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(54) METHOD AND APPARATUS FOR SPACE OUT OF PERMANENTLY DEPLOYED WELL SENSORS

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(57) **ABSTRACT**

A system and a method for adjusting the length of a cable between downhole sensors. The length adjustment system comprises a housing and at least one deforming member configured to translate relative to the housing. An actuator may be coupled to the deforming member and configured to translate the deforming member. The cable is deformed with one or more arcuate deformations, thereby reducing the length of the cable as measured relative to a straight line.

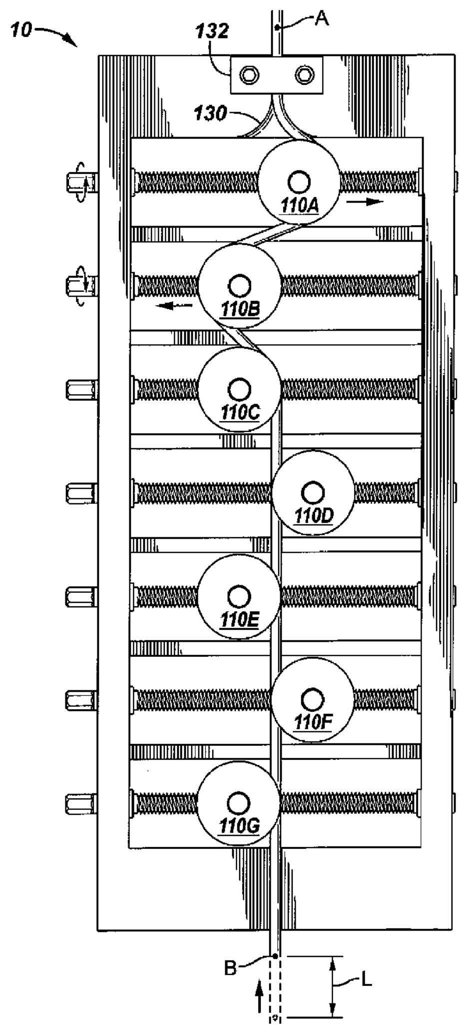
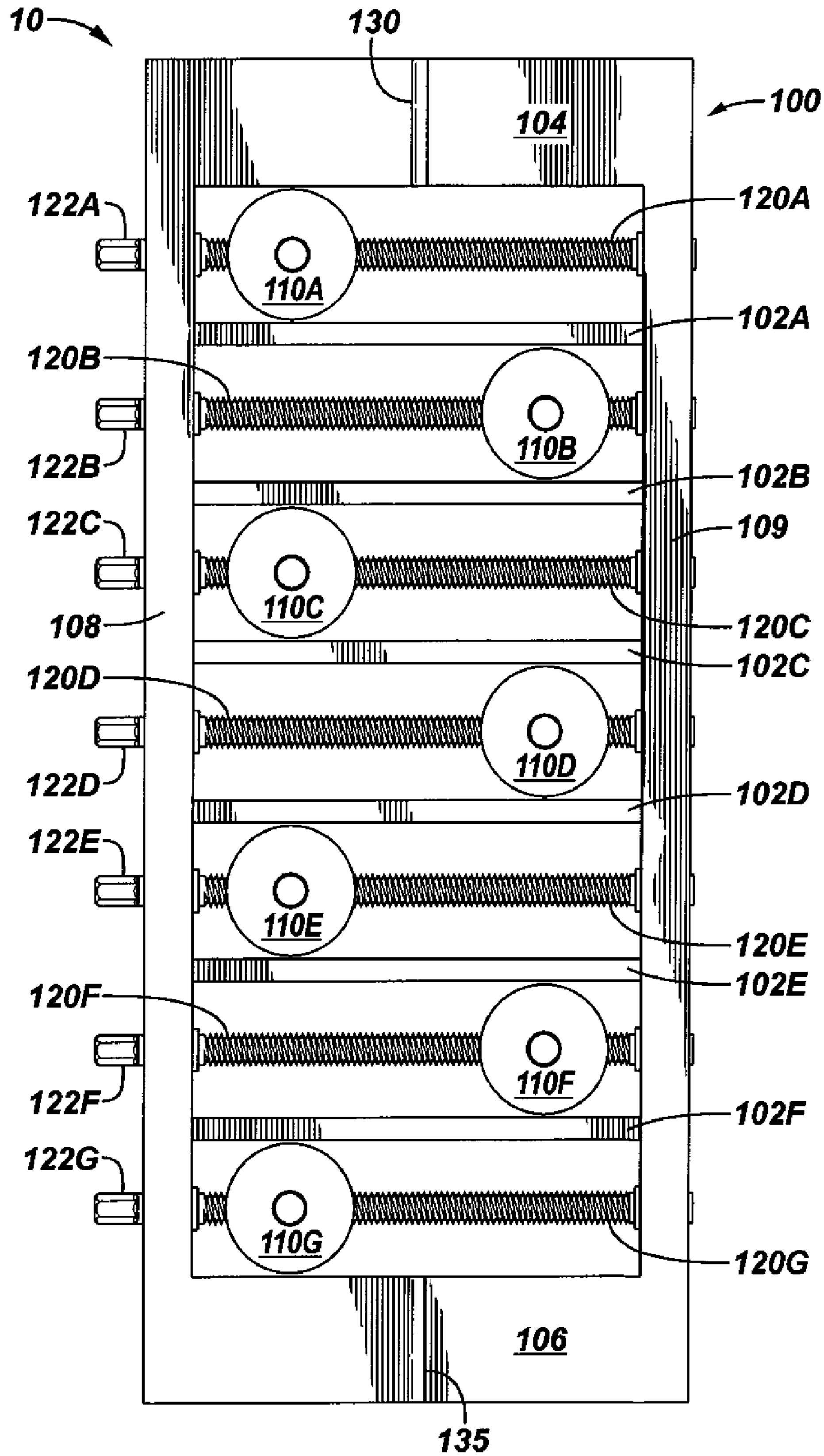


FIG. 1


10
130
104
100
122A
120A
110A
102A
120B
122B
110B
102B
122C
109
110C
108
120C
102C
120D
110D
122D
102D
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120E
102E
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110F
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102F
122G
110G
120G
106
135

