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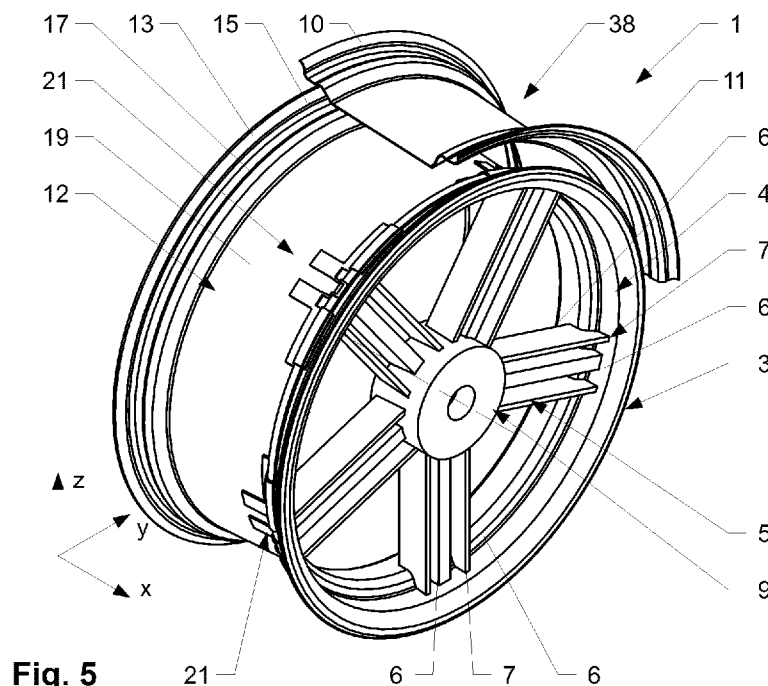


Fig. 5

(57) Abstract: The invention is directed to wheel (1) comprising a rim (2) and a wheel center (3) with several spokes (4) with at least one butt strap (21). The at least one butt strap (21) protrudes from a radially outer end of the spokes (4). The rim (2) comprises at least one opening (20) arranged corresponding to the at least one butt strap (21). The at least one butt strap (21) extends across the related opening (20) in the rim (2) and is attached to the outside of the rim (2).

WHEEL MADE OUT OF A FIBER REINFORCED PLASTIC MATERIAL

FIELD OF THE INVENTION

The present invention is directed to a wheel made out of a fiber reinforced plastic
5 material.

BACKGROUND OF THE INVENTION

DE102011087936B3 was published in February 2013 in the name of ThyssenKrupp Carbon Components GmbH. It describes a wheel made out of a fiber reinforced plastic and a method for producing such type of wheel. According to the
10 document, a wheel is characterized by layers of reinforcing fibers which extend from the rim well over the outer rim bead (flange) to wheel disk without interruption. The wheel disk fades to the outer rim bead. The process to manufacture such a wheel comprises the lay-up of reinforcing fibers on forming tools, which are essentially cylindrically shaped. In order to build the wheel disk, reinforcing fibers
15 are laid on the contour surfaces of essentially cylindrically shaped auxiliary forming tools. The auxiliary tools then are removed and the laid fibers are folded into a plane, which is perpendicular to the rotation axis of the wheel to build.

DE102011077834A1 was published in December 2012 in the name of Bayerische Motoren Werke AG. It describes amongst others a method for producing
20 a wheels made out of a fiber reinforced plastic. Therefore, an injection molding or

a transfer molding process using a fiber reinforced plastic is applied. The wheel is structurally reinforced (augmented) by the insertion of bands consisting of long fibers into the spokes as well as the rim.

DE102010010513A1 was published in September 2011 in the name of Leicht-
5 bau-Zentrum Sachsen GmbH. It describes among others a method for producing of a wheel with a rim made out of a fiber reinforced plastic. The connection between the wheel disk and the rim is established by peripheral braiding of a pre-formed wheel disk.

DE102005041940B4 was published in March 2007 in the name of ThyssenK-
10 rupp Carbon Components GmbH. It describes a wheel made out of a fiber reinforced plastic as well as a method for producing such a wheel. A wheel according to the invention comprises an auxiliary tool which at least partially defines the geometry of the resulting wheel. This auxiliary tool is wrapped by a braided hose, which is inserted into a central bore at the rotation axis of the resulting wheel,
15 expanded and subsequently inverted.

WO13083123 was published in June 2013 in the name of ThyssenKrupp Carbon Components GmbH and shows a wheel with a rim made of fiber reinforced material. The document discloses a connection between wheel disk and rim by connecting at least two partial layers of the wheel disk to the rim by laying contoured
20 joining zones of the partial layers alongside the centripetal contour of the rim. As well, the document discloses methods to produce said wheel.

WO13083500 was published in June 2013 in the name of ThyssenKrupp Carbon Components GmbH and shows a wheel with a wheel spider. The spokes of the wheel spider are made of a fiber reinforced material and comprise linear textile
5 strands, that extend at least once without interruption from the rim to the wheel's hub and back. The ends of the textile strands are laid alongside to the centripetal contour of the rim. As well, the document discloses methods to produce said wheel.

Problems of existing wheel concepts may result from an insufficient mechanical
10 connection between the spoke structure or wheel disk and the rim.

WO13083729 was published in June 2013 in the name of the same applicant. It describes a wheel made out of fiber reinforced material. The wheel comprises an insert in the center of the wheel which is partially embedded in the composite material.

15 SUMMARY OF THE INVENTION

One object of the present invention is to provide a wheel made at least partially out of a fiber reinforced plastic material which provides an improved load capacity. A further object of the invention is to provide a method to make an according wheel.

