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(54) Title: VENTILATED BRAKING BAND, ASSEMBLY OF VENTILATED BRAKE DISC AND METHOD OF VENTILATION

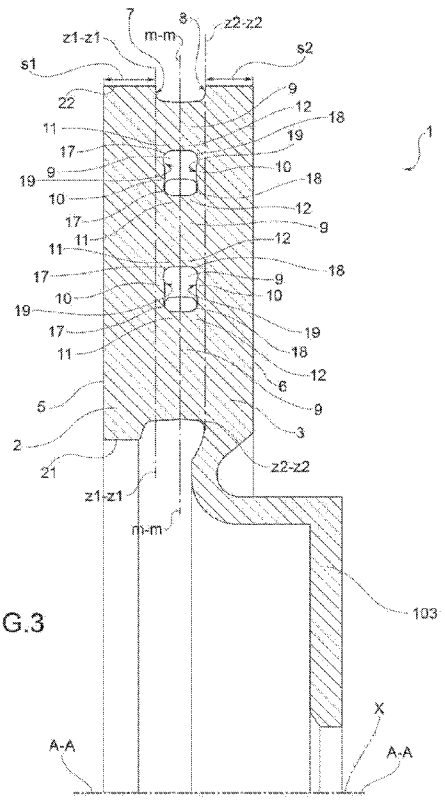


FIG.3

(57) Abstract: A ventilated braking band (100) for brake disc comprising a first plate (2) and a second plate (3); and wherein said first plate (2) comprises at least a first inner surface (7), and wherein said second plate (3) comprises a second inner surface (8), and wherein said first inner surface (7) defines a first inner surface plane or level (z1-z1) coinciding with said first inner surface (7), and wherein said second inner surface (8) defines a second inner surface plane or level (z2-z2) coinciding with said second inner surface (8); and wherein said ventilated braking band (100) comprises connecting elements (9) which extend in an axial direction (A-A) between said first inner surface (7) and said second inner surface (8), connecting together said first plate (2) and said second plate (3); and in which said connecting elements (9) and said first inner surface (7) and said second inner surface (8) at least partially delimit ventilation channels (15) inside said gap (4), and in which said ventilation channels (15) are adapted to convey a fluid current flow for cooling said ventilated braking band (100); and wherein each connecting element (9) comprises at least a first foot (11) which connects each connecting element (9) to said first inner surface (7), and at least a second foot (12) which connects each connecting element (9) to said second inner surface (8); and wherein said ventilated braking band (100) comprises at least one bulge (10) which protrudes from a plate (2, 3) in said gap (4) without reaching the oppositely facing plate (3, 2); wherein said at least one bulge (10) substantially has the shape of at least one portion of a sphere; said at least one bulge (10) is partially interpenetrated with: at least one portion of said first foot (11), thus forming a structural continuity with said first foot (11), thus avoiding said first inner surface level (z1-z1) from being reached; or at least one portion of said second foot (12), thus forming a structural continuity with said second foot (12), thus avoiding said second inner surface level (z2-z2) from being reached.

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DESCRIPTION

# "VENTILATED BRAKING BAND, VENTILATED BRAKE DISC ASSEMBLY AND VENTILATION METHOD"

[0001]. Field of the invention

[0002]. The present invention relates to a ventilated braking band for a ventilated brake disc, as well as to a ventilated brake disc assembly comprising said ventilated braking band.

[0003]. The present invention also relates to a method of ventilating a braking band.

[0004]. Background art

[0005]. In a general brake disc, a system of cylindrical coordinates is generally defined, comprising an axial direction (A-A) coinciding with the rotation axis (X) of the brake disc, a radial direction (R-R) orthogonal to the axial direction, and a tangential or circumferential direction (C-C) orthogonal both to the axial direction (A-A) and to the radial direction (R-R).

[0006]. Brake discs of the ventilated type are generally known, i.e. comprising a ventilated braking band which comprises two plates on which opposite braking surfaces are obtained being adapted to act in conjunction with opposite brake pads of a brake caliper which can be associated with the brake disc to exert the braking action, in which said two plates are spaced apart in axial direction, thus delimiting a gap. Ventilated brake discs are provided with a plurality of axial connecting elements such as fins or pegs, which structurally connect together said two plates, thus forming said gap in conjunction with the two plates. For example, this type of brake disc is known from

International Patent Applications Nos. **WO-2011-058594** and **WO-2012-164465**, and also from documents Nos. **GB-2286438**, **DE-4332693**, **DE-19925003** and **US-5526905** to the same Applicant.

[0007]. This type of brake disc has the advantage that the variously shaped connecting elements of the braking band delimit a plurality of ventilation channels in the gap between the plates, which are adapted to convey a fluid current for cooling the brake disc when the brake disc rotates. In particular, it is important for the fluid current to be in turbulent operation in order to maximize the cooling. For example, International Patent Application No. **WO-2008-078352** shows blind holes made on the inner surface of the plate to increase the turbulence of the cooling current. The holes made on the inner surface of the plate are sites of concentration of the stresses dangerously adapted to trigger cracks, thus necessarily limiting the mechanical resistance of the plates, mass being equal, or imposing an increase in mass to maintain an adequate mechanical resistance.

[0008]. Moreover, as is known, brake disc temperatures which are too high cause a decreased efficiency of the braking action and simultaneously may cause the occurrence of cracks in the body of the brake disc itself.

[0009]. For example, it is known from documents Nos. **EP-2192321**, **DE-202006-017092**, **GB-2060796** and **GB-2116654** to provide bosses or protrusions on the inner surfaces of the plates and separated from the connecting elements to increase the turbulence of the cooling current flow and to provide reasonably distributed reinforcements

adapted to contrast the propagation of cracks. Such solutions necessarily impose an increase of the mass of the disc.

[0010]. For example, International Patent Application No. **WO-2015-092671** to the same Applicant shows a ventilated brake disc comprising connecting elements between the two plates with which fitting burrs are associated, which extend from the connecting elements thus connecting them to the plates.

[0011]. Although it is partly advantageous in reducing the occurrence of cracks in the body of the brake disc, such a solution in any case has certain drawbacks.

[0012]. Indeed, the provision of said fitting burrs makes the manufacturing of the brake disc laborious, and particularly the step of extracting the core material from the gap between the two plates, which has narrow and tortuous ventilation channels.

[0013]. Moreover, although the provision of said fitting burrs increases the turbulence of the cooling fluid current and the heat exchange surface of the connecting elements, it necessarily increases the volume, and therefore the weight, of the connecting elements themselves and of the whole brake disc. Accordingly, in order to ensure the structural integrity of the brake disc when it is in operating conditions, the above-mentioned increase in weight imposes making connecting elements, such as fins or pegs, with a particularly stocky cross section, for example diamond-shaped, as is clearly shown for example, from the cross-sections of fin shown in figures 2, 4, 5 and 6 of document No. WO-2015-092671.

[0014]. Additionally, as is known, the weight of the brake disc is

directly proportional with the inertia of the brake disc during the braking. For example, it is known from document **DE-4332693** to make axially-directed through holes in the connecting elements to lighten the brake disc. However, this type of drillings also imposes a structural weakening of the disc.

[0015]. The need is therefore strongly felt to obviate the drawbacks of the known art mentioned hereto.

[0016]. Therefore, the need is felt to provide a structurally resistant ventilated brake disc while allowing the possibility of making lightweight and thin connecting elements.

[0017]. At the same time, the need is felt to provide a ventilated brake disc with improved lightness with respect to known solutions, without reducing the properties of structural and heat resistance of the brake disc itself.

[0018]. Solution

[0019]. It is an object of the present invention to obviate the drawbacks of the prior art mentioned hereto.

[0020]. It is an object of the present invention to provide a solution of ventilated braking band and also of ventilated brake disc adapted to cause a turbulent fluid current for disposing of the heat from the brake disc in the gap between the plates when the brake disc is rotating.

[0021]. It is an object of the present invention to provide a ventilated braking band and also a ventilated brake disc having increased heat exchange surface with respect to known solutions, mass being equal, or having decreased weight, heat exchange surface

being equal, without therefore providing decreased mechanical and structural resistance.

[0022]. It is an object of the present invention to provide a ventilated braking band and also a ventilated brake disc which, although it is structurally strong, allows making connecting elements such as lightweight fins or pegs, while allowing to make thin plates, or thinner plates with respect to known solutions.

[0023]. It is a further object of the present invention to provide a ventilated braking band and also a ventilated brake disc of the ventilated type adapted to exert a prompt braking when clamped between the brake pads of a brake caliper.

[0024]. It is a further object of the present invention to provide a method of ventilating a braking band adapted to efficiently disposing of the heat accumulated in the plates.

[0025]. These and other objects are achieved by a ventilated braking band according to claim **1**, and also by a ventilated brake disc assembly according to claim **8**, and by with a ventilation method according to claim **10**.

[0026]. Certain advantageous embodiments are the subject matters of the dependent claims.

[0027]. Drawings

[0028]. Further features and advantages of the ventilated braking band, the ventilated brake disc assembly and the method according to the invention will become apparent from the description provided below of preferred embodiments thereof, given by way of non-limiting example, with reference to the accompanying drawings, in which:

[0029]. - figure 1 is an axonometric view of a ventilated brake disc assembly according to one embodiment, in which the plate on the side of the disc bell is partially cross-sectioned along the cutting plane m-m;

[0030]. - figure 1bis is a diagrammatical sectional view showing a portion of a ventilated brake disc assembly according to one embodiment, and associable brake pads;

[0031]. - figure 2 is a front view of a ventilated brake disc according to the embodiment shown in figure 1, in which the plate on the side of the disc bell is partially cross-sectioned along the cutting plane m-m in figure 1;

[0032]. - figure 3 is a sectional view of a ventilated braking band according to a cutting plane parallel to line III-III in figure 2;

[0033]. - figure 4 is an axonometric view of a portion of a ventilated brake disc according to the embodiment shown in figures 1, 1bis, 2 and 3, in which the plate on the side of the disc bell is partially cross-sectioned;

[0034]. - figure 5 is a front view of a portion of a ventilated braking band according to one embodiment, in which a plate is partially cross-sectioned;

[0035]. - figure 6 is a sectional view of a ventilated braking band according to a cutting plane parallel to line VI-VI in figure 5;

[0036]. - figures 7, 8, 9, 10 and 11 are front views of certain portions of ventilated braking band according to certain embodiments, in which a plate is partially cross-sectioned;

[0037]. Description of some preferred embodiments

[0038]. With reference to the accompanying figures, numeral 100 indicates a ventilated braking band for brake disc as a whole.

[0039]. A brake disc defines an axial direction A-A coinciding with the rotation axis X of the brake disc, a radial direction R-R orthogonal to the axial direction A-A, and a tangential C-C or circumferential direction C-C orthogonal to both the axial direction A-A and the radial direction R-R.

[0040]. According to a general embodiment, a ventilated braking band 100 comprises a first plate 2 and a second plate 3, which are coaxial to the same axial direction A-A.

[0041]. According to one embodiment, at least one between said first plate 2 and said second plate 3 is adapted to be connected to a disc bell which can be associated with the ventilated braking band 100. By way of non-limiting example, according to one embodiment shown in **figure 1bis**, the second plate 3 is connected to the disc bell 103 which can be associated with the ventilated braking band 100.

