to the drill string at one end. The upper drill string may have a generally constant outer diameter along its longitudinal length. The outer diameter of the lower drill string along its longitudinal length may vary due to protrusions at the joint connections.

This second exemplary arrangement may include one or more features of the first exemplary arrangement or its embodiments, or vice versa.

According to a third exemplary arrangement, there is provided a drill string assembly for managed pressure drilling comprising:
a plurality of drill pipe members arranged in a first drill string section and a second drill string section;
wherein each drill pipe member has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter;
a tubular body between the first and second tool joints having a tubular body diameter;

wherein the first tool joint outer diameter and second tool joint outer diameter of each drill pipe member in the second drill string section are substantially equal to the tubular body diameter in each drill pipe member in the second drill string section; and
wherein the first tool joint outer diameter and/or second tool joint outer diameter of each drill pipe member in the first drill string section is larger than the tubular body diameter in each the drill pipe member in the first drill string section.

The first tool joint of the drill pipe members in the first and/or second drill string sections may be a box section and the second tool joint of the drill pipe members in the first and/or second drill string sections may be a pin section. Alternatively, the first tool joint may be a pin section and the second tool joint may be a box section.

The first tool joint and/or second tool joint in each drill pipe member in the first drill string section may have an upset. The upset may be an external and/or an internal upset.
The first tool joint and/or second tool joint in each drill pipe member in the second drill string section may have an internal upset.

The second drill string section may be configured to be substantially vertical. The second drill string section may be configured to be used in a substantially vertical section of a well. In an offshore managed pressure drilling operation the second drill string section may be contained within a riser such as a marine riser. In an onshore managed pressure drilling operation the second drill string section may be contained within an upper casing or liner.

The first drill string section may be configured to be located further downhole than the second drill string section. The first drill string section may be a lower drill string section. The second drill string section may be an upper drill string section. The first drill string section may be configured to be used in a substantially horizontal or deviated section of a well.

This second exemplary arrangement may include one or more features of the first or second exemplary arrangements or their embodiments, or vice versa.

According to a fourth exemplary arrangement, there is provided a drill string assembly for managed pressure drilling comprising:

a plurality of drill pipe members wherein each drill pipe members has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and
a tubular body between the first and second tool joints having a tubular body outer diameter;
wherein the first tool joint outer diameter and the second tool joint outer diameter are substantially equal to the tubular body outer diameter in each drill pipe member in the drill string or at least one section of the drill string, wherein the drill string or at least one section of the drill string has a substantially constant outer diameter along its length.

The drill string and/or drill pipe members may have a constant outer diameter without any protruding or irregular surfaces from tool joints or drill collars. The continuous outer surface diameter of the drill string along its longitudinal length may enable sealing elements in an RCD to maintain a robust effective seal around a portion of the drill string without an obstruction or damage to sealing elements in the RCD.

The drill string may comprise drill pipe members with a substantially constant outer diameter which may be moved and passed through a sealing element of an RCD, such as during a drilling operation, while the sealing element is under pressure. As there are no protruding or irregular surfaces from tool joints, upsets or drill collars, damage or wear to the interior sealing surface of the sealing element may be mitigated.

The drill string may be arranged into two or more sections. The drill string may comprise at least one section of the drill string having a first tool joint outer diameter, the second tool joint outer diameter and tubular body outer diameter which are substantially the same is an upper or second drill string section. The drill string may comprise a lower or first drill string section wherein the first tool joint outer diameter and/or the second tool joint outer diameter is larger than the tubular body outer diameter in each drill pipe member in the lower or first drill string section. The drill string may comprise a second or upper drill string section having a first tool joint outer diameter, the second tool joint outer diameter and tubular body outer diameter which are substantially the same.

The fourth exemplary arrangement may include one or more features of the first to third exemplary arrangements or their embodiments, or vice versa.