From the prior art several wheels made out of composite material are known. These wheels are not having a sufficient load carrying capacity, especially in motor sports application. A wheel according to the invention provides a superior performance and a further weight reduction.

5 A wheel according to the invention normally comprises a rim and a wheel center with several spokes which are connected to the rim. Several spokes comprise at least one butt strap protruding from a radially outer end of the spokes. The rim comprises openings which correspond to the cross-section of the spokes (preferably contour sharp) and which are arranged corresponding to the at least one
10 butt strap. In a mounted position the at least one butt strap extends across a related opening in the rim. The openings usually are arranged in the region of a rim well and/or an outer bead seat and/or an outer hump and/or an outer shoulder. Preferably the at least one butt strap is arranged at least partially in a circumferential and/or axial direction to the rim where it is bonded to the rim. Normally the at
15 least one butt strap is arranged tangential to the rim and follows the outer contour. Usually the at least one butt strap is at least partially covered on the outside by at least one additional layer of material, e.g. in that composite material is wound onto the outer surface. If required the additional layer of material envelops a reinforcement ring. The wheel center may comprises a wheel flange with an at
20 least partially therein embedded insert. In a preferred embodiment the wheel may comprise a bundle of reinforcing fibers which directly interconnect the wheel rim with the insert. In a variation the bundle of reinforcing fibers starts in the rim continue along a spoke, embraces the insert, continues along a spoke and ends in the rim. The insert may comprise a mouth wherein the bundle of reinforcing fibers

- crosses the insert. The spokes may comprise an intermediate rib which blends into a rim edge. The intermediate rib may comprise a bundle of reinforcing fibers which continues along the intermediate rib and ends in the rim. The bundle of reinforcing fibers may extend in a loop over the rim edge. At least one rim edge
- 5 may comprise a circumferential reinforcement ring which is enclosed by composite material of the rim and/or the at least one spoke. The wall thickness of the spokes may increase in the direction of the wheel flange for improved load distribution. Alternatively or in addition the cross section of the spokes may widen in the direction of the rim. The spokes may comprise a funnel-shaped outer section.
- 10 A method for producing a wheel according to the invention in principle comprises the following method steps: Providing a rim or a section of a rim which is later covered by at least one layer of additional material. Generating of several openings in the rim distributed in circumferential direction. Good results may be achieved when the openings are made by laser-cutting. Providing of a wheel center comprising several spokes, wherein the spokes comprise a their outer end at
- 15 least one butt strap. Then lacing the butt strap through the openings. Arranging the butt straps on an outer surface of the rim. For improved load transmission the butt straps are expanded on the surface. Bonding the butt straps on the outer surface. Normally at least one additional layer of material is arranged from the outside on the butt straps encompassing them from the outside. The additional layer
- 20 of material may form part of at least one outer rim edge. In a variation the additional layer of material encompasses a reinforcement ring as described and shown in the drawings.

In a preferred embodiment the rim and the wheel center are made out of composite materials, preferably carbon fibers and/or Kevlar fibers and/or glass fibers and/or material fibers, etc. embedded in a matrix material, such as epoxy resin. The matrix may be added by resin transfer molding (RTM) and/or in form of a prepreg where the fibers are already arranged in a matrix which is not yet cured.
5 Several layers of fibers and/or bundles of fibers can be attached to each other by glue and/or sewing before curing of the matrix occurs. If appropriate the rim may be made out of a different material such as metal.

A wheel according to the invention may be used e.g. for vehicles, such as motor-
10 bikes, motorcars, trucks or bicycles. However, it is not limited to these fields of application and may also be used in any other, such as for airplanes.

BRIEF DESCRIPTION OF THE DRAWINGS

The herein described invention will be more fully understood from the detailed description given herein below and the accompanying drawings, which should
15 not be considered as limiting to the invention described in the appended claims.

The drawings are showing:

Fig. 1 a wheel according to the invention in a perspective view from the front and above;

Fig. 2 the wheel according to Figure 1 in a perspective view from the rear and
20 above;

- Fig. 3 an early step in making of the wheel according to Figure 1;
- Fig. 4 an intermediate step in making of the wheel according to Figure 1;
- Fig. 5 a later step in making of the wheel according to Figure 1;
- Fig. 6 the later step in making of the wheel according to Figure 1 in a different view.
5
- Fig. 7 a further embodiment in a perspective front view;
- Fig. 8 the wheel according to Figure 7 in a perspective rear view;
- Fig. 9 the wheel according to Figure 7 in a front view;
- Fig. 10 a section view according to section line DD of Figure 9;
- 10 Fig. 11 Detail E according to Figure 10;
- Fig. 12 the wheel according to Figure 7 in a partially cut manner;
- Fig. 13 an insert in a side view;
- Fig. 14 the insert according to Figure 13 in a front view;
- Fig. 15 the insert in a perspective view;
- 15 Fig. 16 a section view of the insert along section line FF of Figure 14.

DETAILED DESCRIPTION OF THE INVENTION

The foregoing summary as well as the following detailed description of the preferred embodiments is better understood when read in conjunction with the appended drawings. For the purposes of illustrating the invention, an embodiment
5 that is presently preferred, in which like numerals represent similar parts throughout the several views of the drawings, it being understood, however, that the invention is not limited to the specific methods and instrumentalities disclosed.

Figure 1 schematically shows a wheel 1 according to the invention in a perspective view from above and the front. **Figure 2** shows the wheel according to **Figure 1**
10 **ure 1** in a perspective view from above and the rear.

Figure 3 shows in a schematic manner an early step in making of a wheel 1. **Figure 4** shows in a schematic manner an intermediate step in making of the wheel 1. **Figure 5** and **Figure 6** show in a schematic manner later steps in making of the wheel 1.

