

PATENT SPECIFICATION (11)

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(54) DEVICE FOR CENTRALIZING AN ELONGATE ELEMENT WITHIN A BORE

(71) We, HALLIBURTON COMPANY, a Corporation organised under the laws of the State of Delaware, U.S.A., of 1015 Bois D'Arc St., P.O. Drawer 1431. Duncan, Oklahoma, Stephens County, U.S.A., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a device for assembling upon an elongate element to centralize that element within a bore. The device has particular applied to oil well equipment.

The use of such a device, or centralizer, is advantageous for many purposes. The drilling for oil, gas or water and the installation of casing creates a need for casing centralizers. The productive formation or casing cannot be fully protected by cement unless the casing is uniformly cemented on all sides of the wellbore. Tubing centralizers are used on tubing strings in wells for protection against wear on the tubing and collars when the string is frequently pulled and then rerun. Some geographical areas use tubing as a production string and for water injection wells—centralizers provide better centering and thus better cement uniformity.

Since oil wells may be located in various places throughout the world, transportation of centralizers is a significant part of their cost. Also equipment, such as airplanes or helicopters, with limited space must often be utilized for transporting centralizers, and therefore it is desirable to make a centralizer which can be shipped within minimum space confines. U.S. Patents 2,738,019 and 3,055,432 describe two centralizers which have been utilized to alleviate the problem. However, each of these devices has sharp protruding corners and edges which can lead to injury during assembly. It would thus be desirable to eliminate these sharp external features.

Prior art centralizers have traditionally been designed with circumferentially rigid construction. However, for assembly and

for downhole use this holdover from welded centralizers has been determined by us to be unnecessary as it can increase the difficulty of assembly and lead to extra downhole stresses in a helically channeled well-bore.

This invention provides a device for assembling upon an elongate element to centralise said element within a bore, said device comprising two separate collars for circumferentially embracing said element and a plurality of spring bands each with opposite ends adapted to engage, in non-welded interlocking manner, with respective collars, the spring bands being engageable with each collar at points spaced apart circumferentially around that collar with said spring bands bowed outwards between the two collars so as, in use, to resiliently engage the wall of said bore, each end of each spring band being provided with a portion to locate within a respective opening formed in the respective collar, each collar having a portion overlying each said opening so as to overlap the respective end portion of the respective spring band when engaged in its said opening, each said opening being bounded by an arcuate surface of the respective collar and each said band end portion being provided with a corresponding arcuate surface, said arcuate surfaces abutting when the respective band end portion is engaged with its collar opening so as to prevent axial movement of that band end towards the other collar while allowing at least limited rotational movement of the respective band end portion relative to the associated collar.

Embodiments of this invention will now be described, by way of examples only, with reference to the accompanying drawings, in which:

FIGURE 1 is a side view of a centralizer in position in a wellbore;

FIGURE 2 is a radial cross-section of a portion of an end collar and spring end, showing attachment thereof of the Figure 1 centralizer;

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FIGURE 3 is an inside view of the end collar portion and spring end of Figure 2;

FIGURE 4 is an outside view of the end collar portion and spring end portion of Figure 2;

FIGURE 5 is an outside view of the end collar portion alone of FIGURE 2;

FIGURE 5A is an outside view of an equivalent end collar structure;

FIGURE 6 is an inside view of the end collar portion alone of FIGURE 1;

FIGURE 7 is an outside perspective view of the end portion of the spring end of FIGURE 2;

FIGURE 7A is an outside perspective view of an alternative embodiment of the end portion of FIGURE 7;

FIGURE 8 is an outside perspective view of another alternative embodiment of the end portion of FIGURE 7;

FIGURE 9 is a radial cross-section of a first alternative embodiment of an end collar portion and spring end portion in assembled condition;

FIGURE 10 is an internal side perspective view of the spring end portion of FIGURE 9;

FIGURE 11 is an internal side perspective view of a second alternative embodiment of the spring end portion of FIGURE 9;

FIGURE 12 is an external side perspective view of an alternative embodiment of the spring end portion of FIGURE 7;

FIGURE 13 is an external side view of an alternative embodiment of the end collar portion of FIGURE 5; and

FIGURES 14-17 are external side views of other alternative embodiments of the end collar portion of FIGURE 5.

