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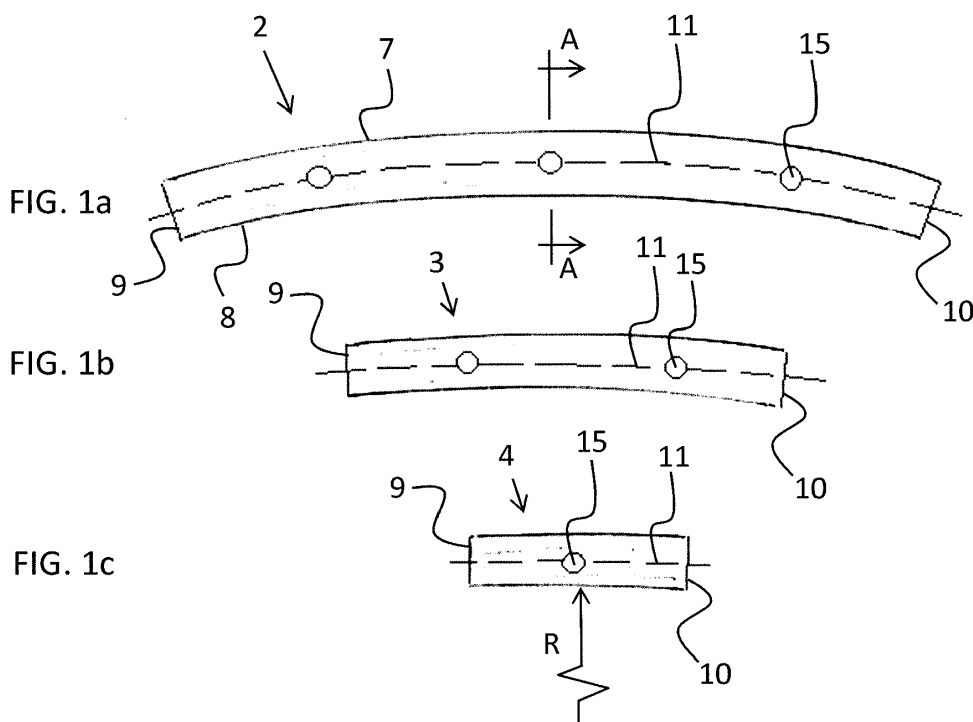
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(54) **Arrangement for forming arc section of right circular cylinder**

(57) The present invention relates to an arrangement for forming an arc section (1) of a right circular cylinder, out of wood, in particular. Such an arc section comprises battens (2, 3, 4) mechanically secured to each other in a parallel position and formed wavelike. In these battens, holes (15) are arranged, essentially perpendicular to and in alignment with the longitudinal axis (11) of the battens, in order to form tightening channels (16). The tightening channel has a tension rod (17) with its stoppage means

(18) extending to the outer edges of the arc section to tighten the battens that the tension rod penetrates against each other. Said battens are formed curved so that each bottom surface (8) has a radius of curvature (R), whereby the top surface (7) and the waveform accomplished on lateral surfaces (5, 6) with its wave crests (12) and wave troughs (13) is arranged to be essentially parallel with the bottom surface.



Description

Background of the invention

[0001] The present invention relates to an arrangement for forming an arc section of a right circular cylinder, in accordance with the preamble of claim 1.

[0002] Such an arrangement may in fact be used for most diverse purposes. It is hence customary to build different kind of arched halls, for example, in such a manner that they have a frame structure made of either wood or metal in order to achieve a large enough span for the hall. This kind of a frame structure then supports the outer casing of the hall. Depending on the nature of use of the hall, the outer casing is equipped with various kinds of waterproofing and heat insulation layers. The frame structure, for the most part implemented as a lattice, requires a substantial space, which can only partly be utilized for installing constructional layers. Consequently, a considerable waste space is established in an arched hall, disadvantageous from the point of view of thermal economy, which substantially adds to the maintenance cost of an arched hall.

[0003] On the other hand, the present arrangement may form a support structure for other constructs. One of such constructs is established by bridges where a bridge deck is supported by an arch built under the deck, or an arc structure extending over the deck. The manufacturing of both of these support structures is labour-intensive and time consuming. In addition, making an arch support requires a substantial amount of lumber for which there is no sensible re-use available after the bridge is completed, but the good raw material ends up, in the best case, being burnt or, in the worst case, as filling material on landfill sites.

Brief description of the invention

[0004] The object of the present invention is therefore to provide an arrangement that solves the above-described prior art problems in a completely novel manner. This object is achieved in such a manner that the arrangement for forming an arc section of a right circular cylinder is, in accordance with the present invention, provided with the characteristic features defined in the claims.

[0005] In particular, the present problems may be solved by combining the characteristics as disclosed in the characterizing part of claim 1.

[0006] Preferred embodiments of the invention are disclosed in the dependent claims.