15 A wheel 1 according to the invention comprises a rim 2 and a wheel center 3 here comprising several spokes 4 interconnecting a wheel flange 5 arranged in the center of the wheel center 3 with the rim 2. The rim 2 and the wheel center 3 are in the shown embodiment made out of composite materials, preferably carbon fibers and/or Kevlar fibers and/or glass fibers and/or material fibers, etc. embed-
20 ded in a matrix material, such as epoxy resin. If appropriate the rim 2 may be made out of a different material such as metal.

In the shown embodiment, the rim 2 comprises in a final state an inner and an outer rim edge 10, 11 between which a rim well 12 extends. Adjacent to the inner and the outer rim edge 10, 11 an inner and an outer bead seat 13, 14 are arranged, which are delimited from the rim well 12 by an inner and an outer hump 15, 16. The difference in level between the smaller diameter of the rim well 12 and the larger diameter of the inner and the outer humps 15, 16 is bridged by an inner and an outer shoulder 17, 18.

The spokes 4 are interconnected to the rim 2 in a mechanically advantageous way as will be explained subsequent in a detailed manner.

10 The spokes 4 of the shown wheel 1 are having an open cross-section, which is accessible from the inside and the outside when viewed in axial direction (x-axis) of the wheel 1 and which is comparably easy to produce. Each spoke 4 comprises two lateral flanges 6 and an intermediate rib 7, which in the shown embodiment per-se has a U-shaped cross-section when cut transversal to the radial direction.

15 The lateral flanges 6 and the intermediate rib 7 are interconnected on the rear side by a cross wall 8 which in the shown embodiment is arranged at the inner end of the lateral flanges 6.

In the shown embodiment the wheel flange 5 comprises an insert 9, e.g. as shown in **Figures 13** through **16**, which is at least partially embedded in the

20 composite material of the wheel center 3.

As schematically indicated in **Figure 11** the insert 9 may interact with a certain amount of fibers 23 of the composite material which run from the wheel center 3 in radial direction of a corresponding spoke 4 without interruption into the rim 2. In a preferred embodiment, said fibers are primarily arranged in the intermediate
5 rib 7. Good results are achieved if the fibers at least partially encompass the insert 9. E.g. as shown in the section view of **Figure 11** fibers 23, schematically indicated by dotted line 23 start in the rim 2, run into the a spoke 4, encompass a beam 24 of the insert 9, run in opposite direction along the spoke 4 and end in the rim 2.

10 The making of a wheel 1 according to the invention is now explained in more detail in accordance with the **Figures 3** through **6**.

As can be seen in **Figure 3**, in a first phase a rim 2 and a wheel center 3 are provided which are prepared independent from each other. These parts are shown here in an idealistic manner. It should be understood that in the process of assembling the rim 2 and the spokes 4, normally at least the fibers forming the spokes 4
15 may be in a non-solid and thereby still deformable condition.

In the rim 2 openings 20 are provided which in principle correspond to the layout an the (final) cross-section of the spokes 4. The openings 20 extend in a radial direction through the rim 2. Good results may be achieved by sharp contoured
20 laser-cutting of the openings 20 matched to the cross-section of the spokes 4.

In the shown embodiment, the openings 20 are arranged adjacent to the outside of the rim 2 in the area of the rim well 12, the outer bead seat 14, the outer hump 16 and the outer shoulder 18. The openings 20 are foreseen to receive at least one butt strap 21, which protrudes at the outer end of a spoke 4. They may later
5 be covered on the outside by additional layers of material in at least one further process step.

As explained above, the rim 2 and the spokes 4 for the wheel center 3 are preferably prepared independent from each other and then assembled in a further step with respect to each other, whereby the butt straps 21 of the spokes 4 are
10 laced through the openings 20 and folded down (indicated by lines 23) on a surface 19 of the rim 2 as schematically indicated in **Figure 4** by lines 22. The fibers of the butt straps are preferably expanded to obtain best load introduction and exchange of forces between the rim 2 and the wheel center 3. The surface 19 may be covered in a later step, e.g. when additional layers of material are applied
15 as described subsequent. The material forming a radially inner section of the rim 2 is in the present step normally in a cured or in a semi cured state. If appropriate it may act as a tool for forming of the still formable fibers for the spokes 4.

In a further process step the composite material forming the spokes 4 and the butt straps 21 are cured by setting the resin in which the reinforcement fibers are
20 embedded. Furthermore, the insert 9 is embedded in the wheel flange 5. This step normally takes place by inserting the wheel center 3 as well as the insert 9 in a corresponding mould (i.e. forming tool; not shown in detail), closing the mould

and initiating the curing process of the matrix. If appropriate, the rim 2 can be also included in the mould or form part of it, e.g. by acting as a wall of the mould.

The fibers later forming the wheel 1 are preferably in the state of a semifinished product when they are assembled as shown in **Figure 4**. Alternatively or in addition,
5 tion, the fibers are at least partially in a dry state. The matrix material is then added e.g. by applying a vacuum and/or pressure to the mold.

After sufficiently curing of the matrix of the composite material, the wheel has a shape as indicated in Figure 5 and 6. The fibers of the butt straps 21 extend across the rim 2 and then in circumferential direction and/or transversal direction in
10 or along the outer surface 19 of the rim 2. The butt straps 21 are following the outer contour, respectively are firmly integrated in the outer surface 19. The openings 20 are normally completely filled in and are therefore not present anymore. If appropriate, the outer surface 19 can be covered at least partially by additional composite material or another cover. For making of the rim 2 and the
15 wheel center 3 usually two separate tools are used.