According to a fifth exemplary arrangement, there is provided a managed pressure drilling system for use in managed pressure drilling operations, the system comprising:
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members arranged in at least a first drill string section and a second drill string section;
wherein each of drill pipe members has a tubular pipe body with connectors at either end thereof for connection to adjacent drill pipe members;
wherein the connectors and the tubular pipe body of the drill pipe member in the second drill string section have substantially the same outer diameter; and
wherein the connectors of the drill pipe members in the first drill string section have an outer diameter which is larger than the outer diameter of the tubular pipe body of the drill pipe members in the first drill string section; and
wherein the rotating sealing device is configured to form a fluid seal against an outer surface of at least part of the second drill string section.

The connectors may be tool joints. The connectors may be a box section at a first end of the drill pipe member and a pin section at a second end of the drill pipe member.

The fifth exemplary arrangement may include one or more features of the first to fourth exemplary arrangements or their embodiments, or vice versa.

According to a sixth exemplary arrangement, there is provided a managed pressure drilling system for use in managed pressure drilling operations, the system comprising:
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members;
wherein each drill pipe member comprises;
a tubular body;
a pin section at a first end of the tubular body; and
a box section at the second end of the tubular body;
wherein the pin section and box section are configured for coupling to an adjacent drill pipe member and wherein the outer diameters of the tubular body, pin section and box section are substantially the same; and
the rotating sealing device is configured to form a fluid seal against the drill string passing through the rotating sealing device.

The sixth exemplary arrangement may include one or more features of the first to fifth exemplary arrangements or their embodiments, or vice versa.

According to a seventh exemplary arrangement, there is provided a managed pressure drilling system for use in managed pressure drilling in a subsea well, the system comprising:
a riser;
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members;
wherein each drill pipe member comprises;
a tubular pipe body with connectors at either end thereof for connection to adjacent drill pipe members;
wherein the connectors and the tubular pipe body of the drill pipe member in the drill string have substantially the same outer diameter; and
the rotating sealing device is configured to form a fluid seal between at least part of the drill string passing through the rotating sealing device and the riser.

The rotating sealing device may be configured to form a fluid seal between an outer surface of the drill string passing through the rotating sealing device and an inner surface of the riser.

The drill string may be an upper drill string section. The system may comprise a lower drill string. The drill string may be connectable to a lower drill string connected to a drill bit. The lower drill string may comprise plurality of drill pipe members; wherein each drill pipe member in the lower drill string comprises a tubular pipe body with connectors at either end thereof for connection to adjacent drill pipe members wherein the connectors of the drill pipe members in the lower drill string have an outer diameter which is larger than the outer diameter of the tubular pipe body of the drill pipe members in the lower drill string.

The larger diameter connectors in the lower drill string may provide structural support to the connections between the drill pipe members in the lower drill string to provide flexibility as the lower drill string deviates from the vertical in the wellbore. The larger diameter connectors may also reduce or minimise mechanical or bending stresses acting on the connections of the lower drill string as it curves and deviates from the vertical.

The seventh exemplary arrangement may include one or more features of the first to sixth exemplary arrangements or their embodiments, or vice versa.

According to an eighth exemplary arrangement, there is provided a managed pressure drilling system for use in managed pressure drilling in an onshore well, the system comprising:
an upper casing;
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members;
wherein each drill pipe member comprises;
a tubular pipe body with connectors at either end thereof for connection to adjacent drill pipe members;
wherein the connectors and the tubular pipe body of the drill pipe member in the drill string have substantially the same outer diameter; and
the rotating sealing device is configured to form a fluid seal between at least part of the drill string passing through the rotating sealing device and the upper casing.

The rotating sealing device may be configured to form a fluid seal between at least part of an outer surface of the drill string passing through the rotating sealing device and an inner surface of the upper casing.

The drill string may be an upper drill string section. The system may comprise a lower drill string section. The drill string may be connectable to a lower drill string connected to a drill bit. The lower drill string may comprise a plurality of drill pipe members; wherein each drill pipe member in the lower drill string comprises a tubular pipe body with connectors at either end thereof for connection to adjacent drill pipe members wherein the connectors of the drill pipe members in the lower drill string have an outer diameter which is larger than the outer diameter of the tubular pipe body of the drill pipe members in the lower drill string.

