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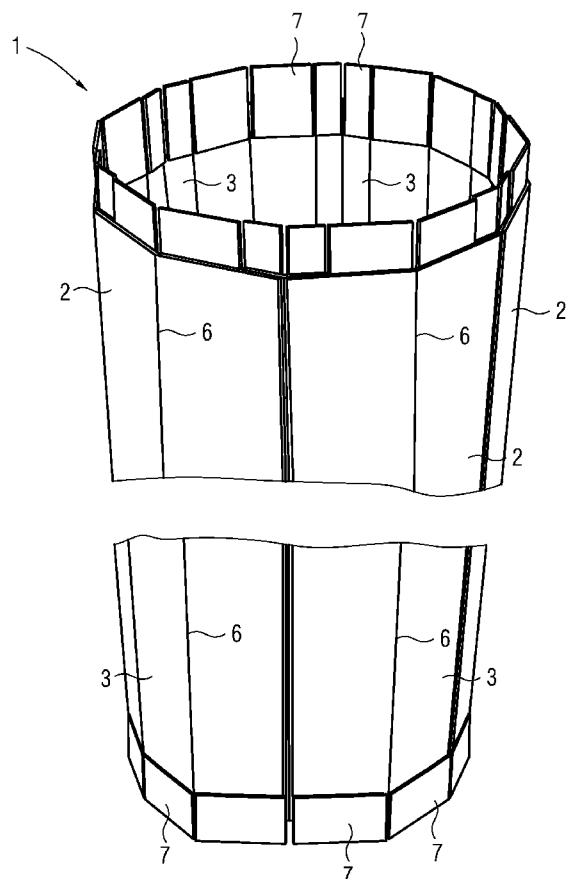
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(54) Title: TOWER CONSTRUCTION

FIG 1



(57) Abstract: Tower construction, particularly for a wind turbine, having a number of axially disposed hollow cylindrical tower sections (1) each comprising a number of circumferentially disposed alternating first and second tower section segments (2, 3).



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Description

Tower construction

5 The invention relates to a tower construction, particularly for a wind turbine.

Tower constructions, particularly for wind turbine towers, are large-scaled constructions regarding diameter and height. Thereby, many different tower constructions for on- and off-shore applications are known differing in their constructive design, that is for example in the type of the connection to the foundation structure, their basic shape, which may be straight, conical or stepwise conical for instance, number and size of respective hollow cylindrical axially aligned tower sections, connecting means, etc.

Particularly in the field of wind energy, the growing interest in renewable energies has resulted in increased dimensions of wind turbines and accordingly, respective tower constructions have also become larger, so that the tower construction nowadays represents a considerable economical factor of the total costs of a wind turbine both regarding material use and makespan. Further, with increased dimensions difficulties may occur regarding manufacture, transport and handling of the components of respective tower constructions.

Therefore, it is the object of the present invention to provide an improved tower construction, particularly regarding manufacture, transportability and handling.

This is achieved by a tower construction as described above, having a number of axially disposed hollow cylindrical tower sections each comprising a number of circumferentially disposed alternating first and second tower section segments.

The present tower construction consists of a number of axially disposed hollow cylindrical tower sections which essen-

tially define the height and basic shape of the tower construction. Thereby, different shapes are thinkable, that is the tower construction may have an essentially round cross-section for instance, whereby the diameter of the tower construction may decrease with increasing height resulting in a conical shape. Yet, other, particularly polygonal cross-sections, which may taper with increasing height of the tower construction are feasible as well.

10 Aside to the vertical segmentation of the tower constructions by means of the tower sections, the tower construction is further segmented in circumferential direction since each tower section comprises a number of circumferentially disposed alternating first and second tower section segments
15 which may be deemed as the basic components of the tower construction. In such a manner, the constructive design of the tower construction, that is mainly regarding height and diameter essentially depends on the number and dimensions of the first and second tower section segments defining the radial and axial dimensions of each tower section and hence,
20 according to the number of tower sections the radial and axial dimensions of the tower construction as a whole.

Thus, the inventive tower construction provides a flexible
25 constructive design suitable to many different tower designs which is essentially defined by the number and the dimensions of the first and second tower section segments since the alternative arrangement of first and second tower section segments building tower sections and axially arranging of respective tower sections on top of each other is always the
30 same .

Further, the basic components of the tower construction, that is the first and second tower section segments are comparatively easy to manufacture, transport and handle.
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It is preferred, that each tower section is provided with overlapping portions of the respective alternating first and

second tower section segments in circumferential direction, whereby the size of the overlapping portions increases in axial direction. This arrangement results in a conical shape of the respective tower sections and the tower construction as a whole. Thereby, a good mechanical stability of the respective connecting portions of the alternatively disposed first and second tower section segments is given, which is mainly defined by the respective circumferentially provided overlapping portions increasing in size in axial upward direction.

Thereby, the respective overlapping portions may be fixed to each other by connecting means, in particular bolted joints and/or welded joints. Of course, other connecting means providing an appropriate and sufficiently stable mechanical joint of the respective circumferentially abutting overlapping portions of the first and second tower section segments are applicable as well.

