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DESCRIPTION

[0001] The invention concerns a wind turbine rotor blade with at least two rotor blade segments, a kit for connecting two rotor blade segments, a pressure piece for connecting two rotor blade segments and a method for connecting two rotor blade segments.

[0002] Wind turbines with wind turbine rotor blades are widely known from the state of the art and are used to convert wind energy into electrical energy. Wind turbines comprise a multitude of components which are connected to each other, for example by means of a flange connection. For example, in the area of a rotor blade root, the rotor blades comprise a rotor blade connection with a number of connecting means integrated into the laminate, via which the rotor blades are connected to a bearing ring of a so-called pitch bearing or to a component connected to the bearing ring, such as a so-called extender of the wind turbine, by means of fastening screws or fastening bolts. The connecting means can, for example, be designed as transverse bolts or bushings and be part of a flange insert for the rotor blade connection. Such a design is known from international application WO 2015/124568 A1.

[0003] Alternatively, (flanged) connections are also used for connecting rotor blade segments which, arranged and joined together lengthwise, form a rotor blade. Such a rotor blade is called a split or segmented rotor blade. For example, connecting means are then located in the laminate of a respective connecting end or dividing flange of the rotor blade segments. The rotor blade segments can be connected to each other by means of bolts either directly or via suitable intermediate pieces.

[0004] Another example of a prior art segmented wind turbine blade is known from EP 3 581 790 A1.

[0005] Segmented rotor blades are preferred especially for transport reasons and are becoming increasingly important, especially due to the increasing overall length of rotor blades.

[0006] One task underlying the present invention is to specify a concept for segmented rotor blades which ensures a particularly advantageous connection of rotor blade segments. According to a first aspect a wind turbine rotor blade is disclosed, which is formed by at least two rotor blade segments. The segments are screwed together at respective connection ends by means of a plurality of connecting bolts. Between the rotor blade segments sleeve-shaped pressure pieces are arranged, each of which is mounted to a connecting bolt. Each pressure piece comprises one or more cylindrical sections and a tool engaging section for an assembly tool. Each pressure piece is connected to a corresponding connecting bolt in a form fit manner, so that a screwing force can be applied to the corresponding connecting bolt by means of the assembly tool via the pressure piece. A diameter of the cylindrical section(s) is less than a diameter of the tool engaging section. Each two adjacent pressure pieces are arranged rotated by 180° relative to one another, so that - along a direction from one rotor blade segment towards the other rotor blade segment - a first axial region is formed in which cylindrical sections of the two adjacent pressure pieces lie opposite one another, a second axial region is formed in which the tool engaging portion of one of the pressure pieces opposes a cylindrical portion of the other of the pressure pieces and a third axial region is formed in which the tool engaging portion of the other of the pressure pieces opposes a cylindrical portion of the one of the pressure piece.

[0007] For connecting the two rotor blade segments of a wind turbine rotor blade, these typically comprise a large number of corresponding connecting elements, such as bushings, at the connection ends to be connected. The connecting elements are used to create a large number of bolt connections between the two segments. The assembly is designed in such a way that the connecting bolts are first screwed into a connection end of one rotor blade segment, e.g. into the bushings. Then the sleeve-shaped pressure pieces are pushed onto the connecting bolts before the free ends of the connecting bolts are threaded into the corresponding connecting element of the other rotor blade segment and at least partially screwed in. Finally, the two rotor blade segments are bolted together, whereby the connection is firmly screw-bolted and pretensioned using the assembly tool. Thus, the pressure pieces are clamped between the rotor blade segments.

[0008] The inventive wind turbine rotor blade provides pressure pieces, which have a special design regarding cylindrical sections and tool engaging sections. In particular, axial lengths of these sections are designed such that - for two adjacent pressure pieces - the above described three axial regions are formed. Since the diameters of the cylindrical sections and tool engaging sections of the pressure pieces are different as defined above, the alternating arrangement of the pressure pieces provides different distances between two adjacent pressure pieces along their longitudinal axes, i.e. free spaces, which are efficiently provided and used.

[0009] This arrangement provides a lot of advantages as explained in the following.

[0010] The inventive solution allows an effective use of the installation space. In particular, a comparatively small distance of adjacent pressure sleeves to each other by same size of the assembly tool can be achieved, in particular due to the nested arrangement of the pressure pieces. In such nested arrangement, the tool engaging sections of two adjacent pressure pieces are not opposing each other related to their longitudinal axes. Thus, the solution contributes to the fact that the pressure pieces require considerably less installation space. As a result, the small distance between the pressure pieces allows a comparatively high number of screw-connections to be made between the segments over the circumference in their connection area.

[0011] Furthermore, a shorter installation time can be achieved, since the assembly tool not necessarily needs to be opened during a complete screwing process of one pressure piece or connecting bolt respectively. Rather, the tool can be easily repositioned in the first axial region, e.g. by rotating it in a closed state around a respective pressure piece.

[0012] Further, the solution enables a particularly simple and inexpensive production of pressure pieces, especially from simple semi-finished tube products. This enables particularly low manufacturing costs.

[0013] The solution further helps to achieve a particularly rigid connection of both blade segments. It enables the absorption and transmission of particularly high tensile and compressive forces between the two rotor blade segments. Furthermore, a particularly efficient power transmission from one segment to the second segment is made possible exclusively via the connecting bolt. In other words, the blade segments are detachably joined without force deflection as with eccentric screw connections or intermediate pieces that are subject to tensile or bending loads. This also enables a very good material utilization. It contributes to a low tendency for the connection to slacken and to a bending load on the screw connections, especially in contrast to conventional flange connections. Furthermore, an even distance between the connecting elements, such as the bushings, and thus connecting ends to each other is ensured over the entire connection circumference.

[0014] For example, the assembly tool is a hydraulic torque tool, e.g. an open swing tool. The assembly tool can also be named mounting tool or screw tool. In a closed state the assembly tool fully surrounds a pressure piece, at least with an engaging or wrapping part. The engaging part is, for example, formed in a ring-like manner. For example, in the closed state, the open swing tool can be positioned in the tool engaging section of a pressure piece, such that a rotation of the assembly tool rotates the pressure piece and thus the respective connecting bolt, due to the form-fit connection of the pressure piece with the respective connecting bolt. The assembly tool can be opened, e.g. by opening one swing or swing arm and folding it away.

[0015] The pressure piece is designed as a sleeve, i.e. the pressure piece comprises a continuous bore/opening along a main direction of extension, i.e. a longitudinal axis. The pressure piece is designed as a clamping sleeve, for example.

[0016] In an axial region, a whole cylindrical section or a part of a cylindrical portion can be arranged.

[0017] The positive-locking connections (form-fit connections) between pressure pieces and bolts are such that a torque about the longitudinal axis of a pressure piece can be transmitted to the inserted connecting bolt for screwing. In other words, the form-fit connections are torque-proof.

[0018] A connecting bolt, for example, is a screw bolt. The connecting bolt is, for example, designed as an expansion shaft bolt (with corresponding external threads).

[0019] The connecting elements mentioned, such as the bushings, are, for example, elements laminated into the connecting ends of the blade segments. It is also conceivable that the two connecting elements are formed by dividing an overall connecting element. In this case, the rotor blade would first be manufactured as a whole, i.e. with a one-piece shell, and then separated at one point of division, for example by cutting or sawing. The separation takes place in the area of the overall connecting elements, so that two connecting element halves are created per overall connecting element, one for each of the two blade segments created by division.

[0020] The cylindrical and tool engaging sections relate to the outer circumference of a pressure piece. The tool engaging section is, for example, hexagonal shaped section, wherein the assembly tool is designed accordingly to engage the pressure pieces in the respective tool engaging section.