Looking to the FIGURES more specifically to understand the invention, FIGURE 1 shows a centralizer 1 already assembled upon a casing, drill pipe or other elongate tubular member 3 disposed within a wellbore 5. Centralizer 1 includes end collars 7 and 9 and a plurality of outwardly bowed springs 11. End collars 7 and 9 can be split to facilitate attachment to tubular member 3 and can be provided with hinges 13 to connect the split portions thereof. A limiting device 15, such as the EZ LOK limit clamp described on page 2425 of Halliburton Services Sales and Service Catalogue Number 37, can be positioned on tubular member 3 and end collars 7 and 9 attached thereabove and therebelow, respectively. Alternatively the end collars could be similarly attached above and below a coupling collar (not shown). FIGURES 2-4 show the connection of one end of one such spring 11 to its respective end collar 7. The end portion 17 of spring 11 comprises an inwardly projecting lug 19 and fulcrum portion 21. An extension 22 of lug 19 extends longitudinally beyond the end of a main body of spring 11 so as to

fit inside a lip 23 of end collar 7 and form a longitudinally outer (relative to the length of the spring band) ledge 24 between fulcrum portion 21 and lug 19. Lip 23 can be semi-circular as shown in FIGURES 3 and 4 or various other shapes so long as lip 23 overlies lug 19 at some point to restrain lug 19 from moving radially outward. The longitudinally inner end surface 25 of lug 19 is arcuate corresponding in shape to the longitudinally arcuate surface 27 of an opening 29 in which lug 19 fits. Lip 23 holds lug 19 radially inward to maintain surfaces 25 and 27 in contact to prevent longitudinal movement of spring end portion 17 relative to its respective end collar 7. Fulcrum portion 21 overlies a portion 31 of end collar 7 to assure that any inward radial movement of center portion 33 of spring 11 will tend to cause outward radial force on lug 19 to cause lug extension 22 forcibly to abut lip 23. Surfaces 25 and 27 are made arcuate to facilitate assembly of centralizer 1 and to allow the spring 11 to assume a helical shape (not shown) in response to torsional loads applied to centralizer 1.

FIGURES 5 and 6 show a preferred embodiment of opening 29, lip 23 and surface 27 wherein the opening is circular and lip 23 is a semi-circle covering approximately what is, longitudinally of the band, the outer half of opening 29. FIGURE 5A shows that opening 29 may assume various configurations and need not even be closed as in FIGURE 5, but could be connected by slot 33 to a longitudinal end 35 of the end collar.

FIGURES 2, 7 and 7A show that surface 25 is rounded to facilitate assembly while ledge 24 can be either straight as in FIGURE 7 to limit rotation of lug 19 in opening 29 once assembled or ledge 24 can be replaced by a rounded ledge 37 to allow a good bit of rotation or a recessed ledge 39 to allow more limited rotation or some other shape of ledge to allow the desired amount of rotation. In the event that a rounded ledge 37 is used, the longitudinally inner (relative to the band length) end surface 41 of lip 23 can be provided with a rounded recess (not shown) to rotatably receive ledge 37.

FIGURE 9 shows that the shapes may be varied and that the extension 22 of FIGURE 2 are useful luxuries as are ledges 24, 37 and 39, yet not mandatory. Lug 57 of the spring end portion 55 is made to have a common end 59 with fulcrum portion 61, and lip 63 is adapted to fit over fulcrum portion 61. This means of attachment of spring 11 to end collars 7 and 9 requires greater diameter end collars, so is somewhat less useful, but the common end 59 can be rounded as in FIGURE 10 to provide limited rotation of spring end 55 relative to the end collar. In fact, fulcrum portion 61 can