FIG. 2A

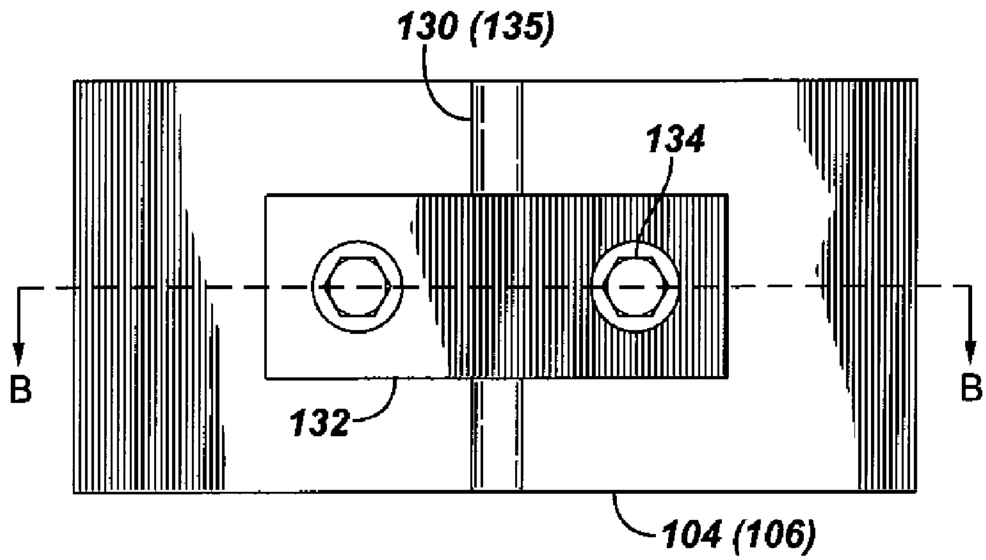


FIG. 2B

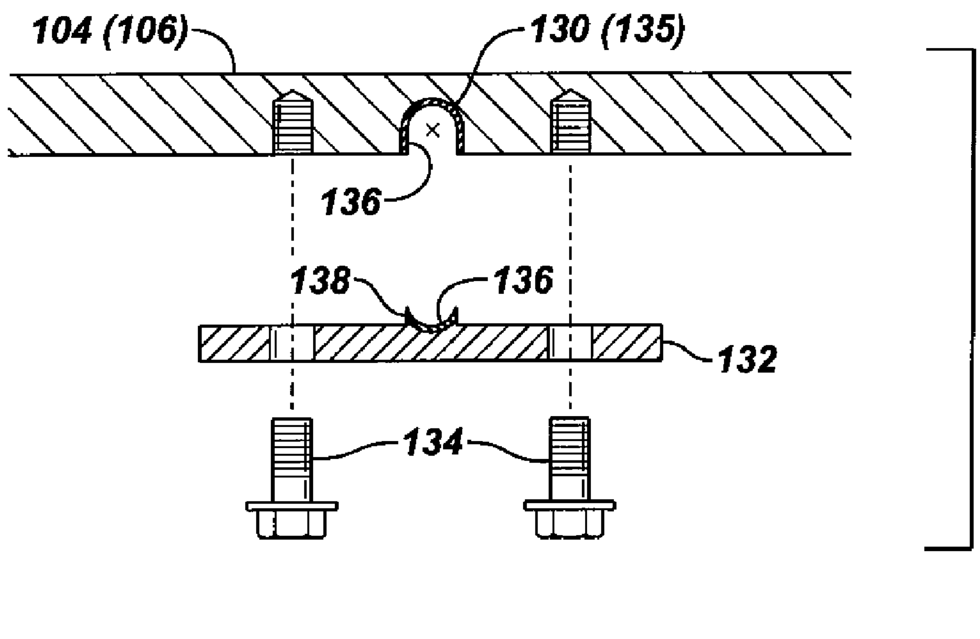


FIG. 2C

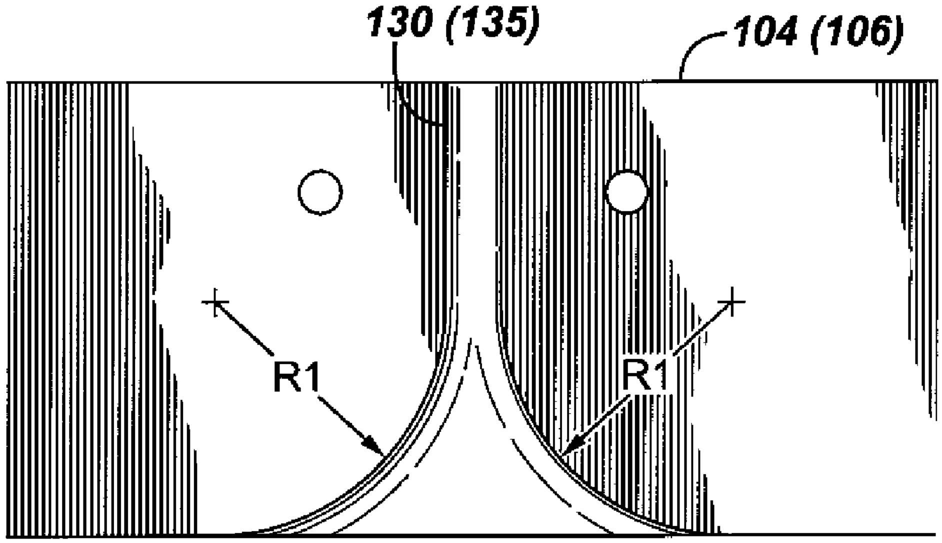


FIG. 3

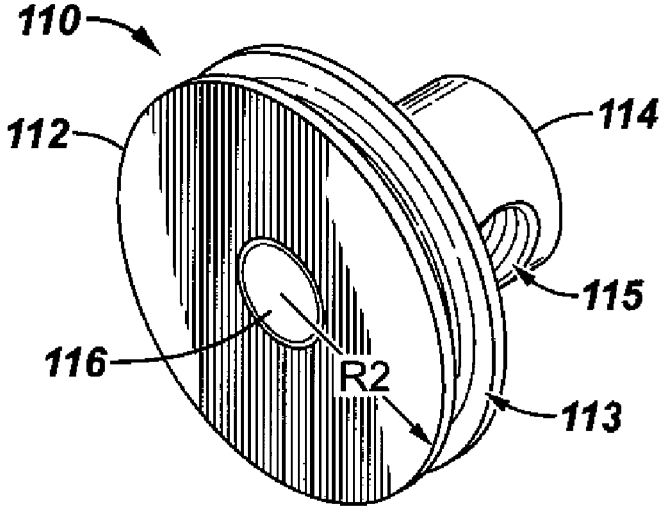


FIG. 4

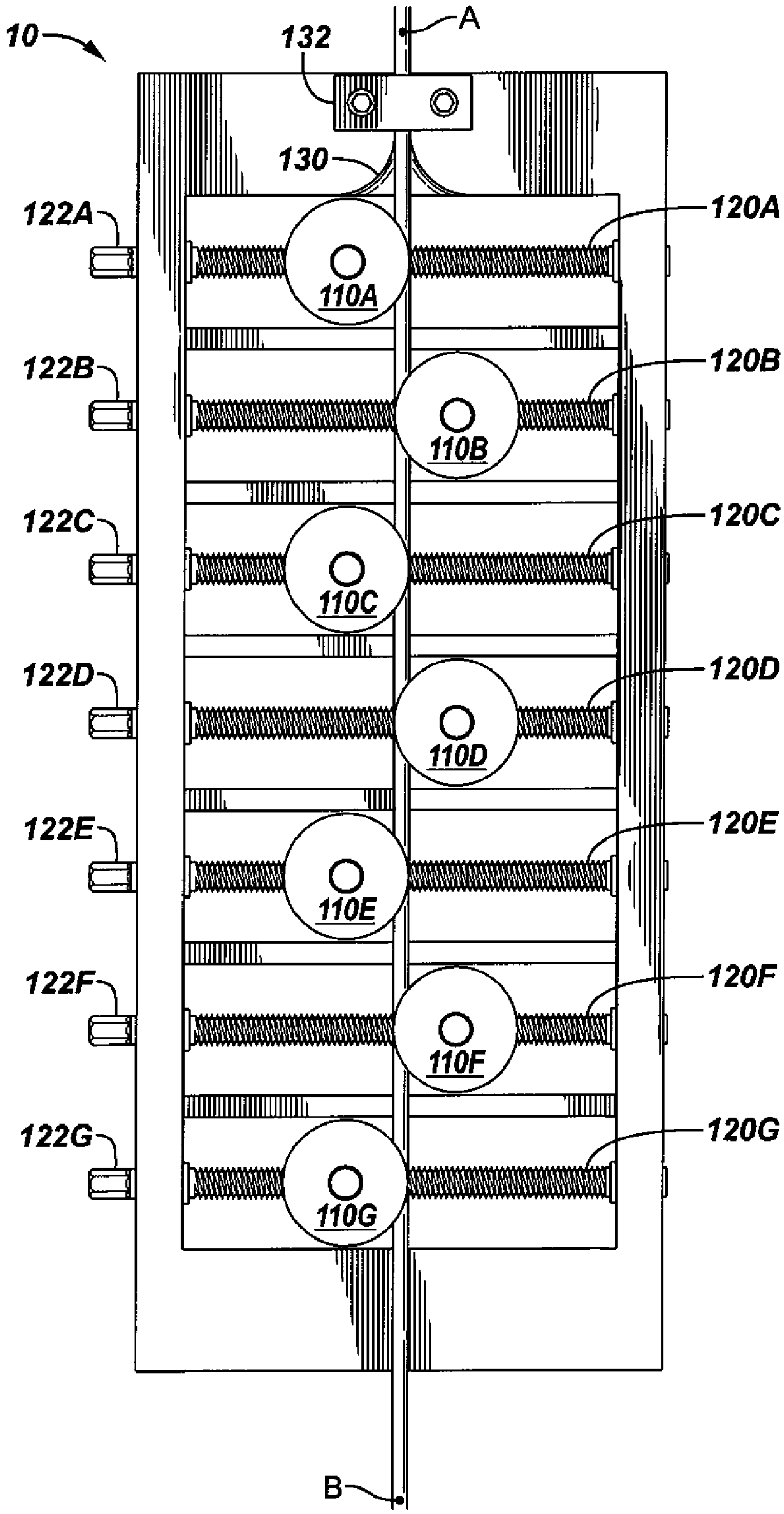

10
132
A
130
122A
122B
122C
122D
122E
122F
122G
120A
120B
120C
120D
120E
120F
120G
110A
110B
110C
110D
110E
110F
110G
B

FIG. 5

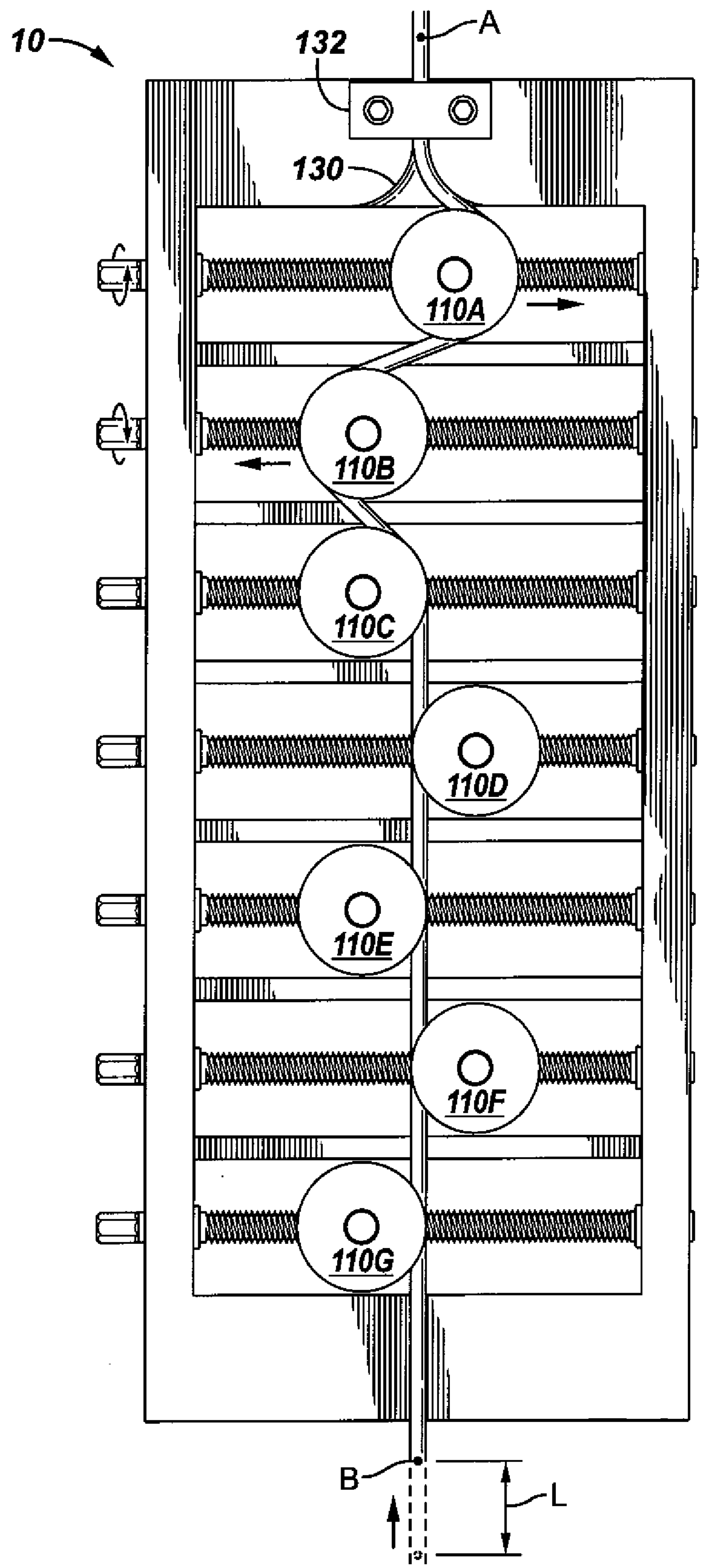


FIG. 6

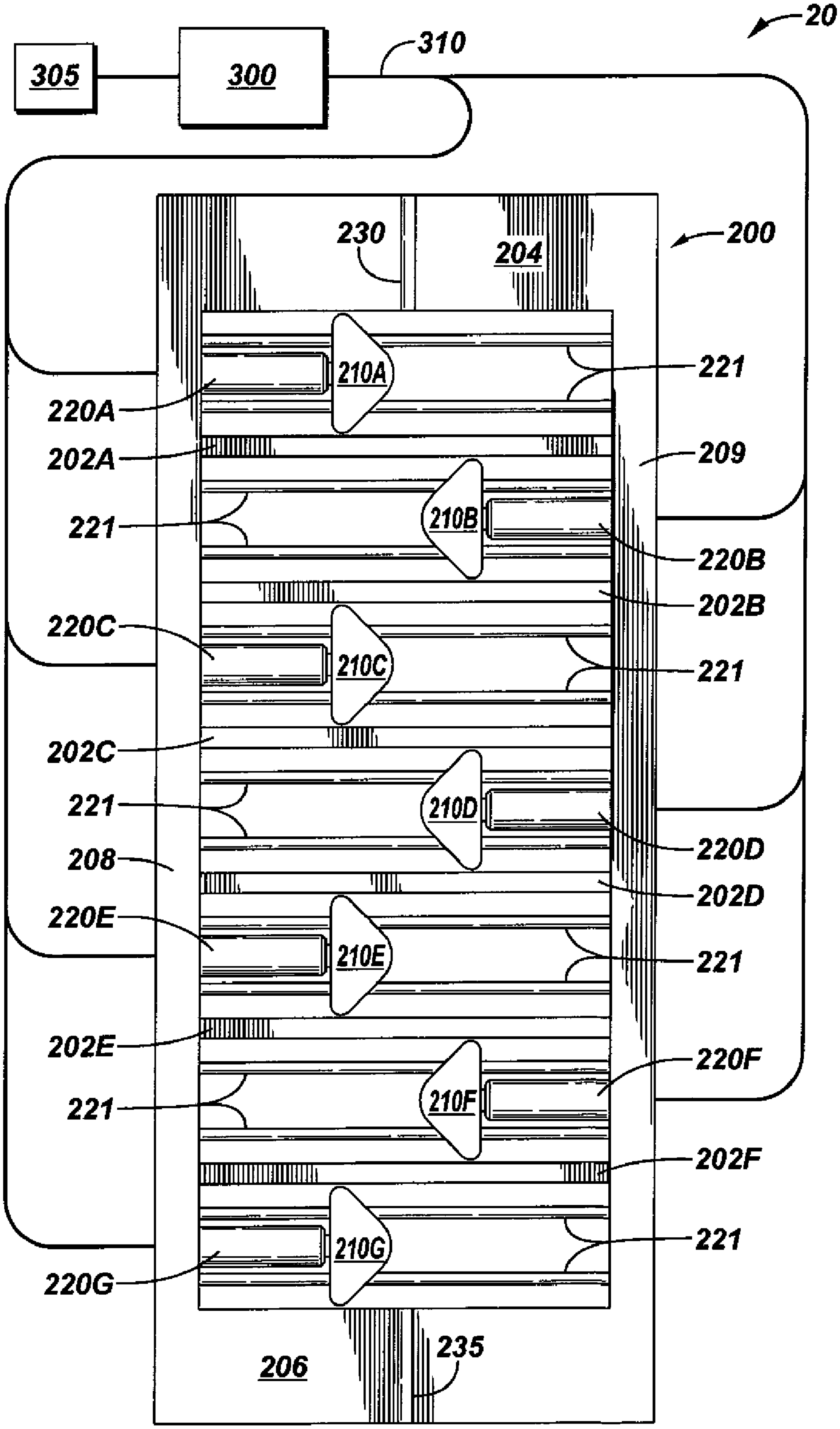