The larger diameter connectors in the lower drill string may provide structural support to the connections between the drill pipe members to provide flexibility as the lower drill string deviates from the vertical in the wellbore. The larger diameter connectors may also reduce or minimise mechanical or bending stresses acting on the connections of the lower drill string as it curves and deviates from the vertical.

The eighth exemplary arrangement may include one or more features of the first to seventh exemplary arrangements or their embodiments, or vice versa.

According to a ninth exemplary arrangement, there is provided a method for managed pressure drilling, comprising the steps of:
providing a managed pressure drilling system, the system comprising:
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members;
wherein each drill pipe member comprises;
a tubular pipe body with connectors at either end thereof for connection to adjacent drill pipe members;
wherein the connectors and the tubular pipe body of the drill pipe member in the drill string have substantially the same outer diameter;
lowering the drill string into a tubular connected to a well;
forming a fluid seal between the drill string and the tubular;
passing at least a portion of the drill string through the rotating sealing device.

The method may comprise drilling the wellbore. The method may comprise drilling the wellbore at a pre-determined fluid annular pressure. The predetermined fluid annular pressure may be less than a casing shoe pressure and/or a formation fracture pressure.

The method may comprise forming a fluid seal between the drill string and the tubular by contacting at least one sealing element in the rotating sealing device with an outer surface of part of the drilling string.

The method may comprise connecting the drill string and/or one or more drill pipe members to a lower drill string. The lower drill string may be configured to be connected to or may be connected to a drill bit.

The drill string may be arranged into an upper drill string portion and a lower drill string portion. The connectors and the tubular pipe body of the drill pipe member in the upper drill string may have substantially the same outer diameter. The connectors and the tubular pipe body of the drill pipe member in the upper drill string may have different outer diameters.

The lower drill string may be connected to a bottom hole assembly. The lower drill string may comprise a plurality of drill pipe members; wherein each drill pipe member in the lower drill string comprises a tubular pipe body with connectors at either end thereof for connection to adjacent drill pipe members wherein the connectors of the drill pipe members in the lower drill string have an outer diameter which is larger than the outer diameter of the tubular pipe body of the drill pipe members in the lower drill string.

The method may be used for onshore or offshore drilling. The tubular may be a riser, casing and/or liner. The method may comprise deviating the lower drill string from the vertical. The method may comprise maintaining the upper drill string substantially vertical.

The method may comprise locating and/or maintaining the drill string in a substantial vertical section of the tubular and/or well. The method may comprise locating the lower drill string in a substantial non-vertical section of the wellbore.

The ninth exemplary arrangement may include one or more features of the first to eighth exemplary arrangements or their embodiments, or vice versa.

According to a tenth exemplary arrangement, there is provided a method for managed pressure drilling in a subsea well, comprising:
providing a managed pressure drilling system, the system comprising:
a riser;
a rotating sealing device;
a drill string comprising a plurality of drill pipe members arranged in a first drill string section and a second drill string section;
wherein the drill pipe members of the second drill string section are flush joint drill pipe members having an equal outer diameter along its length; and
wherein the drill pipe members of the first drill string section have tool joints at each end of a tubular body which have an outer diameter greater than the tubular body outer diameter;
lowering the drill string into the riser;
forming a fluid seal between the riser and an outer surface of the second drill string section; and
passing at least a portion of the section drill string through the rotating sealing device; and
drilling the wellbore.

The method may comprise drilling the wellbore at a pre-determined fluid annular pressure. The method may comprise connecting a drill bit to the first drill string section.

The method may comprise locating and/or maintaining the second drill string section in a substantial vertical section of the riser. The method may comprise locating the first drill string section in a substantial non-vertical section of the wellbore.