In **Figures 5** and **6** the assembled wheel 1 is shown after curing of the fibers forming the wheel center 3 in perspective views from the front and the rear. As it can be seen, the spokes 4 cross the rim 2 and end into the butt straps 21, which are folded down, expanded and coalesced with the rim 2. As the drawings are
20 only schematic, the shape and the arrangement of the butt straps is only exemplary. The openings 20 are not visible anymore as they are completely filled in by composite material. Normally the butt straps 21 and the area where the spokes 4

cross the rim are covered by additional layers of material which are applied in the same or in a different process step. Good results may be achieved when at least one additional layer 38 of composite material is attached and/or wound in circumferential direction onto the outer surface 19 forming part of the rim 2 thereby at least partially covering the surface 19. Normally the butt straps 21 are not visible in the final product as they are coalesced with the rim 2. The butt straps 21 may overlap in a tangential direction forming circumferential ring segments with each other. The butt straps 21 arranged in axial direction may enlase a reinforcement ring arranged in a rim edge.

10 **Figures 7** through **12** are showing a further embodiment of a wheel 1 according to the invention. With respect to the general description and the manufacturing process it is referred to the elaborations made above. **Figure 9** shows a front view of the wheel 1 according to **Figures 7** and **8**. **Figure 10** shows a section view along section line DD according to **Figure 9**. **Figure 11** shows Detail E according to **Figure 10** in a magnified manner. **Figure 12** shows the wheel 1 according to 15 **Figures 7** through **11** in a partially cut manner and with hidden lines displayed as dashed lines. **Figures 13** through **16** are showing an insert 9 as embedded in the wheel 1 according to **Figure 7** through **12**.

Compared to the embodiment as shown in **Figures 1** and **2**, the shown variation 20 comprises a different interconnection between the rim 2 and the spokes 4 of the wheel center 3. As well visible in **Figure 7**, the intermediate rib 7 merges very close to the front of the outer rim edge 11 and (in a sectional view) almost tan-

gential into the outer rim edge 11. This offers an advantageous arrangement of the fibers in this area and therefore an improved load application and distribution at very high load levels.

As visible in **Figures 7** and **8**, the cross-section of the spokes 4 widens in a radially outward direction of the rim 2 and opens-up into an outer section 25 which is funnel-shaped and then merges into the rim 2. Thereby the wall thickness of the lateral flanges 6 the intermediate rib 7 and the cross wall 8 reduces. As visible in the detailed section view according to **Figure 11**, wall thickness of the intermediate rib 7 increases significantly in the direction of the wheel center by a factor. Depending on the field of application and the design the factor is normally in the range of 2 to 10 when comparing the thinnest to the thickest wall area.

The rim 2 comprises thickenings 26 arranged on the inside, which act as local reinforcements in the area where the spokes 4 are connected to the rim 2. On the outside, the butt straps (21) are not visible as they are fully integrated into the outer surface 19 of the rim.

In **Figures 13** through **16**, an embodiment of an insert 9 is shown, which after the production of a wheel as described above, is mounted in the wheel center 3 forming part of the wheel flange 5. The insert 9 forms the main connection between the wheel 1 and a hub of a car (not shown in detail). Due to the special design and arrangement of the insert 9 in the composite material forming the wheel center 3, direct contact of the composite material and the hub of a car can be prevented. The herein shown insert 9 is an improvement over the insert as de-

scribed in the international patent application published under WO2013/083729 in the name of the same applicant. The insert 9 comprises fastening holes 30 to attach the insert to a hub of a car. Furthermore, the insert comprises several contact areas 31, 32, 33 which protrude above the composite material as e.g. shown

5 in **Figure 10** when in a mounted position and by which the insert 9 (respectively the wheel 1) is in primary contact with the hub of a car (both not shown). The first contact areas 31 are arranged in the fastening holes 30 acting as support for the fastening nuts (not shown). The second contact areas 32 are arranged at the inside forming a contact area between the hub of a car (both not shown) and the

10 insert 9. The third contact areas 33 are arranged in a center opening 28 of the wheel 1 and act as radial support of the wheel 1 with respect to the hub. The first and the third contact areas of the shown embodiment are, with respect to the circumferential direction, aligned with respect to each other. Bridges 34 are arranged between the fastening holes 30. Although the general principle is similar,

15 a difference exists with respect to the design of the bridges 34, which in the shown variation comprise an upper part 35 and a lower part 36 and a mouth 37 in between through which fibers of the composite material can be strapped. As e.g. shown in **Figure 11** at least one bundle of fibers 23 (schematically indicated by dotted line 23) passes across the mouth 37 preferably start in the rim 2 con-

20 tinue along the in- or the outside of a spoke 4, pass through the mouth 37, continue again along the spoke 4 on an opposite side and end in the rim 2 again. As indicated in **Figure 11** the outer rim edge 11 may comprise a reinforcement ring 24, e.g. in the form of unidirectional fibers or an other appropriate material such as metal.

REFERENCE SIGNS

1	Wheel	21	Butt strap
2	Rim	22	Line (indicating folding process)
3	Wheel center (Spoke structure)	23	Fibers (dotted line)
5 4	Spoke (wheel center)	25 24	Reinforcement ring
5	Wheel flange	25	Outer section (spokes 4)
6	Lateral flange	26	Thickenings (Reinforcement)
7	Intermediate rib		
8	Cross wall		
10 9	Insert (wheel center)	30 28	Center opening (of wheel 1)
10	Inner rim edge	29	Composite material
11	Outer rim edge	30	Fastening hole
12	Rim well	31	First contact area
13	Inner bead seat	32	Second contact area
15 14	Outer bead seat	35 33	Third contact area
15	Inner hump	34	Bridge
16	Outer hump	35	Upper part (of bridge 34)
17	Inner shoulder	36	Lower part (of bridge 34)
18	Outer shoulder	37	Mouth
20 19	Surface (rim 2)	40 38	Layer (of composite material)
20	Opening		