[0007] The invention provides considerable advantages. An arched hall built with the present solution has a considerably better thermal economy than a structure implemented with the conventional lattice technology or glued laminated beams. The present invention allows the bottom surface of a roof to be brought to the level of the tie beam in competing solutions, whereby there will be

considerably less waste space to be heated in a hall.

[0008] An arc section according to the invention can also be implemented with structural elements that are very economical to manufacture. The joining together of the structural elements is simple and does not require any special skills worth mentioning, let alone special tools.

[0009] The battens used in building an arc section may be so dimensioned that they can be stored on standardized pallets, and to be transported by utilizing conventional means of transport.

[0010] The arc section is simple to dismount and transport, which additionally promotes its re-use. This also makes it possible to make use of the solution in emergency construction situations in trouble spots where structures are needed which are fast and simple to set up.

[0011] An arc section according to the invention is, in addition to halls, also suitable for the manufacturing of bridge support structures or, for example, falsework use at bridge construction sites. For example, the casting mould of an arch for a bridge opening will be finished much faster than previously, and is additionally markedly simple to dismantle and transfer to a new usage location after casting has been completed.

[0012] Furthermore, an arc section is simple to make essentially flat as far as both the top and bottom surfaces are concerned. This way, a hall or other building made of arc sections may be provided with an essentially flat ceiling surface, if so desired. When arc sections are used as casting moulds, an essentially flat mould surface is correspondingly achieved.

[0013] Other advantages provided by the invention are disclosed in the following more detailed description of the specific embodiments of the invention.

Brief description of the figures

[0014] In the following, some preferred embodiments of the invention will be explained in more detail with reference to the accompanying drawing, in which

Figures 1a - 1C shows exemplary battens forming the structure of the presented arc section, Figure 2 is a schematic sectional view of a batten at A-A of Figure 1 a, Figure 3 shows how an arc section according to the invention is utilized as the supporting structure of a building such as an arched hall or the like, Figure 4 shows is closer detail a bottom corner of an arched hall according to Figure 3, Figure 5 shows a top view of the schematic structure of an arc section as it is being constructed, Figure 6 shows a cross section at B-B of Figure 4 of the schematic structure of an alternative construction of an arc section used as the arc section is being constructed, Figure 7 shows a detailed view of an extension alternative for a tension rod used for joining battens in

the alternative construction according to Figure 6, Figure 8 shows how an arc section according to the invention is utilized as the supporting structure of a bridge, and

Figure 9 shows how an arc section according to the invention is utilized as the mould of a supporting arch structure of a bridge.

Detailed description of preferred embodiments

[0015] The presented figures do not show a full-scale arrangement for forming an arc section of a right circular cylinder but the figures are schematic, illustrating the general structure and operation of the preferred embodiments. The structural elements shown by reference numbers in the attached figures then correspond to the structural parts marked by reference numbers in this specification.

[0016] An arc section 1 is formed by using battens 2, 3 and 4 according to Figures 1a, 1b and 1c, for example, whereby the figures show some advantageous structures for the battens. The battens in such a case comprise a structural element made either of raw wood, or wood processed by manners known per se, such as heat-treated or pressure-treated wood. Each batten according to Figures 1a - 1c has lateral surfaces 5 and 6, joined by a top surface 7 and bottom surface 8.

[0017] As the example in Figure 2 shows, the lateral surfaces of the batten 2, 3, and 4 are formed symmetrically essentially parallel and wavelike. The uniform wavelike form has in such a case been established by utilizing a machining method known per se, such as milling or planing. The waveform in this case has a radius of curvature whose radius R may be chosen in accordance with the desired span of the final structure. So, this means that the wavelike surface form progresses curving on the lateral surfaces of the batten, but its cross-section otherwise unchanged. The top surface 7 and bottom surface 8 of the batten are, as regards their shape, essentially flat and advantageously parallel, being conventionally machined ready to be sanded. The top and bottom surface may in such a case be rectilinearly parallel, or one or both of them may be curved in their lengthwise direction in which case the radius R of the arc may be chosen in accordance with the desired span of the final structure. The battens are dimensioned so that parallel battens arranged against one another as in Figures 5 and 6, for example, are adapted to set against each other in a tight and bonded fashion thanks to their wavelike lateral surface shape. For example, the ends 9 and 10 of a batten shown in Figures 1a - 1c are also essentially flat, their plane surfaces being substantially parallel to the radius R and perpendicular to the longitudinal axis 11 of the batten.

[0018] As the battens 2, 3 and 4 are being pressed against each other as in Figure 5, for example, the battens comprising the wavelike lateral surfaces 5 and 6 are guided mutually bonded so that the wave crests 12 of

the previous batten are positioned at the wave troughs 13 of the corresponding subsequent battens and vice versa, thus creating the close fitting joint face 14 shown in Figure 7, to which the wave crests and wave troughs essentially parallel to and having the same radius of curvature as the bottom surface 8 contribute. The wave height H shown in Figure 2 is advantageously so chosen that it extends through the annual growth of a plurality of pieces of machined wood, making the joint between battens stronger. The length L of the wave, for its part, is advantageously essentially longer than the total depth D of the batten, being easy to machine, durable enough, and this way contributing to the positioning of battens in opposed positions. One of the most noteworthy advantages of a structure compiled of such battens is that the wavelike structure tightens itself, so to speak, regardless of moisture conditions. If even the smallest gap should emerge between adjacent battens, the batten will slide, thanks to the opposed waveforms, slightly apart from each other, creating pressure against the structures that hold the group of battens together.