It is preferred, that the first and second tower section segments have a rectangular shape. This leads to great advantages regarding manufacture, transport and handling of the respective first and second tower section segments since they may be easily cut from respective metal plates, whereby the width of the metal plate may define the width or length respectively of the first or second tower section segment.

Likewise, cutting costs and material waste is reduced. Further, the rectangular shape regularly allows a good stackability of the respective first and second tower section segments and the transport with standard transport containers, that is no highly specialised equipment is necessary for transportation resulting in lower transportation costs. In exceptional cases, the first and second tower section segments may comprise trapezoid or other shapes as well.

In a further embodiment of the invention, the first and second tower section segments of a tower section have the same height but different widths. This implies the geometric difference of the first and second tower section segments.

Thereby, it is preferred that the width of the first tower section segments is constant throughout each tower sections and the width of the second tower section segments decreases
5 throughout each tower section. In such a manner, the cross-section or diameter of the axially upward aligned tower sections reduces towards the top of the tower construction resulting in a tapered, conical shape of the tower sections and the entire tower construction. Further, this feature has
10 positive effects regarding the manufacture of the first tower section segments since their dimensions may essentially be constant throughout the whole tower construction, that is the first tower section segments comprise identical or uniform dimensions throughout the tower sections and hence, the entire tower construction leading to a further simplified manufacturing process of the inventive tower construction.
15

The first tower section segments may be axially connected to further first tower section segments and the second tower section segments may be axially connected to further second tower section segments. Thus, the constructive design of the inventive tower construction consists of alternating first and second tower section segments in circumferential direction and vertically or axially aligned first or second tower section segments, that is first tower section segments are placed on axially abutting further first tower section segments and second tower section segments are placed on axially abutting further second tower section segments. Hence, first and second tower section segments are each placed on top of
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25
30 each other.

It is of advantage, when at least one first and second tower section segment comprises at least one connecting portion for connecting with further first and second tower section segments disposed at a respective axial free ending. The connecting portion provides a safe and firm connection site for axially abutting further first or second tower section segments respectively. This also leads to an eased assembly of
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adjacently disposed tower sections since the connecting portions may also serve in terms of a support structure which contributes to a proper arrangement of the respective first and second tower section segments on top of each other.

5

Thereby, it is in favour when at least one connecting portion is disposed at each axial free ending of the respective first and/or second tower section segments. In such a manner, the connectability of axially adjacently disposed first or second tower section segments is further improved since an engagement of corresponding connecting portions is feasible.

10

Therefore, it is preferred that at least one connecting portion is disposed radially outside and at least one connecting portion is disposed radially inside of the respective first and/or second tower section segment with respect to the tower construction axis. In such a manner, the connecting portions may also serve as a guiding means for a proper attachment of first or second tower section segments to be disposed downstream, thereby defining the correct order of axially connecting first or second tower section segments.

15

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The connecting portions of abutting first or second tower section segments may be connected by means of bolted joints and/or welded joints. Likewise, in exceptional cases other connecting means providing a safe and firm mechanical joint of abutting first or second tower section segments may be thinkable as well.

25

It is possible, that the connecting portions are pre-mounted to the respective first and/or second tower section segments. Thus, the connecting portions and the respective first or second tower section segments represent a pre-mounted component ready to be connected with further first or second tower section segments respectively, thereby simplifying the erection process of the tower construction. Pre-mounting of the connecting portions may be achieved by a small number of bolts. Of course, the connecting portions may also be inte-

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grally built with the respective first or second tower section segments.

The connecting portions are preferably built as a fishplate.
5 Of course, other types of connecting portions such as lugs, butt straps or any other type of plate-like members are thinkable as well. Thereby, the widths of the fishplates may vary or be adapted to the respective overlapping portions of the first and second tower section segments.

10

In a further preferred embodiment of the invention, at least one first and/or second tower section segment comprises at least one at least partially axially extending bent. The bent is preferably a small angle bent, which is easy to manufacture so that the processing of the respective first or second tower section segment is still fast and easy to accomplish particularly without the need of complex bending tools. Further, the bent does also contribute to the good stackability of the respective first or second tower section segments.

20

Aside, the invention relates to a wind turbine comprising a tower construction as describes above. Hence, the lower part of the inventive wind turbine, that is the wind turbine tower is provided with a high degree of constructive flexibility as well as advantages concerning manufacture, transport and handling .

25

Further advantages and details of the present invention can be taken from the following detailed description of preferred
30 embodiments of the invention as well as the principle drawings, whereby:

fig. 1 shows a perspective view of a tower section;

35 fig. 2 shows a perspective view of first and second tower section segments;

fig. 3 shows a top-view of first tower section segments;

- fig. 4 shows a top-view of second tower section segments;
- fig. 5-7 show cut-out views of overlapping portions of first
5 and second tower section segments;
- fig. 8 shows a front-view of a first and a second tower
section segment; and
- 10 fig. 9 shows an exploded view of axial arrangement of sec-
ond tower section segments.

