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10 The aforementioned design practices of multiple part stop collar constructions may result in lost parts of the stop collar, or associated components, falling into the wellbore. This is considered as catastrophic in the industry.

15 Problems also occur with centralizers where the bore has an upper part of a generally smaller cross section than a lower part where the centralizer is needed to act. Clearly the centralizer must pass through the upper part without breakage, and without requiring too great an insertion force. The two constraints may of course be interrelated.

20 One such scenario is with so-called "under-reamed" bores. This occurs for example where wellbores are 'opened out' in a region lower than a previously installed tubular.

25 In one example, a drill bit is passed through the 21.68 cm (8.535") internal diameter of a previously installed 24.45 cm (9-5/8") tubular and then the bit is rotated out of concentric to create a 24.13 cm (9.5") hole. So, a centralizer is required to fit the nominal size of 24.13cm (9.5") diameter so as to centralize a tubular in that bore, but also is required to pass through 21.58 cm (8.535") diameter of the upper tubular..

Summary of the Invention

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In a first aspect there is provided a one-piece device for engagement over and onto a downhole tubular comprising a generally cylindrical band having at least one arcuate

portion with opposing end regions, the end regions being coupled together by a connecting portion having a pair of arm portions extending on respective sides of a body portion, distal ends of the arm portions extending into the end regions, the body portion having a formation for engagement therein of a tool whereby rotation of the body portion by a tool varies the size of the device, the device further comprising engagement means to secure the arm portions with respect to an adjacent end region so that the device can be locked.

The device may have a plurality of arcuate portions each having respective end regions, and a corresponding plurality of connecting portions.

The connecting portions may be generally S-shaped.

The arcuate portions may have prolongations to form guides for constraining sideways movement of the arm portions.

The guides may have teeth to interact with counterpart teeth on the arm portions to form the engagement means.

The device may be substantially circular with an axis, the or each arcuate portion have a first axis-parallel width and the arm portions have a second axis-parallel width that is less than the first width.

The device may be of a micro-alloy steel. An example that may be used is boron steel.

In a second aspect, there is provided a stop collar or like device which is adapted to mount around a tubular member such as a length of pipe, drill string or tubing string to grip the exterior of the tubular member and restrict axial travel of any further associated product that is assembled onto the exterior of the tubular member along the member, the device being characterised in that the construction of the stop collar and

a means of activating radial gripping of a tubular member is from a single piece of material.

5 In a third aspect there is provided a method of securing a one-piece stop collar to a tubular comprising sliding the stop collar over the tubular to a desired location, and rotating a portion of the stop collar to draw the collar tighter onto the tubular.

Prior art examples, where sufficient annular width allows, have attempted to draw the open ends of a stop collar band or ring together for example with bolt and nut designs.

10 The desire to change developed circumferential length requires that slippage takes place between all of the internal diameter of the stop collar and the surface of the tubular to which it is being affixed yet achieve high radial loads. It is given that the two desires are contradictory.

15 In a fourth aspect, a centralizer has first and second opposing end collars that are axially separated by plural spring bows, the spring bows forming a generally convex curve, with first bows extending from the first end collar substantially axis parallel for a first distance before extending via the curve into the second end collar, and second bows extending curvedly from the first end collar and into a substantially axis parallel

20 portion at the second end collar, whereby the centralizer is formed of a single piece of material.

The material may be a micro-alloy steel. The micro-alloy steel may be boron steel.

25 One or both collars of the centralizer may be in accordance with the first aspect.

In a further aspect there is provided a device for disposition on a tubular member, the device having a band or collar, and having plural resilient axial protrusions for distributing point loading.

The circular body portions 45, 55, 65 have a formation for a tool. In this embodiment, the formation is a hex hole 70 dimensioned to be engaged by a hex key.

5 In use, the stop collar 1 is fitted and secured to a tubular by sliding the stop collar 1 over the tubular to a desired location, and rotating the body portions 45, 55, 65 one-by-one to draw the collar into tight engagement onto the tubular. The engagement state is maintained by the interlocking of the teeth of the toothed projections in a sort of ratchet fashion.