The tenth exemplary arrangement may include one or more features of the first to ninth exemplary arrangements or their embodiments, or vice versa.

According to an eleventh exemplary arrangement, there is provided a method for managed pressure drilling in a well, comprising:
providing a managed pressure drilling system, the system comprising:
an upper casing;
a rotating sealing device;
a drill string comprising a plurality of drill pipe members arranged in a first drill string section and a second drill string section;
wherein the drill pipe members of the second drill string section are flush joint drill pipe members having an equal outer diameter along its length; and
wherein the drill pipe members of the first drill string section have tool joints at each end of a tubular body which have an outer diameter greater than the tubular body outer diameter;
lowering the drill string into the casing;
forming a fluid seal between the casing and an outer surface of the second drill string section; and
passing at least a portion of the second drill string section through the rotating sealing device; and
drilling the wellbore.

The method may comprise drilling the wellbore at a pre-determined fluid annular pressure. The well may be an onshore or offshore well. The method may comprise locating and/or maintaining the second drill string in a substantial vertical section of the casing, liner and/or well. The method may comprise locating and/or maintaining the first drill string in a substantial non-vertical section of the wellbore.

The first drill section may be a lower drill string section connected to a drill bit. The second drill string section may be an upper drill string section.

The eleventh exemplary arrangement may include one or more features of the first to tenth exemplary arrangements or their embodiments, or vice versa.

According to a twelfth exemplary arrangement, there is provided a method for drilling a well, comprising:
providing a drilling system, the system comprising:
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members arranged in a first drill string section;
wherein each drill pipe member comprises a tubular pipe body with connectors at either end thereof for connection to adjacent drill pipe members;
drilling a first section of the well using the first drill string section comprising a plurality of first drill pipe members with connectors larger than the outer diameter of the tubular pipe body;
connecting a second drill string section to the first drill string section wherein the connectors and the tubular pipe body of the plurality of drill pipe members in the second drill string section have substantially the same outer diameter;
forming a fluid seal between a tubular connected in the well and a part of the outer surface of the second drill string section; and
passing at least a portion of the second drill string through the rotating sealing device; and
drilling a second section of the well.

The method may comprise drilling a second section of the well at a pre-determined fluid annular pressure. The method may comprise installing or connecting the tubular to the first section of the well. The tubular may be a riser, casing and/or liner. The method may comprise drilling the first section of the well using conventional well control drilling. The method may comprise drilling the second section of the well by using managed pressure drilling.

The method may comprise drilling a third section of the well by using conventional well control drilling. The method may comprise drilling a third section of the well by connecting a third drill string section to an upper portion of the second drill string section. The outer

diameter of the connectors of the drill pipe members in the third drill string section may be larger or different than the outer diameter of the tubular pipe body of the drill pipe members in the third drill string section. The method may comprise removing or deactivating the seal and/or the rotating sealing device before drilling the third section of the well.

The method may comprise drilling one or more further sections of the well using managed pressure drilling by reforming or reactivating the seal and/or reinstalling the RCD and connecting a further drill string section to the drill string wherein the connectors and the tubular pipe body of the plurality of drill pipe members in the further drill string have substantially the same outer diameter.. The method may comprise passing at least a portion of the further drill string through the rotating sealing device; and drilling the further section of the well at a pre-determined fluid annular pressure.

The method may comprise alternating between conventional drilling and managed pressure drilling to drill further sections of the well. When managed pressure drilling is required the uppermost section of drill string may comprise parallel drill pipe with a continuous outer surface diameter along its longitudinal length of the drill string section to allow an effective seal to be maintained with the RCD as the drill pipe is moved downhole or raised uphole. The continuous outer surface diameter of the parallel drill string mitigates wear on sealing elements in the RCD.

The method may comprise drilling at a deviated angle to the horizontal.

The twelfth exemplary arrangement may include one or more features of the first to eleventh aspects of the disclosure or their embodiments, or vice versa.