Fig. 1 shows a perspective view of a tower section 1 of a not
explicitly shown tower construction of a wind turbine. The
15 hollow cylindrical tower section 1 may be axially coupled to
further tower sections 1 in order to erect the tower con-
struction, whereby a typical tower construction may comprise
eight axially aligned tower sections 1 for instance. Thereby,
in dependence on the diameter or cross-section of the respec-
20 tive tower sections 1, the tower construction may have a
straight or conical shape for instance.

The tower section 1 consists of a number of circumferentially
disposed first tower section segments 2 and second tower sec-
25 tion segments 3 in an alternating arrangement, whereby the
first tower section segments 2 have a radially outward and
the second tower section segments 3 have a radially inward
position relative to the vertical axis of the tower construc-
tion. Of course, an opposite arrangement of the first and
30 second tower section segments 2, 3 would be feasible as well.

The tower section 1 is provided with overlapping portions 4
of the respective alternating rectangular first and second
tower section segments 2, 3 in circumferential direction,
35 whereby the size of the overlapping portions 4 increases in
axial direction (cf. figures 5 - 7 depicting that the width
 d_1 of the lower part of the overlapping portion 4 is smaller
than the width d_2 of the upper part of the overlapping por-

tion 4). A connection of the respective overlapping portions 4 and hence, the alternating first and second tower section segments 2, 3 is provided by means of bolts 5 for instance.

5 As is particularly deducible from figures 2 - 4, the first and second tower section segments 2, 3 have the same height, yet differ in width. Further, the first tower section segments 2 have a uniform shape and essentially the same dimensions throughout the entire tower construction, whereas the
10 second tower section segments 3 become narrower, that is are reduced in width with every tower section 1.

Fig. 2 shows representative first and second tower section segments 2, 3, whereby the first tower section segments 2 are
15 disposed in the front row and the second tower section segments 3 are disposed in the back row. Thereby, eight pairs of first and second tower section segments 2, 3 each being used for a respective tower section 1 of a tower construction, which consequently consists of eight axially disposed tower
20 sections 1 are built from the left to the right. That is, a number of the left first and second tower section segments 2, 3 is used in the bottom tower section and a number of the following first and second tower section segments 2', 3' is used for the following tower section disposed on a subsequent
25 axial higher level, etc.

Both the first and second tower section segments 2, 3, which are preferably made of a high class steel grade, comprise an axially extending low-angle bent 6. Hence, the first and sec-
30 ond tower section segment 2, 3 are easy to manufacture and require only a minimum of processing, since they only have to be cut from a metal plate in order to obtain their basic shape and further be provided with bores or holes for respective connecting means, that is mainly bolts, as well as be
35 provided with the bent 6.

As is particularly deducible from fig. 7, the first tower section segments 2 are axially connected to further first

tower section segments 2 and the second tower section segments 3 are axially connected to further second tower section segments 3. Thereby, the axial free endings of the respective first and/or second tower section segments 2, 3 comprise connecting portions in the shape of fishplates 7. The fishplates 7 may be pre-mounted components, whereby pre-mounting may be accomplished by a number of small bolts or the like. The upper fishplates 7 are disposed radially inside and the lower fishplates 7 are disposed radially outside of the respective first and/or second tower section segments 2, 3 with respect to the tower construction axis. Of course, an opposite arrangement of the fishplates 7 is applicable as well.

Since the size of the overlapping portions 4 of the respective first and second tower section segments 2, 3 is not uniform, but increases in axial direction, the dimensions, that is mainly the widths of the fishplates 7 is preferably adapted thereto (cf. fig. 9). Thus, the axially upper fishplates 7 may have a reduced width allowing that the respective first or second tower section segments 2, 3 may overlap to an extent where the fishplates 7 abut each other.

Fig. 9 shows the axial arrangement of respective second tower section segments 3 in an exploded view, whereby the respective corresponding radially outer and inner fishplates 7 serve in terms of a support abutting the respective outer or inner surfaces of the second tower section segments 3 in the region of the axial free endings. In other words, the fishplates 7 partially overlap the respective free axial endings of the second tower section segments 3, that is they may engage. Bolts (not shown) are used in order to provide a safe and mechanically stable connection. The same applies to the axial connection of respective first tower section segments 2.

35

Regarding exemplary dimensions of the first tower section segments 2, typical widths may be ca. 1250 mm. The second tower section segments 3 may have a width of ca. 1500 mm at a

lower tower section 1 and may be reduced in width by ca. 150 mm for each following tower section 1 for instance. The height of the first and second tower section segments 2, 3 may be ca. 12000 mm for instance, that is they easily fit in a standard transport container. The inventive tower may have a diameter of ca. 5000 mm at the bottom and ca. 2500 mm at the top.