[0042]. Said first plate 2 and said second plate 3 are mutually spaced apart in axial direction A-A so as to delimit a gap 4 therebetween.

[0043]. Said first plate 2 comprises a first braking surface 5 adapted to face at least a first brake pad 101 of a brake caliper which can be associated with said ventilated braking band 100, and said second plate 3 comprises a second braking surface 6, parallel and opposite to said first braking surface 5, so as to be adapted to face at least a second brake pad 102, opposite to said first brake pad of said brake caliper which can be associated with said

ventilated braking band 100.

[0044]. Said first plate 2 comprises at least a first inner surface 7 facing said second plate 3.

[0045]. Said first inner surface 7 is substantially parallel to said first braking surface 5.

[0046]. Said second plate 3 comprises a second inner surface 8 facing said first plate 2.

[0047]. Said second inner surface 8 is substantially parallel to said second braking surface 6.

[0048]. Said first inner surface 7 defines a first inner surface plane or level z1-z1 coinciding with said first inner surface 7. The distance between said first inner surface level z1-z1 and said first braking surface 5 defines a first plate thickness s1.

[0049]. Said second inner surface 8 defines a second inner surface plane or level z2-z2 coinciding with said second inner surface 8. The distance between said second inner surface level z2-z2 and said second braking surface 6 defines a second plate thickness s2.

[0050]. According to a preferred embodiment, said first inner surface level f z1-z1 and said second inner surface level z2-z2 are substantially parallel to each other.

[0051]. Said ventilated braking band 100 comprises connecting elements 9 which extend in axial direction A-A between said first inner surface 7 and said second inner surface 8, thus connecting together said first plate 2 and said second plate 3.

[0052]. Said connecting elements 9 and said first inner surface 7 and said second inner surface 8 at least partially delimit

ventilation channels 15 inside said gap 4, and in which said ventilation channels 15 are adapted to convey a fluid current flow for cooling said ventilated braking band 100.

[0053]. Each connecting element 9 comprises at least a first foot 11 which connects each connecting element 9 to said first inner surface 7, and at least a second foot 12 which connects each connecting element 9 to said second inner surface 8.

[0054]. Said ventilated braking band 100 comprises at least one bulge 10 which protrudes from a plate 2, 3 in said gap 4 without reaching the oppositely facing plate 3, 2.

[0055]. According to one embodiment, said at least one bulge 10 protrudes from said first plate 2 without reaching said second plate 3.

[0056]. According to one embodiment, said at least one bulge 10 protrudes from said second plate 3 without reaching said first plate 2.

[0057]. Advantageously, said at least one bulge 10 substantially has the shape of at least one portion of a sphere.

[0058]. The provision of such a bulge 10 in the shape of at least one portion of a sphere allows the heat exchange surface of bulge 10 to be made larger than any other shape, without discontinuities, and easily, the mass added to the plate being equal. At the same time, the provision of said at least one bulge 10 in the shape of at least one portion of a sphere allows a constriction in said gap 4 to be at least partially delimited, thus affecting the fluid current flow for cooling the ventilated braking band 100, for example by increasing

the speed and turbulence thereof. As is known, this causes an increase of the cooling efficiency of the ventilated braking band 100 when it is in operating conditions.

[0059]. According to one embodiment, said at least one bulge 10 is partially interpenetrated with at least one portion of said first foot 11, thus forming a structural continuity with said first foot 11, thus avoiding said first inner surface level z1-z1 from being reached.

[0060]. The term "structural continuity" hereinafter means the provision of a continuous portion of material which comprises said at least one bulge 10 and at least one portion of foot 11, 12.

[0061]. The provision of said at least one bulge 10 partially interpenetrated with at least one portion of said first foot 11 avoids a structural discontinuity from being formed between said at least one bulge 10 and at least one portion of said first foot 11 such as to bring back to the first inner surface level z1-z1.

[0062]. Advantageously, the provision of said at least one bulge 10 partially interpenetrated with at least one portion of said first foot 11 which avoids said first inner surface level z1-z1 from being reached, structurally strengthens the first plate 2, thus avoiding or delaying the propagation of cracks. Thereby, said first plate thickness s1 may be obtained so that said first plate 2 is thinner, and therefore lighter, with respect to known solutions, structural resistance being equal, or said first plate 2 may be made more structurally resistant than known solutions, mass being equal.

[0063]. According to one embodiment, said at least one bulge 10 is

partially interpenetrated with at least one portion of said second foot 12, thus forming a structural continuity with said second foot 12 which avoids said second inner surface level z2-z2 from being reached.

[0064]. The provision of said at least one bulge 10 partially interpenetrated with at least one portion of said second foot 12 avoids a structural discontinuity from being formed between said at least one bulge 10 and at least one portion of said second foot 12 such as to bring back to the second inner surface level z2-z2.

[0065]. Advantageously, said at least one bulge 10 partially interpenetrated with at least one portion of said second foot 12 structurally strengthens the second plate 3, thus avoiding or delaying the propagation of cracks. Thereby, said second plate thickness s2 may be obtained so that said second plate 3 is thinner, and therefore lighter, with respect to known solutions, structural resistance being equal, or said second plate 3 may be made more structurally resistant than known solutions, mass being equal.

[0066]. According to a preferred embodiment, said ventilated braking band 100 comprises a plurality of bulges 10.

[0067]. The provision of a plurality of bulges 10 allows to at least partially delimit a plurality of constrictions in said gap 4, thus affecting the flow of fluid current for cooling the ventilated braking band 100, for example by increasing the speed and the turbulence, and therefore improving the cooling efficiency of the braking band 100 when in operating conditions.

[0068]. According to a preferred embodiment, said ventilated braking

band 100 comprises a plurality of bulges 10 which protrude from said first plate 2 and a plurality of bulges 10 which protrude from said second plate 3, in which each bulge 10 which protrudes from said first plate 2 is partially interpenetrated with at least one portion of said first foot 11, thus forming a structural continuity with said first foot 11 which avoids said first inner surface level z1-z1 from being reached, and in which each bulge 10 protruding from said second plate 3 is partially interpenetrated with at least one portion of said second foot 12, thus forming a structural continuity with said second foot 12 which avoids said second inner surface level z2-z2 from being reached.

[0069]. Thereby, both the first plate 2 and the second plate 3 are strengthened and at the same time, an optimized increase of heat exchange surface is supplied for quantity of mass added to the plates 2, 3. Therefore, it is possible to supply a more structurally and thermally resistant ventilated braking band 100 with respect to known solutions, weight being equal, or a lighter one with respect to known solutions, structural and heat resistance being equal.

[0070]. According to a preferred embodiment, said at least one bulge 10 is made in a single piece with said plates 2, 3 and with said connecting elements 9. In other words, said ventilated braking band 100 is made in a single piece. For example, said ventilated braking band 100 is made in a single piece by means of known foundry processes.

[0071]. According to one embodiment, said at least one bulge 10 is substantially hemispherical in shape.

[0072]. According to one embodiment, said at least one bulge 10 is a semi-spherical boss.

[0073]. According to one embodiment, said at least one bulge 10 substantially has the shape of a spherical sector.

[0074]. According to one embodiment, said at least one bulge 10 substantially has the shape of a spherical segment of a base.

[0075]. According to one embodiment, said at least one bulge substantially has the shape of a quarter of a sphere.

[0076]. According to one embodiment, said at least one bulge 10 substantially has the shape of a spherical wedge.

[0077]. The provision of different shapes of said at least one bulge 10 allows to tune the fluid-dynamic properties of the flow of cooling fluid current of the braking band 100 by acting on the shape, size and volume of each bulge 10.

[0078]. According to one embodiment, said at least one bulge 10 comprises a bulge surface 13 which delimits at least one portion of said gap 4, in which said bulge surface 13 is in the shape of at least one portion of spherical cap.

[0079]. According to one embodiment, said bulge surface 13 is in the shape of a spherical half-cap.

[0080]. According to one embodiment, said first foot 11 is connected to the first inner surface 7, thus forming at least a first foot fitting 17.

[0081]. According to one embodiment, said second foot 12 is connected to the second inner surface 8, thus forming at least a second foot fitting 18.

[0082]. According to one embodiment, said first foot 11 is connected to the first inner surface 7, thus forming at least a first foot fitting 17, and said second foot 12 is connected to the second inner surface 8 thus forming at least a second foot fitting 18.

[0083]. The provision of said first foot fitting 17 and also of said second foot fitting 18 improves the structural resistance of the connecting element 9, the same way as a capital and plinth made at end portions of a column.

[0084]. According to one embodiment, said at least one bulge 10 is connected to at least one of said first inner surface 7 and said second inner surface 8, thus forming a bulge fitting 16.

[0085]. The provision of said first foot fitting 17 and also of said second foot fitting 18 and also of said bulge fitting 16 allows an easier extraction of the core material accommodated between the plates 2, 3 during the manufacturing of the ventilated braking band 100.

[0086]. According to one embodiment, at least one between said first foot fitting 17, said second foot fitting 18 and said bulge fitting 16 comprises a fitting surface 14 which delimits at least one portion of said gap 4, in which said fitting surface 14 comprises at least one curved portion defining at least one radius of curvature.

[0087]. According to one embodiment, said at least one curved portion of said fitting surface 14 is a concave surface.

[0088]. According to one embodiment, a median plane m-m is defined, substantially parallel to said first inner surface level z1-z1 and said second inner surface level z2-z2, in which said median plane m-

m is substantially equally spaced apart from said first inner surface level z1-z1 and from said second inner surface level z2-z2.

[0089]. According to one embodiment, said ventilated braking band 100 comprises at least one radially inner edge 21 and at least one radially outer edge 22 which delimit the extension along the radial direction R-R of the ventilated braking band 100.

[0090]. When in operating conditions, said ventilation channels 15 are adapted to convey the flow of fluid current for cooling the braking band 100 towards said radially outer edge 22.

[0091]. According to one embodiment, said connecting elements 9 comprise a plurality of pegs. The term "peg" means a connecting element 9 which intersects the median plane m-m in a section of substantially equal extension in all the directions of the median plane m-m. For example, the section of the peg may be circular or elliptical or low eccentricity.

[0092]. According to one embodiment, said connecting elements 9 comprise a plurality of fins. The term "fin" means a connecting element 9 which intersects the median plane m-m in a section of prevailing extension in one direction with respect to the others. For example, there may be defined radial fins of prevailing extension along the radial direction R-R, or circumferential fins of prevailing extension along a circumferential direction C-C, or oblique fins of prevailing extension along a direction of the median plane m-m not which is parallel to the radial direction R-R or to the circumferential direction C-C.

[0093]. According to one embodiment, said connecting elements 9

comprise a plurality of pegs and a plurality of fins.

[0094]. The shape and arrangement of the connecting elements 9 may vary and be specifically designed to delimit ventilation channels 15 of predetermined flow rate, speed and also turbulence.

[0095]. According to one embodiment, said ventilated braking band 100 comprises a plurality of bulges 10 and each bulge 10 is partially interpenetrated with at least one connecting element 9.