According to a thirteenth exemplary arrangement, there is provided a method for raising or lowering a drill string in well, comprising:
providing a drilling system, the system comprising:
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members wherein each drill pipe member has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and

a tubular body between the first and second tool joints having a tubular body outer diameter;
wherein at least one section of the drill string has a first tool joint outer diameter, the second tool joint outer diameter and the tubular body outer diameter are substantially the same; and
wherein the rotating sealing device is configured to form a fluid seal against at least part of the at least one section of the drill string;
lowering or raising the at least one section of the drill string in the well through the rotating sealing device.

The thirteenth exemplary arrangement may include one or more features of the first to twelfth exemplary arrangements or their embodiments, or vice versa.

According to a fourteenth exemplary arrangement, there is provided a drill string assembly for managed pressure drilling the drill string comprising:
a plurality of drill pipe members wherein each drill pipe members has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and
a tubular body between the first and second tool joints having a tubular body outer diameter;
wherein each drill pipe members in at least one section of the drill string has a first tool joint outer diameter and a second tool joint outer diameter which are substantially equal to the tubular body outer diameter wherein in at least one section of the drill string has a substantially constant outer diameter along its length.

The at least one section of the drill string may be a section of the drill string located at a uphole end of the drill string section. The at least one section of the drill string may be a section of the drill string located closest to the surface or closest to the top of a riser.

The at least one section of the drill string may be a located above a lower section of drill string. The lower section of drill string may be configured to be connected to or may be connected to a drill bit. The at least one section of the drill string may be configured to connected to the lower drill string.

The lower drill string may comprise a plurality of drill pipe members wherein each drill pipe member has a first tool joint having a first tool joint outer diameter; a second tool joint having a second tool joint outer diameter; and a tubular body between the first and second tool joints having a tubular body outer diameter; wherein the first tool joint outer diameter and the second tool joint outer diameter may be larger than or different to the tubular body outer diameter.

The fourteenth exemplary arrangement may include one or more features of the first to thirteenth exemplary arrangements or their embodiments, or vice versa.

According to a fifteenth exemplary arrangement, there is provided a managed pressure drilling system comprising:
a rotating sealing device; and
a drill string comprising a plurality of drill pipe members wherein each drill pipe member has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and
a tubular body between the first and second tool joints having a tubular body outer diameter;
wherein in at least one section of the drill string the first tool joint outer diameter, the second tool joint outer diameter and the tubular body outer diameter are substantially the same; and
wherein the rotating sealing device is configured to form a fluid seal against at least a part of the at least one section of drill string.

The at least one section of the drill string may have an outer diameter that is substantially uniform along its longitudinal length.

The drill string may be arranged into two or more sections wherein the at least one section of the drill string having a first tool joint outer diameter, the second tool joint outer diameter and tubular body outer diameter which may be substantially the same may be an upper drill string section. The drill string may comprise a lower drill string section wherein the first tool joint outer diameter and/or the second tool joint outer diameter may be larger than or different to the tubular body outer diameter in each drill pipe member in the lower drill string section.

The fifteenth exemplary arrangement may include one or more features of the first to fourteenth exemplary arrangements or their embodiments, or vice versa.

According to a sixteenth exemplary arrangement, there is provided a method for drilling a well, the method comprising:
providing a drilling system, the system comprising:
a rotating sealing device; and
a plurality of drill pipe members comprising first drill pipe members and second drill pipe members;
wherein each drill pipe member comprises a tubular pipe body with connector joints at either end thereof;
wherein first drill pipe members have connector joint outer diameters which are larger than the outer diameter of the tubular pipe body;
wherein second drill pipe members have connector joint outer diameters which are substantially the same as the outer diameter of the tubular pipe body;
wherein the first drill pipe members are configured to be connected to form a first drill string section and the second drill pipe members are configured to be connected to form a second drill string section;
drilling a first section of the well using the first drill string section comprising a plurality of first drill pipe members;
connecting second drill pipe members to the first drill string section;
forming a fluid seal between a tubular connected in the well and an outer surface of at least part of a second drill pipe member in the second drill string section;
passing at least part of the second drill string through the rotating sealing device; and
drilling a second section of the well at a pre-determined fluid annular pressure.