be modified, as shown at 67 in Figure 11, to extend beyond the outer longitudinal end 69a of lug 69 if desired, although this will make assembly more difficult unless opening 29 extends from surface 25 to the outer end 65 of the fulcrum portion. Also, the fulcrum portions, such as fulcrum portion 67 and lug such as lug 69 could have one or more internal openings 71 to save metal, if desired. These openings could pass through just the lug 69 or through both the lug and fulcrum portion. In fact the lug could simply be a washer of suitable size welded to the spring end. The lug can be of larger diameter than the full width of the main body of the spring band, as enlarged disc lug 72 of FIGURE 12. Also, as shown in FIGURES 13 and 17, the longitudinally outer portion 75 or 76 of the collar opening need not be circular or arcuate but could be rectangular or some other shape which could be designed to allow limited rotation of the spring ends. Also, lip 77 of FIGURE 14 could be substituted for lip 23 as could one or more tabs 79 as shown in FIGURE 16. The openings 29 could be provided with a longitudinally inner extension such as extension 78 of FIGURE 15 which could receive a similarly shaped spring end to prevent rotation or could alternatively receive such spring ends as shown in FIGURES 2, 3, 4, 7A, 8, 10, 11 or 12 to allow rotation.

Assembly could be done manually as in U. S. Patent 3,055,432, but would preferably be done with pipe wrenches or other tools as in U. S. Patent 2,738,019 so as to help avoid cutting or pinching of the assembler's hands. However, with the present device, assembly can be facilitated by use of the optional circular spring end lugs in that the circular spring ends can be rotated slightly during assembly and sharp corners are avoided, and neither projections (radially outwards of the collar) nor extensions (circumferentially of the collar) of the spring width are required.

Also, lips 23 can be made by forging or otherwise radially and outwardly bending a portion of the end collar so as to make an overlying lip for a portion of the lug. Also, such lugs could be formed on springs 11 by simple forging, or otherwise forming the end portions thereof to produce the desired lug shape. The openings 29 could be either drilled, punched, or otherwise formed in end collar 7 or end collar 7 could be cast with a lip and opening already shaped.

WHAT WE CLAIM IS:—

1. A device for assembling upon an elongate element to centralize said element within a bore, said device comprising two separate collars for circumferentially embracing said element and a plurality of spring bands each with opposite ends adapted to

engage, in non-welded interlocking manner, with respective said collars, the spring bands being engageable with each collar at points spaced apart circumferentially around that collar with said spring bands bowed outwards between the two collars so as, in use, to resiliently engage the wall of said bore, each end of each spring band being provided with a portion to locate within a respective opening formed in the respective collar, each collar having a portion overlying each said opening so as to overlap the respective end portion of the respective spring band when engaged in its said opening, each said opening being bounded by an arcuate surface of the respective collar and each said band end portion being provided with a corresponding arcuate surface, said arcuate surfaces abutting when the respective band end portion is engaged with its collar opening so as to prevent axial movement of that band end towards the other collar while allowing at least limited rotational movement of the respective band end portion relative to the associated collar.

2. A device as claimed in claim 1 wherein each said band comprises a main body and each said end portion comprises a lug extending from said main body.

3. A device as claimed in claim 2, wherein each said lug extends longitudinally of its spring band beyond an adjacent end of the main body of said spring band and the respective overlying collar portion is arranged to abut said end of said main body portion in a manner permitting rotation of said band relative to the associated collar.

4. A device as claimed in claim 2, wherein each spring band main body has each end co-terminous with the longitudinal end of the respective lug.

5. A device as claimed in any one of claims 2 to 4, wherein each said opening is circular and each said lug is a disc of slightly lesser diameter than its said opening.

6. A device as claimed in claim 5, wherein each said overlying collar portion is a semi-circular disc.

7. A device as claimed in claim 5, wherein each said lug extends longitudinally of its spring band beyond an adjacent end of its main body a longitudinal distance substantially the same longitudinal distance by which its respective said overlying collar portion overlies the associated said openings.

8. A device as claimed in any one of claims 5 to 7 wherein each said disc is of larger diameter than the full width of said main body of the respective spring band.