[0021] The term adjacent means directly arranged pressure pieces next to each other along the circumference of the wind turbine rotor blade.

[0022] The term diameter refers to the outer diameter and in particular preferably means the maximum outside diameter in the respective area or of the respective element.

[0023] According to an embodiment an axial length of the first axial region corresponds to at least one width of the assembly tool.

[0024] According to an embodiment an axial length of the second and/or third axial region corresponds to at least one width of the assembly tool.

[0025] According to an embodiment a width of the tool is up to 20 to 40 mm. The width of the assembly tool is for example a wrench width, e.g. of a wrapping part of the open swing tool.

[0026] According to an embodiment the pressure pieces are each formed by a cylindrical portion comprising an axial length of at least twice the width of the mounting tool and the tool engaging portion having an axial length of at least the width of the mounting tool. This is a possible, easy to produce solution enabling the above mentioned functions and advantages.

[0027] According to an embodiment the pressure pieces each comprise a further cylindrical portion having an axial length at least the width of the mounting tool, with the tool engaging portion being located between the two of the cylindrical portions. This is a further possible solution for a pressure piece, wherein, for example, for two adjacent pressure pieces two first axial regions are formed, which allow for mounting/releasing or repositioning of the assembly tool.

[0028] According to an embodiment a diameter of a pressure piece in the first axial region is such that the assembly tool can freely rotate coaxially around the respective pressure piece in the first axial region, in particular the diameter is 64 mm, 74 mm, 79 mm or another value, e.g. less or more than the given values, depending on which size is necessary - however 1 mm less than a used wrench size or less. Thus, a free space is defined between two adjacent pressure pieces, large enough in order to allow the tool to rotate at least partially around a respective pressure piece.

[0029] As an example, the diameter of a pressure piece in the first axial region is smaller than a wrench size of the assembly tool, which allows for the free rotation of the tool. Further, the free space is just as large that the tool can be opened and closed for releasing the tool from a pressure piece or placing it onto a pressure piece. This also allows for an easy repositioning of the tool, e.g. in order to re-engage the same tool engaging section for further screwing of a same pressure piece. During repositioning, opening of the assembly tool, e.g. its surrounding or wrapping part, is not necessary. Furthermore, non-ratcheting tools possible.

[0030] According to an embodiment a clearance between two adjacent pressure pieces in the second and/or third axial region is smaller than a clearance in the first axial region, in particular the clearance is 10 mm or smaller.

[0031] The clearance is large enough that the assembly tool - in a state engaging the tool engagement section - can be rotated to screw the corresponding connecting bolt.

[0032] According to an embodiment, in the first axial region the clearance between two adjacent pressure pieces is maximum, in particular compared to the clearance between all remaining portions of the two adjacent pressure pieces.

[0033] According to an embodiment a pressure piece comprises uniformly formed cylindrical sections at opposite ends. Thus, the front surfaces (contact surfaces to the rotor blade segments and in particular to the inserts like sleeves or bushings) are dimensioned essentially identically, so that in principle, friction or contact conditions are the same on both sides of the pressure pieces.

[0034] According to an embodiment the plurality of pressure pieces are identically formed. Thus, all pressure pieces are the same, which contributes to comparatively low productions costs and makes the mounting and installation similar for all bolt connections.

[0035] According to a further aspect, a kit for connecting two rotor blade segments of a wind turbine rotor blade is disclosed as defined in the claims.

[0036] The kit essentially enables the above-mentioned advantages and functions. The kit can be further developed according to the above-mentioned embodiments with respect to the first aspect of the present disclosure. Exemplarily, several kits can be provided for all of the used bolt connections.

[0037] According to a further aspect, a pressure piece for connecting two rotor blade segments of a wind turbine rotor blade according to any one of the above mentioned embodiments is disclosed as defined in the claims. The pressure piece essentially enables the above-mentioned advantages and functions.

[0038] According to a further aspect, a method of joining two rotor blade segments of a wind turbine rotor blade according to any one of the above mentioned embodiments is disclosed. The method comprises the steps:

partially screwing connecting bolts into the first connection end of the first rotor blade segment in such a way that the connecting bolts project from the first connection end,

providing sleeve-shaped pressure pieces, each comprising one or more cylindrical portions and a tool engaging portion for an assembly tool, and wherein a diameter of the cylindrical portion(s) is less than a diameter of the tool engaging portion,

form-fit mounting of the pressure pieces to the connecting bolts in such a way that two adjacent pressure pieces are arranged in each case rotated by 180° relative to one another,

bringing the second connection end of the second rotor blade segment close to the first connection end of the first rotor blade segment,

partially screwing the connecting bolts into the second connection end,

attaching an assembly tool to a first pressure piece in the first axial region relative to an adjacent second pressure piece,

aligning and axially moving the assembly tool along the first pressure piece such that the assembly tool engages the first pressure piece in the tool engaging portion; and

screwing the corresponding connecting bolt using the assembly tool.

[0039] The method essentially enables the above-mentioned advantages and functions.

[0040] According to an embodiment, after the screwing step, the assembly tool is axially displaced back into the first axial region. Then, the assembly tool is then removed and attached to the second pressure piece or the assembly tool is realigned by freely rotating it around the first pressure piece in the first axial region. In other words, the assembly tool is re-adjusted or removed from the first pressure piece to be used for the second pressure piece.

[0041] Further advantages, features and functions are given in the following exemplary embodiment of the invention, which are explained in connection with the figures. Identical, similar or similarly acting elements are provided with the same reference signs in the figures.

[0042] In the figures:

Figure 1 shows a schematic view of a wind turbine,

Figure 2 shows a schematic view of a split rotor blade with two rotor blade segments,

Figure 3 shows a schematic sectional view of an exemplary bolt connection of two rotor blade segments,

Figure 4 shows a pressure piece according to an embodiment of the invention,

Figure 5 shows an exemplary arrangement of three pressure pieces of Figure 4 for connection of two rotor blade segments according to an embodiment of the invention,

Figures 6 to 9 show perspective views of different stages of mounting with an assembly tool according to an embodiment of the invention,

Figures 10a to 10d show an exemplary installation procedure according to an embodiment of the invention, and

Figure 11 shows a schematic flow chart of a method for joining two rotor blade segments according to an embodiment of the invention.

[0043] Figure 1 shows a schematic view of a wind turbine 100, which comprises a tower 102. The tower 102 is fixed to the ground by means of a foundation 104. At one end of the tower 102 opposite to the ground a nacelle 106 is rotatably mounted. The nacelle 106, for example, comprises a generator which is coupled to a rotor 108 via a rotor shaft (not shown). The rotor 108 comprises one or more (wind turbine) rotor blades 110, which are arranged on a rotor hub 112.

[0044] During operation, the rotor 108 is set in rotation by an air flow, for example wind. This rotational movement is transmitted to the generator via the rotor shaft and, if necessary, a gearbox. The generator converts the kinetic energy of the rotor 108 into electrical energy.

[0045] Figure 2 shows an exemplary wind turbine rotor blade 110. The rotor blade 110 has the shape of a conventional rotor blade and has a rotor blade root area 114 facing the rotor hub 112. The rotor blade root area 114 typically has an essentially circular cross-section. The rotor blade root area 114 is followed by a transition area 116 and a profile area 118 of rotor blade 110. The rotor blade 110 has a pressure side 122 and an opposite suction side 124 with respect to a longitudinal extension direction 120 (also main extension direction). The rotor blade 110 is essentially hollow inside.

[0046] In the rotor blade root area 114 a rotor blade connection end 126 with a flange connection 128 is provided, by means of which the rotor blade 110 is mechanically connected to a pitch bearing or an extender.