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In summary, there is provided a circular band with radially-disposed cut forms each capable of being distorted or moved to draw adjoining areas closer together to change in total the circumferential developed-length of the stop collar in sequential minor increments to accommodate take up of the tubular diametral tolerance. Following this additional intentional distortion or movement gives rise to a radially inwards loading the sum of which supplies sufficient contact force between the inner diameter of the stop collar and the tubular to which it is affixed, to maintain it secured. The number of cut forms is not critical to the invention. In different embodiments different numbers than three may be provided commensurate with the tubular base diameter, the degree of tubular manufacturing tolerance to be taken up and the level of required axial holding ability of the final assembly.

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In addition to addressing the problems of the prior art designs of stop collar as discussed above, embodiments provide a capability of accommodating for variations in diameter which exist on the tubular member due to manufacturing tolerances of tubulars. The segmental cut form design of the present invention may locally distort at each segment to proportionally reduce or eliminate contradictory radial and circumferential loads.

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25 In addition, distortion or movement together of segmental forms may be activated for example but not limited to substantially enlarged hexagonal wrenches for example 12mm across flats as opposed to the prior art forms of common set screws with 6mm across

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plus, minimise encroachment of fluid flow cross sectional area of the annulus so formed.

Figure 3 shows a second embodiment in which the hex hole is supplanted by a
5 different formation –here three smaller holes 80, aligned in a row. Other formations will be readily conceived by the skilled person.

Although the technique of the invention is shown in use as a stop collar, it is also applicable to other components used in similar context.

10 Referring to Figure 4, a one-piece centralizer 200 has first and second opposing end collars 210,220 that are axially separated by plural spring bows 240-245.

Each spring bow forming a generally convex curve. First bows 241,243,254 extending from the first end collar 210 with a respective portion 241a, 243a, 245a
15 substantially axis parallel for a first distance before extending into a continuously curved portion 241b, 243b, 245b to the second end collar 220. Second bows 240,242,244 extend through respective curved portions 240b, 242b, 244b from the first end collar 210 and into a substantially axis parallel portion 240a, 242a, 244a at the second end collar 220. In this embodiment, the end collars are plain, and the
20 centralizer be formed for cooperation with a stop collar.

However, in other embodiments –see for example Figures 7 and 8, the end collars are each end collar is formed similarly to the collar of Figure 2.

25 In the illustrated embodiment there are 6 bows separated into two sets of three, with – in a circumferential direction- a first bow-type followed by a second bow-type followed by a first bow-type. The effect is to reduce very substantially (around 45%) the initial insertion force into a diameter that is smaller than the free outside diameter over the bows.

30 The centralizer of the described embodiment has bows of equal length, and this means it can be made from a single blank, an example of which is shown in Figure 5.

The blank is then cold-formed into a generally cylindrical shape. This may be accomplished by rolling or by other techniques known in themselves in the art.

5 The relatively ductile nature of the boron steel material forming the blank allows for the blank to remain in its cylindrical state after the forming has taken place.

With a known one-piece centralizer a major benefit is that due to the efficiency of leaf spring bows blending homogenously into the end bands at either end, the centralizer could be slide fit into the nominal size wellbore diameter as they were onto the
10 load/deflection performance curve immediately upon the onset of load. By contrast, the traditional spring bow products needed to be greatly oversize to achieve performance and so imparted a high initial insertion force.

Referring to Figure 6, the full (undashed) line shows a centralizer to exactly the same
15 bow chordal width and bow height and without longitudinal offset of every other bow.

On this type the initial insertion force is quite savage as all 6 bows are being urged together towards the restriction and the centralizer is trying to change the developed length so as to conform to the restriction. Typically there is a loss of bow height by as
20 much as 1.5 cm (0.6 in) on diameter as permanent set or yield occurs where the bow meets the end band. This loss means the centralizer outside diameter can reduce to 23.5 cm (9.25") to locate in a 25.1 cm (9.875") well bore. This itself is an improvement over previous types of centralizer.