9. A device as claimed in any one of claims 5 to 8, wherein said disc has a hole therethrough.

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be modified, as shown at 67 in Figure 11, to extend beyond the outer longitudinal end 69a of lug 69 if desired, although this will make assembly more difficult unless opening 29 extends from surface 25 to the outer end 65 of the fulcrum portion. Also, the fulcrum portions, such as fulcrum portion 67 and lug such as lug 69 could have one or more internal openings 71 to save metal, if desired. These openings could pass through just the lug 69 or through both the lug and fulcrum portion. In fact the lug could simply be a washer of suitable size welded to the spring end. The lug can be of larger diameter than the full width of the main body of the spring band, as enlarged disc lug 72 of FIGURE 12. Also, as shown in FIGURES 13 and 17, the longitudinally outer portion 75 or 76 of the collar opening need not be circular or arcuate but could be rectangular or some other shape which could be designed to allow limited rotation of the spring ends. Also, lip 77 of FIGURE 14 could be substituted for lip 23 as could one or more tabs 79 as shown in FIGURE 16. The openings 29 could be provided with a longitudinally inner extension such as extension 78 of FIGURE 15 which could receive a similarly shaped spring end to prevent rotation or could alternatively receive such spring ends as shown in FIGURES 2, 3, 4, 7A, 8, 10, 11 or 12 to allow rotation.

Assembly could be done manually as in U. S. Patent 3,055,432, but would preferably be done with pipe wrenches or other tools as in U. S. Patent 2,738,019 so as to help avoid cutting or pinching of the assembler's hands. However, with the present device, assembly can be facilitated by use of the optional circular spring end lugs in that the circular spring ends can be rotated slightly during assembly and sharp corners are avoided, and neither projections (radially outwards of the collar) nor extensions (circumferentially of the collar) of the spring width are required.

Also, lips 23 can be made by forging or otherwise radially and outwardly bending a portion of the end collar so as to make an overlying lip for a portion of the lug. Also, such lugs could be formed on springs 11 by simple forging, or otherwise forming the end portions thereof to produce the desired lug shape. The openings 29 could be either drilled, punched, or otherwise formed in end collar 7 or end collar 7 could be cast with a lip and opening already shaped.

WHAT WE CLAIM IS:—

1. A device for assembling upon an elongate element to centralize said element within a bore, said device comprising two separate collars for circumferentially embracing said element and a plurality of spring bands each with opposite ends adapted to

engage, in non-welded interlocking manner, with respective said collars, the spring bands being engageable with each collar at points spaced apart circumferentially around that collar with said spring bands bowed outwards between the two collars so as, in use, to resiliently engage the wall of said bore, each end of each spring band being provided with a portion to locate within a respective opening formed in the respective collar, each collar having a portion overlying each said opening so as to overlap the respective end portion of the respective spring band when engaged in its said opening, each said opening being bounded by an arcuate surface of the respective collar and each said band end portion being provided with a corresponding arcuate surface, said arcuate surfaces abutting when the respective band end portion is engaged with its collar opening so as to prevent axial movement of that band end towards the other collar while allowing at least limited rotational movement of the respective band end portion relative to the associated collar.

2. A device as claimed in claim 1 wherein each said band comprises a main body and each said end portion comprises a lug extending from said main body.

3. A device as claimed in claim 2, wherein each said lug extends longitudinally of its spring band beyond an adjacent end of the main body of said spring band and the respective overlying collar portion is arranged to abut said end of said main body portion in a manner permitting rotation of said band relative to the associated collar.

4. A device as claimed in claim 2, wherein each spring band main body has each end co-terminous with the longitudinal end of the respective lug.

5. A device as claimed in any one of claims 2 to 4, wherein each said opening is circular and each said lug is a disc of slightly lesser diameter than its said opening.

6. A device as claimed in claim 5, wherein each said overlying collar portion is a semi-circular disc.

7. A device as claimed in claim 5, wherein each said lug extends longitudinally of its spring band beyond an adjacent end of its main body a longitudinal distance substantially the same longitudinal distance by which its respective said overlying collar portion overlies the associated said openings.

8. A device as claimed in any one of claims 5 to 7 wherein each said disc is of larger diameter than the full width of said main body of the respective spring band.

9. A device as claimed in any one of claims 5 to 8, wherein said disc has a hole therethrough.



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10. A device as claimed in any one of the preceding claims in which the ends of all spring bands are engageable with their respective collars in an identical manner.
- 5 11. A device as claimed in any one of the preceding claims, in which the spring bands have their opposite end portions naturally directed outwards but requiring flexing into axial alignment, in order to engage with the collars, by the fulcruming
- 10 of portions of the bands, between said

end portions and the central bowed portions, against outer surfaces of the collars.

12. A device as claimed in any preceding claim, when assembled on an elongated element.

13. A device substantially as herein-described with reference to Figures 1 to 5, 6 and 7, or to any one of Figures 5a, 7a and 8 to 17.

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