[0096]. According to one embodiment, each connecting element 9 is interpenetrated with a least one bulge 10.

[0097]. According to one embodiment, at least two connecting elements 9 are interpenetrated with a single bulge 10 so as to form a structural continuity.

[0098]. The arrangement of the bulges 10 with respect to the connecting elements 9 and also the volume of said bulges 10 may vary and be specifically designed to give the flow of cooling fluid current of the braking band 100 a predetermined level of turbulence when in operating conditions, for example by means of the arrangement of a plurality of constrictions.

[0099]. According to one embodiment, the distribution of said plurality of bulges 10 is substantially symmetrical with respect to or mirrors the median plane m-m. This allows an easier manufacturing by means of known foundry techniques.

[00100]. According to one embodiment, said ventilated braking band 100 has a modular structure and comprises a plurality of replicas of a module W placed side-by-side in circumferential direction C-C, in which said module W extends between said at least one radially inner

edge 21 and at least one radially outer edge 22 along a connection direction y-y, and in which said module W comprises a portion of said first plate 2, a portion of said second plate 3, at least one connecting element 9 and at least one bulge 10.

[00101]. Due to the provision of said modular structure of the ventilated braking band 100, a uniformly distributed and controlled flow of fluid current for cooling the braking band may be supplied, thus allowing a uniform and predictable cooling of the braking band 100 when it is in operating conditions.

[00102]. According to one embodiment, said ventilation channels 15 extend between said radially inner edge 21 and said radially outer edge 22 along a direction which is substantially parallel to said connection direction y-y. This allows the average outflow direction of the flow of fluid current for cooling the braking band, or the prevailing outflow direction of the flow of fluid current for cooling the braking band, to be substantially coincident or parallel to said connection direction y-y.

[00103]. According to one embodiment, shown for example in **figure 5** or **figure 7**, said module W comprises at least two connecting elements 9 which extend along the connection direction y-y aligned with one another, and in which said at least two connecting elements 9 are both interpenetrated with a single bulge 10.

[00104]. The provision of this feature allows to form constrictions inside said gap 4 at least along the circumferential direction C-C, or to form circumferential constrictions which partially occlude the flow of fluid current for cooling the braking band 100 along the

circumferential direction C-C, thus imposing turbulent motions to the flow of fluid current for cooling the braking band 100 and promoting the outflow of the flow of fluid current for cooling the braking band 100 along the connection direction y-y.

[00105]. According to one embodiment, each bulge 10 comprises a top point 19 or a maximum axial extension point 19, in which the extension of the bulge along the axial direction A-A is maximum.

[00106]. For example, when said at least one bulge 10 is substantially hemispherical in shape, said top point 19 is placed substantially in the middle of bulge 10 assessed on a plane comprising the radial R-R and circumferential C-C directions and intersecting at least one section of said bulge 10.

[00107]. According to one embodiment, said module W comprises connecting elements 9 and top points 19 aligned along the connection direction y-y.

[00108]. According to one embodiment, said module W comprises three connecting elements 9 and at least two bulges 10, in which said three connecting elements 9 extend aligned along the connection direction y-y, and in which said at least three connecting elements 9 are interpenetrated in pairs with a bulge 10.

[00109]. According to one embodiment, said module W comprises at least two groups each comprising at least two connecting elements 9 and a bulge 10, in which said at least two connecting elements 9 extend along the connection direction y-y aligned with one another, and in which said at least two connecting elements 9 are both interpenetrated with a single bulge 10, and in which the top point

19 of bulge 10 of one group is placed offset along the radial direction R-R with respect to the top point 19 of bulge 10 of the other group.

[00110]. Thereby, circumferential constrictions offset along the circumferential direction C-C are caused inside said gap 4, thus imposing turbulent motions to the flow of fluid current for cooling the braking band 100.

[00111]. According to one embodiment, said module W comprises at least two groups each comprising three connecting elements 9 and at least two bulges 10, in which said three connecting elements 9 extend aligned along the connection direction y-y, and in which said at least three connecting elements 9 are interpenetrated in pairs with a bulge 10, and in which the top points 19 of the bulges 10 of one group are placed offset along the radial direction R-R with respect to the top points 19 of the bulges 10 of the other group.

[00112]. Thereby, circumferential constrictions offset along the circumferential direction C-C are caused inside said gap 4, thus imposing turbulent motions to the flow of fluid current for cooling the braking band 100.

[00113]. According to one embodiment, shown for example in **figure 8** or in **figure 9** or in **figure 10**, each module W comprises at least one connecting element 9 which extends along the connection direction y-y, and in which said at least one connecting element 9 is interpenetrated with at least two bulges 10.

[00114]. According to one embodiment, each connecting element 9 comprises two side walls 23 which each delimit at least one portion

of a ventilation channel 15.

[00115]. According to one embodiment, said module W comprises at least one connecting element 9 interpenetrated with at least two bulges 10, in which said at least two bulges 10 form a structural continuity with at least one portion of said side walls 23.

[00116]. The provision of this feature allows to form constrictions inside said gap 4 at least along the connection direction y-y, which partially occlude the flow of fluid current for cooling the braking band 100 along the connection direction y-y, thus imposing local accelerations and turbulent motions to the flow of fluid current for cooling the braking band 100.

[00117]. According to one embodiment, said module W comprises at least one connecting element 9 interpenetrated with at least two bulges 10, in which said at least two bulges 10 form a structural continuity with at least one portion of said side walls 23, and in which the top points 19 of said at least two bulges 10 are aligned with one another along the circumferential direction C-C.

[00118]. According to one embodiment, said module W comprises at least one connecting element 9 interpenetrated with at least two bulges 10, in which said at least two bulges 10 form a structural continuity with at least one portion of said side walls 23, and in which the top points 19 of said at least two bulges 10 are offset with one another along the circumferential direction C-C.

[00119]. According to one embodiment, said module W comprises at least two groups each comprising at least one connecting element 9 interpenetrated with at least two bulges 10, in which said at least

two bulges 10 form a structural continuity with at least one portion of said side walls 23, and in which the top points 19 of said at least two bulges 10 of one group are placed offset along the circumferential direction C-C with respect to the top points 19 of said at least two bulges 10 of the other group, and in which the connecting element 9 of one group and the connecting element 9 of the other group are both parallel to the connection direction y-y.

[00120]. According to one embodiment, said connection direction y-y is orthogonal to said axial direction A-A.

[00121]. According to one embodiment, said connection direction y-y is coincident or parallel to the radial direction R-R.

[00122]. According to one embodiment, said connection direction y-y is a curved direction which connects said radially inner edge 21 and said radially outer edge 22.

[00123]. According to one embodiment, shown for example in **figure 11**, said module W comprises at least two connecting elements 9 aligned along the connection direction y-y, in which at least one connecting element 9 is interpenetrated with two bulges 10, and in which said at least two bulges 10 form a structural continuity with portions of the side walls 23 of the connecting element 9, and in which at least one connecting element 9 is interpenetrated with a single bulge 10, and in which said module W further comprises at least one further connecting element 9, which is misaligned with respect to said at least two connecting elements 9 both in circumferential direction C-C and in radial direction R-R.

[00124]. According to a general embodiment, a ventilated brake disc

assembly 1 comprises at least one ventilated braking band 100 according to any one of the claims described above, and at least one disc bell 103.

[00125]. According to one embodiment, said ventilated braking band 100 and said disc bell 103 are made in a single piece. In other words, said ventilated brake disc assembly 1 is made in a single piece.

[00126]. According to one embodiment, said ventilated braking band 100 and said disc bell 103 are made separately and then assembled, thus forming said ventilated brake disc assembly 1. By way of non-limiting example, said ventilated braking band 100 and said disc bell 103 may be interlocked, geometrically coupled, coupled by means of fastening elements such as screws or rivets, or welded to each other.

[00127]. A method of ventilating a braking band is described below.

[00128]. A method ventilating of a braking band comprises the following steps:

[00129]. - providing a ventilated braking band 100 according to any one of the embodiments described above;

[00130]. - arranging said connecting elements 9 and said bulges 10 in the ventilated braking band 100, thus causing constrictions at least in one direction between said circumferential direction C-C and said connection direction y-y so as to provide the desired outflow of the flow of cooling fluid current of the braking band when the braking band is in use.

[00131]. According to a possible operating manner, a method comprises

the further step of arranging said connecting elements 9 and said bulges 10 in the ventilated braking band 100, thus causing constrictions at least in radial direction R-R so as to provide the desired outflow of the flow of cooling fluid current of the braking band when the braking band is in use.

[00132]. According to a possible operating manner, a method comprises the further step of arranging said connecting elements 9 and said bulges 10 in the ventilated braking band 100, thus causing constrictions at least in axial direction A-A so as to provide the desired outflow of the flow of cooling fluid current of the braking band when the braking band is in use.

[00133]. Those skilled in the art may make many changes and adaptations to the embodiments described above or can replace elements with others which are functionally equivalent in order to satisfy contingent needs without however departing from the scope of the appended claims.

## LIST OF REFERENCES

| | |
|---|---|
| 1 | Ventilated brake disc assembly |
| 2 | First plate |
| 3 | Second plate |
| 4 | Gap |
| 5 | First braking surface |
| 6 | Second braking surface |
| 7 | First inner surface |
| 8 | Second inner surface |
| 9 | Connecting elements |
| 10 | Bulge |
| 11 | First foot |
| 12 | Second foot |
| 13 | Bulge surface |
| 14 | Fitting surface |
| 15 | Ventilation channels |
| 16 | Bulge fitting |
| 17 | First foot fitting |
| 18 | Second foot fitting |
| 19 | Top point |
| 21 | Radially inner edge |
| 22 | Radially outer edge |
| 23 | Side wall |
| 100 | Ventilated braking band |
| 101 | First pad |
| 102 | Second pad |
| 103 | Disc bell |
| A-A | Axial direction |
| X | Rotation axis |
| R-R | Radial direction |
| C-C | Tangential or circumferential direction |
| z1-z1 | First inner surface level |
| z2-z2 | Second inner surface level |
| s1 | First plate thickness |
| s2 | Second plate thickness |
| m-m | Median plane |
| W | Module |
| y-y | Connection direction |