[0019] By choosing such a wavelike shape of the joint faces 14 for the battens 2, 3 and 4, a notably large contact surface is accomplished between the battens, which significantly adds to the strength and load-carrying capacity of the structure. The wavelike seam structure of the wood structure set forth stiffens the structure against warping and curling, whereby the laminar structure that it accomplishes remains straight and planar. The shape at the same time substantially facilitates assembling the structure as a result of the battens aligning in place against each other in a straightforward manner.

[0020] The arc section 1 at hand is formed by, for example, arranging battens 2, 3 and 4 side by side as in Figures 5 - 7. In such a case, one or more holes 15, shown by Figures 1a - 1c, have advantageously been drilled beforehand in the lateral surfaces of the battens in a direction perpendicular to the longitudinal axis 11 of the batten. There is, of course, nothing to prevent making the holes in the battens at the same time as the battens are arranged side by side, but holes made in advance substantially contribute to the completion of the arc section.

[0021] When the battens 2, 3 and 4 are in an adjacent position, the holes 15 in them form an essentially uniform tightening channel 16, as outlined in Figure 5, in which a tension rod 17 may be fitted, such as a threaded rod known per se. At its outermost ends, the tension rod is equipped with nuts or other stoppage means 18, which prevent the tension rod from getting out of the tightening channel.

[0022] In another embodiment of an arc section, according to Figures 6 and 7, it is advantageous to provide the arc section with specific tightening nuts 19 at regular intervals to tighten the battens 2, 3 and 4 against each other, these tightening nuts pressing the battens within this regular interval tightly against each other. By continuing the joining together of battens this way, the arc sec-

tion at hand may be extended to cover the length of an entire arched hall or another arced structure.

[0023] By arranging arc sections established in this manner side by side, or by making use of arc sections tightened against each other, they will form a flat surface structure that comprises, if so required, a surface ready for sanding or coating. If the goal is a particularly high strength, it is in fact possible to arrange elastic adhesive in the seams 14 of the battens to join the battens together.

[0024] The thickness of a batten 2, 3 and 4 as measured from its top surface 7 to its bottom surface 8 may vary, as may the width of the batten as measured between the lateral surfaces 5 and 6, as well as the radius of curvature R of the batten. So, battens of different thicknesses and curvatures may be made according to appropriate fixed sizes, as schematically shown in Figures 1a, 1b, and 1c. The required construction thickness is achieved by choosing a batten that has the most suitable height at any one time. If so desired, it is possible to enhance the strength and load-carrying capacity of, for example, special premises by arranging in the joints between the battens a planar structural element shaped into a wavelike form and made of other material than wood.

[0025] The arc section at hand is also very economical from the material technology viewpoint. By examining Figures 1a - 1c and 3, it may be noted that the fixed-length battens 2, 3 and 4 in the wood structure may in the present invention be installed in their longitudinal direction one after the other in a simple manner, and side-by-side in the width direction of the structure so that the joints 20 of successive battens, visible in Figure 5, never fall adjacent to each other in a finished structure, but between adjacent batten joints there are always two solid battens passing the joint. Resulting from the support provided by the wavelike form of a batten, adjacent battens joined together by tension rods 17 and stoppage means 18, only, rest on each other's wavelike shapes thus creating a part of a functional static system. This way, a rigid structure that can handle large loads is accomplished even though not all of the individual battens reach a support 21.

[0026] As shown by Figures 1a - 1c, there may be, for example, three different lengths of the battens 2, 3 and 4 - short, medium-length, and long, with the lengths being integer multipliers of the length of the shortest batten. Thus, sizes that have been found out to be advantageous for a batten are such that the short batten 4 is essentially 500 mm long, the medium-length batten 3 is essentially 1000 mm long, and the long batten 2 is essentially 1500 mm long. It should, of course, be noted that such batten lengths are exemplary, only, and that the desired outcome may obviously be reached by making use of other dimensions. A shorter batten, is however, more economical to produce both from the viewpoint of the processing technique and availability of raw material. A shorter batten may advantageously be produced out of pieces of wood that are otherwise ill-suited to be used for industrial

or construction purposes.

[0027] In this exemplary case, the holes in the battens, referred to in the above, are implemented so that the shortest batten 4 has one hole 15, the medium-length batten 3 has two holes, and the longest batten 2 has three holes.