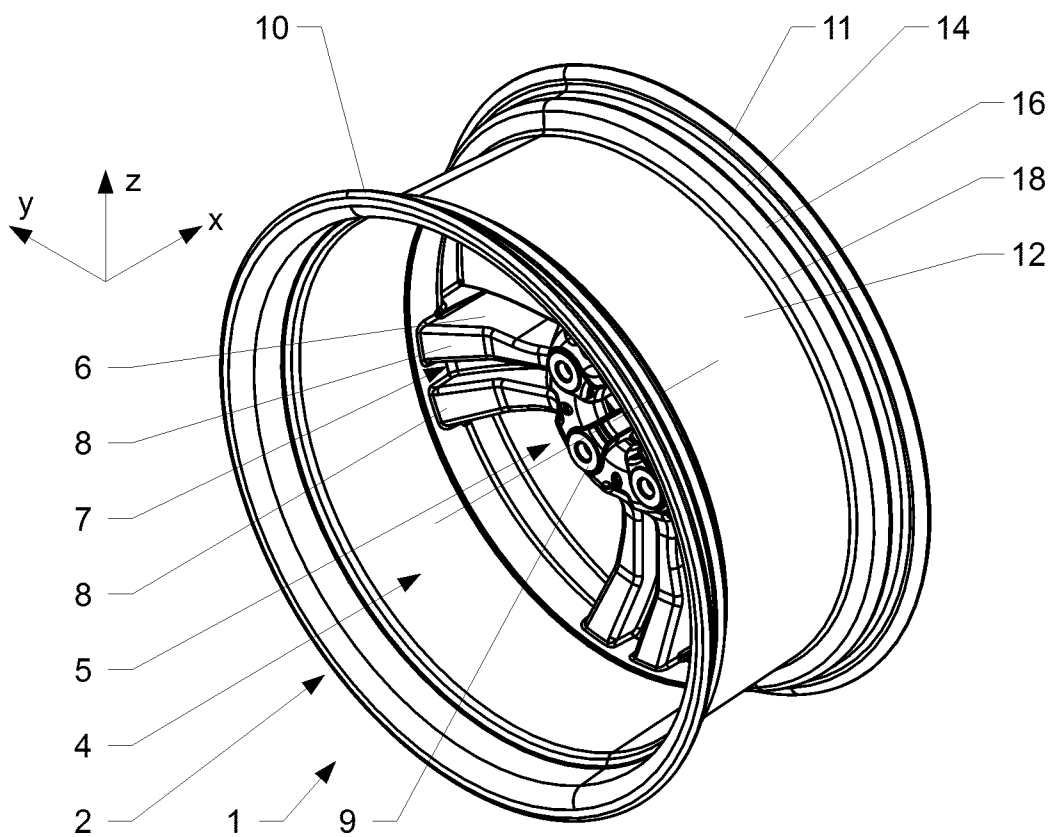
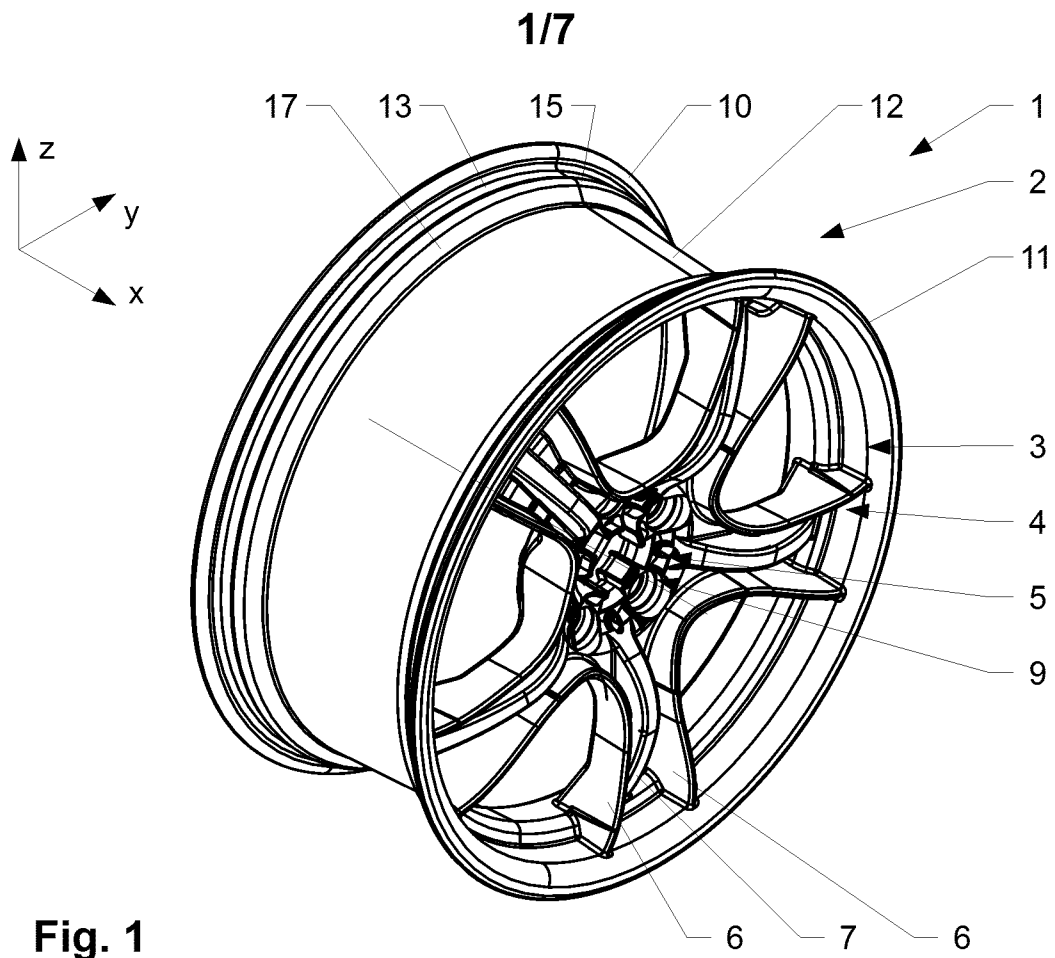
WHAT IS CLAIMED IS:

1. Wheel (1) comprising a rim (2) and a wheel center (3) with several spokes (4) with at least one butt strap (21) protruding from a radially outer end of the spokes (4), wherein the rim comprises at least one opening (20) arranged corresponding to the at least one butt strap (21) and wherein the at least one butt strap (21) extends across the related opening (20) in the rim (2).
5
2. The wheel (1) according to claim 1, **wherein** the openings (20) are arranged in the region of the rim well (12) and/or the outer bead seat (14) and/or the outer hump (16) and/or the outer shoulder (18).
10
3. The wheel (1) according to one of the previous claims, **wherein** the at least one butt strap (21) is arranged at least partially in a circumferential and/or axial direction to the rim (2).
4. The wheel (1) according to one of the previous claims, **wherein** the at least one butt strap (21) is arranged tangential to the rim (2).
15
5. The wheel (1) according to one of the previous claims, **wherein** the outer surface (19) and the at least one butt strap (21) are at least partially covered on the outside by at least one additional layer (38).
6. The wheel (1) according to claim 5, **wherein** the additional layer (38) envelops a reinforcement ring (24).
20

7. The wheel (1) according to one of the previous claims, **wherein** the wheel center (3) comprises a wheel flange (5) with an at least partially in the material embedded insert (9).
8. The wheel (1) according to claim 7, **wherein** the wheel (1) comprises a bundle
5 (23) of reinforcing fibers which directly interconnect the wheel rim (2) with the insert (9).
9. The wheel (1) according to claim 8, **wherein** the bundle of reinforcing fibers start in the rim (2) continue along a spoke (4), embrace the insert (9) at least partially continue along a spoke (4) and end in the rim (2).
10. 10. The wheel (1) according to claim 8 or 9, **wherein** the insert (9) comprises a mouth (37) and the bundle (23) of reinforcing fibers (23) crosses the mouth (37).
11. 11. The wheel (1) according to one of the previous claims, **wherein** the spokes (4) comprise an intermediate rib (7).
12. 12. The wheel (1) according to claim 11, **wherein** the intermediate rib (7) blends into
15 a rim edge (10, 11).
13. 13. The wheel (1) according to claim 12, **wherein** the intermediate rib (7) comprises a bundle of reinforcing fibers (23) which continue along the intermediate rib (7) and end in the rim (2).
14. 14. The wheel (1) according to claim 13, **wherein** the bundle of reinforcing fibers (23)
20 extends in a loop over the rim edge (10, 11).

15. The wheel (1) according to one of the previous claims, **wherein** at least one rim edge (10, 11) comprises a circumferential reinforcement ring (24) which is enclosed by composite material of the rim (2) and/or at least one spoke (4).
16. The wheel (1) according to one of the previous claims, **wherein** the wall thickness
5 of the spokes increases in the direction of the wheel flange (5).
17. The wheel (1) according to one of the previous claims, **wherein** the cross section of the spokes (4) widens in the direction of the rim (2).
18. Method for producing a wheel (1) comprising the following method steps:
- a) Providing a rim (2);
- 10 b) Generating of several openings (20) in the rim (2) in circumferential direction;
- c) Providing of a wheel center comprising several spokes (4) comprising a their outer end at least one butt strap (21);
- d) Lacing the butt strap (21) through the openings (20);
- 15 e) Arranging the butt straps (21) on an outer surface (19) of the rim (2);
- f) Bonding the butt straps (21) on the outer surface (19).

19. The method according to claim 18, **wherein** at least one additional layer of material is arranged from the outside on the butt straps (21).
20. The method according to one of the claims 18 or 19, **wherein** the additional layer of material forms part of at least one outer rim edge (10, 11).
- 5 21. The method according to one of the claims 18 or 20, **wherein** the additional layer of material encompasses a reinforcement ring (24).