[0047] The rotor blade 110 comprises a division area 130 where a blade root-side rotor blade segment 132 and a blade tip-side rotor blade segment 134 are connected to each other. For this purpose, both segments 132, 134 each comprise a segment connection area 136, 138 (also connection ends). The rotor blade 110 is thus a split rotor blade as described above. Each connection end 136, 138 has a multitude of sleeves or bushings 140, 142, which are arranged according to the profile (in circumferential direction) and comprise internal threads for the reception of screw bolts, also called bearing bolts or connecting bolts. For example, the first bushings 140 comprise left-hand threads (first internal threads) and the second bushings 142 right-hand threads (second internal threads) or vice versa. A connection end 136, 138 is realized for example as a flange insert, which is inserted as an insert into a production mould for the manufacture of the rotor blade 110. However, it is also conceivable that no flange insert is provided and the bushings are embedded and laminated directly into the rotor blade half shells. The bushings are steel sleeves, for example.

[0048] In the following, the connection of both rotor blade segments 132, 134 will be described in more detail, whereby this will be explained using a single bolt connection as an example.

[0049] Figure 3 shows a schematic sectional view in a partial area of two connected rotor blade segments 132, 134 at the division area 130, where a single bolt connection 148 is shown. The first connecting end 136 of the first rotor blade segment 132 comprises a multitude of first bushings 140 as described above. The second connection end 138 of the second rotor blade segment 134 comprises a number of second bushings 142. A connecting bolt 146 is screwed into each pair of aligned first and second bushings 140, 142. This bolt 146 connects the two connection ends 136, 138 and thus the two rotor blade segments 132, 134 mechanically. In addition, a pressure piece 144 is clamped between the two connection ends 136, 138 per bolt connection 148.

[0050] Figure 4 shows a perspective view of a pressure piece 144 according to an embodiment of the invention. The pressure piece 144 is designed as a cylindrical sleeve and is manufactured from a simple semi-finished tube product. The pressure piece 144 comprises a (central) longitudinal axis 150 and a continuous bore 152 (general opening). The pressure piece 144 is designed to be pushed onto the connecting bolt 146 (not shown), thereby engaging the bolt 146 in a form-fit manner in order that a rotation applied to the pressure piece 144 is transferred to the bolt 146. The pressure piece 144 has a first axial end 154 and an opposite second axial end 156. Starting from the first axial end 154, the pressure piece 144 has a first cylindrical section 158, a subsequent tool engaging section 160 followed by a short second cylindrical section 162. An outer diameter 164 of the cylindrical sections 158, 162 is smaller than an outer diameter 166 of the tool engaging section 160. In the present embodiment, the cylindrical sections 158, 162 are uniformly formed and comprise the axial ends 154, 156. This guarantees the same contact conditions of the pressure piece 144 at both rotor blade segments 132, 134. The cylindrical section 158 comprises slots 163 serving as windows that allow a view of the connecting bolt 146 (not shown) inside the pressure piece 144.

[0051] The tool engaging section 160 has a hexagonal outer shape in order to be engaged by a respective assembly tool, as will be described later. The tool engaging section 160 comprises holes 161 in the flat areas of the hexagon. The holes are provided for inserting a bolt-like assembly tool for turning the pressure piece 144 in a pre-assembling step.

[0052] The design of the pressure piece 144 according to figure 4 enables a special, nested arrangement of several such pressure pieces 144 for the connection of two rotor blade segments as shown in figure 5. In figure 5, three of such pressure pieces 144 are shown, wherein for sake of clarity, no bolts 146 or bushings 140, 142 are shown and the rotor blade segments 132 are simply indicated by dotted lines. Each two adjacent pressure pieces 144 are arranged 180° rotated to each other. Thus, the pressure pieces 144 alternate along the circumference of the rotor blade 110 with respect to their orientations.

[0053] By this arrangement, along the direction from one rotor blade segment, e.g. the first segment 132, towards the other rotor blade segment, e.g. the second segment 134, several axial regions are formed with respect to two adjacent pressure pieces 144. In a first axial region 168 only cylindrical sections (e.g. portions of the first cylindrical sections 158) of two adjacent pressure pieces are arranged, e.g. opposing each other. In second and third axial regions 170 and 172 a respective tool engaging section 160 and a cylindrical section (e.g. portions of the first cylindrical sections 158) of the respective two adjacent pressure pieces 144 are arranged, e.g. opposing each other.

[0054] The axial lengths 174, 176 and 178 (e.g. axial expansions) of the axial regions 168, 170 and 172 essentially correspond to at least a width 181 of an assembly tool 180, shown in figures 6 to 9. In other words, the first cylindrical section 158 of a pressure piece 144 has a length of at least two times width 181 of the assembly tool 180. In other words, in the presently shown embodiment the first axial region 168 extends from the middle (dotted line) at least half the width 181 of the assembly tool 180 towards both the first and second axial ends 154, 156.

[0055] A first clearance 182, e.g. distance, between two adjacent pressure pieces 144 in the first axial region 168 is smaller than a second clearance 184, e.g. distance, between the two adjacent pressure pieces 144 in the second and third axial regions. Thus, in the first axial region 168 a free space 186 is formed between two adjacent pressure pieces 144, which is larger than spaces in the second and third axial regions 170, 172.

[0056] Figures 6 to 9 show different mounting stages of one bolt connection 148 with the help of the assembly tool 180. Again, for sake of clarity no rotor blade segments and bolts are shown. Two bushings 140, 142 are at least partially shown. The assembly tool 180 is a hydraulic torque tool, which has an engaging part 188, which is formed ring-like in a closed state. This engaging part 188 specifies the width 181 of the assembly tool 180 in the present embodiment.

[0057] In the first axial region, the assembly tool 180 can be attached to or released from a respective pressure piece 144, as is shown in figure 6, wherein the engaging part 188 is in an opened state. In this opened state, a swing part 190 is unlocked and folded away.

[0058] With respect to figure 7, after closing the engaging part 188, the engaging part 188 fully surrounds the pressure piece 144. While in the first axial region, the assembly tool 180, e.g. the engaging part 188, can freely rotate around the cylindrical section 158 of the pressure piece. In a certain orientation, the assembly tool 180 can then be axially moved over the respective tool engaging section 160.

[0059] Figure 8 shows the state in which the assembly tool 180 engages the pressure piece 144 in order to apply a screwing force onto the pressure piece 144.

[0060] With respect to figure 9, after having rotated the pressure piece 144 for screwing the corresponding bolt 146, the assembly tool 180 can by axially moved back into the first axial region 168 in order to be released or rotated for repositioning to be again moved onto the tool engaging portion 160.

[0061] At this point, it is noted that at least two bolts 146 and at least two pressure pieces 144 form together a kit or assembly kit for mounting two rotor blade segments.

[0062] Figures 10a to 10d show an exemplary method for connecting two segments 132, 134 with the help of the flow chart of figure 11 according to an embodiment of the invention.

[0063] In a first step S1, connection bolts 146 are partially screwed into the first connection end 136 of the first rotor blade segment 132, in particular into first bushings 140, in such a way that the connecting bolts 146 project from the first connection end 136 (not shown).

[0064] In a further step S2, the sleeve-shaped pressure pieces 144 are provided as described above (not shown).

[0065] In a further step S3, the pressure pieces 144 are mounted to the connecting bolts 146 in a form-fit manner, wherein that two adjacent pressure pieces are arranged in each case rotated by 180° relative to one another (please refer to Figures 10a to 10d, exemplarily showing this arrangement).

[0066] In a further step S4, the second connection end 138 of the second rotor blade segment 134 is brought close to the first connection end 136 of the first rotor blade segment 132 (not shown).

[0067] In a further step S5, the connecting bolts 146 are partially screwed into the second connection end 138 of the second rotor blade segment 134, in particular into second bushings 142 (not shown).