[0028] The desired arc section 1 is formed of these battens so that the end 22 of the arc section, which positions on the support 21, is formed of battens placed side-by-side and having an increasing length, or, as shown in Figure 5, of battens having a decreasing length. At every four battens, the selection of a batten is repeated. In other words, battens are grouped either in an ascending or descending length order at the end of an arc section arranged on the support. Alternatively, the battens grouped at the ends of the arc section arranged on the support may also be in an ascending or descending length order by turns. In the case according to Figure 5, on the support there will be positioned a long, medium-length, short, long, medium-length, short, long batten, and so forth. The opposite end of the arc section consists in the same manner of battens whose length varies. The other battens in an arc section are advantageously all long. The battens added in the longitudinal direction of the battens at the ends of an arc section are advantageously selected from among the longest battens.

[0029] An arc section may be formed essentially continuous, as to its width, in the manner described in the above and Figures 6 and 7, whereby the battens 2, 3 and 4 are tightened against each other by tightening nuts 19 installed at fixed intervals on the tension rods 17. Said tension rods are interconnected in their longitudinal direction by extension nuts 23 in order to extend a tension rod through all the battens arranged side-by-side, which establishes a uniform surface structure for the rest of the arc structure, which is ready to be used, if so required. By installing a spring component 24 between the tightening nut or the extension nut and a batten, the arc structure may also take into account the extension in the lateral direction of the batten, taking place in a group of battens. In such a case, a small allowance for expansion is left between the arc sections at the desired regular intervals, every 2 metres, for example, which ensures a controlled humidity behaviour of the structure.

[0030] An arc section may also be formed of narrower structural elements, which are connected to each other by a separate frame or support structure. Such a support structure may be formed by roof tiers of an arched hall, or by longitudinal strengthenings installed on the bottom surface of an arc section as the casting mould of an arch for a bridge arch is manufactured.

[0031] When manufacturing both arched halls and different kinds of arched centerings a major benefit of the present invention is, on the one hand, the glue-free joint technique of the battens 2, 3 and 4 and easy handling brought along by the small physical size of the battens. In addition, the assembly of an arc section without special fixing devices or glues makes it possible to disassemble

the structure and to transfer it to a new usage location.

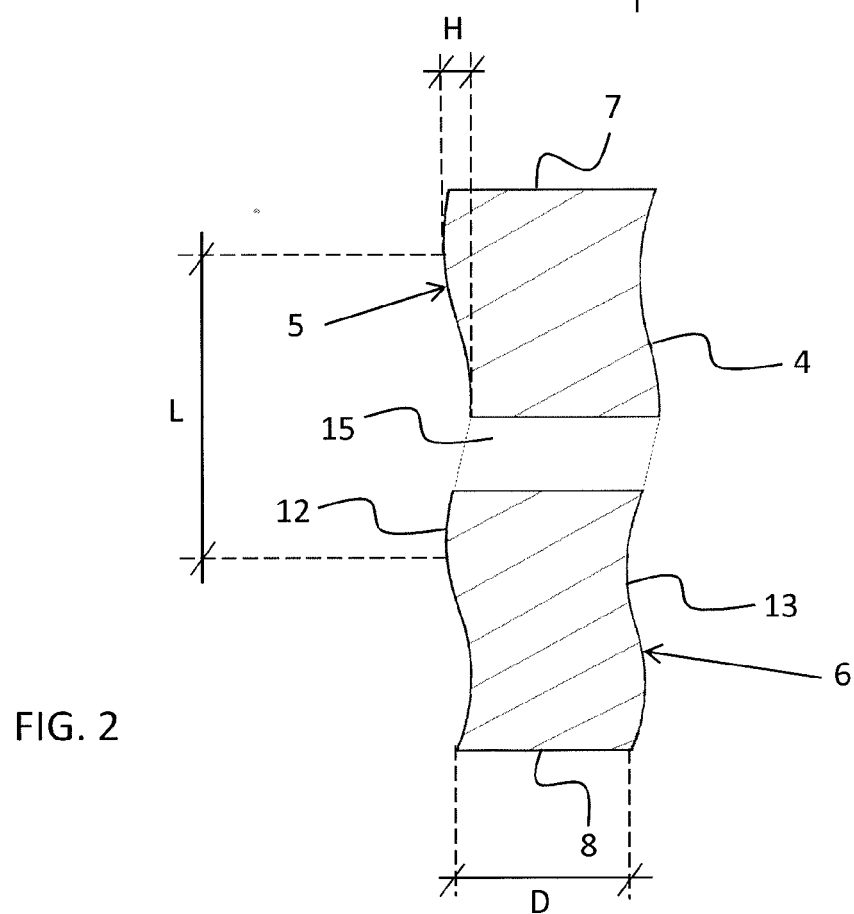
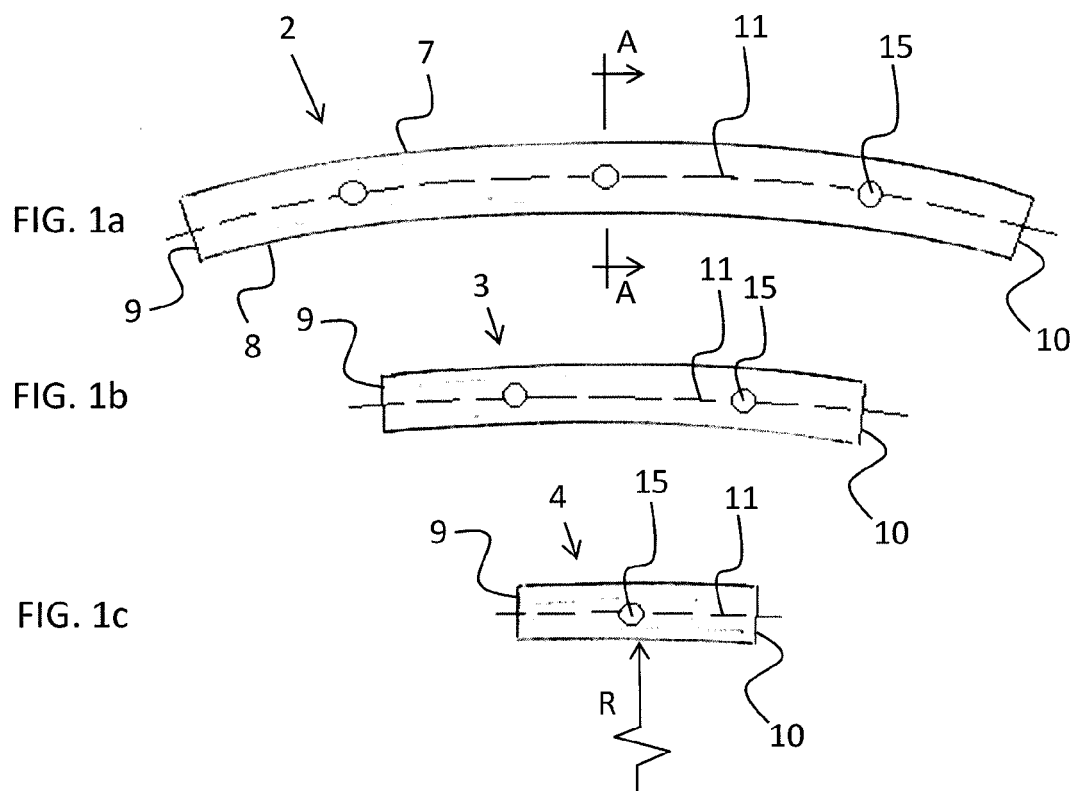
[0032] It is obvious to a person skilled in the art that, as technology advances, the basic idea of the described solution may be implemented in various ways. The disclosed solution and its embodiments are thus not restricted to the above examples but may vary within the scope of the claims.