Claims

1. Tower construction, particularly for a wind turbine, having a number of axially disposed hollow cylindrical tower sections (1) each comprising a number of circumferentially disposed alternating first and second tower section segments (2, 3).
2. Tower construction according to claim 1, wherein each tower section (1) is provided with overlapping portions (4) of the respective alternating first and second tower section segments (2, 3) in circumferential direction, whereby the size of the overlapping portions (4) increases in axial direction.
3. Tower construction according to claim 2, wherein the respective overlapping portions (4) are fixed to each other by connecting means, in particular bolted joints (5) and/or welded joints.
4. Tower construction according to one of the preceding claims, wherein the first and second tower section segments (2, 3) have a rectangular shape.
5. Tower construction according to one of the preceding claims, wherein the first and second tower section segments (2, 3) of a tower section (1) have the same height but different widths.
6. Tower construction according to one of the preceding claims, wherein the width of the first tower section segments (2) is constant throughout each tower section (1) and the width of the second tower section segments (3) decreases throughout each tower section (1).
7. Tower construction according to one of the preceding claims, wherein the first tower section segments (2) are axially connected to further first tower section segments (2)

and the second tower section segments (3) are axially connected to further second tower section segments (3) .

8. Tower construction according to one of the preceding
5 claims, wherein at least one first and second tower section segment (2, 3) comprises at least one connecting portion for connecting with further first and second tower section segments (2,3) disposed at a respective axial free ending.

10 9. Tower construction according to claim 8, wherein at least one connecting portion is disposed at each axial free ending of the respective first and/or second tower section segment (2, 3) .

15 10. Tower construction according to claim 9, wherein at least one connecting portion is disposed radially outside and at least one connecting portion is disposed radially inside of the respective first and/or second tower section segment (2, 3) with respect to the tower construction axis.

20 11. Tower construction according to one of the claims 8 to 10, wherein the connecting portions of abutting first or second tower section segments (2, 3) are connected by means of bolted and/or welded joints.

25 12. Tower construction according to one of the claims 8 to 11, wherein the connecting portions are pre-mounted to the respective first and/or second tower section segments (2, 3) .

30 13. Tower constructions according to one of the claims 8 to 12, wherein the connecting portion is built as a fishplate (7) .

35 14. Tower construction according to one of the preceding claims, wherein at least one first and/or second tower section segment (2, 3) comprises at least one at least partially axially extending bent (6) .