## CLAIMS

1. A ventilated braking band (100) for brake disc defining an axial direction (A-A) coinciding with the rotation axis (X) of the brake disc, a radial direction (R-R) orthogonal to the axial direction (A-A), and a tangential or circumferential direction (C-C) orthogonal to both the axial direction (A-A) and the radial direction (R-R);

said ventilated braking band (100) comprises a first plate (2) and a second plate (3), which are coaxial to the same axial direction (A-A);

said first plate (2) and said second plate (3) are mutually spaced apart in axial direction (A-A) so as to delimit a gap (4) therebetween;

wherein said first plate (2) comprises a first braking surface (5) adapted to face at least a first brake pad (101) of a brake caliper which can be associated with said ventilated braking band (100); and

wherein said second plate (3) comprises a second braking surface (6) parallel and opposite to said first braking surface (5) so as to be adapted to face at least a second brake pad (102) opposite to said first brake pad of said brake caliper which can be associated with said ventilated braking band (100);

and wherein said first plate (2) comprises at least a first inner surface (7) facing said second plate (3); and wherein said first inner surface (7) is substantially parallel to said first braking surface (5); and wherein said second plate (3) comprises a second inner surface (8) facing said first plate (2); and wherein said

second inner surface (8) is substantially parallel to said second braking surface (6); and wherein said first inner surface (7) defines a first inner surface plane or level (z1-z1) coinciding with said first inner surface (7), and wherein said second inner surface (8) defines a second inner surface plane or level (z2-z2) coinciding with said second inner surface (8);

and wherein said ventilated braking band (100) comprises connecting elements (9) which extend in an axial direction (A-A) between said first inner surface (7) and said second inner surface (8), connecting together said first plate (2) and said second plate (3);

and wherein said connecting elements (9) and said first inner surface (7) and said second inner surface (8) at least partially delimit ventilation channels (15) inside said gap (4), and wherein said ventilation channels (15) are adapted to convey a fluid current flow for cooling said ventilated braking band (100);

and wherein each connecting element (9) comprises at least a first foot (11) which connects each connecting element (9) to said first inner surface (7), and at least a second foot (12) which connects each connecting element (9) to said second inner surface (8);

and wherein said ventilated braking band (100) comprises at least one bulge (10) which protrudes from a plate (2, 3) in said gap (4) without reaching the oppositely facing plate (3, 2); and wherein said at least one bulge (10) substantially has the shape of at least one portion of a sphere;

**characterized in that**

said at least one bulge (10) is partially interpenetrated with at least one portion of said first foot (11), thus forming a structural continuity with said first foot (11), thus substantially avoiding discontinuities which separate said first foot (11) from said bulge (10), thus exposing said first inner surface level (z1-z1).

**2.** A ventilated braking band (100) according to claim **1**, wherein at least one portion of said second foot (12) forms a structural continuity with said second foot (12), thus avoiding discontinuities which separate said second foot (12) from said bulge (10), thus exposing said second inner surface level (z2-z2); and/or wherein said ventilated braking band (100) comprises a plurality of bulges (10) which protrude from said first plate (2) and a plurality of bulges (10) which protrude from said second plate (3);

wherein each bulge (10) which protrudes from said first plate (2) is partially interpenetrated with at least one portion of said first foot (11), thus forming a structural continuity with said first foot (11), thus avoiding said first inner surface level (z1-z1) from being reached;

and wherein each bulge (10) which protrudes from said second plate (3) is partially interpenetrated with at least one portion of said second foot (12), thus forming a structural continuity with said second foot (12), thus avoiding said second inner surface level (z2-z2) from being reached.

**3.** A ventilated braking band (100) according to claim **1** or **2**, wherein said at least one bulge (10) is made in a single piece with

said plates (2, 3) and with said connecting elements (9); and/or wherein

said at least one bulge (10) is substantially hemispherical in shape; and/or wherein

said at least one bulge (10) substantially has the shape of a spherical section; and/or wherein

said at least one bulge (10) substantially has the shape of a spherical segment of a base; and/or wherein

said at least one bulge (10) substantially has the shape of a quarter of a sphere; and/or wherein

said at least one bulge (10) substantially has the shape of a spherical wedge; and/or wherein

said at least one bulge (10) comprises a bulge surface (13) which delimits at least one portion of said gap (4), wherein said bulge surface (13) is in the shape of at least one portion of spherical cap; and/or wherein

said bulge surface (13) is in the shape of a spherical half-cap; and/or wherein

said first foot (11) is connected to the first inner surface (7), thus forming at least a first foot fitting (17); and/or wherein

said second foot (12) is connected to the second inner surface (8), thus forming at least a second foot fitting (18); and/or wherein

said at least one bulge (10) is connected to at least one of said first inner surface (7) and said second inner surface (8), thus forming a bulge fitting (16); and/or wherein

said ventilated braking band (100) comprises at least one radially

inner edge (21) and at least one radially outer edge (22) which delimit the extension along the radial direction (R-R) of the ventilated braking band (100); and/or wherein

said connecting elements (9) comprise a plurality of pegs; and/or wherein

said connecting elements (9) comprise a plurality of fins; and/or wherein

said ventilated braking band (100) comprises a plurality of bulges (10) and each bulge (10) is partially interpenetrated with at least one connecting element (9); and/or wherein

each connecting element (9) is interpenetrated with a least one bulge (10); and/or wherein

at least two connecting elements (9) are interpenetrated with a single bulge (10) so as to form a structural continuity.

**4.** A ventilated braking band (100) according to any one of the preceding claims, wherein said ventilated braking band (100) has a modular structure and comprises a plurality of replicas of a module (W) placed side-by-side in circumferential direction (C-C), wherein said module (W) extends between said at least one radially inner edge (21) and at least one radially outer edge (22) along a connection direction (y-y), and wherein said module (W) comprises a portion of said first plate (2), a portion of said second plate (3), at least one connecting element (9) and at least one bulge (10).

**5.** A ventilated braking band (100) according to claim **4**, wherein each module (W) comprises at least two connecting elements (9) which extend along the connection direction (y-y) aligned with each other,

and wherein said at least two connecting elements (9) are both interpenetrated with a single bulge (10); and/or wherein

each bulge (10) comprises a top point (19) or a maximum axial extension point (19), wherein the extension of the bulge along the axial direction (A-A) is maximum; and/or wherein

said module (W) comprises connecting elements (9) and top points (19) aligned along the connection direction (y-y); and/or wherein

said module (W) comprises three connecting elements (9) and at least two bulges (10), wherein said three connecting elements (9) extend aligned along the connection direction (y-y), and wherein said at least three connecting elements (9) are interpenetrated in pairs with a bulge (10); and/or wherein

said module (W) comprises at least two groups each comprising at least two connecting elements (9) and a bulge (10), wherein said at least two connecting elements (9) extend along the connection direction (y-y) aligned with each other, and wherein said at least two connecting elements (9) are both interpenetrated with a single bulge (10), and wherein the top point (19) of the bulge (10) of one group is placed offset along the radial direction (R-R) with respect to the top point (19) of the bulge (10) of the other group; and/or wherein

said module (W) comprises at least two groups each comprising three connecting elements (9) and at least two bulges (10), wherein said three connecting elements (9) extend aligned along the connection direction (y-y), and wherein said at least three connecting elements (9) are interpenetrated in pairs with a bulge (10), and wherein the

top points (19) of the bulges (10) of one group are placed offset along the radial direction (R-R) with respect to the top points (19) of the bulges (10) of the other group.

**6.** A ventilated braking band (100) according to claim **4** or **5**, wherein each module (W) comprises at least one connecting element (9) which extends along the connection direction (y-y), and wherein said at least one connecting element (9) is interpenetrated with at least two bulges (10); and/or wherein

each connecting element (9) comprises two side walls (23) which each delimit at least one portion of a ventilation channel (15); and/or wherein

said module (W) comprises at least one connecting element (9) interpenetrated with at least two bulges (10), wherein said at least two bulges (10) form a structural continuity with at least one portion of said side walls (23);

said module (W) comprises at least one connecting element (9) interpenetrated with at least two bulges (10), wherein said at least two bulges (10) form a structural continuity with at least one portion of said side walls (23), and wherein the top points (19) of said at least two bulges (10) are aligned with each other along the circumferential direction (C-C); and/or wherein

said module (W) comprises at least one connecting element (9) interpenetrated with at least two bulges (10), wherein said at least two bulges (10) form a structural continuity with at least one portion of said side walls (23), and wherein the top points (19) of said at least two bulges (10) are offset from each other along the

circumferential direction (C-C); and/or wherein

said module (W) comprises at least two groups each comprising at least one connecting element (9) interpenetrated with at least two bulges (10), wherein said at least two bulges (10) form a structural continuity with at least one portion of said side walls (23), and wherein the top points (19) of said at least two bulges (10) of one group are placed offset along the circumferential direction (C-C) with respect to the top points (19) of said at least two bulges (10) of the other group, and wherein the connecting element (9) of one group and the connecting element (9) of the other group are both parallel to the connection direction (y-y).

**7.** A ventilated braking band (100) according to any one of claims **4** to **6**, wherein said connection direction (y-y) is parallel to or coinciding with the radial direction (R-R); and/or wherein

said connection direction (y-y) is orthogonal to said axial direction (A-A); and/or wherein

said connection direction (y-y) is a curved direction which connects said radially inner edge (21) and said radially outer edge (22); and/or wherein

said module (W) comprises at least two connecting elements (9) aligned along the connection direction (y-y), wherein at least one connecting element (9) is interpenetrated with two bulges (10), and wherein said at least two bulges (10) form a structural continuity with portions of the side walls (23) of the connecting element (9), and wherein at least one connecting element (9) is interpenetrated with a single bulge (10) and wherein said module (W) further

comprises at least one further connecting element (9), which is misaligned with respect to said at least two connecting elements (9) both in circumferential direction (C-C) and in radial direction (R-R).

**8.** A ventilated brake disc assembly (1) comprising at least one ventilated braking band (100) according to any one of the preceding claims, and at least one disc bell (103).

**9.** A ventilated brake disc assembly (1) according to claim **8**, said ventilated braking band (100) and said disc bell (103) are made in a single piece.

**10.** A method of ventilating a braking band, comprising the following steps:

- providing a ventilated braking band (100) according to any one of claims **1** to **7**;
- arranging said connecting elements (9) and said bulges (10) in the ventilated braking band (100), thus causing constrictions at least in one direction between said circumferential direction (C-C) and said connection direction (y-y) so as to provide the desired outflow of the flow of cooling fluid current of the braking band when the braking band is in use.