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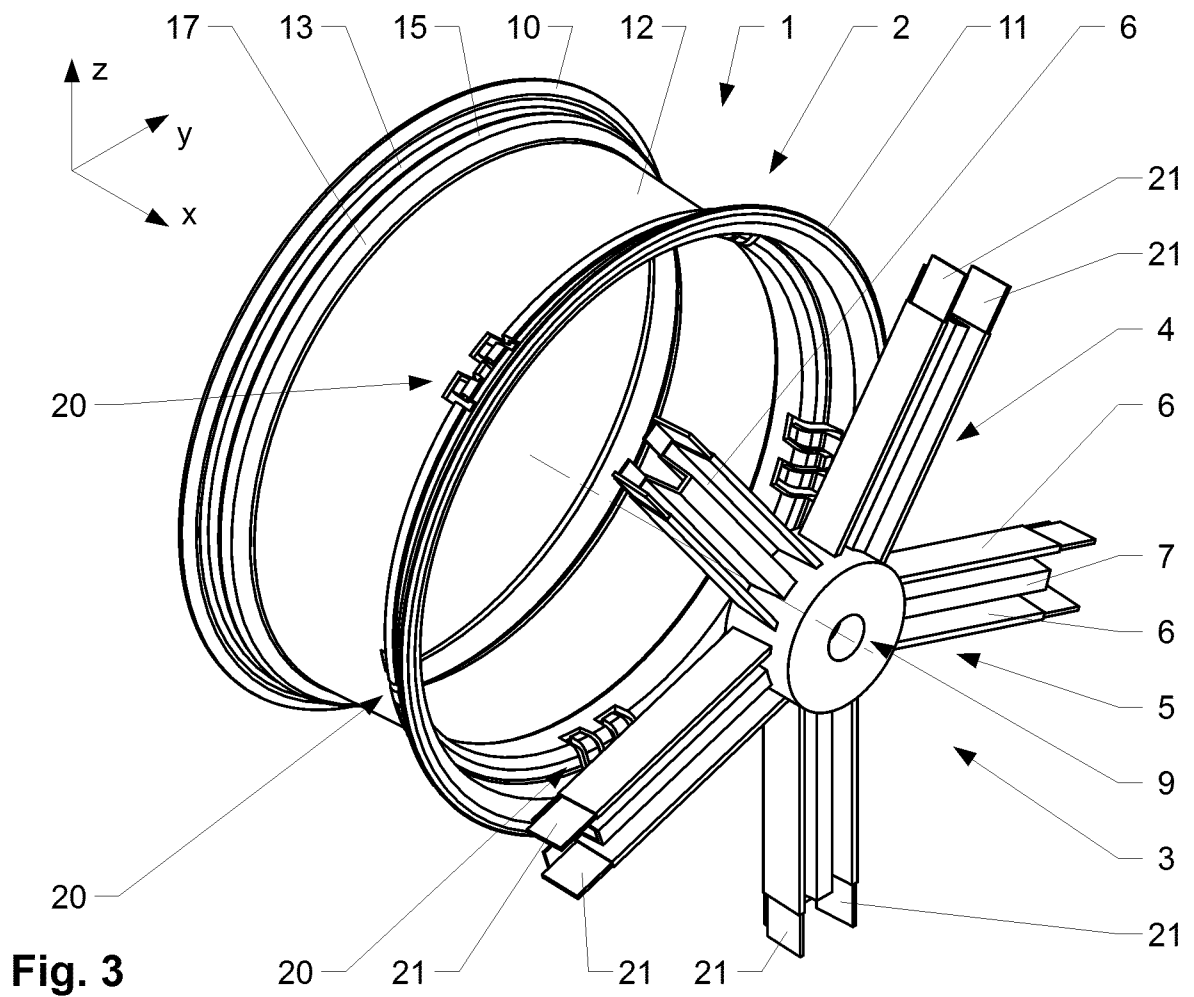