15. Wind turbine comprising a tower construction according to one of the preceding claims.

FIG 1

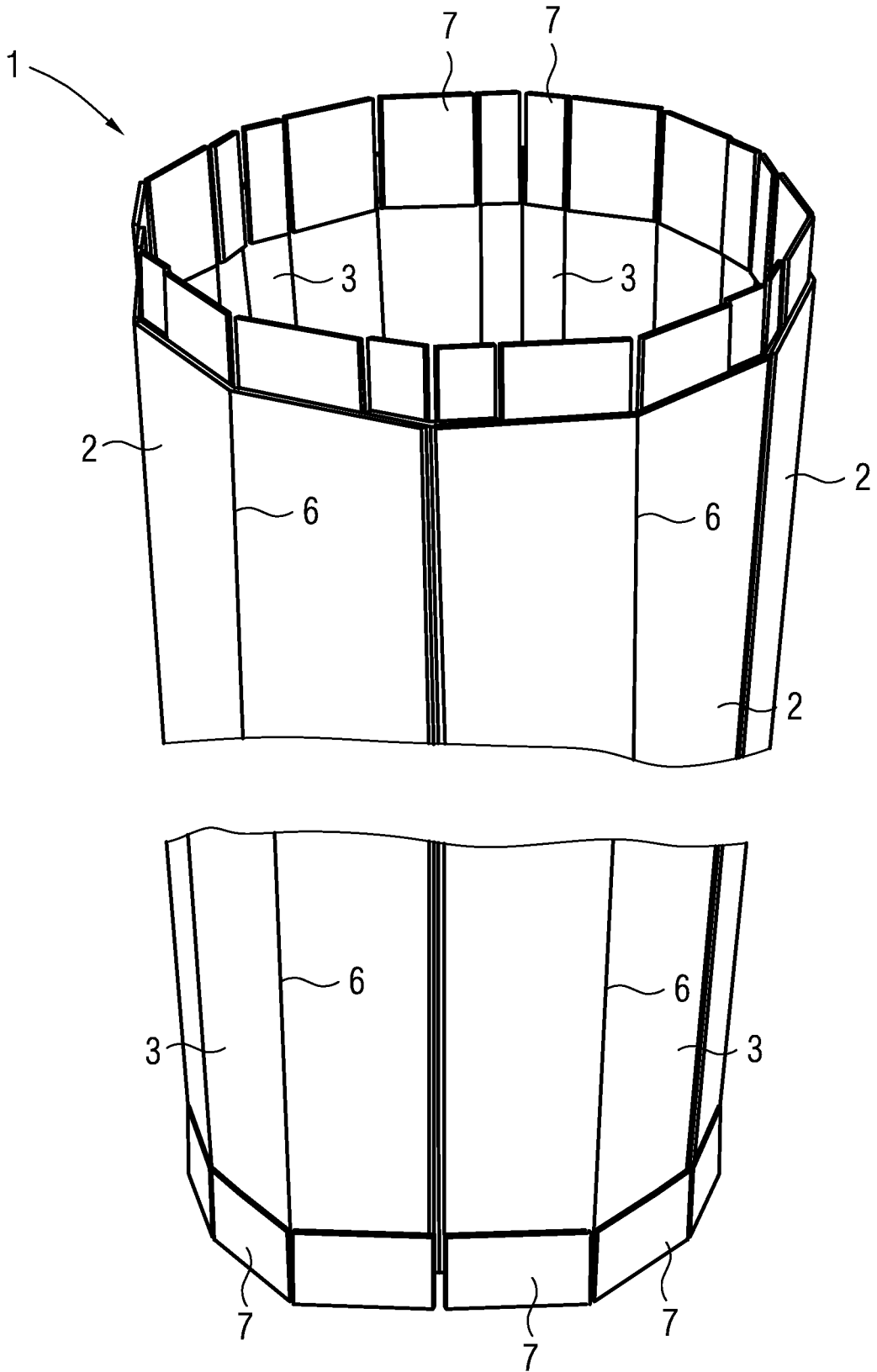


FIG 2

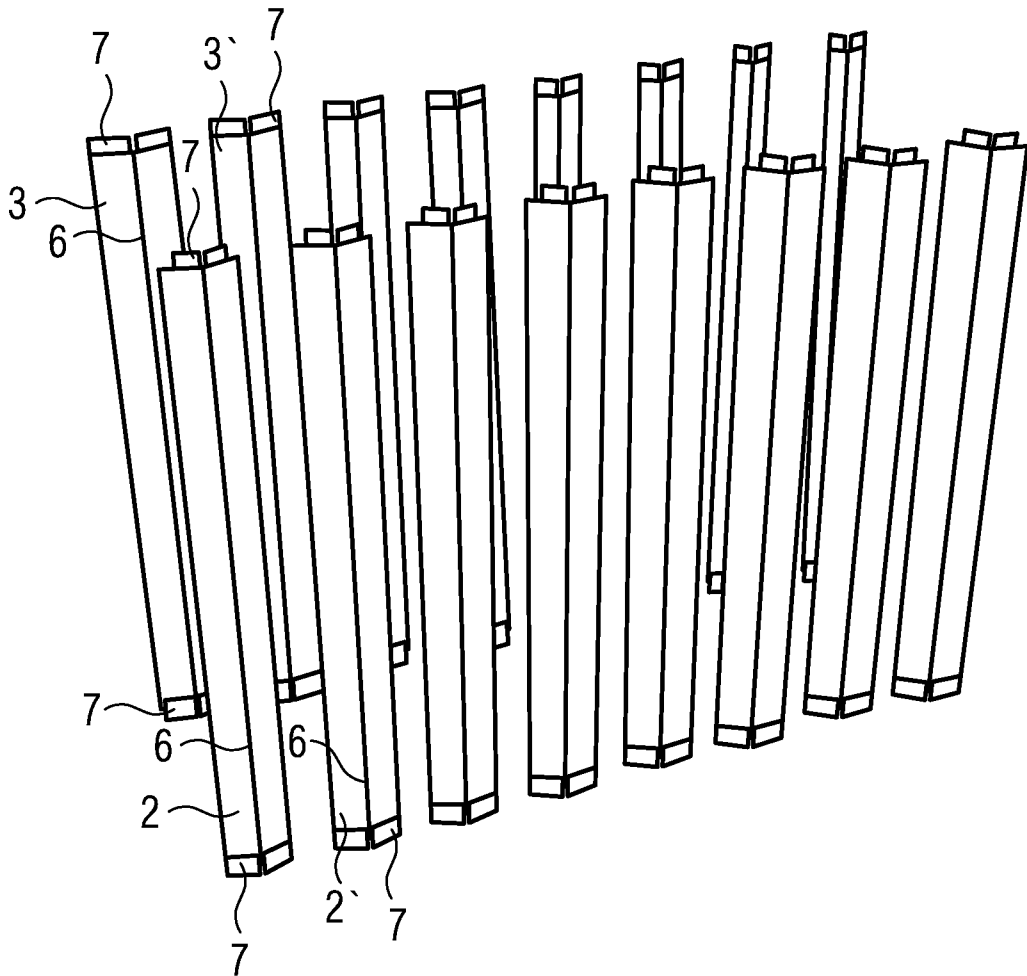


FIG 3

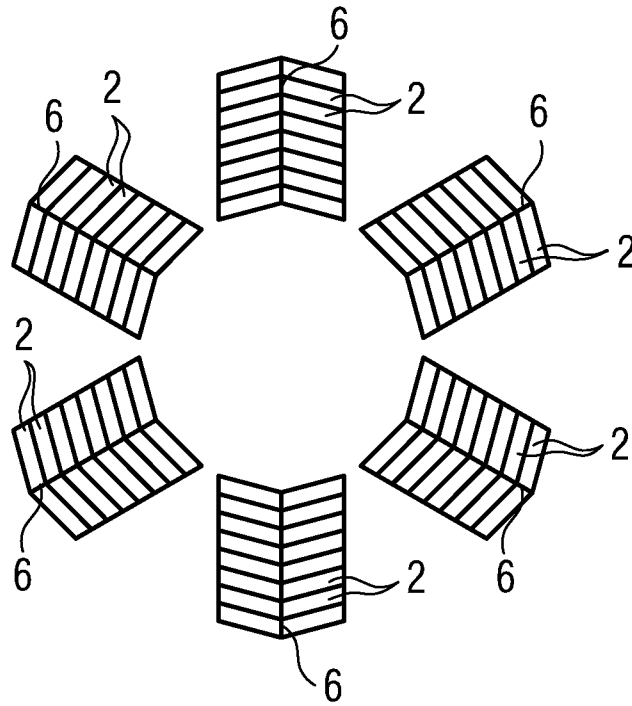


FIG 4

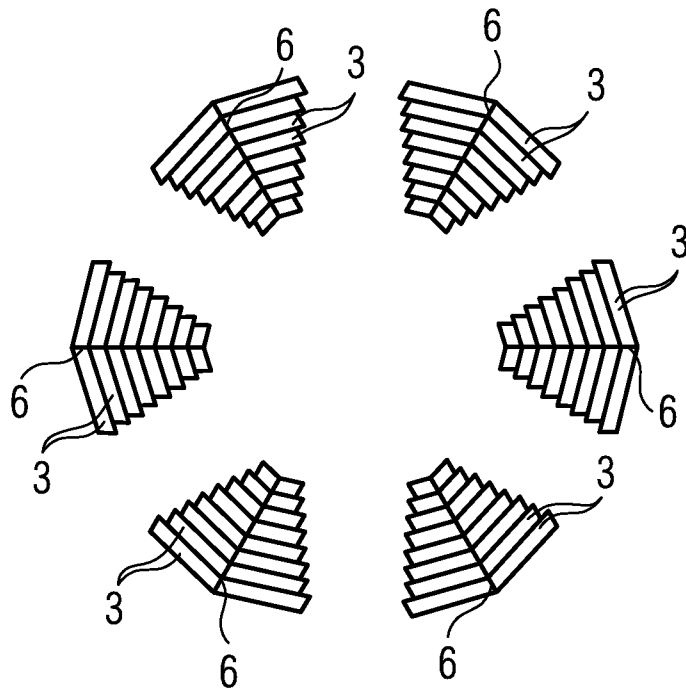


FIG 5

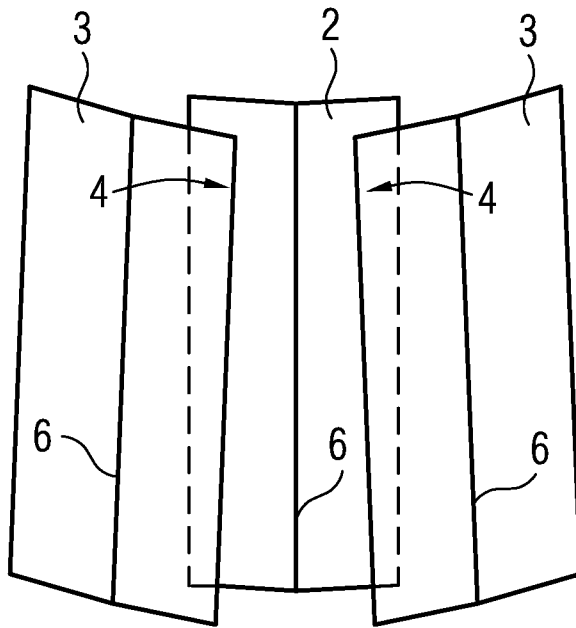


FIG 6

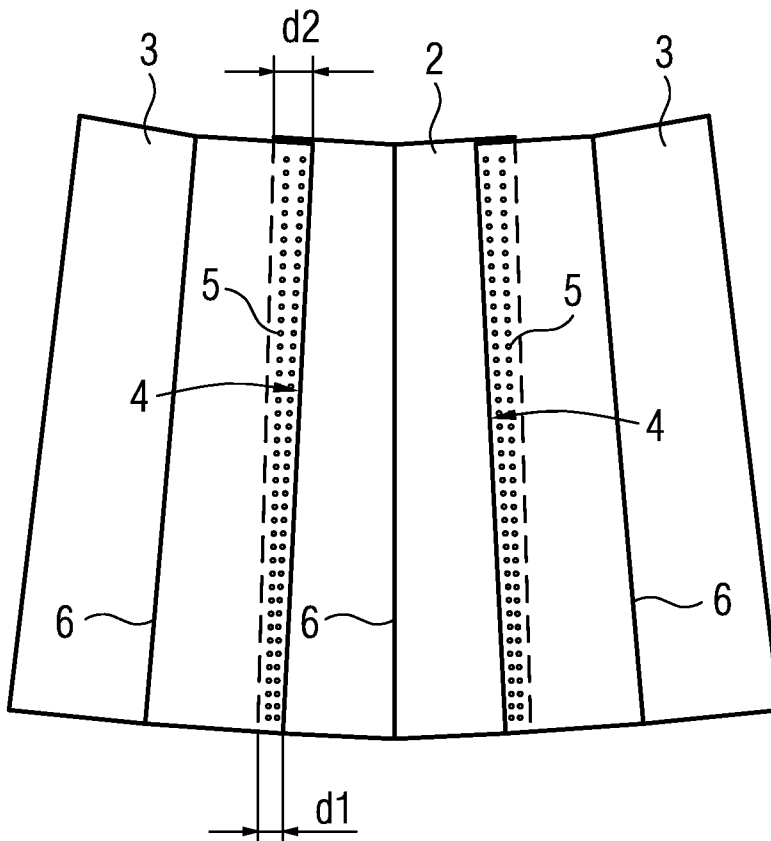


FIG 7

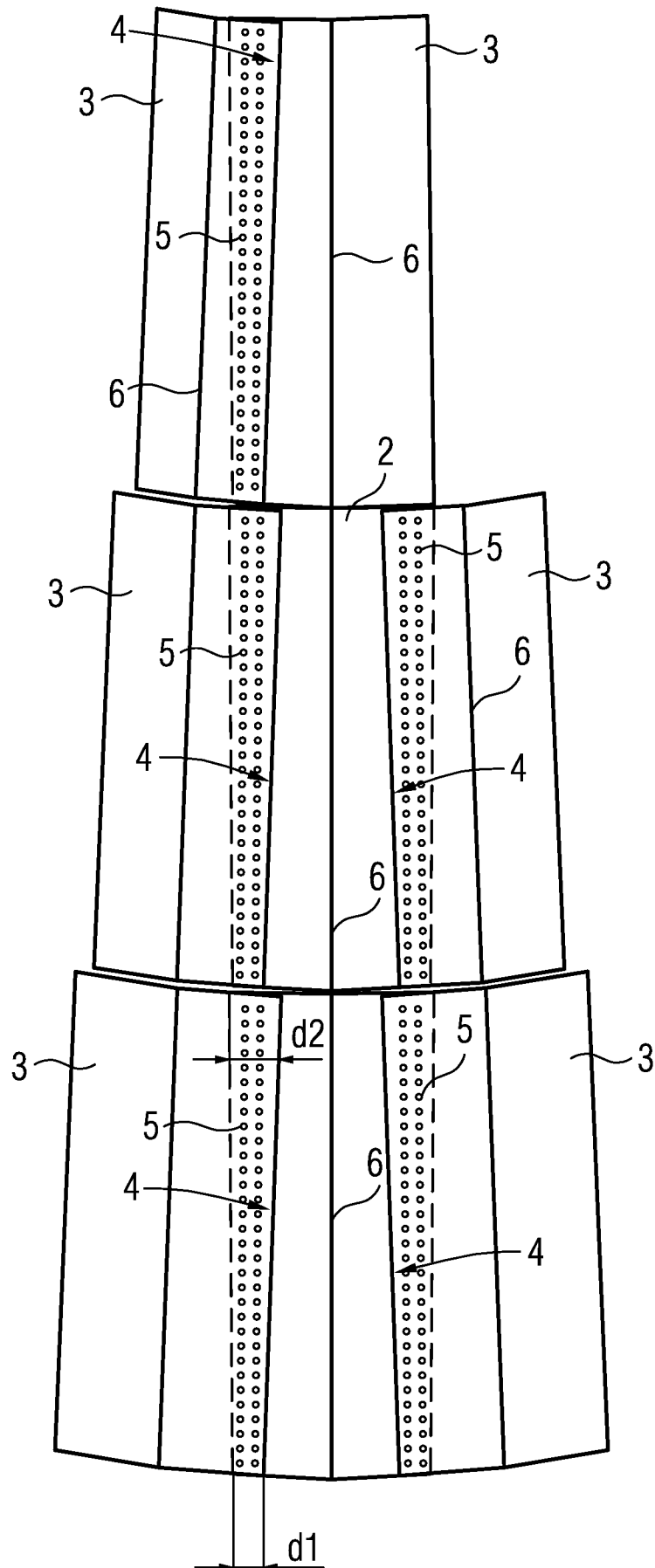