20
305
300
310
230
204
200
210A
221
220A
202A
209
210B
221
220B
202B
220C
210C
221
202C
210D
221
220D
208
202D
220E
210E
221
202E
220F
210F
221
202F
210G
221
220G
206
235

FIG. 7

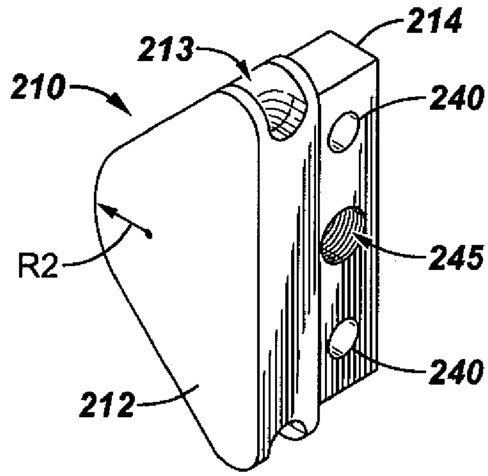


FIG. 8

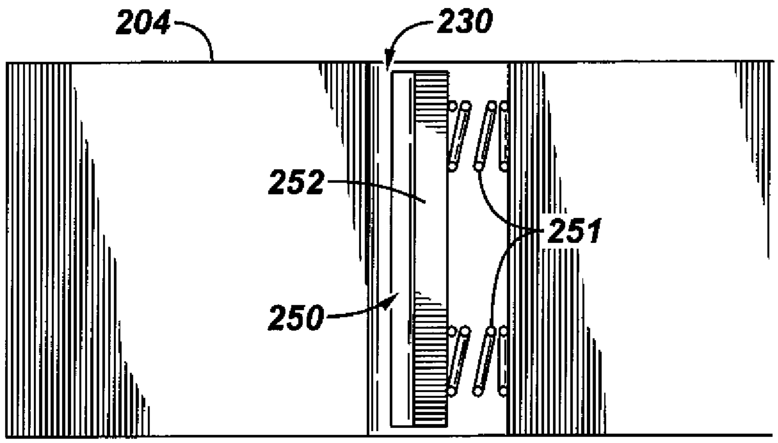
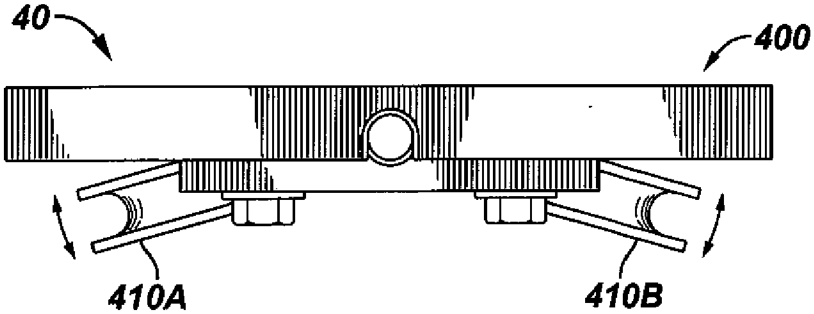


FIG. 9



METHOD AND APPARATUS FOR SPACE OUT OF PERMANENTLY DEPLOYED WELL SENSORS

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/971,121, filed Sep. 10, 2007, the contents of which are herein incorporated by reference.

BACKGROUND

[0002] 1. Field of the Invention

[0003] Embodiments of the present invention relate generally to well methods and apparatuses, and more particularly to well methods and apparatuses for taking up cable slack.

[0004] 2. Description of the Related Art

[0005] The following descriptions and examples are not admitted to be prior art by virtue of their inclusion within this section.