25 The dashed curve shows the performance of a 6-bow centralizer embodying the invention where we still have the contradiction of pushing towards the resistance which is against bows trying to change their developed length. With only 3 bows entering initially the initial insertion force is only 60%, (there is still some reshaping of the bow profile until it conforms to the restriction diameter). However it remains
30 within the specified yield and on test only lost about 0.4mm (0.017") on bow height - as well as considerably lower insertion force and some 25% reduction on re-start of

CLAIMS:

1. A one-piece device for engagement over and onto a downhole tubular, the device comprising a generally cylindrical band having at least one arcuate portion with opposing end regions, the end regions being coupled together by a connecting portion having a pair of arm portions extending on respective sides of a body portion, distal ends of the arm portions extending into the end regions, the body portion having a formation for engagement therein of a tool whereby rotation of the body portion by a tool varies the size of the device, the device further comprising engagement means to secure the arm portions with respect to an adjacent end region so that the device can be locked.
2. The device of claim 1, having a plurality of arcuate portions each having respective end regions, and a corresponding plurality of connecting portions.
3. The device of claim 1, wherein the connecting portions are generally S shaped.
4. The device of claim 1, wherein the or each arcuate portion has prolongations to form guides for constraining sideways movement of the arm portions.
5. The device of claim 4, wherein the guides have teeth to interact with counterpart teeth on the arm portions to form the engagement means.
6. The device of claim 1, wherein the device is be substantially circular with an axis, the or each arcuate portion have a first axis-parallel width and the arm portions have a second axis-parallel width that is less than the first width.
7. The device of claim 1, being formed of micro-alloy steel.
8. A stop collar or like device which is adapted to mount around a tubular member such as a length of pipe, drill string or tubing string to grip the exterior of the tubular member and restrict axial travel of any further associated product that is

assembled onto the exterior of the tubular member along the member, the device being characterised in that the construction of the stop collar and a means of activating radial gripping of a tubular member is from a single piece of material.

5 9. A method of securing a one-piece stop collar to a tubular comprising sliding the stop collar over the tubular to a desired location, and rotating a portion of the stop collar to draw the collar tighter onto the tubular.

10 10. A centralizer having first and second opposing end collars, the end collars being axially separated by plural spring bows, the spring bows forming a generally convex curve, with first bows extending from the first end collar substantially axis-parallel for a first distance before extending via the curve into the second end collar, and second bows extending curvedly from the first end collar and into a substantially axis-parallel portion at the second end collar, whereby the centralizer is formed of a
15 single piece.

11. A centralizer according to claim 10, comprising the device of claim 1.

short life and the tendency is not to change for new hexagonal drives before rotational failure of the hexagonal drive corners, with resultant insufficient torque input to achieve desired axial holding forces.

- 5 The protrusion of screws or wedge devices beyond the outer diameter of the stop collar main body considerably restricts the use of traditional stop collars in a narrow annulus configuration existing between the tubular to which the stop collars are affixed and the wellbore or internal diameter of a previously installed larger tubular.
- 10 The aforementioned design practices of multiple part stop collar constructions may result in lost parts of the stop collar, or associated components, falling into the wellbore. This is considered as catastrophic in the industry.
- 15 Problems also occur with centralizers where the bore has an upper part of a generally smaller cross section than a lower part where the centralizer is needed to act. Clearly the centralizer must pass through the upper part without breakage, and without requiring too great an insertion force. The two constraints may of course be interrelated.
- 20 One such scenario is with so-called "under-reamed" bores. This occurs for example where wellbores are 'opened out' in a region lower than a previously installed tubular.
- 25 In one example, a drill bit is passed through the 21.68 cm (8.535") internal diameter of a previously installed 24.45 cm (9-5/8") tubular and then the bit is rotated out of concentric to create a 24.13 cm (9.5") hole. So, a centralizer is required to fit the nominal size of 24.13cm (9.5") diameter so as to centralize a tubular in that bore, but also is required to pass through 21.58 cm (8.535") diameter of the upper tubular..

Summary of the Invention

- 30 The invention is defined in the independent claim. Some optional features of the invention are defined in the dependent claims. In a first example there is provided a one-piece device for engagement over and onto a downhole tubular comprising a generally cylindrical band having at least one arcuate

portion with opposing end regions, the end regions being coupled together by a connecting portion having a pair of arm portions extending on respective sides of a body portion, distal ends of the arm portions extending into the end regions, the body portion having a formation for engagement therein of a tool whereby rotation of the body portion by a tool varies the size of the device, the device further comprising engagement means to secure the arm portions with respect to an adjacent end region so that the device can be locked.