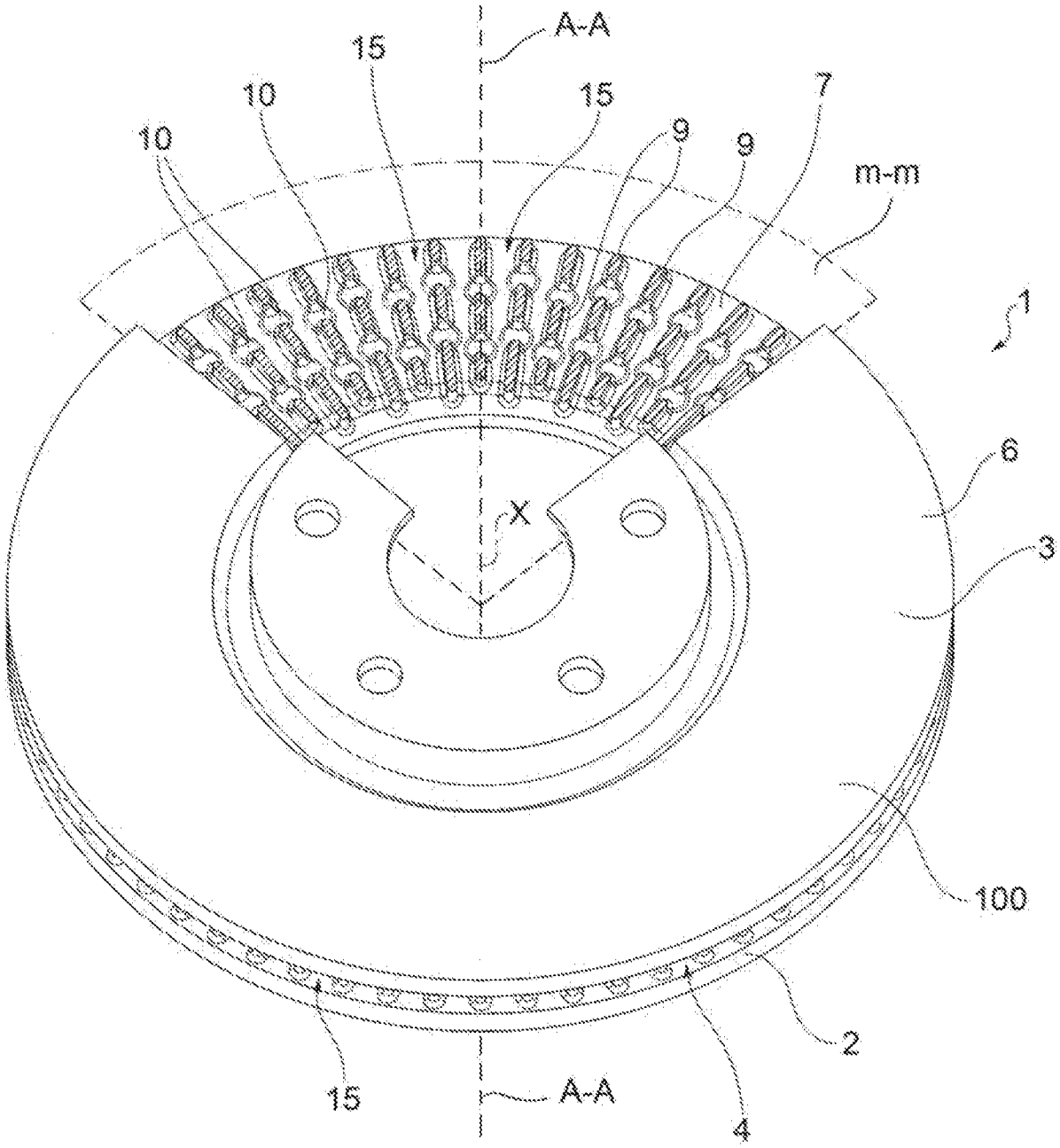



FIG. 1

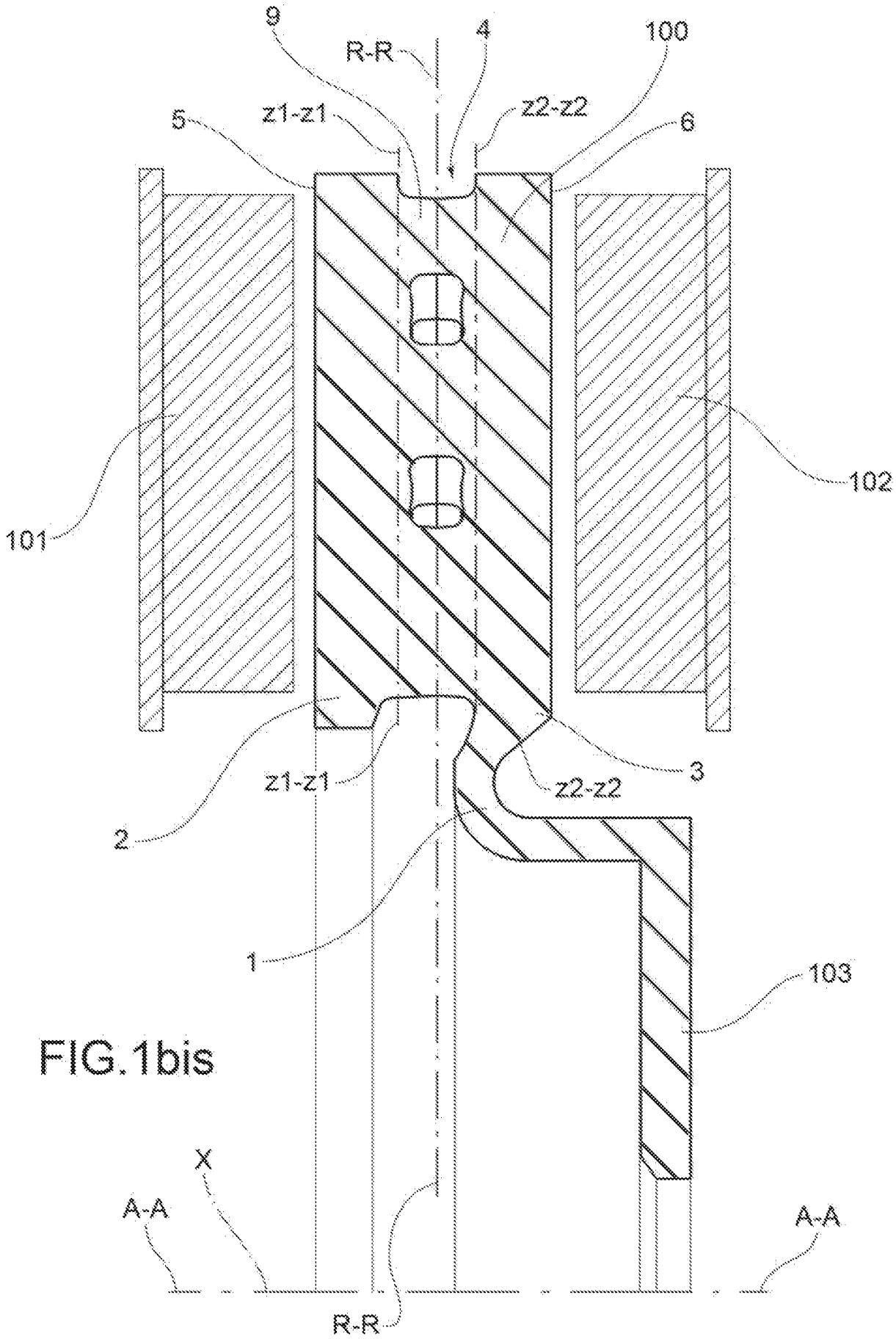



FIG.1bis

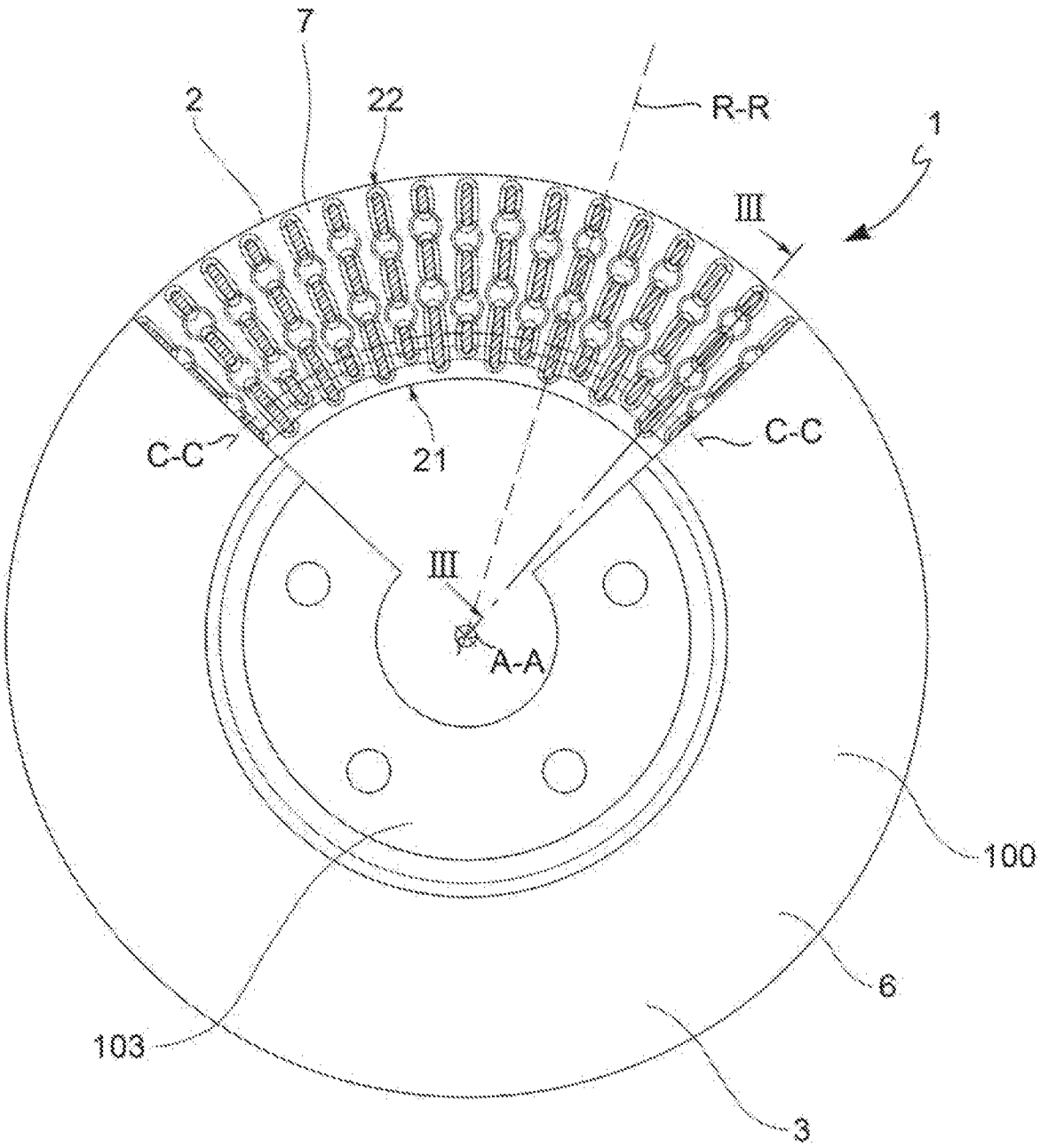
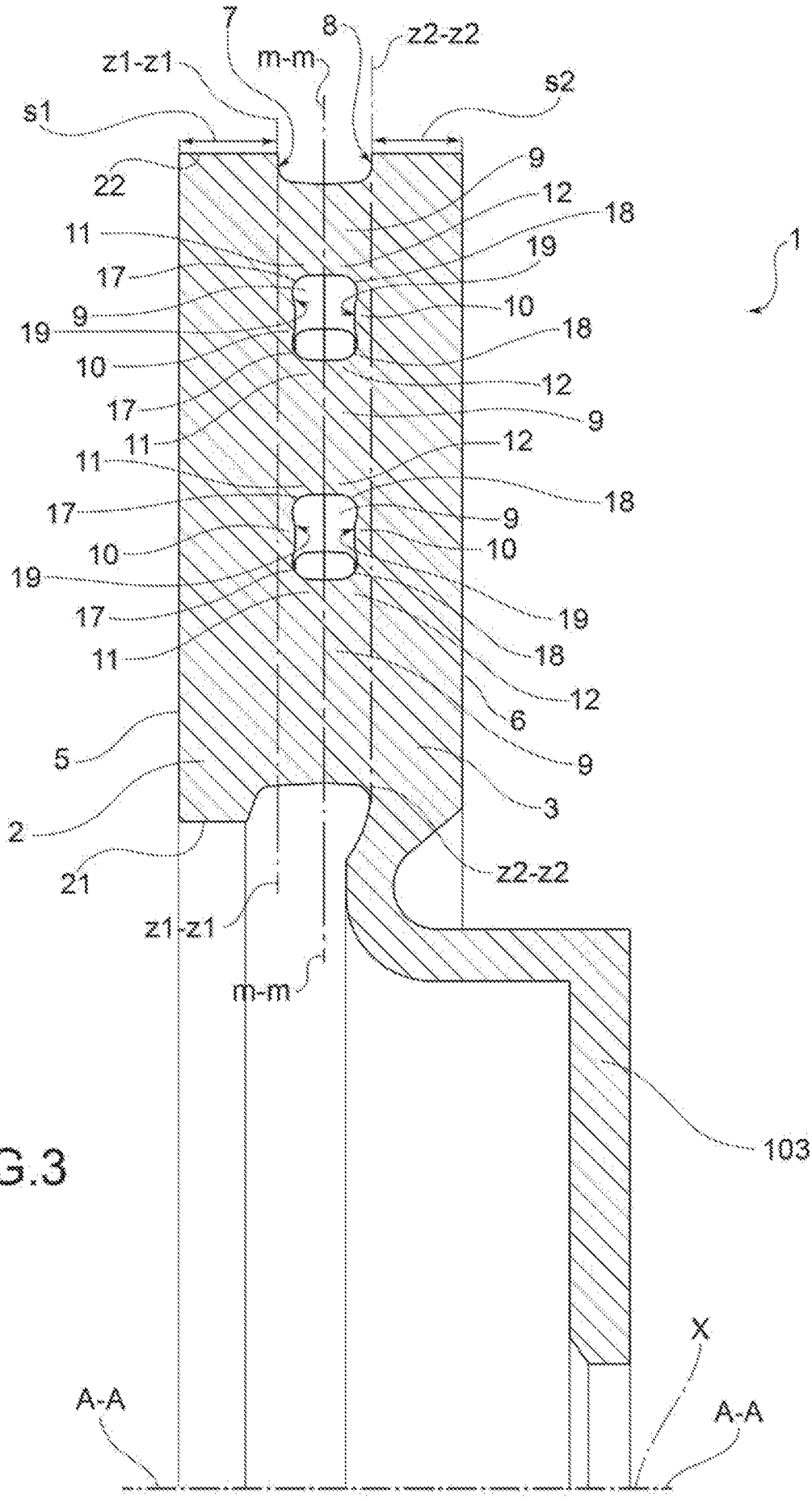