[0006] When deploying permanent reservoir sensors in a multi-sensor array in an oil or gas well, the sensors must normally be spaced out precisely to match the oilfield tubulars (tubing, casing, screens, liners, etc.) upon which the sensors are mounted. During the normal manufacturing processes of both the tubulars and the sensor array, there will be manufacturing tolerances on length for each that must be accommodated during run in hole procedures in order for the sensor to mount precisely in a correct position upon the tubular string. In other words, the sensor array must be made to precisely match the spacing of the tubulars and the sensor clamps that are normally positioned on or near the couplings joining the tubulars. This is normally done by providing for some consistent small amount of excess cable length between the sensors, which can then be taken up (shortened) in order for the spacing to match.

[0007] Several methods have been used in the past to take up cable slack, including wrapping the excess cable around the tubular. While this method can be used to remove several feet of cable slack, wrapping is not capable of removing small length mismatches (e.g., up to 4") of cable slack. Wrapping can also leave the cable unprotected and subject to damage while running in hole with the tubulars.

[0008] Additionally, small, handheld cable bending tools can be used to make small radius 90, or 180 degree bends, but this type of handheld cable bending tool can damage the cable if not handled very carefully, and can also bend the cable in a radius that is smaller than the cable's minimum bend radius (MBR). If a cable is bent beyond a predetermined MBR, the risk of kinking the cable becomes high. This kink can represent a critical weakpoint in the cable. In addition, the use of a hand held cable bending tool is a very manual process and not repeatable. Also, the process is not readily adjustable or predictable for removing small amounts of cable slack.

[0009] What is needed is an apparatus and method for performing the length matching operation in a consistent and repeatable fashion, without generating an unpredictable level of risk of damage to the oilfield cable joining the sensors.

SUMMARY

[0010] In general, embodiments of the present invention provide a system and method for removing cable slack in a permanent downhole cable. A cable (e.g., conduit, control line, among others) may be placed within a length adjustment system. The length adjustment system may then deform the cable into one or more arcuate sections. The arcuate sections may be adjusted in number and/or depth to control the length of the cable along a well axis.

[0011] Another embodiment of the present invention provides a method for reducing the overall length of a cable along a well axis. The method may include steps of providing a length adjustment system, placing the length adjustment system in a first position, and installing a cable in the length adjustment system. Additional steps may include holding the cable in place, deforming the cable to a first amount via movement of a first deforming member, and then moving a second deforming member located proximate to the first deforming member, thereby deforming the cable to a second amount. The second deforming member may be the next in position along the length of the cable away from the holding position of the cable. The next step may involve moving a third deforming member to deform the cable to a third amount. The movements of the deforming members and the number of deforming members may be determined as needed.

[0012] The claimed subject matter is not limited to implementations that solve any or all of the noted disadvantages. Further, the summary section is provided to introduce a selection of concepts in a simplified form that are further described below in the detailed description section. The summary section is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Certain embodiments of the invention will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying drawings illustrate only the various implementations described herein and are not meant to limit the scope of various technologies described herein. The drawings are as follows:

[0014] FIG. **1** is a front elevation view of a length adjustment system according to an embodiment of the present invention;

[0015] FIGS. **2**A-C are enlarged views of portions of other embodiments of a housing member of a length adjustment system of the present invention;

[0016] FIG. **3** is a side perspective view of a deforming member used with the length adjustment system of FIG. **1**, according to an embodiment of the present invention;

[0017] FIG. **4** is a front elevation view of a length adjustment system in a first position, according to an embodiment of the present invention;

[0018] FIG. **5** is a front elevation view of the length adjustment system of FIG. **4** shown in a second position, according to an embodiment of the present invention;

[0019] FIG. **6** is a front elevation view and partial schematic of a length adjustment system, according to another embodiment of the present invention;

[0020] FIG. **7** is a side perspective view of a deforming member of a length adjustment system, according to another embodiment of the present invention;

[0021] FIG. **8** is an enlarged front view of a conduit restraining device used with a length adjustment system, according to another embodiment of the present invention; and

[0022] FIG. **9** is a top view of a length adjustment system with deforming members configured to deform a cable about a longitudinal axis, according to another embodiment of the present invention.

DETAILED DESCRIPTION

[0023] As used here, the terms "up" and "down"; "upper" and "lower"; "upwardly" and "downwardly"; "below" and "above"; and other similar terms indicating relative positions above or below a given point or element may be used in connection with some implementations of various technologies described herein. However, when applied to equipment and methods for use in wells that are deviated or horizontal, or when applied to equipment and methods that when arranged in a well are in a deviated or horizontal orientation, such terms may refer to a left to right, right to left, or other relationships as appropriate.

[0024] In the following description, numerous details are set forth to provide an understanding of the present invention. However, it will be understood by those of ordinary skill in the art that the present invention may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0025] Referring generally to FIG. **1**, one embodiment of a length adjusting system **10** is illustrated as comprising a housing **100**. The housing **100** may be generally rectangular in shape and include a left member **108**, right member **109**, top member **104** and bottom member **106** for example. In some embodiments, the housing **100** may be machined out of a single piece of material. In other embodiments, the housing **100** may be joined together using known conventional methods.

[0026] The housing **100** may be separated into sections by a plurality of support members **102**A-F. In the illustrative embodiment shown, there are seven sections comprising similar components in each section. More than seven or less than seven sections may be used depending on such factors as cost, portability, effective length adjustment amount and manufacturability of the length adjustment system **10**, among others. The plurality of support members **102**A-F may be relatively evenly spaced between the top and bottom members **104** and **106**. The plurality of support members **102**A-F may help to stabilize the left and right members **108** and **109** during a length adjustment of an inserted cable (not shown in this figure).

[0027] The cable may also be a conduit, control line, or other downhole component requiring length adjustment. The cable may itself be a measuring device, such as a control line containing an optical fiber, or the cable may have measuring devices disposed along the length of cable. The slack adjustment may be to align components along the cable to specified locations along a downhole tubular, or the adjustment may be to ensure non-alignment of components to specified locations on that tubular. For example, it may be required to align sensors to precise axial positions related to couplings between threaded joints, or it may be required to place the sensors in such a way that they not be lying over a coupling. In a preferred embodiment the slack management of the cable will take place concurrent with the deployment of the tubular into a wellbore. The tubular may have specific indentations or protrusions designed to receive components along the cable.

[0028] Top member **104** may include a top guide channel **130** and the bottom member **106** may include a bottom guide channel **135**. In some embodiments, the top and bottom guide channels **130**, **135** may be relatively straight and slightly wider than the outside diameter of an adjusted cable. However, embodiments of the length adjustment system **10** are not to be limited to this illustrative example. Non-symmetrical, arcuate, or other geometric configurations may be used for the top and bottom guide channels **130**, **135**. In some cases, the top guide channel **130** may be configured differently than the bottom guide channel **135**.