Claims

1. An arrangement for forming an arc section (1) of a right circular cylinder, such an arc section comprising battens (2, 3, 4) mechanically secured to each other in a parallel position, in such a manner that each batten comprises two lateral surfaces (5, 6) that are formed wavelike, and a top surface (7) and a bottom surface (8) joining them, the lateral surfaces being arranged in pairs in an opposed position whereby wave crests (12) and wave troughs (13) of such opposed lateral surfaces are essentially parallel, and holes (15), which are in the lateral surfaces of the battens, essentially perpendicular to and in alignment with the longitudinal axis (11) of the battens, in order to form tightening channels (16), which tightening channel has a tension rod (17) having stoppage means (18), the rod extending to the outer edges of the arc section to tighten the battens that the tension rod penetrates against each other, **characterised in that** the wave crests (12) and the wave troughs (13) in the waveform of the lateral surfaces of the battens (2, 3, 4) are formed curved so that they have a radius of curvature (R).
2. An arrangement as claimed in claim 1, **characterised in that** the top surface (7) and/or the bottom surface (8) is/are formed to be essentially parallel to the waveform of the lateral surfaces.
3. An arrangement as claimed in claim 1 or 2, **characterised in that** there are advantageously three different lengths of battens (2, 3, 4), the lengths being integer multiples of the shortest batten.
4. An arrangement as claimed in claim 3, **characterised in that** the short one of the battens (2, 3, 4) is essentially 500 mm long, the medium-length one essentially 1000 mm, and the long one essentially 1500 mm.
5. An arrangement as claimed in claim 3 or 4, **characterised in that** the battens comprise holes (15) in the same proportion, so that the shortest batten (4) has one hole, the medium-length batten (3) has two holes, and the longest batten (2) has three holes.
6. An arrangement as claimed in any one of the pre-

ceding claims, **characterised in that** the formed arc section (1) of a right circular cylinder comprises battens (2, 3, 4) arranged side-by-side, and **in that** there are battens arranged successively in the direction of their longitudinal axis (11) in such a manner that there are always two solid battens between joints (20) of side-by-side battens, passing the joint.