FIG. 2


7
8
z2-z2
z1-z1
m-m
s2
s1
22
9
12
18
11
19
1
17
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19
9
18
10
12
17
9
11
12
11
18
17
9
10
10
19
19
17
18
11
12
6
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103
X
A-A
A-A

FIG.3

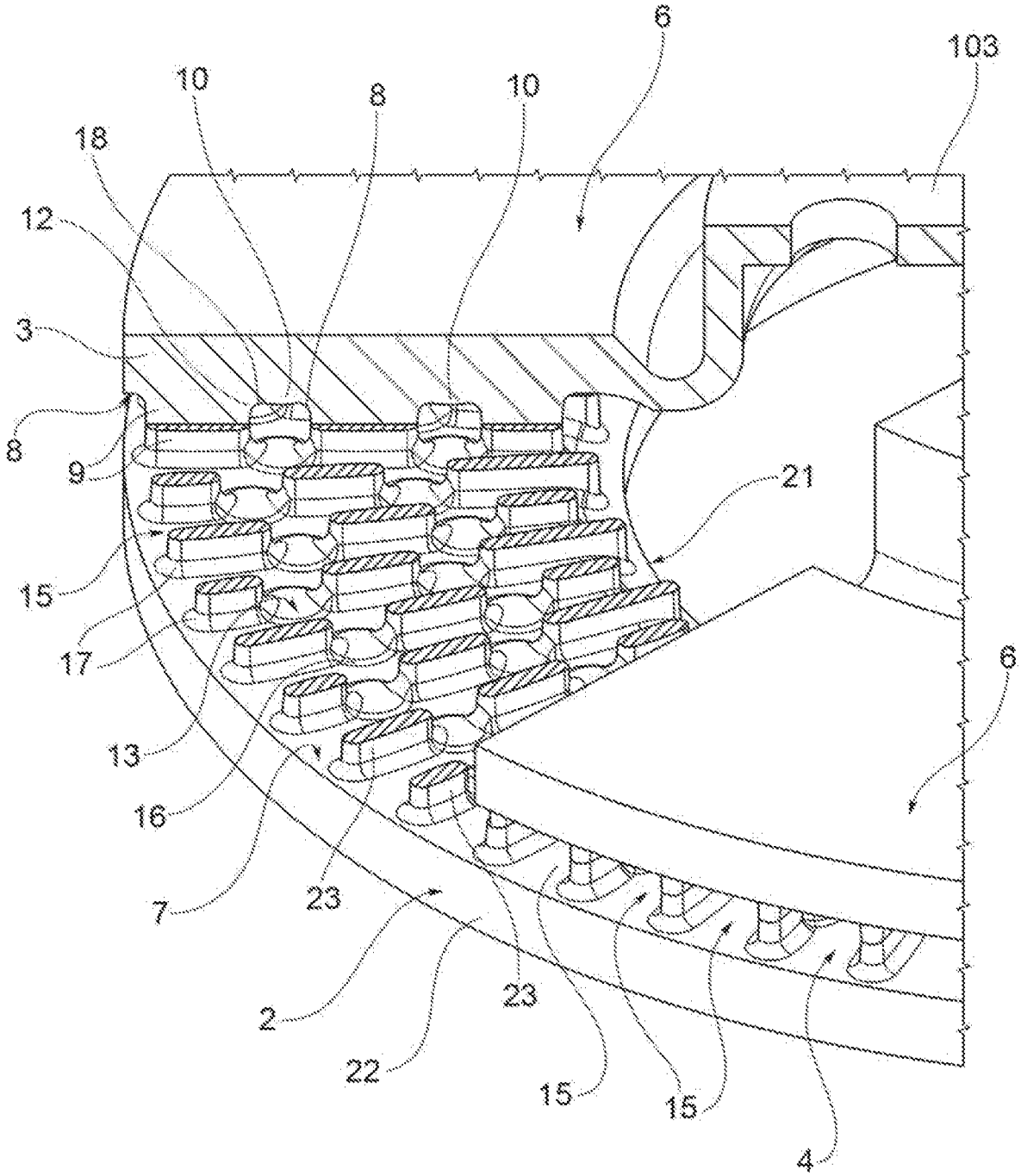
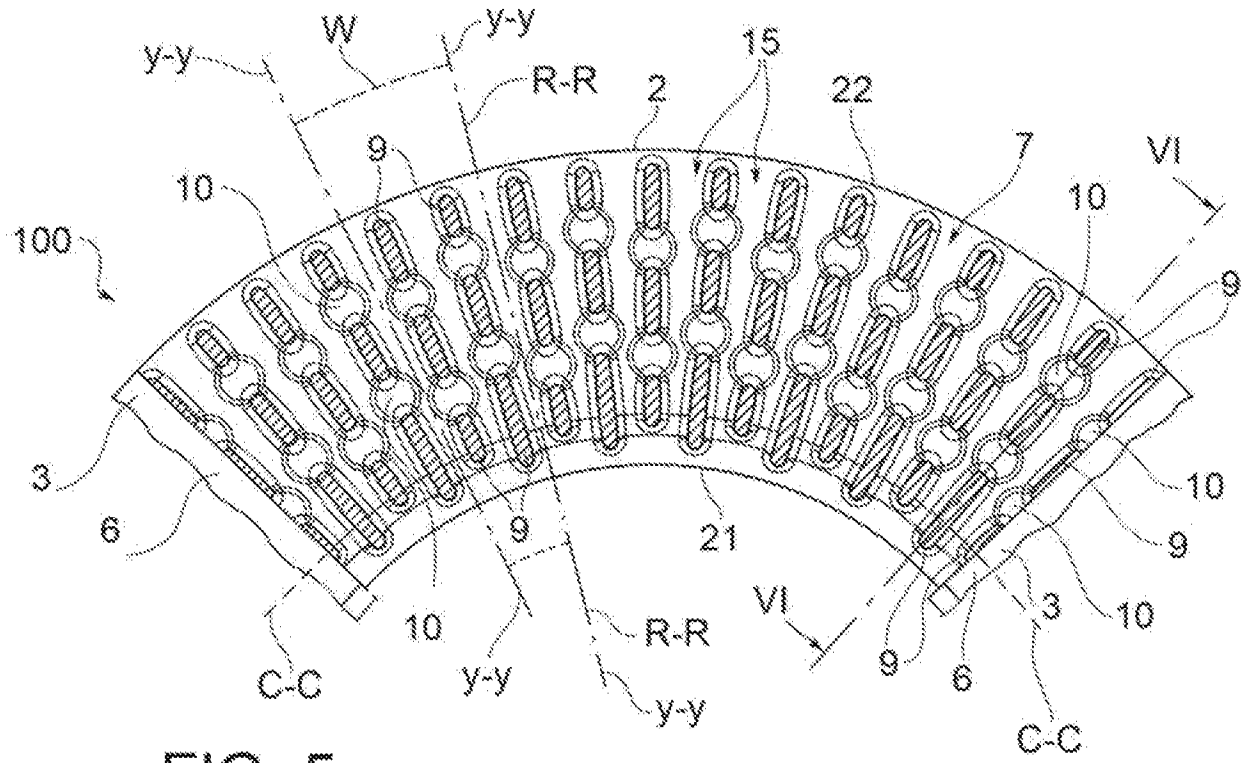