[0029] As shown in FIG. **2**A, an embodiment of the top and bottom members **104**, **106** may further include a positioning device **132** for holding or controlling movement of a cable (not shown in this figure) relative to the top and bottom members **104**, **106**. The positioning device **132** may be movable or removable in order to facilitate the insertion of a cable. In the embodiment shown, the positioning device **132** may be coupled to the top and bottom members **104**, **106** by two threaded fasteners **134**, for example. In other embodiments, an additional restraining force may be applied to the side of a cable (for example) from a spring loaded restraining device (not shown) coupled to the respective top and bottom members **104**, **106**. Although, the positioning device **132** is described with reference to the top and bottom members **104**, **106**, the positioning device **132** may be provided for one, both, or neither of the top and bottom members **104**, **106**.

[0030] Turning now to FIG. **2**B, this drawing represents an assembly cross-section of FIG. **2**A taken from line BB. A cross-section of the top and bottom guide channels **130**, **135** may be substantially semi-circular in shape and correspond to the diameter of a cable to be bent or deformed. In other embodiments, the semi-circular cross-section may be larger than the diameter of the cable to be bent or the cross-section may be configured to accommodate a range of cable diameters. The semi-circular shape may be recessed within the top and bottom members **104**, **106** such that the centerline of the semi-circular shape is located behind the front surface of the top and bottom members **104**, **106**. In the embodiment shown, the centerline is positioned such that the outer circumference of an inserted cable may be relatively flush with a front surface of the top and bottom members **104**, **106**. Recessing the centerline of the semi-circular shape to this degree may also facilitate controlling the cable with the restraining device **132** previously described.

[0031] In some cases, embodiments of the top and bottom guide channels **130**, **135** may be lined with a guide liner **136** comprising resilient or deformable material such as Teflon, plastic, rubber, leather, or other material able to prevent or inhibit damage to the cable. The guide liner **136** may have a higher frictional value and be a different material in the top guide channel **130** than in the bottom guide channel **135**. This would facilitate securely holding the cable by the top guide channel **130** of the top member **104** while allowing the cable to translate relative to the bottom member **106** within the bottom guide channel **135**.

[0032] The restraining device **132** may have a protrusion **138** with a semi-circular recess approximately in the shape of a cross-section of a cable to be clamped. The protrusion **138** may be configured in this way so as to not apply a concentrated stress upon a single location of a clamped cable. In some embodiments, the protrusion **138** may also comprise a guide liner **136** similar to one provided with the top and bottom guide channels **130**, **135**. However, the guide liner **136** for the restraining device **132** may also be a different material than the guide liner **136** used for the guide channel **130**.

Additionally, there may only be one guide liner **136** on either the top and bottom members **104**, **106** or the restraining device **132**.

[0033] The top and bottom guide channels **130**, **135** may have a radiused R**1** upper or lower portions (only the lower portion is shown as being radiused in FIG. **2**C). The radius R**1** may be substantially equal to the radius of the deforming members **110** described later. These radiuses may further be limited by the MBR of the cable or range of cables intended for the length adjustment system **10**. However, if radiuses R**1** are present in the top and bottom guide channels **130**, **135**, they are not limited to the dimensions of the deforming members **110** and may be larger or smaller in size. In addition, although two radiuses R**1** are shown symmetrically provided about a central axis of the top and bottom guide channels **130**, **135**, some embodiments of the present invention may use one, three, or four radiuses R per top and bottom member **104**, **106**. If more than one radius R**1** is used, the radiuses do not have to have the same dimensions, and they may be sized according to the application of the length adjustment system **10**.

[0034] The invention does not restrict the deformation to lie within a plane. For example, in many case the slack management of the cable will require that the cable then be placed alongside a cylindrical tubular. The deformation system can be designed so as to match the curvature of the deformed cable against the curvature of the tubular. In another embodiment, the deformation may be designed to induce a twist into the cable. For example, in the case that the cable has protruding components which must be placed flush with the downhole tubular, then the deformation apparatus can apply that needed twist to make the protruding component lie with the desired aspect to the tubular.

[0035] The housing **100** of the length adjustment system **10** may be divided into sections. Each section may comprise a deforming member **110**A-G, an actuator **120**A-G, and an adjustor **122**A-G (detailed later). In order to simplify the detailed description, only one section will be described. The other sections are similar in form and function.

[0036] The first or top most section shown in FIG. **1** comprises a deforming member **110**A, actuator **120**A, and an adjustor **122**A. In the illustrative embodiment shown, the deforming member **110**A is coupled with the actuator **120**A. Turning or manipulating the adjustor **122**A results in a side-to-side or left-to-right translation of the deforming member **110**A. Each of these components will be described in more detail below.

[0037] An embodiment of a deforming member **110** is shown in FIG. **3**. The deforming member **110** may comprise an arcuate member **112** and a hub member **114**. The arcuate member **112** may be a roller configured with a radius R**2** at greater than or equal to the MBR of a cable intended for the length adjustment system **10** (FIG. **1**). The arcuate member **112** of the current embodiment may be coupled to the hub member **114** via a bearing **116**. Accordingly, the arcuate member **112** may rotate relative to the hub member **114**.

[0038] The arcuate member **112** may further have a radially recessed arcuate channel **113** similar in general cross-sectional configuration to the top and bottom guide channels **130**, **135** of the top and bottom members **104**, **106** (see FIG. **1**). For example, the arcuate channel **113** may be configured with a semi-circular cross-sectional area used for abutting against a cable. As with the top and bottom guide channels **130**, **135**, the arcuate channel **113** may be recessed such that a centerline of the cable is within the radially outermost portions of the arcuate member **112**. Locating the centerline of a cable in such a way may further constrain the cable from flattening, kinking, or otherwise experiencing unintentional deformation while bending occurs to reduce the overall length. The arcuate channel **112** may also be lined with a guide liner (not shown in this figure) of resilient or deformable material such as Teflon, plastic, rubber, leather, or other material able to prevent or inhibit damage to the cable.

[0039] The hub member **114** may comprise a junction **115** for engaging an actuator **120**A-G. In the illustrative embodiment shown in FIG. **3**, the junction **115** is an internally threaded orifice configured to engage corresponding external threads surrounding the circumference of an actuator **120**A-G. The junction **115** permits the deforming member **110** to translate along an actuator **120**A-G.

[0040] The actuator **120**A may be an externally threaded cylindrical shaft rotatively coupled to the left and right members **108**, **109** of the housing **100**. One end of the actuator **120**A may extend through one of the left and right members **108**, **109** to form the adjustor **122**A. In the embodiment shown, only one adjustor **122**A per actuator **120**A is shown extending to the left of the left member **108**. In other embodiments of the present invention, the ends of the actuator **120**A may extend through both the left and right members **108**, **109** resulting in the formation of two adjustors **122**A per actuator **120**A.

[0041] The adjustor **122**A may be in the form or a knob, recess, or other couple able configuration for manipulation by hand, tool, or machine. As shown, the adjustor **122**A is in the form of a hex head allowing for rotation by an air-tool configured with a standard size socket. In other cases, a knob configured to grasped and rotated by hand may be used. In still other situations, the adjustor **122**A may be engaged by an electro-mechanical motor configured to respond to the instructions of a processing device (not shown in this figure). The configuration of the adjustor **122**A may depend upon the availability of tools at the well-site and the amount of force required to deform the cable, among other factors.