[0068] In a further step S6, the assembly tool 180 is attached to a first pressure piece 144 in the first axial region 168 relative to an adjacent second pressure piece 144 (see also figures 6 and 7).

[0069] In a further step S7, the assembly tool 180 is aligned and axially moved along the first pressure piece 144 such that the assembly tool 180 engages the first pressure piece 144 in the tool engaging portion 160 (see figure 10a and figure 8). Thus, the tool 180 is moved into the second axial region 170.

[0070] In a further step S8, the corresponding connecting bolt 146 (not shown) is screw at least partially by using the assembly tool 180 (see figure 10a).

[0071] In a further step S9, the assembly tool 180 is axially moved back into the first axial region 168 (see figure 10b).

[0072] If necessary, in a further step S10, the assembly tool 180 is repositioned in the first axial region 168(free rotation around the cylindrical part of the pressure piece 144) and steps S7 to S9 are repeated.

[0073] Otherwise, in a further step S11, the assembly tool 180 is detached from the first pressure piece 144 and attached to the next, second pressure piece 144 (see figure 10c).

[0074] Now, steps S7 to S9 and possibly S10 are repeated, with the difference, that the tool 180 is moved to the third axial region in step S7 for screwing the respective pressure piece 144/bolt 146 (see figure 10d).

[0075] The embodiments as described above enables the functions, effects and advantages as listed in the introductory part of this writing. In particular, the pressure pieces 144 can be arranged very close to each other, while still the access and screwing by the assembly tool 180 is possible. Here it is noted that in the shown and described embodiments all pressure pieces 144 are formed identically.

Reference signs

[0076]

100
: wind turbine

102
: tower

104
: foundation

106
: nacelle

108
: rotor

110
: rotor blade

112
: rotor hub

114

rotor blade root area
116
transition area
118
profile area
120
longitudinal extension direction
122
pressure side
124
suction side
126
rotor blade connection end
128
flange connection
130
division area
132
first rotor blade segment
134
second rotor blade segment
136
first connection end
138
second connection end
140
first bushing
142
second bushing
144
pressure piece
146
connection bolt
148
bolt connection
150
longitudinal axis
152
bore
154
first axial end
156
second axial end
158

first cylindrical section
160
tool engaging section
161
hole
162
second cylindrical section
163
slotted hole
164
outer diameter
166
outer diameter
168
first axial region
170
second axial region
172
third axial region
174-178
axial length
180
assembly tool
181
width
182
first clearance
184
second clearance
186
free space
188
engaging part
190
swing part
S1 - S11
steps

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

- WO2015124568A1 [0002]
- EP3581790A1 [0004]

P A T E N T K R A V

1. Vindmøllerotorvinge (110), som er formet af mindst to rotorvingesegmenter (132, 134), hvilke segmenter (132, 134) er skruet sammen ved respektive forbindelsesender (136, 138) ved hjælp af en flerhed af forbindelsesbolte (146), hvor

muffeformede trykstykker (144) er anbragt mellem rotorvingerne (132, 134), hvoraf hver er monteret på en forbindelsesbolt (146),

hvert trykstykke (144) omfatter en eller flere cylindriske sektioner (158, 162) og en værktøjsindgrebssektion (160) til et samleværktøj (180),

hvert trykstykke (144) er forbundet med en tilsvarende forbindelsesbolt (146) på en formsluttende måde, således at en skruekraft kan påføres den tilsvarende forbindelsesbolt (146) ved hjælp af samleværktøjet (180) via trykstykket (144),

en diameter (164) af den eller de cylindriske sektion(er) (158, 162) er mindre end en diameter (166) af værktøjsindgrebssektionen (160), **k e n d e t e g n e t ved, at**

hver to hosliggende trykstykker (144) er anbragt drejet 180° i forhold til hinanden, således at i tilfælde af hosliggende trykstykker (144) – i en retning af det ene rotorvingesegment (132, 134) mod det andet rotorvingesegment (132, 134) – dannes et første aksialt område (168), i hvilket de cylindriske sektioner (158, 162) af de to trykstykker (144) er overfor hinanden, et andet aksialt område (170) dannes, i hvilket værktøjsindgrebsdelen (160) af det ene trykstykke (144) er overfor en cylindrisk del (158, 162) af det andet trykstykke (144), og et tredje område (172) dannes, i hvilket værktøjsindgrebsdelen (160) af det andet trykstykke (144) er overfor en cylindrisk del (158, 162) af det ene trykstykke (144).

2. Vindmøllerotorvinge (110) ifølge krav 1, hvor en aksial længde (174) af det første aksiale område (168) svarer til i det mindste en bredde (181) af samleværktøjet (180).

3. Vindmøllerotorvinge (110) ifølge krav 1 eller 2, hvor en aksial længde (176, 178) af det andet og/eller det tredje område (170, 172) svarer til i det mindste én bredde (181) af samleværktøjet (180).

4. Vindmøllerotorvinge (110) ifølge et hvilket som helst af de foregående krav, hvor en bredde (181) af samleværktøjet (180) er op til 20 til 40 mm.

5. Vindmøllerotorvinge (110) ifølge et hvilket som helst af de foregående krav, hvor trykstykkerne (144) hver er dannet af en cylindrisk del (158) omfattende en aksial længde (176) på mindst to gange bredden (181) af samleværktøjet (180) og værktøjsindgrebsdelen (160), hvis aksiale længde (176) i det mindste er lig med bredden (181) af samleværktøjet (180).

6. Vindmøllerotorvinge (110) ifølge krav 5, hvor trykstykkerne (144) hver omfatter en yderligere cylindrisk del med en aksial længde på i det mindste bredden (181) af samleværktøjet (180), med værktøjsindgrebsdelen (160) placeret mellem de to cylindriske dele (158).

7. Vindmøllerotorvinge (110) ifølge et hvilket som helst af de foregående krav, hvor

en diameter (164) af et trykstykke (144) i det første aksiale område (168) er sådan, at samleværktøjet (180) frit kan dreje koaksialt omkring det respektive trykstykke (144) i det første aksiale område (168), navnlig er diameteren (164) 64 mm, 74 mm, 79 mm eller mindre eller mere.

8. Vindmøllerotorvinge (110) ifølge et hvilket som helst af de foregående krav, hvor en afstand (184) mellem to hosliggende trykstykker (144) i det andet og/eller tredje område (170, 172) er mindre end afstanden (182) i det første aksiale område (168), navnlig afstanden (184) er 10 mm eller mindre.

9. Vindmøllerotorvinge (110) ifølge et hvilket som helst af de foregående krav, hvor afstanden mellem to hosliggende trykstykker (144) i det første aksiale område er maksimal.

10. Vindmøllerotorvinge (110) ifølge et hvilket som helst af de foregående krav, hvor et trykstykke (144) omfatter ensartet formede cylindriske sektioner ved modstående ender (154, 156).

11. Vindmøllerotorvinge (110) ifølge et hvilket som helst af de foregående krav, hvor flerheden af trykstykker (144) er identisk formede.