FIG. 4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y-y
R-R
2
15
22
7
VI
9
10
100
10
9
3
6
21
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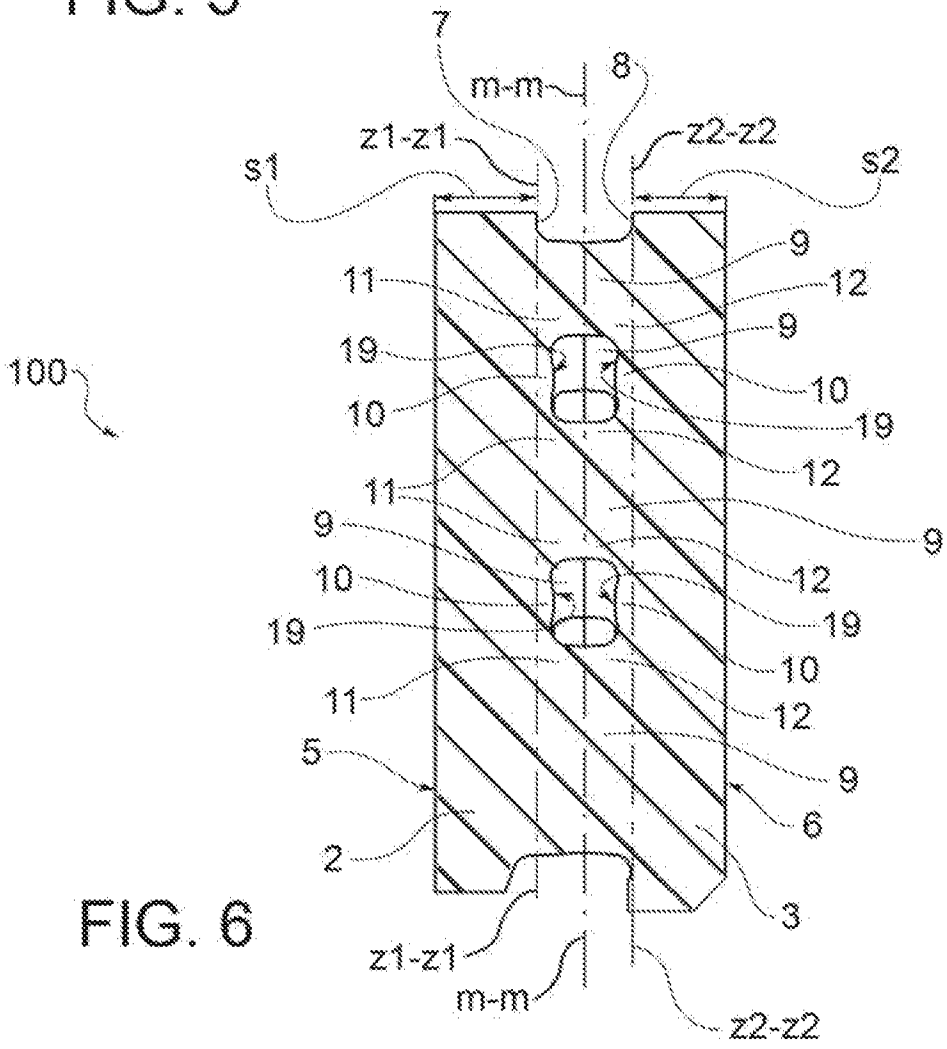
9
10
C-C
y-y
R-R
y-y
VI
9
6
3
10
C-C

FIG. 5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11
9
9
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19
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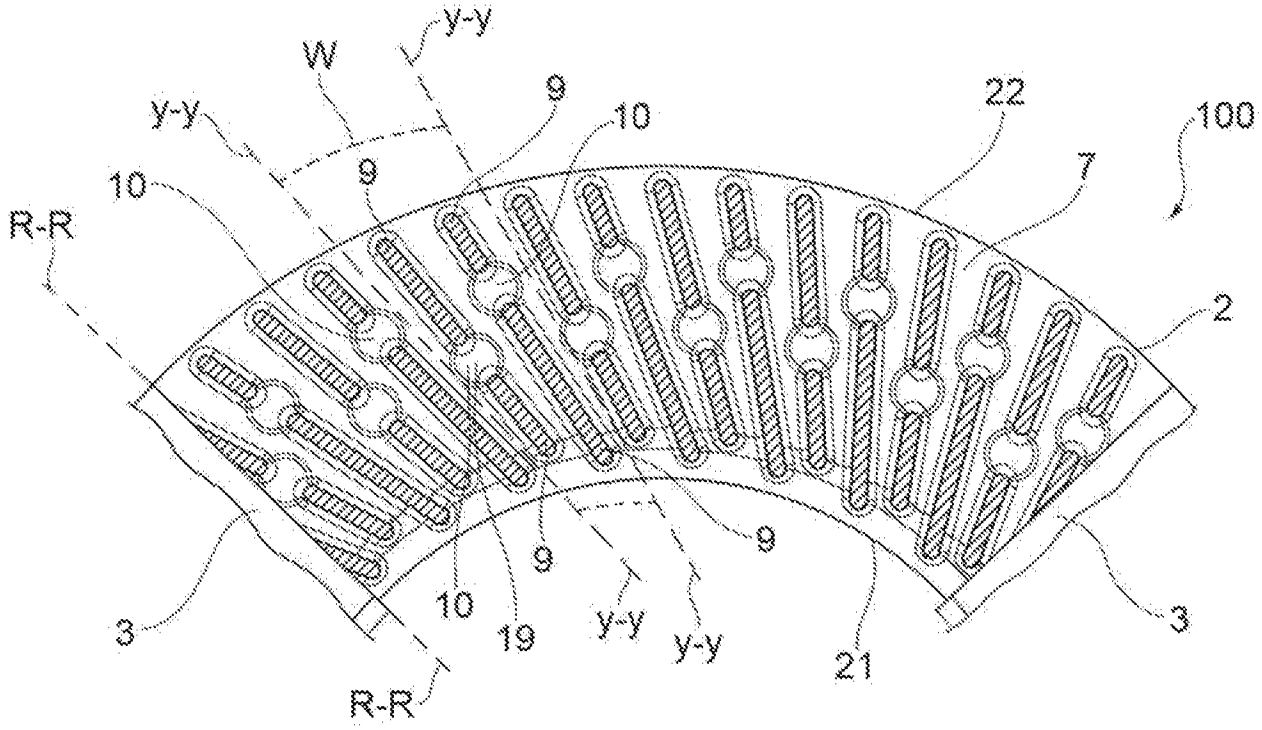
11
12
5
9
6
2
3
z1-z1
m-m
z2-z2

FIG. 6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10
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9
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R-R
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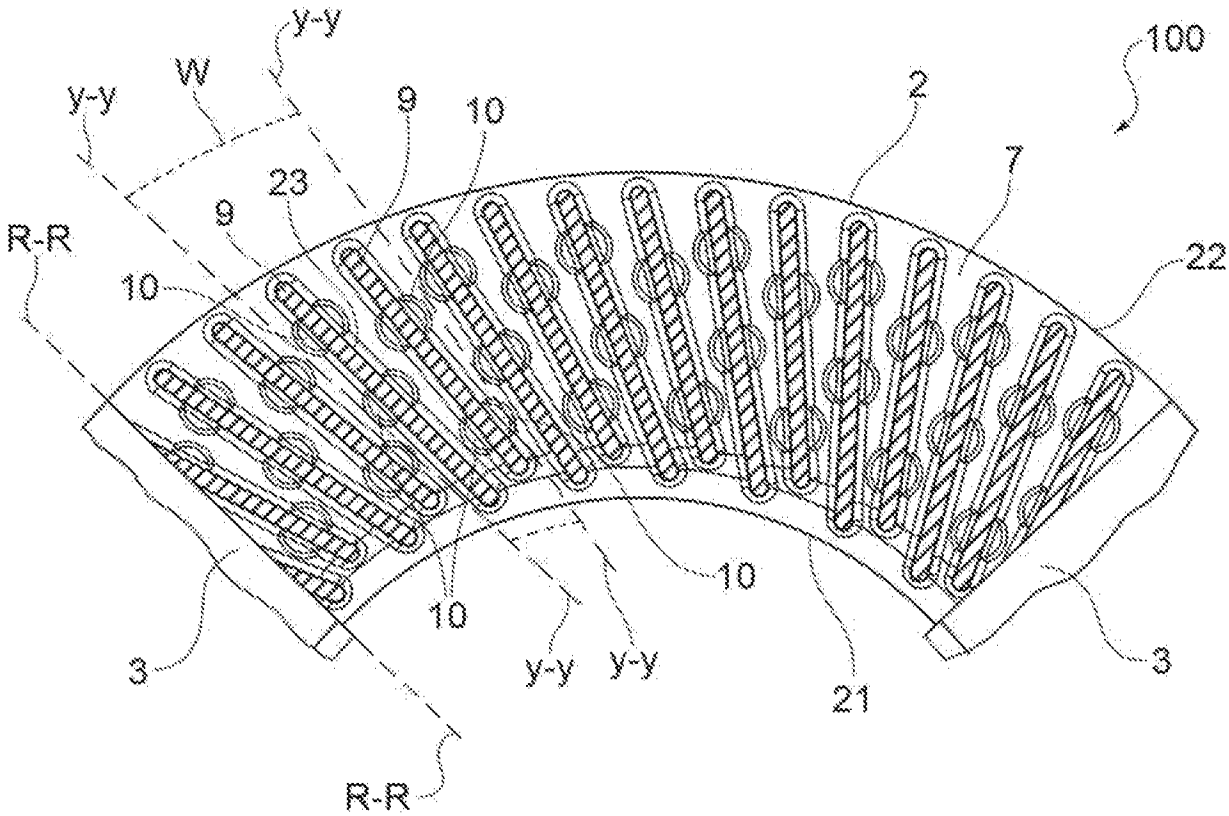
9
10
3
19
y-y
y-y
21
3
R-R

FIG.7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R-R
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10
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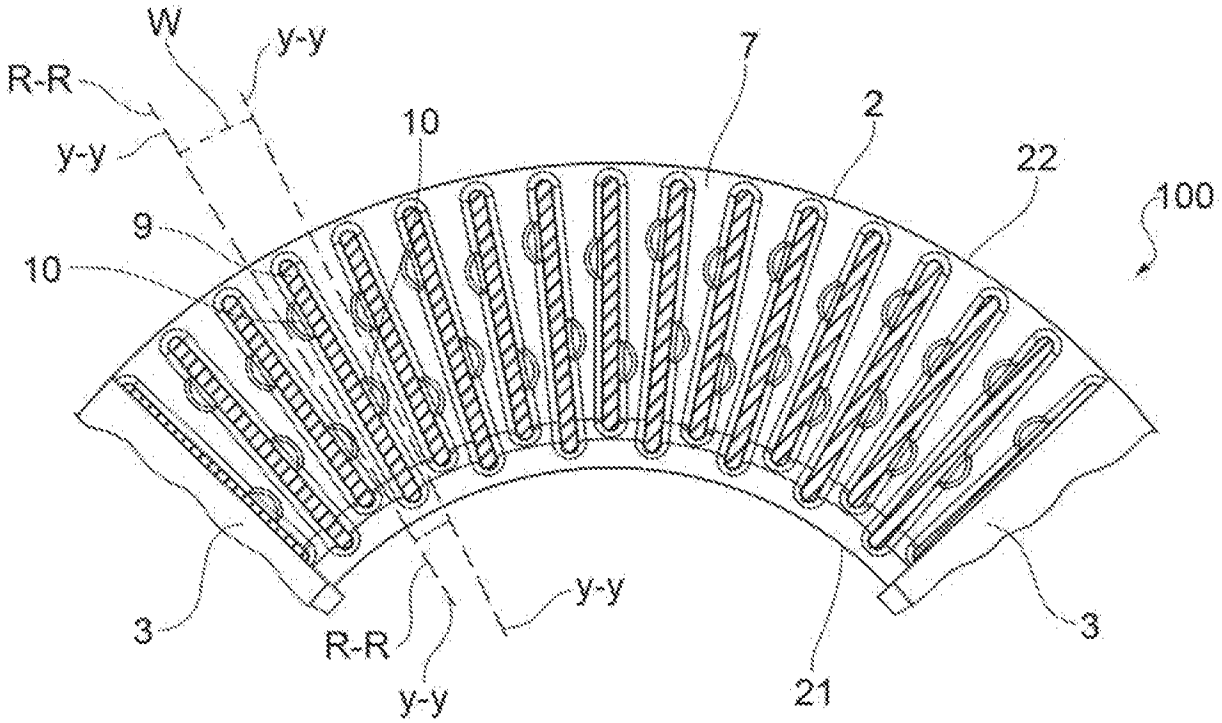
y-y
y-y
21
3
R-R