[0042] Turning now to FIG. **4**, a method of adjusting the length of a cable, conduit or control line will be detailed with reference to the drawings. In FIG. **4**, the length adjustment system **10** is shown in a first adjustment position. In the first adjustment position, a cable has been placed within the length adjustment system **10** and may be retained in the top guide channel **130** by positioning device **132**. Manipulation of the adjusters **122**A-G may cause the actuators **120**A-G to move the deformation members **110**A-G to either side of the cable. In the embodiment shown, the deformation members **110**A-G are alternatively placed on either side of the cable in order from top to bottom of the length adjustment system **10**. In some cases, the first adjustment position may be used to hold the cable in place relative to the length adjustment system **10**. The initial length of the cable may be represented as the length between points A and B as shown.

[0043] In FIG. **5**, the first and second deformation members **110**A and **110**B are shown in a secondary adjustment position. In the secondary adjustment position, the first deformation member **110**A and the second deformation member **110**B have deformed the cable from the previous relatively straight configuration presented in FIG. **4**. In this figure, two arcuate bends have been placed in the cable causing point B in the cable to move upward by an amount L. The effective length of the cable between points A and B has now been reduced by the amount L traveled by the lower section of the cable. Although two deforming members **110**A and **110**B are shown as having been moved, one or more than one deforming members **110** may have been moved.

[0044] The deforming members **110**A and **110**B may preferably be moved in sequence from top to bottom relative to the length adjusting system **10**. By using this sequence of movement, only undeformed sections of cable will translate through the bottom of the length adjusting system **10**. If another sequence were used, the cable may be cold worked as previously bent sections of cable may be pulled through the length adjustment system **10**. Additionally, the preferred sequence may facilitate estimating the amount of length reduction by observing the movement of a single point B on the cable. The reduced length may be predicted based upon factors such as the radius and movement of the individual deforming members **110**A-G.

[0045] As further shown in FIG. **5**, deforming member **110**C and the radiused right side of top guide channel **130** may be used to maintain a relatively straight overall configuration of the undeformed entry and exit portions of the cable. Accordingly, the cable may be easier to align and run in downhole.

[0046] The movements of deforming members **110**A and **110**B may be substantially equal in order to provide for symmetry along the overall length of cable. However, embodiments of the present invention may not be limited to this illustrative example. Deforming members **110**A and **110**B may be translated in differing amounts. In some cases, bends may be made only to one side of the cable. In addition, the number of deforming members **110** moved and the individual amounts of movement may vary depending upon the technician performing the length adjustment. In the case of a processor controlled length adjustment system **10**, an optimizing program may be configured to precisely control the adjusting of the individual deforming members **110**A-G.

[0047] After the cable is adjusted to the correct length, the deforming members **110**A-G may be adjusted in the opposite directions to release the cable. If a positioning device **132** is used, the positioning device **132** may be released, thereby releasing the cable. If further adjustment is still needed, a new section of cable (e.g., a lower, undeformed section) may be inserted into the length adjustment system **10** and the process repeated for as many times as necessary until the desired length adjustment is reached.

[0048] Referring generally to FIG. **6**, another illustrative embodiment of a length adjusting system **20** is illustrated as comprising a housing **200** and processor **300**. The housing **200** may be generally rectangular in shape and include a left member **208**, right member **209**, top member **204** and bottom member **206** for example. In some embodiments, the housing **200** may be machined out of a single piece of material. In other embodiments, the housing **200** may be joined together using known conventional methods. The processor **300** may comprise an input device **305** and communication conduit **310** for coupling with actuators **220**A-E contained within the housing **200**.

[0049] The housing **200** may be separated into sections by a plurality of support members **202**A-F. In the illustrative embodiment shown, there are seven sections comprising similar components in each section. More than seven or less than seven sections may be used depending on such factors as cost, portability, effective length adjustment amount and manufacturability of the length adjustment system **20**, among others. The plurality of support members **202**A-F may be relatively evenly spaced between the top and bottom members **204** and **206**. The plurality of support members **202**A-F may help to stabilize the left and right members **208** and **209** during a length adjustment of an inserted cable (not shown in this figure). The cable may also be a conduit, control line, or other downhole component requiring length adjustment. Each section may comprise a deforming member **210**A-G, an actuator **220**A-G, and one or more guide rails **221** (detailed later).

[0050] Top member **204** may include a top guide channel **230** and the bottom member **206** may include a bottom guide channel **235**. In some embodiments, the top and bottom guide channels **230**, **235** may be relatively straight and slightly wider than the outside diameter of an adjusted cable. However, embodiments of the length adjustment system **20** are not to be limited to this illustrative example. Non-symmetrical, arcuate, or other geometric configurations may be used for the top and bottom guide channels **230**, **235**. In some cases, the top guide channel **230** may be configured differently than the bottom guide channel **235**. As with the length adjustment system **10**, one or both of the top and bottom guide channels **230**, **235** may comprise a positioning device **132** (see FIG. 2A) or a resilient restraining device **250** (see FIG. **8**).

[0051] As shown in FIG. **8**, an embodiment of a resilient restraining device **250** may comprise a resilient member **251** and a translating restraining member **252**. As with other aspects of embodiments of the current invention, the contacting surface of the restraining member **252** may be configured to approximate and accommodate a circumferential profile of an inserted cable (not shown). The contacting surface of the restraining member **252** may also be lined with a resilient or deformable material such as Teflon, plastic, rubber, leather, or other material able to prevent or inhibit damage to the cable. The resilient member **251** may comprise one or more springs, foam, or other material able to exert a compression force upon an inserted cable.

[0052] As previously recited, the housing **200** of the length adjustment system **20** may be divided into sections. In order to simplify the detailed description, only one section will be described. The other sections are similar in form and function.

[0053] The first or top most section shown in FIG. **6** comprises a deforming member **210**A, actuator **220**A, and first and second guide rails **221**. The deforming member **210**A may be coupled to the actuator **220**A. Further, the deforming member **210**A may be movably coupled with the first and second guide rails **221**. Actuating the actuator **220**A may result in the deforming member **210**A translating along the first and second guide rails **221**. Each of these components will be described in more detail below.

[0054] An embodiment of a deforming member **210** is shown in FIG. **7**. The deforming member **210** may comprise an arcuate member **212** and a hub member **214**. The arcuate member **212** may be a triangular shaped structure comprising two sides joined together with a radius R**2** at greater than or equal to the MBR of a cable intended for the length adjustment system **20** (FIG. **6**). The arcuate member **212** of the current embodiment may be coupled to the hub member **214**, or in some cases, the arcuate member **212** and the hub member **214** may be machined out of a single piece of material. The arcuate member **212** may not be required to rotate relative to the hub member **214** in this illustrative embodiment.