7. An arrangement as claimed in claim 6, **characterised in that** the battens (2, 3, 4) are grouped either in an ascending or descending length order at the end of the arc section (1) formed on the support.
8. An arrangement as claimed in claim 6, **characterised in that** the battens (2, 3, 4) are grouped in an ascending and descending length order, by turns, at the end of the arc section (1) formed on the support.
9. An arrangement as claimed in claim 7 or 8, **characterised in that** the battens added in the direction of the longitudinal axis (11) of the battens (2, 3, 4) at the ends of the arc section (1) arranged on the supports have been selected from among the longest battens (2).
10. An arrangement as claimed in any one of the preceding claims, **characterised in that** the tension rod (17) penetrating the battens (2, 3, 4) is equipped with a tightening nut (19) which comprises an extension nut (23) in order to extend the tension rod through all the battens arranged side-by-side.
11. An arrangement as claimed in claim 10, **characterised in that** there is a spring component (24) arranged between the batten (2, 3, 4) and the extension nut (23) to allow for the transverse expansion of the batten.



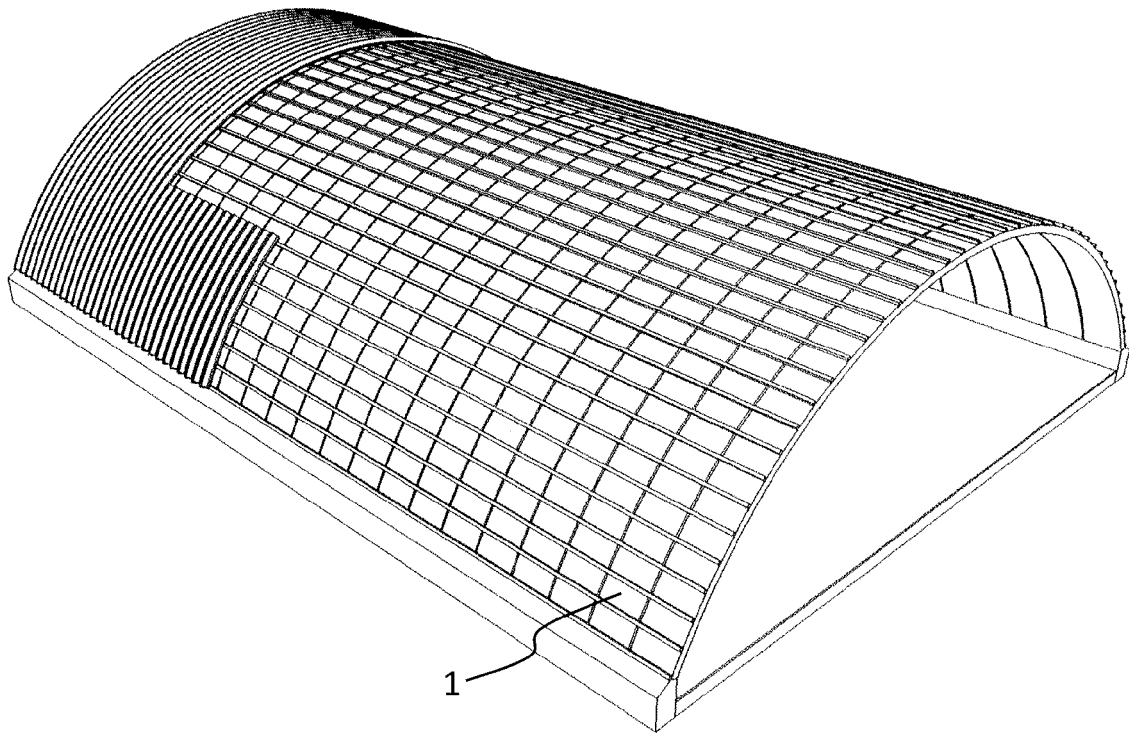


FIG. 3

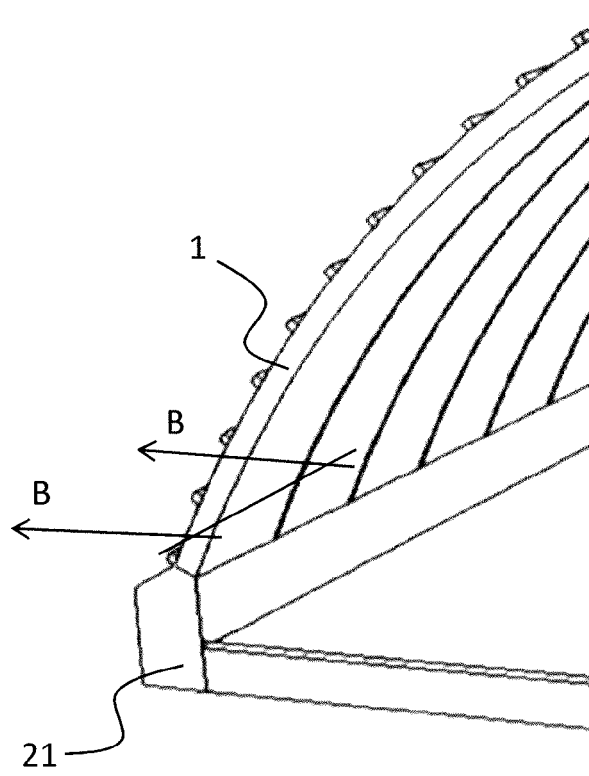


FIG. 4

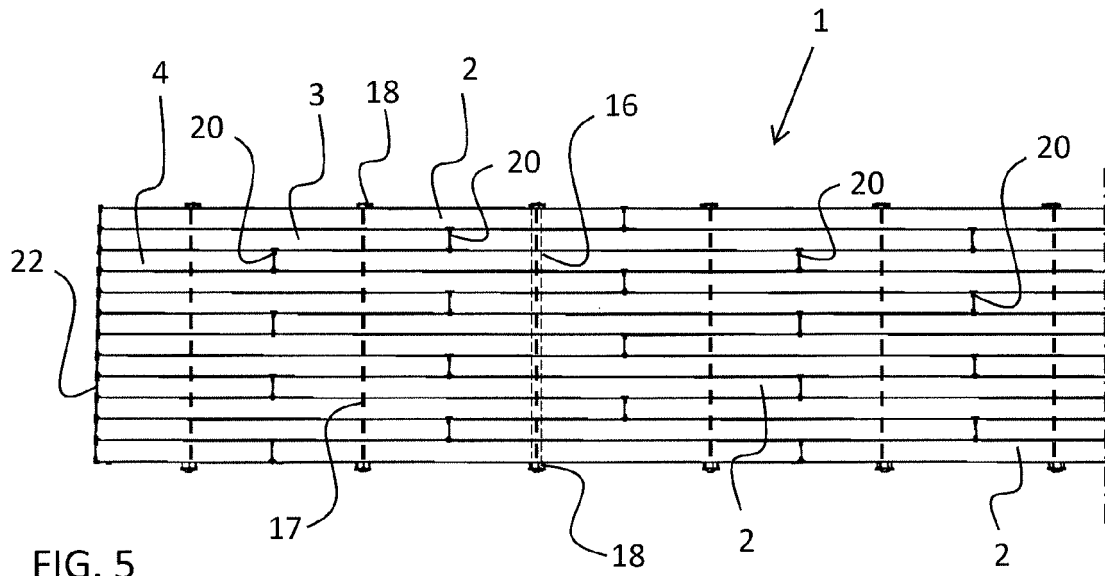


FIG. 5

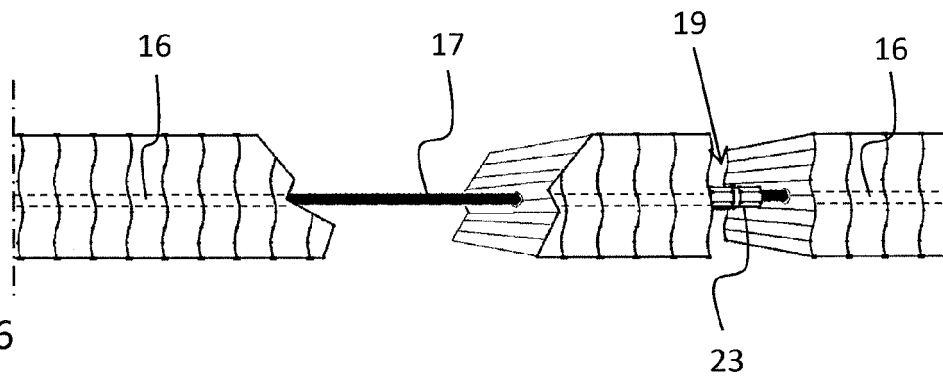


FIG. 6

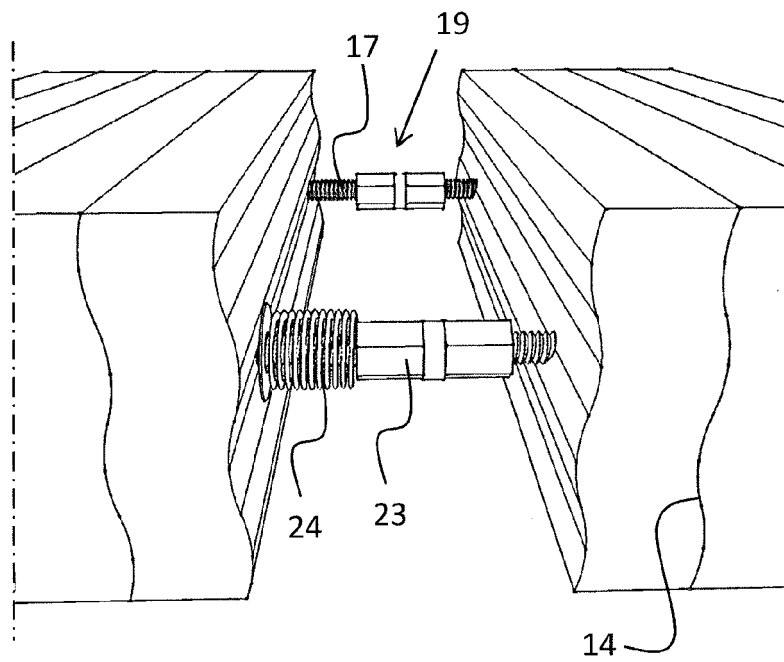


FIG. 7

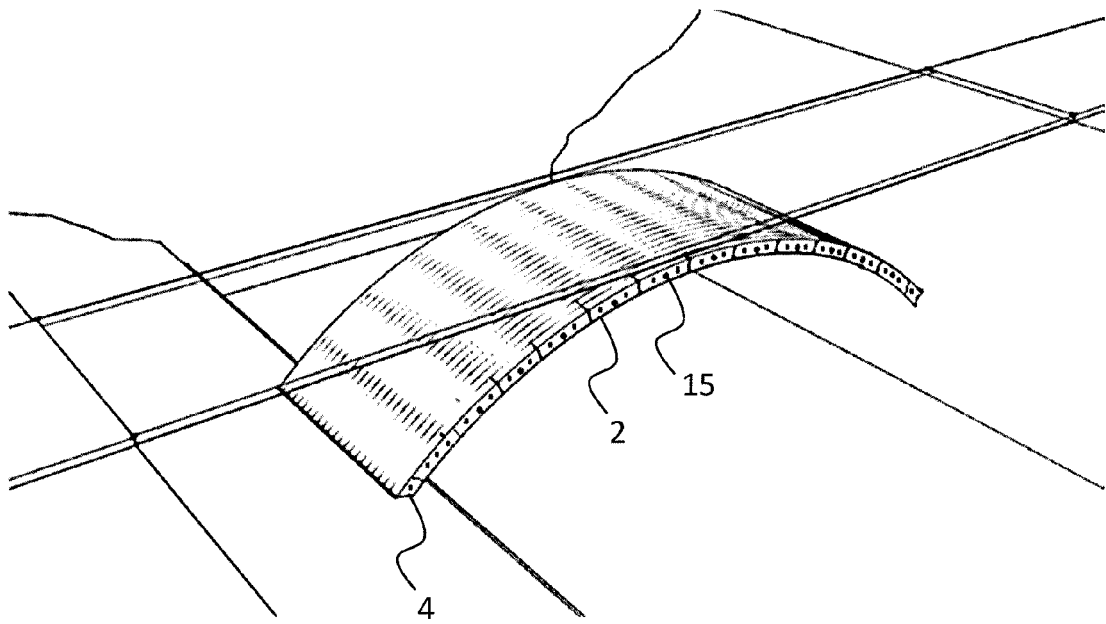


FIG. 8

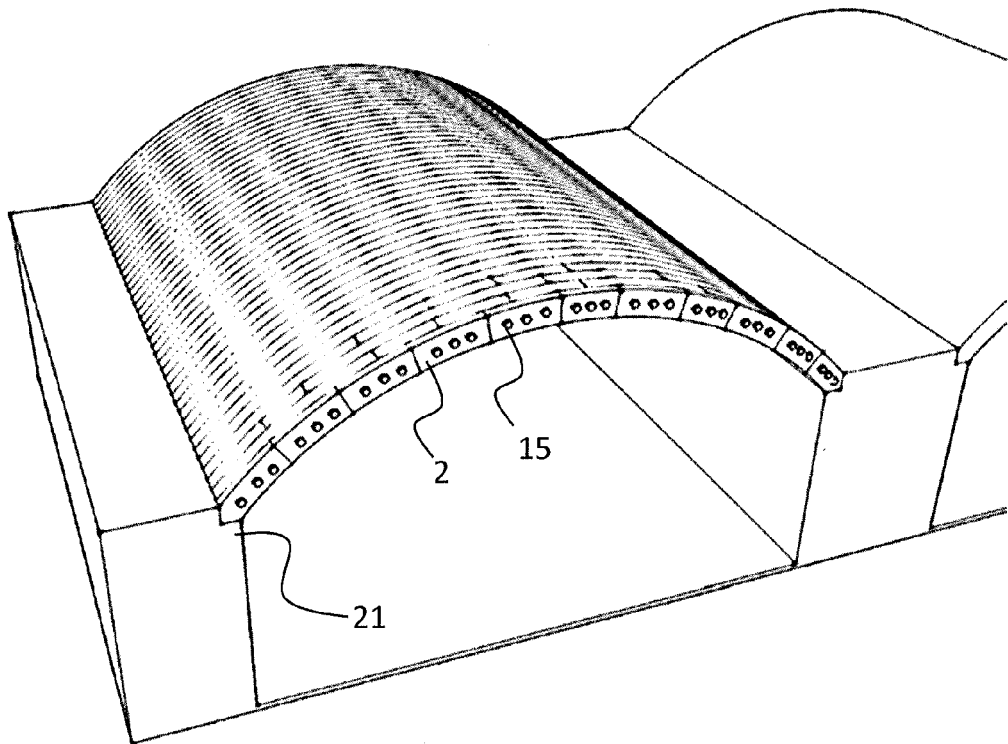


FIG. 9



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Application Number
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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