12. Sæt til at forbinde to rotorvingesegmenter (132, 134) af en vindmøllerotorvinge (110), omfattende mindst to forbindelsesbolte (146) til at skrue de to rotorvingesegmenter (132, 134) sammen og mindst to muffeformede trykstykker (144), som hver kan påføres på en forbindelsesbolt (146) og er anbragt mellem rotorvingesegmenterne (132, 134) i en forbundet tilstand af de to rotorvingesegmenter (132, 134), hvor

hvert trykstykke (144) omfatter en eller flere cylindriske sektioner (158, 162) og en værktøjsindgrebssektion (160) til et samleværktøj (180),

hvert trykstykke (144) kan forbindes med en tilsvarende forbindelsesbolt (146) på en formsluttende måde, således at en skruekraft kan påføres den tilsvarende forbindelsesbolt (146) ved hjælp af samleværktøjet (180) via trykstykket (144),

en diameter af den eller de cylindriske sektion(er) (158, 162) er mindre end en diameter (166) af værktøjsindgrebssektionen (160), **k e n d e t e g n e t ved, at**

trykstykkerne (144) i den forbundne tilstand af rotorvingesegmenterne (132, 134) kan anbringes ved siden af og drejet 180° i forhold til hinanden, således at i tilfælde af hosliggende trykstykker (144) – i en retning af det ene rotorvingesegment (132, 134) mod det andet rotorvingesegment (132, 134) – dannes et første aksialt område (168), i hvilket de cylindriske sektioner (158, 162) af de to trykstykker (144) er overfor hinanden, et andet aksialt område (170) dannes, i hvilket værktøjsindgrebsdelen (160) af det ene trykstykke (144) er overfor en cylindrisk del (158, 162) af det andet trykstykke (144), og et tredje område (172) dannes, i hvilket værktøjsindgrebsdelen (160) af det andet trykstykke (144) er overfor en cylindrisk del (158, 162) af det ene trykstykke (144).

13. Trykstykke (144) til at forbinde to rotorvingesegmenter (132, 134) af en vindmøllerotorvinge (110) ifølge et hvilket som helst af kravene 1 til 11, hvor

trykstykket (144) er muffeformet,

trykstykket (144) omfatter en eller flere cylindriske dele (158, 162) og en værktøjsindgrebsdel (160) til et samleværktøj (180),

trykstykket (144) kan påføres på en forbindelsesbolt (146) med formsluttende låsning, således at en skruekraft kan påføres den tilsvarende forbindelsesbolt (146) ved hjælp af samleværktøjet (180) via trykstykket (144),

en diameter (164) af den eller de cylindriske sektioner (158, 162) er mindre end en diameter (166) af værktøjsindgrebssektionen (160), **k e n d e t e g n e t ved, at**

trykstykket (144) er formet på en sådan måde, at i en forbundet tilstand af rotorvingesegmenterne (132, 134), hvor trykstykket (144) er anbragt mellem rotorvingesegmenterne (132, 134), kan trykstykket (144) anbringes drejet 180° i forhold til et hosliggende yderligere trykstykke (144), således at – i en retning af det ene rotorvingesegment (132, 134) mod det andet rotorvingesegment (132, 134) – dannes et første aksialt område (168), i hvilket de cylindriske sektioner (158, 162) af de to trykstykker (144) er overfor hinanden, et andet aksialt område (170) dannes, i hvilket værktøjsindgrebsdelen (160) af det ene trykstykke (144) er overfor en cylindrisk del (158, 162) af det andet trykstykke (144), og et tredje område (172) dannes, i hvilket værktøjsindgrebsdelen (160) af det andet trykstykke (144) er overfor en cylindrisk del (158, 162) af det ene trykstykke (144).

14. Fremgangsmåde til at forbinde to rotorvingesegmenter (132, 134) af en vindmøllerotorvinge (110) ifølge et hvilket som helst af kravene 1 til 11, omfattende trinnene:

at delvist skrue forbindelsesbolte (146) ind i en første forbindelsesende (136) af det første rotorvingesegment (132) på en sådan måde, at forbindelsesboltene (146) rager ud fra den første forbindelsesende (136),

at tilvejebringe muffeformede trykstykker (144), som hver omfatter en eller flere cylindriske dele (158, 162) og en værktøjsindgrebsdel (160) til et samleværktøj (180), og hvor en diameter af den eller de cylindriske del(e) (158, 162) er mindre end en diameter (166) af værktøjsindgrebsdelen (160),

at formslut-montere trykstykkerne (144) til forbindelsesboltene (146) på en sådan måde, at to hosliggende trykstykker (144) i hvert tilfælde anbringes drejet 180° i forhold til hinanden,

at bringe den anden forbindelsesende (138) af det andet rotorvingesegment (134) tæt på den første forbindelsesende (136) af det første rotorvingesegment (132),

at delvist skrue forbindelsesboltene (146) ind i den anden forbindelsesende (138),

at forbinde et samleværktøj til et første trykstykke (144) i det første aksiale område (168) i forhold til et hosliggende andet trykstykke (144),

at justere og/eller aksialt bevæge samleværktøjet (180) langs det første trykstykke (144), således at samleværktøjet (180) kommer i indgreb med det første trykstykke (144) i værktøjsindgrebsdelen (160); og

at skrue den tilsvarende forbindelsesbolt (146) ved hjælp af samleværktøjet (180).

15. Fremgangsmåde ifølge krav 14, hvor samleværktøjet (180) efter skruetrinnet forskydes aksialt tilbage i det første aksiale område (168) og

samleværktøjet (180) fjernes derefter og forbindes med det andet trykstykke (144) eller

samleværktøjet (180) omjusteres ved frit at dreje det omkring det første trykstykke (144) i det første aksiale område (168).