[0055] The arcuate member **212** may further have a radially recessed arcuate channel **213** similar in general cross-sectional configuration to the top and bottom guide channels **130**, **135** of the top and bottom members **104**, **106** (see FIG. **1**). For example, the arcuate channel **213** may be configured with a semi-circular cross-sectional area used for abutting against a cable. As with the top and bottom guide channels **130**, **135**, the arcuate channel **213** may be recessed such that a centerline of the cable is within the radially outermost portions of the arcuate member **212**. Locating the centerline of a cable in such a way may further constrain the cable from flattening, kinking, or otherwise experiencing unintentional deformation while bending occurs to reduce the overall length. The arcuate channel **212** may also be lined with a guide liner (not shown in this figure) of resilient or deformable material such as Teflon, plastic, rubber, leather, or other material able to prevent or inhibit damage to the cable.

[0056] The hub member **214** may comprise a first and second orifice **240** configured to translatably accommodate the first and second guide rails **221**. In some embodiments, the first and second orifice **240** may comprise a separate bushing made from Teflon or other material configured to facilitate relative movement between the hub member **214** and the first and second guide rails **221**. The hub member **214** may further comprise a coupling member **245** for engaging an end of the actuator **220**A. In the illustrative embodiment shown, the coupling member **245** is represented as an internally threaded orifice configured to threadably attach to a corresponding end of the actuator **220**A. However, various permanent and temporary methods of coupling the hub member **214** to the actuator **220**A are considered within the scope of this disclosure. The coupling between the hub member **214** and the actuator **220**A may permit the actuation of force in two directions parallel to a central axis of a guide member **221**.

[0057] The actuator **220**A may be a pressure driven piston for example, such as a hydraulic or pneumatic piston. As shown in FIG. **6**, each of the actuators **220**A-G may be operatively coupled to a processor **300** via a communications conduit **310**. The processor **300** may individually actuate and control each of the actuators **220**A-G so as to bendably deform an inserted cable. The processor **300** may control the order of actuation of the actuators **220**A-G (e.g., from top-to-bottom, bottom-to-top, all left side, all right side, or some combination thereof). The processor **300** may also control the extent of movement of each of the actuators **220**A-G, so as to precisely adjust the length of the cable in response to a dimension inserted via the input device **305**. The processor **300** may comprise an optimizing routine in order to determine the extent and selection of actuation of the individual actuators **220**A-G in response to an inputted length adjustment.

[0058] In the illustrative embodiment, two guide rails **221** are shown, however embodiments of the present invention may not be limited to this configuration. A single guide rail **221** or three or more guide rails **221** may be used. The guide rails **221** are shown in FIG. **6** as polished metallic rods, for example, configured such that the central axis of the first guide rail **221** is substantially parallel to the central axis of the second guide rail **221**. However, a wide variety of structures may be used to permit and control the translation of the deforming member **210**A. For example, in some cases a track may be machined into a surface of the housing **200** (e.g., between the left and right members **208** and **209**) and the deforming member **210**A may comprise a corresponding guide member (not shown) able to translate within and along the track. In other cases, a telescoping member (not shown) may be attached to a single side of the housing **200**. In still other cases, the actuator **220**A may be configured to provide a translation force along with the directional control otherwise provided by a guiding device (e.g., a hydraulic, telescoping piston for example, among others).

[0059] The method for operating the length adjustment system **20** may be the same or similar to the method used for operating the previously described length adjustment system **10**.

[0060] Referring generally to FIG. **9**, in some illustrative embodiments of the present invention, deforming members **310** may be hingedly or rotatably coupled to the length adjustment system **30**. In such a situation, a cable (not shown) may be adjusted to provide accurate spacing along a tubular and/or to provide relatively consistent spacing for sensors. In addition, the cable may be twisted about a longitudinal axis so as to more readily conform to the curvature of the tubular upon which it is subsequently attached.

[0061] Accordingly, although only a few embodiments of the present invention have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this invention. Such modifications are intended to be included within the scope of this invention as defined in the claims.

What is claimed is:

1. A length adjustment system for adjusting a length of a cable comprising:
- a housing;
- at least one deforming member configured to translate relative to the housing;
- at least one actuator respectively coupled to the at least one deforming member and configured to translate the deforming member;
- wherein translating the deforming member deforms an inserted cable thereby reducing the length of the cable as measured in a straight line.

2. The length adjustment system according to claim **1** further comprising:
- a guide channel in at least one of a top member or a bottom member of the housing and configured to accommodate the inserted cable.

3. The length adjustment system according to claim **1** wherein the at least one deforming member comprises three or more deforming members and the at least one actuator comprises three or more corresponding actuators.

4. The length adjustment system according to claim **1** wherein the actuator is configured as an externally threaded rod and further comprises an adjustor.

5. The length adjustment system according to claim **1** wherein the actuator is configured as a pressure operated piston.

6. The length adjustment system according to claim **1** wherein the deformable member comprises an arcuate member rotatively coupled to the actuator.

7. A method for adjusting a length of a cable comprising the steps of:
- providing a length adjustment device configured in an initial position;
- placing the cable within the length adjustment device;
- deforming the cable via actuating at least one deforming member, thereby reducing the length of the cable as measured in a substantially straight line.

8. The method according to claim **7**, wherein the deforming the cable step comprises:

actuating the at least one deforming member to a first position abutting the cable;

actuating the at least one deforming members to a second position configured so as to deform the cable;

actuating the at least one deforming member to a third position so as to facilitate release of the deformed cable.

9. The method according to claim **7**, wherein the actuating of the at least one deforming member is controlled by a processor.

10. The method according to claim **7**, wherein deforming the cable further comprises twisting the cable about a longitudinal axis after reducing the length.

11. The method according to claim **7**, wherein deforming the cable further comprises providing substantially equal spacing between three or more sensors coupled to the cable.

12. The method according to claim **7**, wherein actuating of the at least one deforming member is via a corresponding adjustor.

13. The method according to claim **10**, wherein the cable is a hydraulic conduit.

14. A method for adjusting a length of a cable comprising the steps of:

providing a length adjustment device configured in an initial position;

placing the cable within the length adjustment device;

holding one end of the cable in position relative to the length adjustment device;

deforming the cable via actuating at least one of a plurality of deforming members, thereby reducing the length of the cable as measured in a substantially straight line.

15. The method according to claim **14**, wherein the plurality of deforming members comprises three or more deforming members.

16. The method according to claim **15**, wherein deforming the cable is sequentially performed in a single direction from the held end of the cable.

17. The method according to claim **14**, wherein deforming the cable further comprises providing substantially equal spacing between three or more sensors coupled to the cable.

18. The method according to claim **14**, wherein deforming the cable is performed by a processor controlling pressure operated pistons coupled to each of the plurality of deforming members.

19. The method according to claim **14**, wherein deforming the cable is performed by manipulation of adjustors respectively coupled to actuators translating each of the plurality of deforming members.

20. The method according to claim **14**, wherein deforming the cable further comprises twisting the cable about a longitudinal axis after length reduction.

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