The device may have a plurality of arcuate portions each having respective end regions, and a corresponding plurality of connecting portions.

The connecting portions may be generally S-shaped.

The arcuate portions may have prolongations to form guides for constraining sideways movement of the arm portions.

The guides may have teeth to interact with counterpart teeth on the arm portions to form the engagement means.

The device may be substantially circular with an axis, the or each arcuate portion have a first axis-parallel width and the arm portions have a second axis-parallel width that is less than the first width.

The device may be of a micro-alloy steel. An example that may be used is boron steel.

In a second example, there is provided a stop collar or like device which is adapted to mount around a tubular member such as a length of pipe, drill string or tubing string to grip the exterior of the tubular member and restrict axial travel of any further associated product that is assembled onto the exterior of the tubular member along the member, the device being characterised in that the construction of the stop collar and

a means of activating radial gripping of a tubular member is from a single piece of material.

5 In a third example there is provided a method of securing a one-piece stop collar to a tubular comprising sliding the stop collar over the tubular to a desired location, and rotating a portion of the stop collar to draw the collar tighter onto the tubular.

Prior art examples, where sufficient annular width allows, have attempted to draw the open ends of a stop collar band or ring together for example with bolt and nut designs.
10 The desire to change developed circumferential length requires that slippage takes place between all of the internal diameter of the stop collar and the surface of the tubular to which it is being affixed yet achieve high radial loads. It is given that the two desires are contradictory.

15 In a fourth example, a centralizer has first and second opposing end collars that are axially separated by plural spring bows, the spring bows forming a generally convex curve, with first bows extending from the first end collar substantially axis parallel for a first distance before extending via the curve into the second end collar, and second bows extending curvedly from the first end collar and into a substantially axis parallel
20 portion at the second end collar, whereby the centralizer is formed of a single piece of material.

The material may be a micro-alloy steel. The micro-alloy steel may be boron steel.

25 One or both collars of the centralizer may be in accordance with the first aspect.

In a further example there is provided a device for disposition on a tubular member, the device having a band or collar, and having plural resilient axial protrusions for distributing point loading.
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The circular body portions 45, 55, 65 have a formation for a tool. In this embodiment, the formation is a hex hole 70 dimensioned to be engaged by a hex key.

5 In use, the stop collar 1 is fitted and secured to a tubular by sliding the stop collar 1 over the tubular to a desired location, and rotating the body portions 45,55,65 one-by-one to draw the collar into tight engagement onto the tubular. The engagement state is maintained by the interlocking of the teeth of the toothed projections in a sort of ratchet fashion.

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In summary, there is provided a circular band with radially-disposed cut forms each capable of being distorted or moved to draw adjoining areas closer together to change in total the circumferential developed-length of the stop collar in sequential minor increments to accommodate take up of the tubular diametral tolerance. Following this additional intentional distortion or movement gives rise to a radially inwards loading the sum of which supplies sufficient contact force between the inner diameter of the stop collar and the tubular to which it is affixed, to maintain it secured. The number of cut forms is not critical to the invention. In different embodiments different numbers than three may be provided commensurate with the tubular base diameter, the degree of tubular manufacturing tolerance to be taken up and the level of required axial holding ability of the final assembly.

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In addition to addressing the problems of the prior art designs of stop collar as discussed above, embodiments provide a capability of accommodating for variations in diameter which exist on the tubular member due to manufacturing tolerances of tubulars. The segmental cut form design may locally distort at each segment to proportionally reduce or eliminate contradictory radial and circumferential loads.

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Distortion or movement together of segmental forms may be activated for example but not limited to substantially enlarged hexagonal wrenches for example 12mm across flats as opposed to the prior art forms of common set screws with 6mm across

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plus, minimise encroachment of fluid flow cross sectional area of the annulus so formed.

Figure 3 shows a second embodiment in which the hex hole is supplanted by a different formation –here three smaller holes 80, aligned in a row. Other formations will be readily conceived by the skilled person.

Although the technique is shown in use as a stop collar, it is also applicable to other components used in similar context.