FIG.8


W
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R-R
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100
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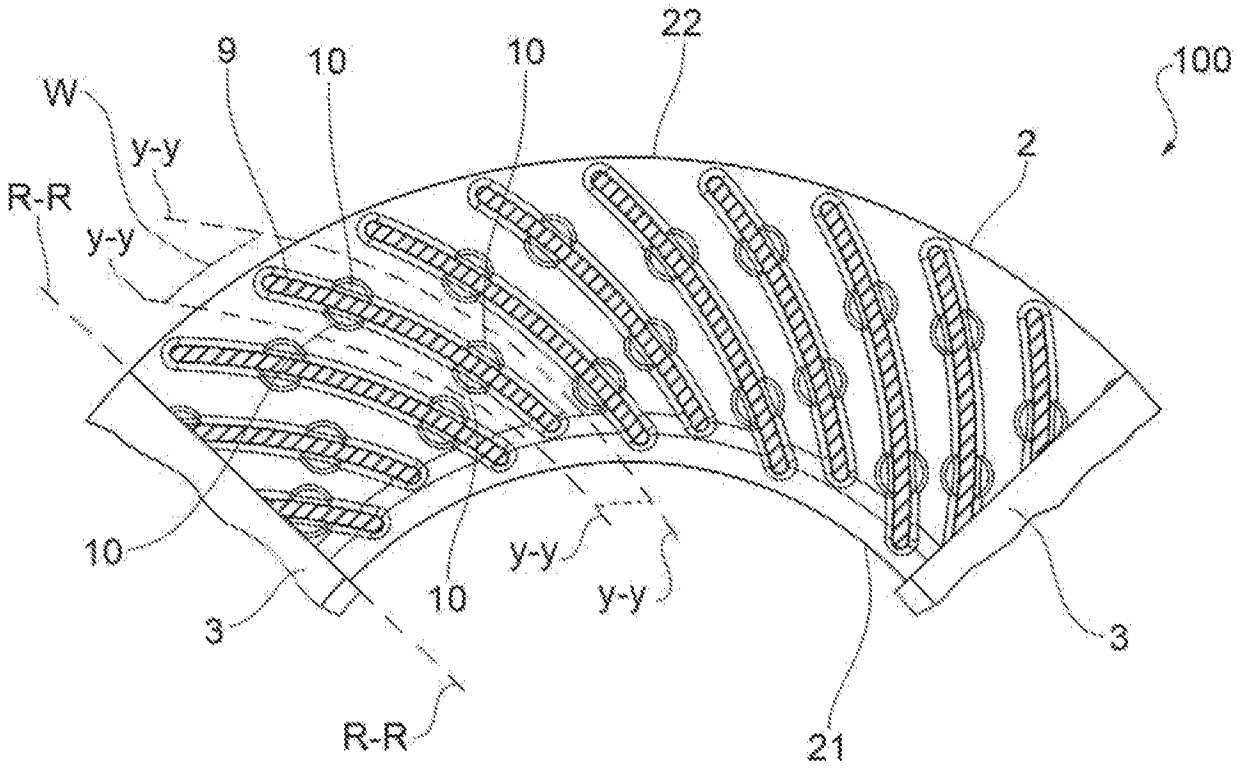
y-y
y-y
21
3

FIG.9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y-y
10
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y-y
10
3
3
R-R
21

FIG.10

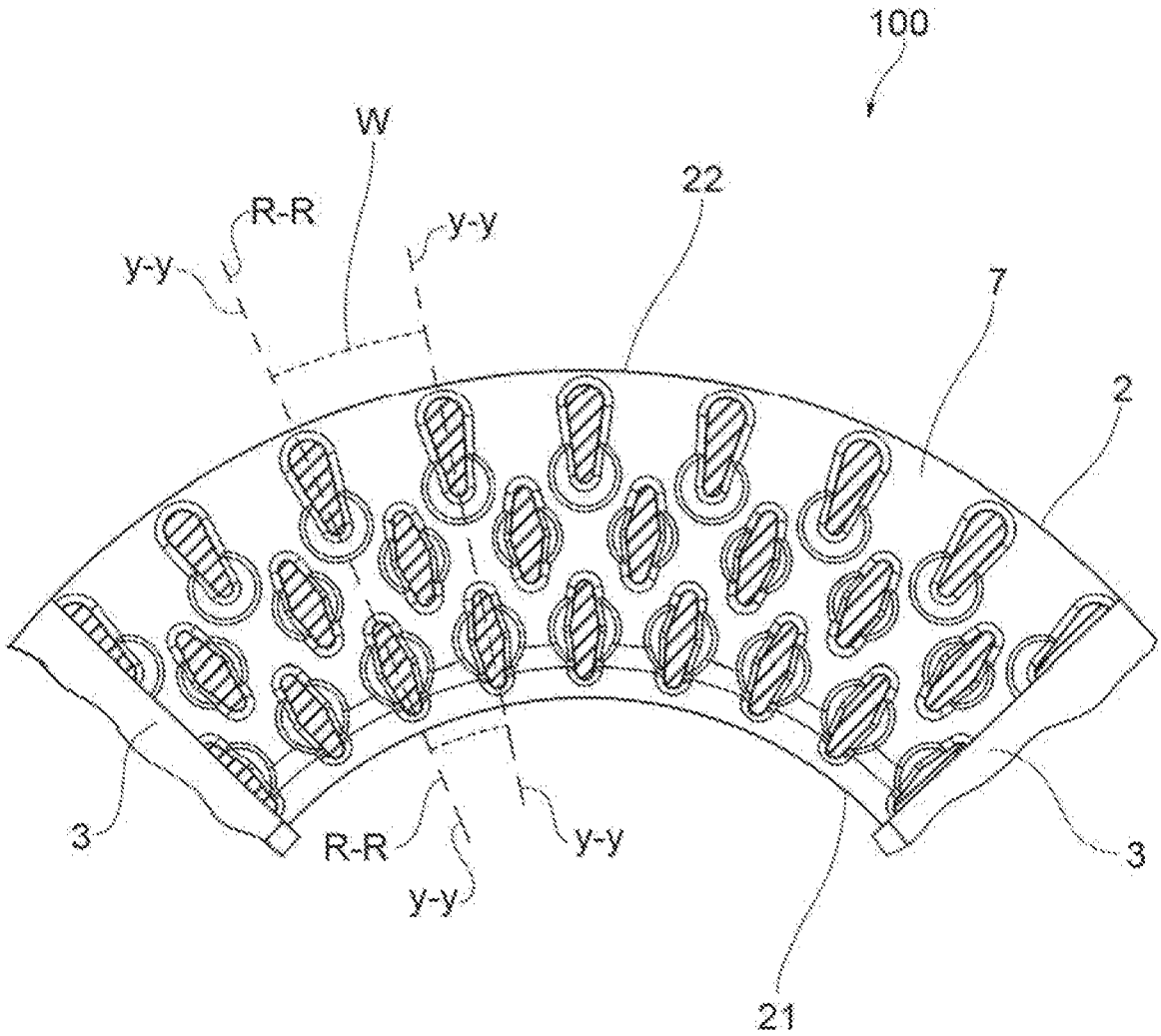


FIG.11

# INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/051310

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16D65/12
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)
F16D

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | WO 2008/136032 A2 (FRENI BREMBO SPA [IT]; BIONDO SIMONE [IT]; DONATI MICHELE [IT]) 13 November 2008 (2008-11-13) page 8, last paragraph - page 9, paragraph 2; figures | 1,2,4, 8-10 |
| X | WO 2015/092671 A1 (FRENI BREMBO SPA [IT]) 25 June 2015 (2015-06-25) cited in the application page 4, line 12 - page 6, line 18; figures 1,2,4 | 1,2,4, 8-10 |
| X | DE 20 2015 102580 U1 (FORD GLOBAL TECH LLC [US]) 8 September 2015 (2015-09-08) paragraph [0027]; figures 3,5 | 1,2,4, 8-10 |

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 3 August 2017 | 22/08/2017 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | van Koten, Gert |

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Form PCT/ISA/210 (second sheet) (April 2005)

# INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/051310

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | DE 10 2013 210700 A1 (BAYERISCHE MOTOREN WERKE AG [DE])<br>11 December 2014 (2014-12-11)<br>paragraph [0024] - paragraph [0027];<br>figures<br>----- | 1,2,4,<br>8-10 |
| X | WO 2008/135876 A2 (FRENI BREMBO SPA [IT]; BIONDO SIMONE [IT]; MEDICI STEFANO [IT])<br>13 November 2008 (2008-11-13)<br>figure 8<br>----- | 1,2,4,8,<br>9 |

1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2017/051310

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 2008136032 A2 | 13-11-2008 | CN 101743410 A | 16-06-2010 |
| | | EP 2145119 A2 | 20-01-2010 |
| | | JP 5211152 B2 | 12-06-2013 |
| | | JP 2010526259 A | 29-07-2010 |
| | | US 2010230221 A1 | 16-09-2010 |
| | | WO 2008136032 A2 | 13-11-2008 |
| WO 2015092671 A1 | 25-06-2015 | CN 105829756 A | 03-08-2016 |
| | | EP 3084256 A1 | 26-10-2016 |
| | | JP 2016540947 A | 28-12-2016 |
| | | US 2017002879 A1 | 05-01-2017 |
| | | WO 2015092671 A1 | 25-06-2015 |
| DE 202015102580 U1 | 08-09-2015 | CN 204755673 U | 11-11-2015 |
| | | DE 202015102580 U1 | 08-09-2015 |
| | | RU 2015121933 A | 27-12-2016 |
| | | US 2015354648 A1 | 10-12-2015 |
| | | US 2016298709 A1 | 13-10-2016 |
| DE 102013210700 A1 | 11-12-2014 | NONE | |
| WO 2008135876 A2 | 13-11-2008 | AT 482348 T | 15-10-2010 |
| | | BR PI0810735 A2 | 14-10-2014 |
| | | CN 101743411 A | 16-06-2010 |
| | | EP 2140166 A2 | 06-01-2010 |
| | | ES 2353261 T3 | 28-02-2011 |
| | | JP 5605648 B2 | 15-10-2014 |
| | | JP 2010526257 A | 29-07-2010 |
| | | US 2010084231 A1 | 08-04-2010 |
| | | WO 2008135876 A2 | 13-11-2008 |

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**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 3, 5-7
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/** 210

Continuation of Box II.2

Claims Nos.: 3, 5-7

The dependent claims 3 and 5 to 7 can not be searched as they are not clear. Due to the use of the wording 'and/or', in some claims up to 16 times, the scope is rendered unclear due to the vary high number of different combinations within one claim, which even in some cases lead to impossible combinations of features.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.