DRAWINGS

Fig. 1

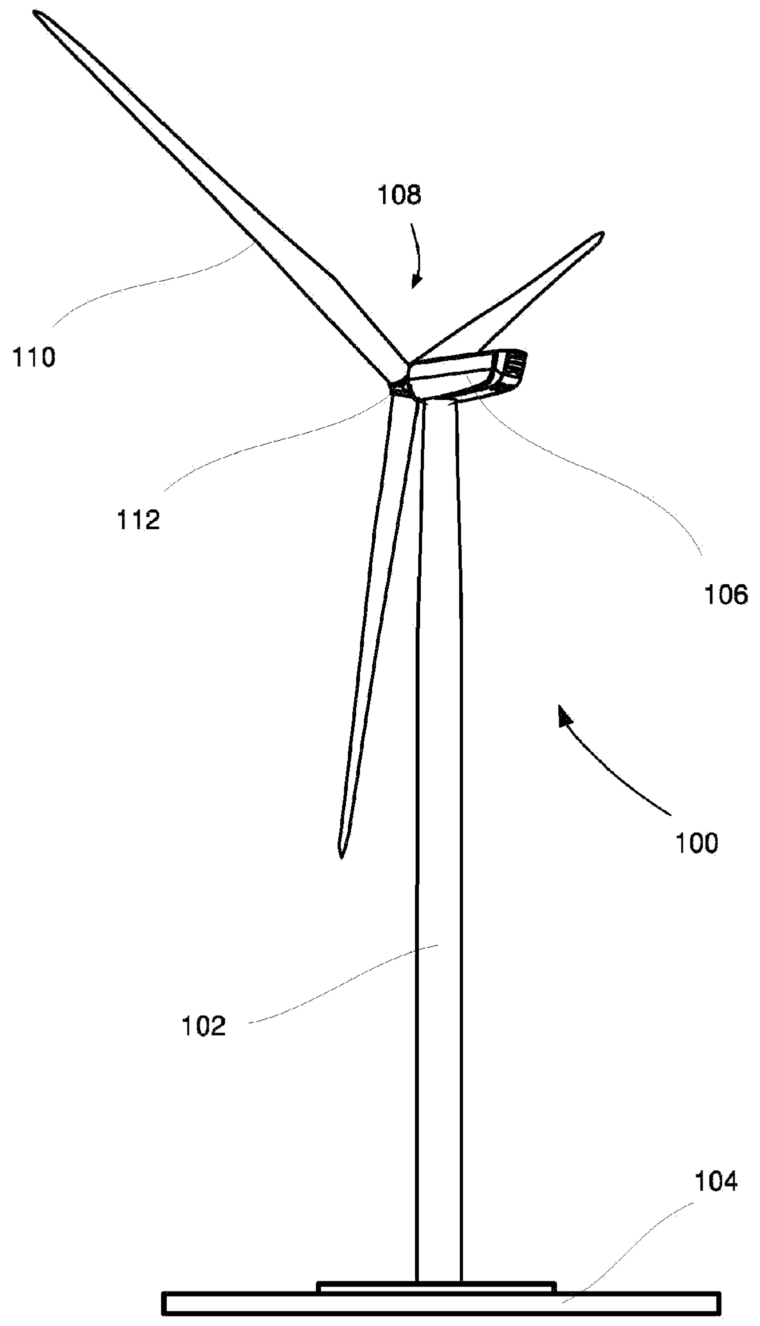

Fig. 2

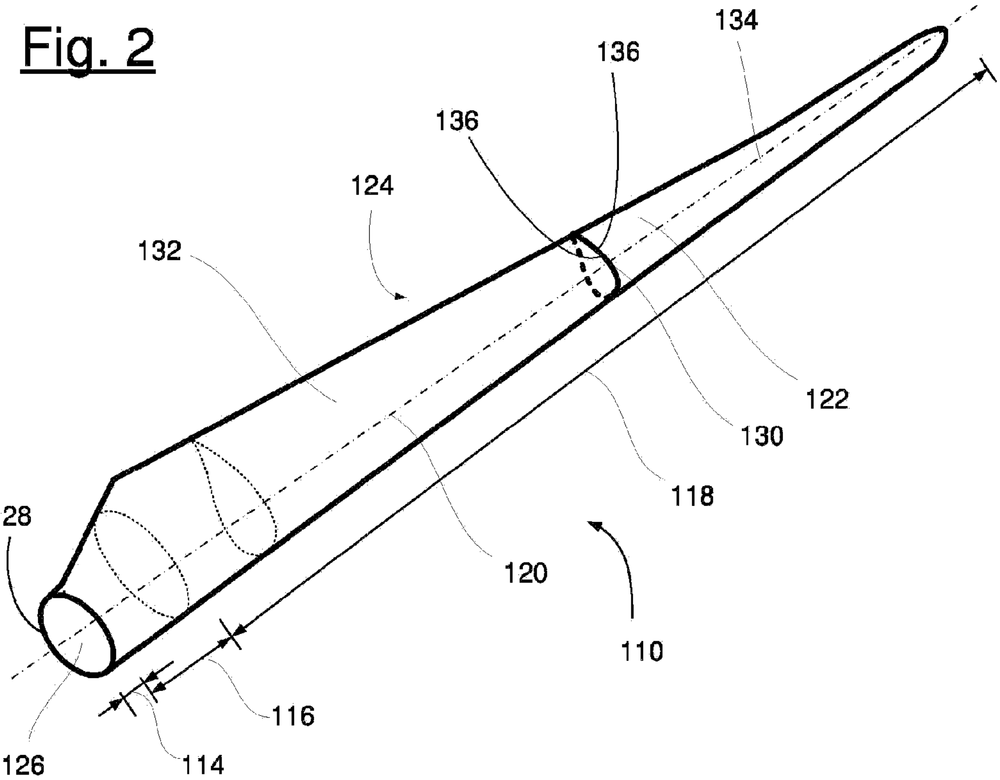
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Fig. 3

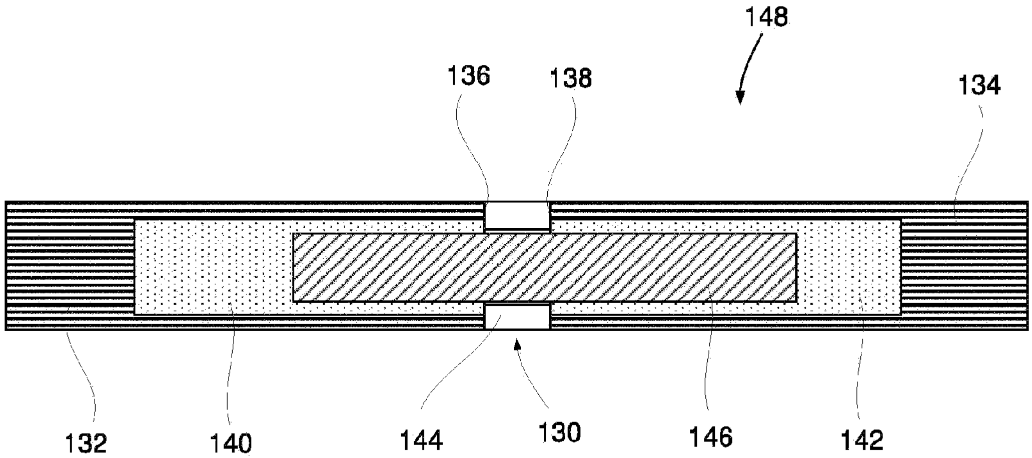
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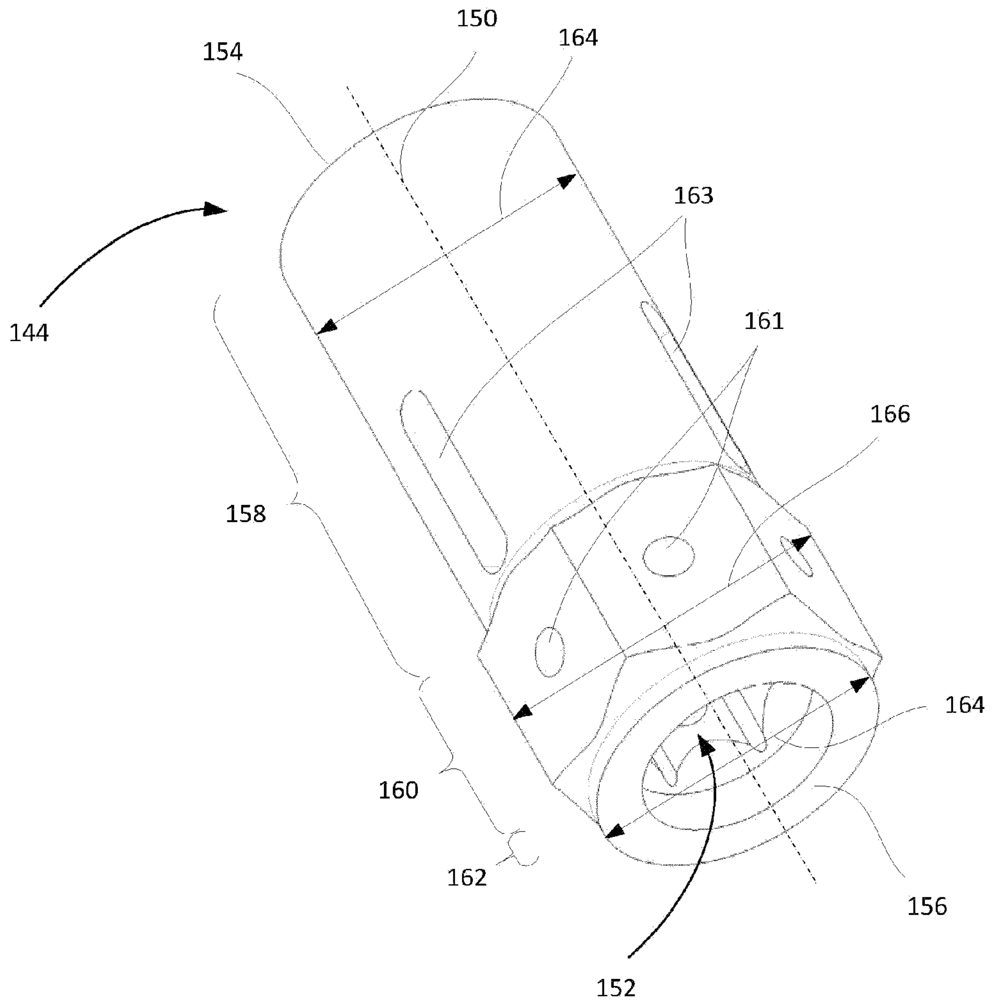
Fig. 4