The method may comprise drilling a first section of the well using conventional drilling and drilling the second section of the well using managed pressure drilling. The method may comprise drilling a third section of the well using conventional drilling or managed pressure drilling.

The method may comprise drilling a third section of the well by connecting a plurality of third drill pipe members to an upper portion of the second drill string section.

The third section of the well may be drilled using conventional drilling wherein the rotating sealing device is removed or deactivated and the third drill pipe members in third drill string section comprise connector joints which are larger than the outer diameter of the tubular pipe body of the third drill pipe members in the third drill string section.

Embodiments of the sixteenth exemplary arrangement may include one or more features of the first to fifteenth exemplary arrangements or their embodiments, or vice versa.

Brief description of the drawings

There will now be described, by way of example only, various embodiments of the invention with reference to the drawings, of which:

Figure 1A is a sectional side view of a drill pipe assembly according to an embodiment of the invention;

Figure 1B is an enlarged sectional side view of part of an upper drill string portion of the drill pipe assembly of Figure 1A;

Figure 1C is an enlarged sectional side view of part of a lower drill string portion of the drill pipe assembly of Figure 1A;

Figure 2 is a schematic representation of a managed pressure drilling system for offshore managed pressure drilling in a deviated well according to an embodiment of the invention with the managed pressure drilling components omitted for clarity;

Figure 3 is a schematic representation of a managed pressure drilling system for onshore managed pressure drilling in a deviated well according to an embodiment of the invention with the managed pressure drilling components omitted for clarity; and

Figures 4A, 4B and 4C are schematic representations of stages of drilling a deviated well using conventional and managed pressure drilling operations according to an embodiment of the invention.

Claims

1. A managed pressure drilling system comprising:
a rotating sealing device; and
a drill string comprising an upper drill string section and a lower drill string section;
each drill string section comprises a plurality of drill pipe members wherein each drill pipe member has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and
a tubular body between the first and second tool joints having a tubular body outer diameter;
wherein the first tool joint, the second tool joint and the tubular body of drill pipe members of the upper drill string section have substantially the same outer diameter;
wherein the outer diameter of the first tool joint and/or the second tool joint of drill pipe members of the lower drill string section is larger than the outer diameter of the tubular body of drill pipe members of the lower drill string section; and
wherein the rotating sealing device is configured to form a fluid seal against at least one part of the upper drill string section.

2. The system according to claim 1, wherein the rotating sealing device is a rotary control device (RCD), wherein the rotary control device comprises at least one sealing element configured to form and/or maintain a fluid seal against the at least one part of the upper drill string section.

3. The system according to claim 1 or 2, wherein at least one section of the drill string is configured to be located in a substantially vertical portion or section of a wellbore in a riser, liner and/or casing.

4. The system according to any preceding claim, wherein a first or second tool joint of the upper drill string section is configured to connect to a first or second tool joint of the lower drill string section to connect the upper and lower drill string sections together.

5. The system according to any preceding claim, wherein the first tool joint and/or the second tool joint of the drill pipe members in the lower drill string portion has an external upset and/or an internal upset.

6. The system according to any of preceding claim, wherein the first tool joint and/or the second tool joint of the drill pipe members has an internal upset.

7. The system according to any preceding claim, wherein the lower drill string section is connected to or configured to be connected to a drill bit.

8. The system according to any preceding claim, wherein the lower drill string section is configured to be located in a substantially non-vertical, horizontal and/or deviated portion or section of the wellbore.

9. The system according to any preceding claim, wherein the system is configured for use in managed pressure drilling in a subsea well wherein the system comprises a riser and the rotating sealing device is configured to form a fluid seal between the at least one part of the upper drill string section passing through the rotating sealing device and the riser.