FIG 8

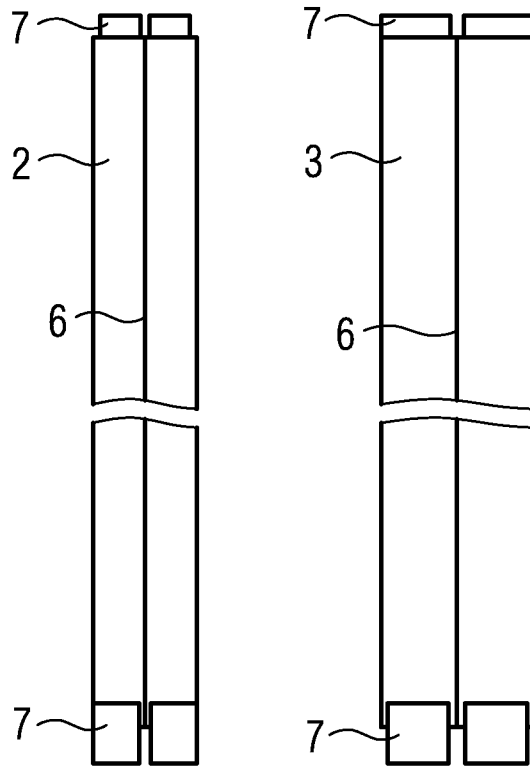
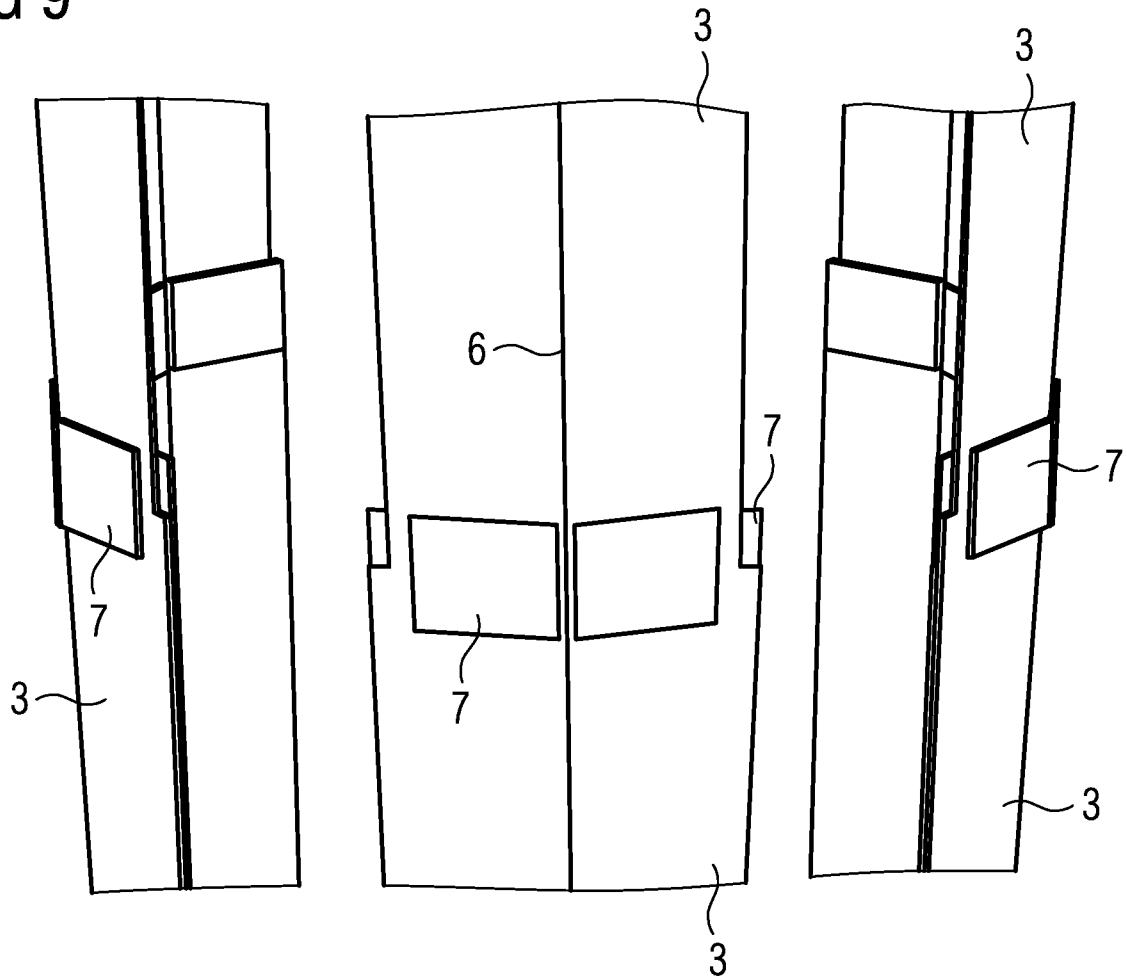


FIG 9



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/066812

A. CLASSIFICATION OF SUBJECT MATTER
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ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	wo 2010/049313 A2 (VESTAS WIND SYS AS [DK]; KRISTENSEN JONAS [DK]) 6 May 2010 (2010-05-06) abstract; figures 6,7 -----	1-15
X	wo 2009/056969 A2 (CORTINA-CORDERO ALEJANDRO [MX]; CORTINA-ORTEGA JOSE PABLO [MX]; CORTIN) 7 May 2009 (2009-05-07) abstract; figures 10-16 -----	1-15
X	wo 2008/031912 A1 (GAMESA INNOVATION & TECH SL [ES]; LLORENTE GONZALEZ JOSE IGNACIO [ES]) 20 March 2008 (2008-03-20) abstract; figures 1-5 -----	1-15
	-/- .	

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search 10 October 2011	Date of mailing of the international search report 18/10/2011
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Avrami di s, Pavl os
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/066812

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	wo 2010/026098 A2 (BOEGL MAX BAUUNTERNEHMUNG GMBH [DE] ; BOEGL STEFAN [DE] ; REICHEL DI ETER) 11 March 2010 (2010-03-11) abstract; claim 20; figure 3 -----	1-15
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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