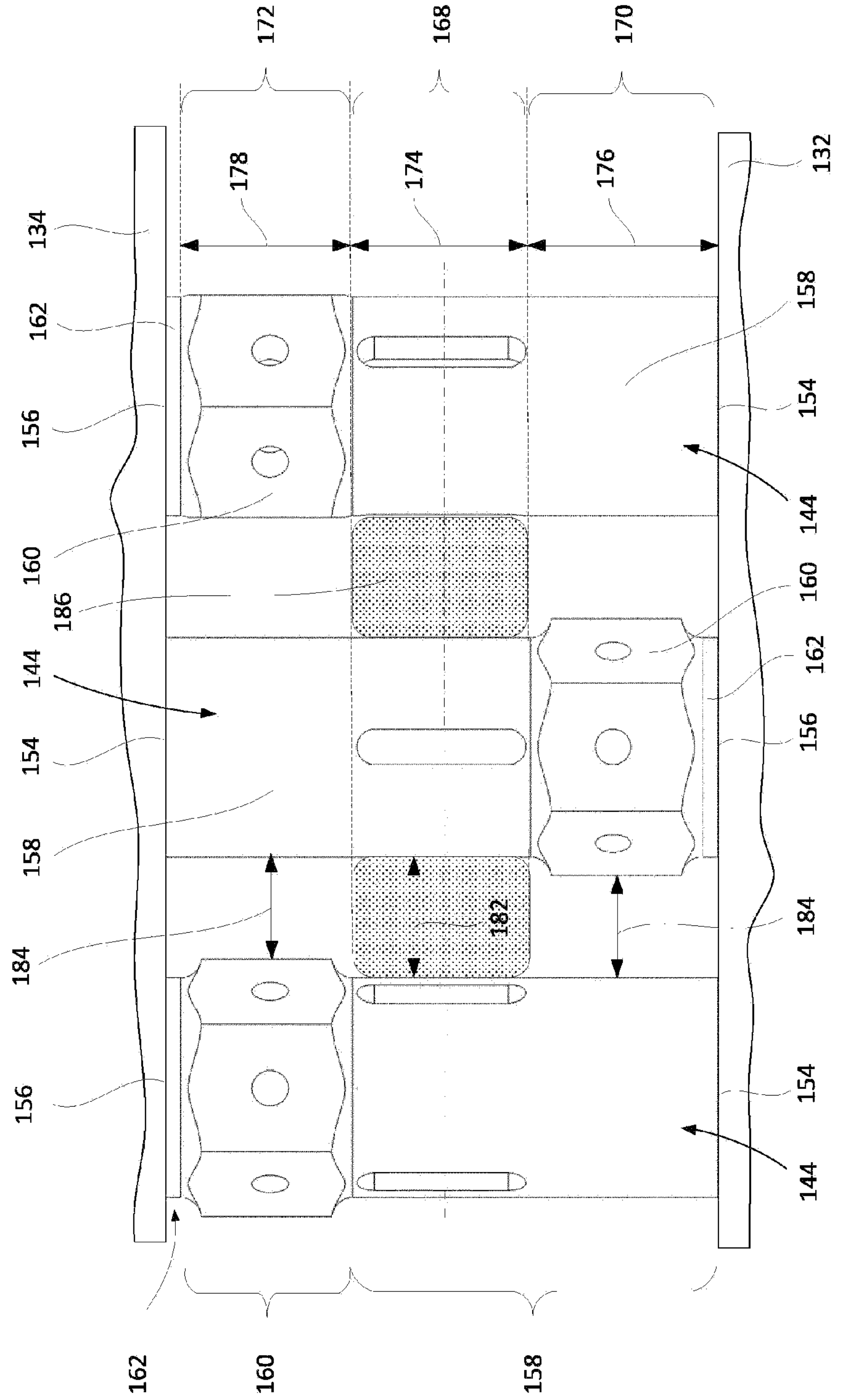

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Fig. 5

Fig. 6

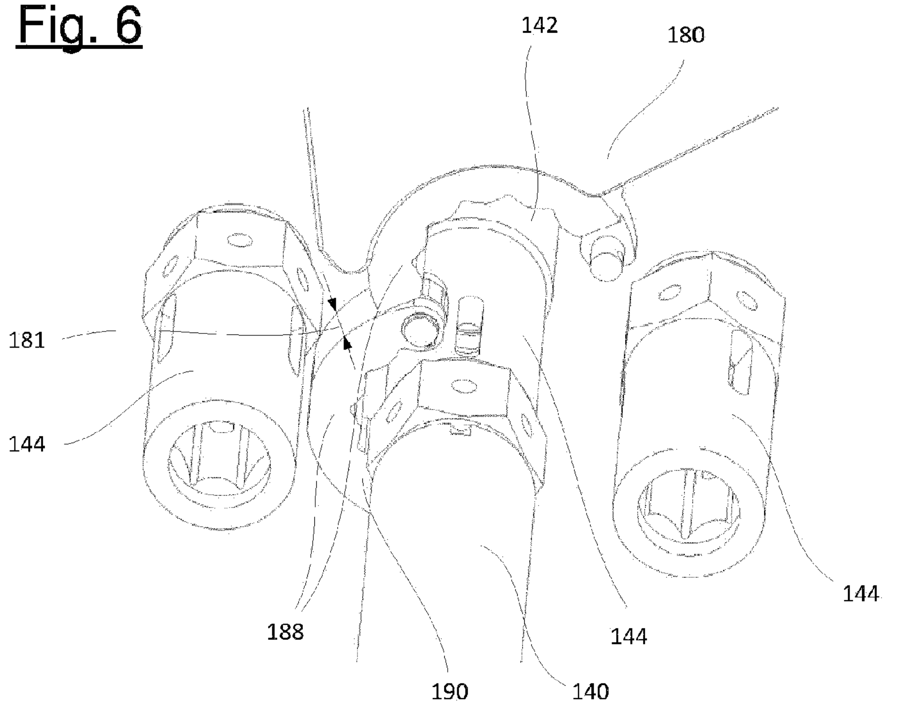

Fig. 7

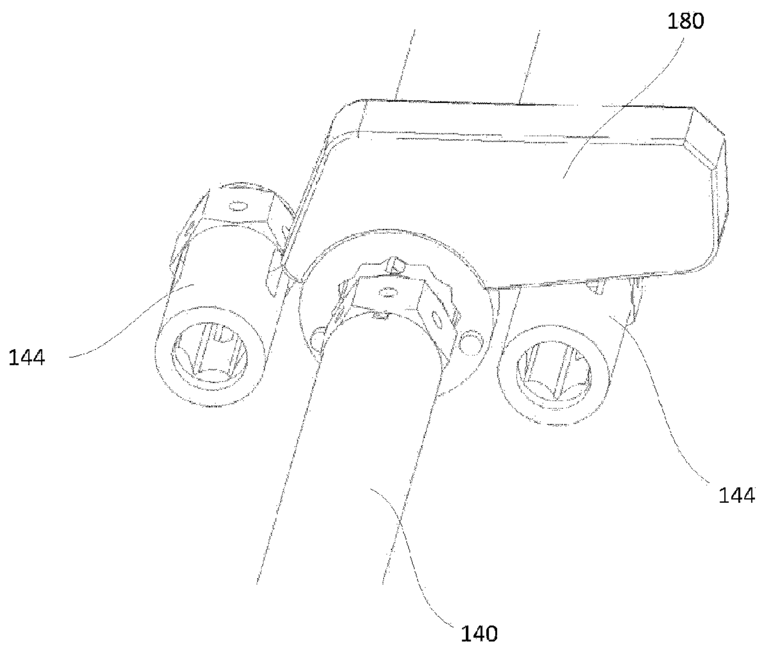

Fig. 8

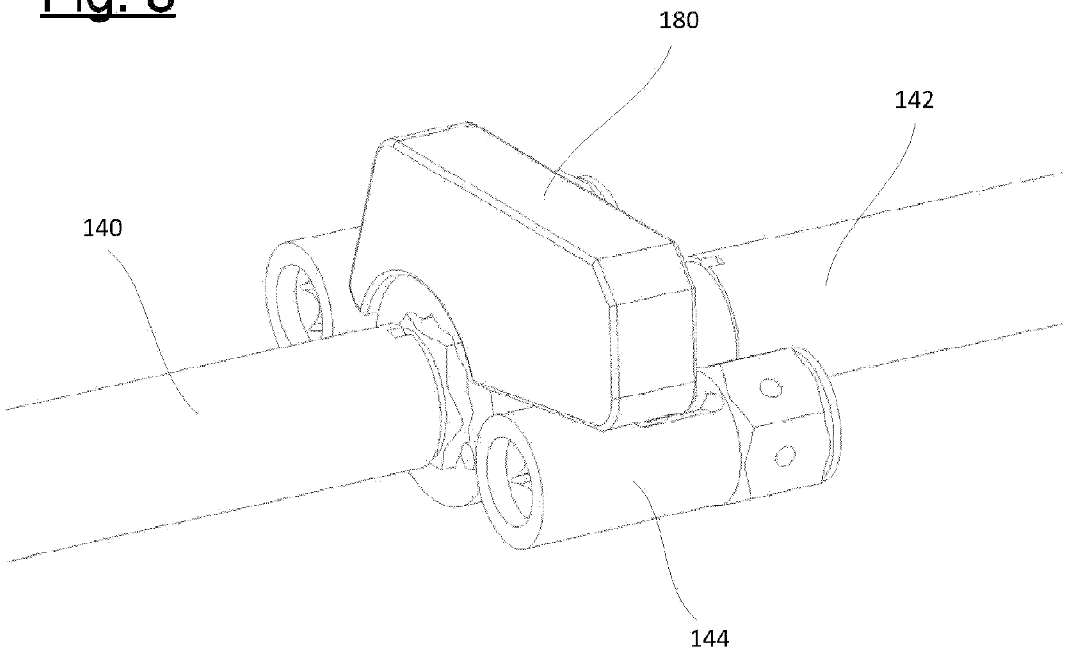

Fig. 9