10. The system according to any preceding claim, wherein the system is configured for use in managed pressure drilling in an onshore well wherein the system comprises a casing and the rotating sealing device is configured to form a fluid seal between the at least one part of the upper drill string section passing through the rotating sealing device and the casing.

11. A drill string assembly for managed pressure drilling comprising:
an upper drill string section connectable to a lower drill string section;
each drill string section comprises a plurality of drill pipe members wherein each drill pipe member has a first tool joint having a first tool joint outer diameter;
a second tool joint having a second tool joint outer diameter; and
a tubular body between the first and second tool joints having a tubular body outer diameter;
wherein the outer diameters of the first tool joint, the second tool joint and the tubular body of the drill pipe members of the upper drill string section are substantially equal;

wherein the outer diameters of the first tool joint and/or the second tool joint of the drill pipe members of the lower drill string section is larger than the outer diameter of the tubular body of the drill pipe members of the lower drill string section.

12. A method for managed pressure drilling, the method being performed using a managed pressure drilling system, the system comprising:
a rotating sealing device; and
a drill string comprising an upper drill string section and a lower drill string section; each drill string section comprises a plurality of drill pipe members;
wherein each drill pipe member comprises:
a tubular pipe body with connectors at either end thereof;
wherein the connectors and the tubular pipe body of each drill pipe member of the upper drill string section have substantially the same outer diameter;
wherein the outer diameter of the connectors of drill pipe members of the lower drill string section is larger than the tubular body outer diameter of drill pipe members of the lower drill string section; the method comprising:
lowering the drill string into a tubular connected to or in a well;
forming a fluid seal between at least one part of the upper drill string section and the tubular connected to or in the well;
passing at least one part of the drill string through the rotating sealing device; and
drilling the wellbore.

13. The method according to claim 12, wherein the upper drill string section is connected to the lower drill string connected to a drill bit.

14. The method according to claim 12 or claim 13, comprising locating the upper drill string section in a substantial vertical section of the well and/or in a substantial vertical section of the tubular connected to or in the well.

15. The method according to any of claims 12 to 14, comprising drilling a non-vertical or deviating wellbore by deviating the lower drill string section from the vertical.

16. A method for drilling a well, the method being performed using a drilling system, the system comprising:
a rotating sealing device; and

a plurality of drill pipe members comprising first drill pipe members and second drill pipe members;
wherein each drill pipe member comprises a tubular pipe body with connector joints at either end thereof;
wherein the first drill pipe members have connector joint outer diameters which are larger than the outer diameter of the tubular pipe body;
wherein the second drill pipe members have connector joint outer diameters which are substantially the same as the outer diameter of the tubular pipe body;
wherein the first drill pipe members are configured to be connected to form a first drill string section and the second drill pipe members are configured to be connected to form a second drill string section; the method comprising:
drilling a first section of the well using the first drill string section comprising a plurality of first drill pipe members;
connecting at least one second drill pipe member to the first drill string section;
forming a fluid seal between a tubular connected in the well and an outer surface of at least part of a second drill pipe member in the second drill string section;
passing at least part of the second drill string through the rotating sealing device; and
drilling a second section of the well at a pre-determined fluid annular pressure.

17. The method according to claim 16, comprising drilling the first section of the well using conventional drilling.

18. The method according to claim 16 or claim 17, comprising drilling a second section of the well using managed pressure drilling.

19. The method according to any of claims 16 to 18, comprising drilling a third section of the well using conventional drilling or managed pressure drilling.

20. The method according to claim 19, comprising drilling the third section of the well by connecting a third drill string section comprising a plurality of third drill pipe members to an upper portion of the second drill string section.

21. The method according to claim 20, wherein the third section of the well is drilled using conventional drilling wherein the rotating sealing device is removed or deactivated and the third drill pipe members in the third drill string section comprise

connector joints which are larger than the outer diameter of the tubular pipe body of the third drill pipe members in the third drill string section.