Referring to Figure 4, a one-piece centralizer 200 has first and second opposing end collars 210,220 that are axially separated by plural spring bows 240-245.

Each spring bow forming a generally convex curve. First bows 241,243,254 extending from the first end collar 210 with a respective portion 241a, 243a, 245a substantially axis parallel for a first distance before extending into a continuously curved portion 241b, 243b, 245b to the second end collar 220. Second bows 240,242,244 extend through respective curved portions 240b, 242b, 244b from the first end collar 210 and into a substantially axis parallel portion 240a, 242a, 244a at the second end collar 220. In this embodiment, the end collars are plain, and the centralizer be formed for cooperation with a stop collar.

However, in other embodiments –see for example Figures 7 and 8, the end collars are each end collar is formed similarly to the collar of Figure 2.

In the illustrated embodiment there are 6 bows separated into two sets of three, with – in a circumferential direction- a first bow-type followed by a second bow-type followed by a first bow-type. The effect is to reduce very substantially (around 45%) the initial insertion force into a diameter that is smaller than the free outside diameter over the bows.

The centralizer of the described embodiment has bows of equal length, and this means it can be made from a single blank, an example of which is shown in Figure 5.

The blank is then cold-formed into a generally cylindrical shape. This may be accomplished by rolling or by other techniques known in themselves in the art.

5 The relatively ductile nature of the boron steel material forming the blank allows for the blank to remain in its cylindrical state after the forming has taken place.

With a known one-piece centralizer a major benefit is that due to the efficiency of leaf spring bows blending homogenously into the end bands at either end, the centralizer could be slide fit into the nominal size wellbore diameter as they were onto the
10 load/deflection performance curve immediately upon the onset of load. By contrast, the traditional spring bow products needed to be greatly oversize to achieve performance and so imparted a high initial insertion force.

Referring to Figure 6, the full (undashed) line shows a centralizer to exactly the same
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On this type the initial insertion force is quite savage as all 6 bows are being urged together towards the restriction and the centralizer is trying to change the developed length so as to conform to the restriction. Typically there is a loss of bow height by as
20 much as 1.5 cm (0.6 in) on diameter as permanent set or yield occurs where the bow meets the end band. This loss means the centralizer outside diameter can reduce to 23.5 cm (9.25") to locate in a 25.1 cm (9.875") well bore. This itself is an improvement over previous types of centralizer.

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30 only lost about 0.4mm (0.017") on bow height - as well as considerably lower insertion force and some 25% reduction on re-start of

Claims

1. A centralizer (2101) having first and second opposing end collars (210,220), the end collars being axially separated by plural spring bows (240-245), characterised by a first set of bows (241, 2435, 245; 2105) that extend from the first end collar (210) substantially axis-parallel for a first distance before extending via a generally convex curved portion into the second end collar (220), and a second set of bows (240,242,244; 2107) that extend via a generally convex curved portion from the first end collar (210) and into a substantially axis-parallel portion at the second end collar (220) such that the curved portions of the first and second sets of bows are longitudinally off-set relative to each other, whereby the centralizer is formed of a single piece.
2. A centralizer according to claim 1, having comprising a generally cylindrical band having at least one arcuate portion with opposing end regions, the end regions being coupled together by a connecting portion having a pair of arm portions extending on respective sides of a body portion, distal ends of the arm portions extending into the end regions, the body portion having a formation for engagement therein of a tool whereby rotation of the body portion by a tool varies the size of the device, the device further comprising engagement means (12,44) to secure the arm portions with respect to an adjacent end region so that the device can be locked.
3. A centraliser according to claim 2, having a plurality of arcuate portions each having respective end regions, and a corresponding plurality of connecting portions.
4. A centraliser according to claim 2, wherein the connecting portions are generally S shaped.
5. The centraliser of claim 2, wherein the or each arcuate portion has prolongations to form guides for constraining sideways movement of the arm portions.
6. The centraliser of claim 5, wherein the guides have teeth to interact with counterpart teeth on the arm portions to form the engagement means.
7. The centraliser of claim 2, being substantially circular with an axis, the or each arcuate portion have a first axis-parallel width and the arm portions have a second axis-parallel width that is less than the first width.

8. The centraliser of any preceding claim, being formed of micro-alloy steel.