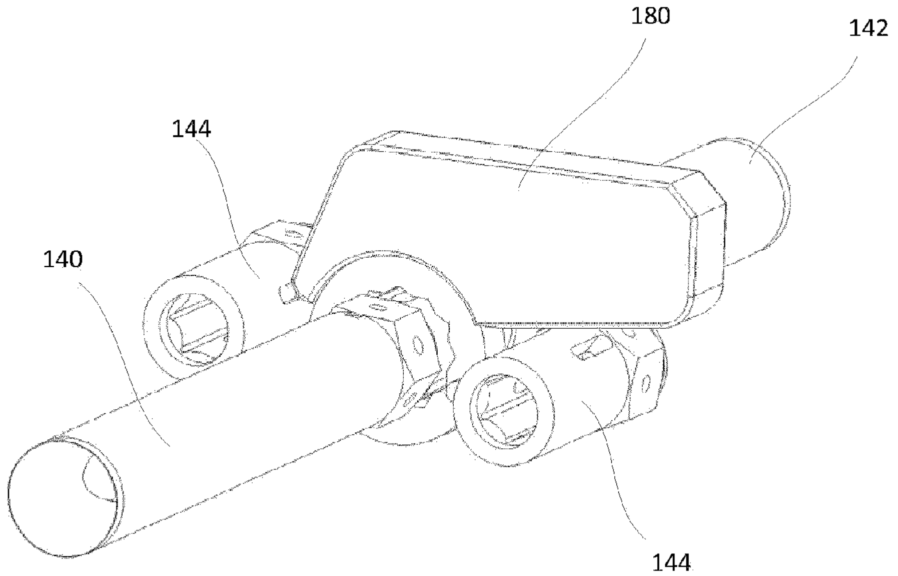

Fig. 10a

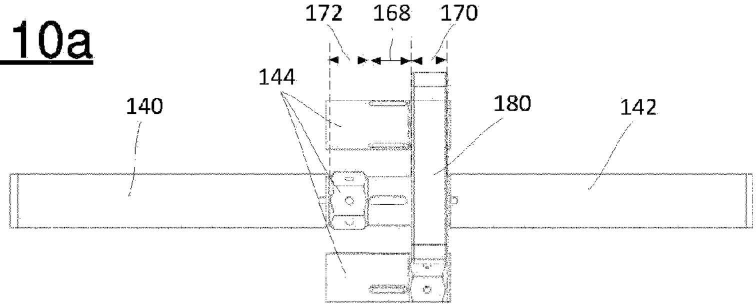

Fig. 10b

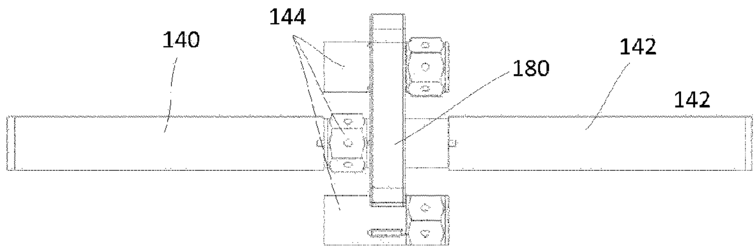

Fig. 10c

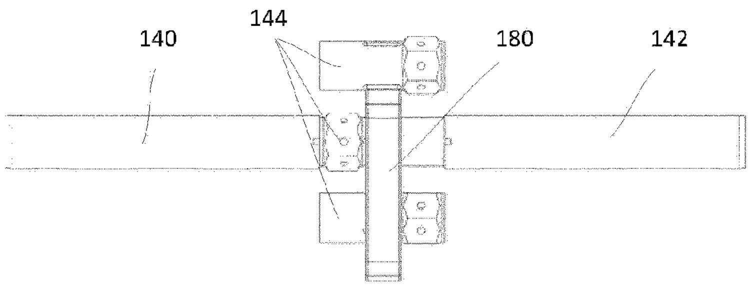

Fig. 10d

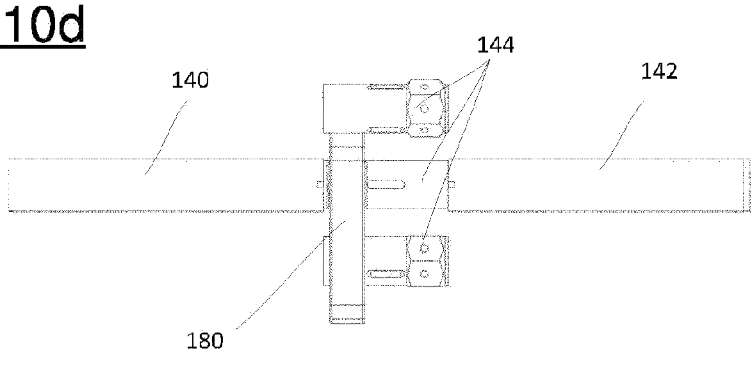

Fig. 11