Fig. 3

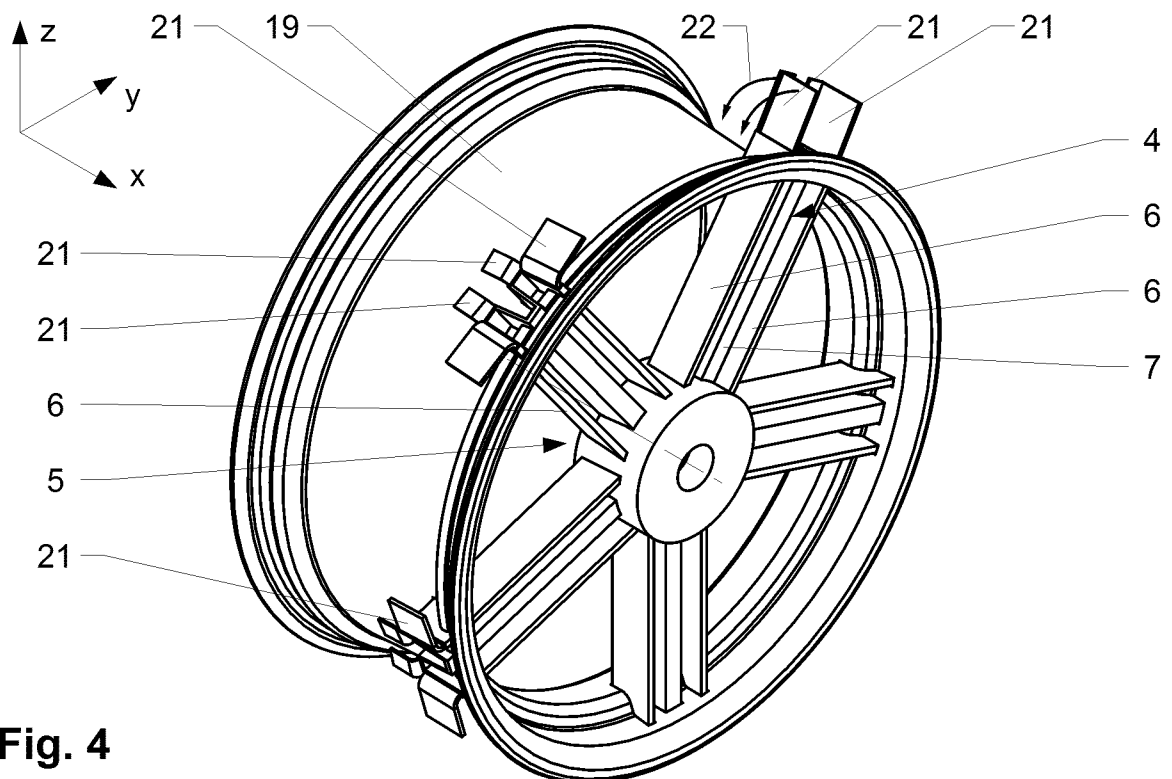


Fig. 4

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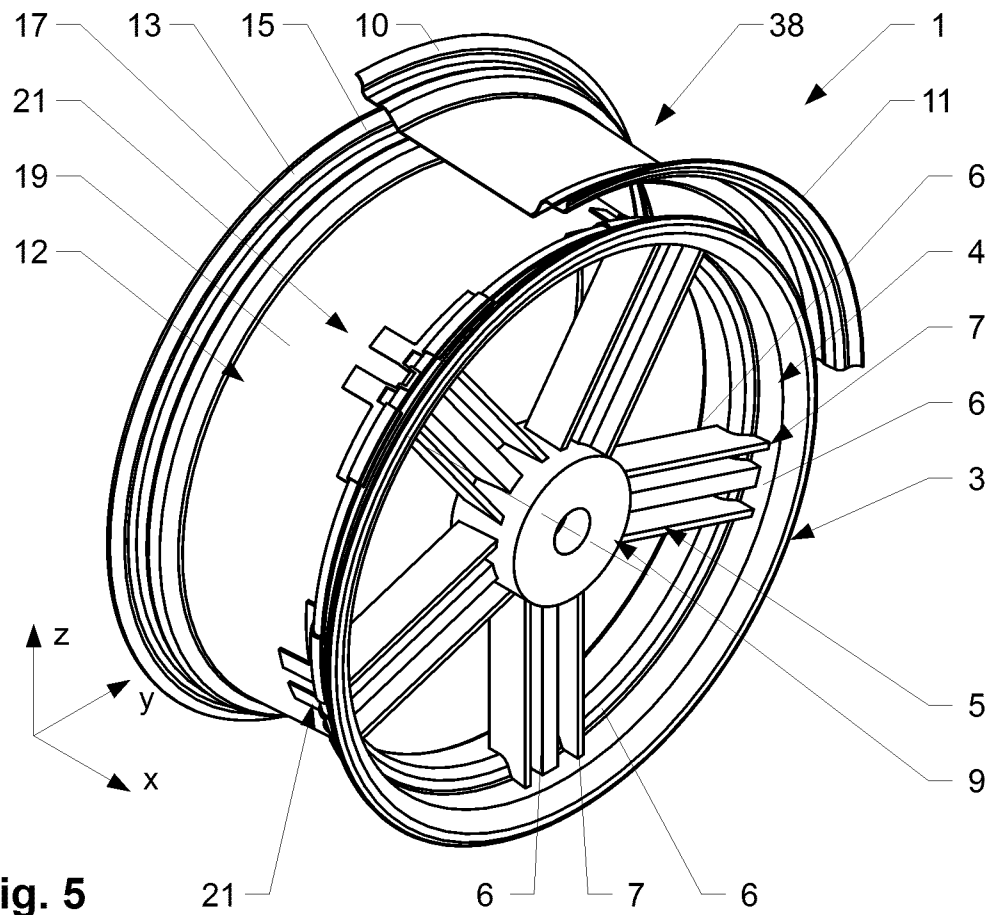


Fig. 5

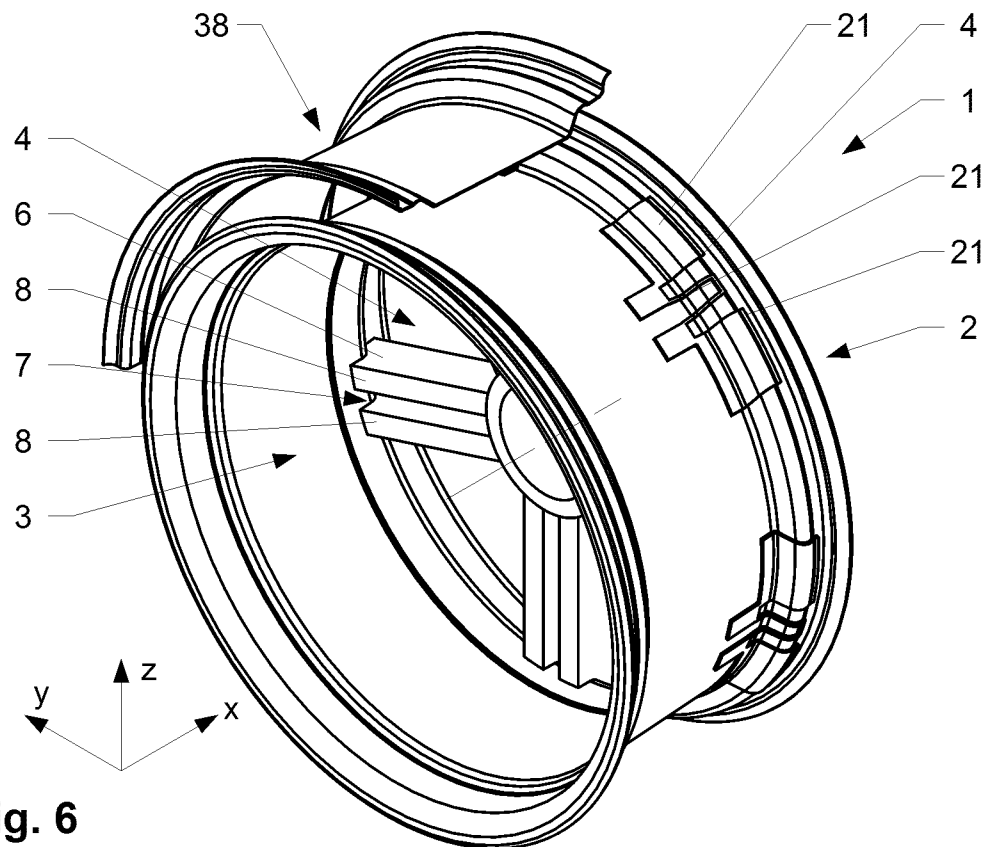
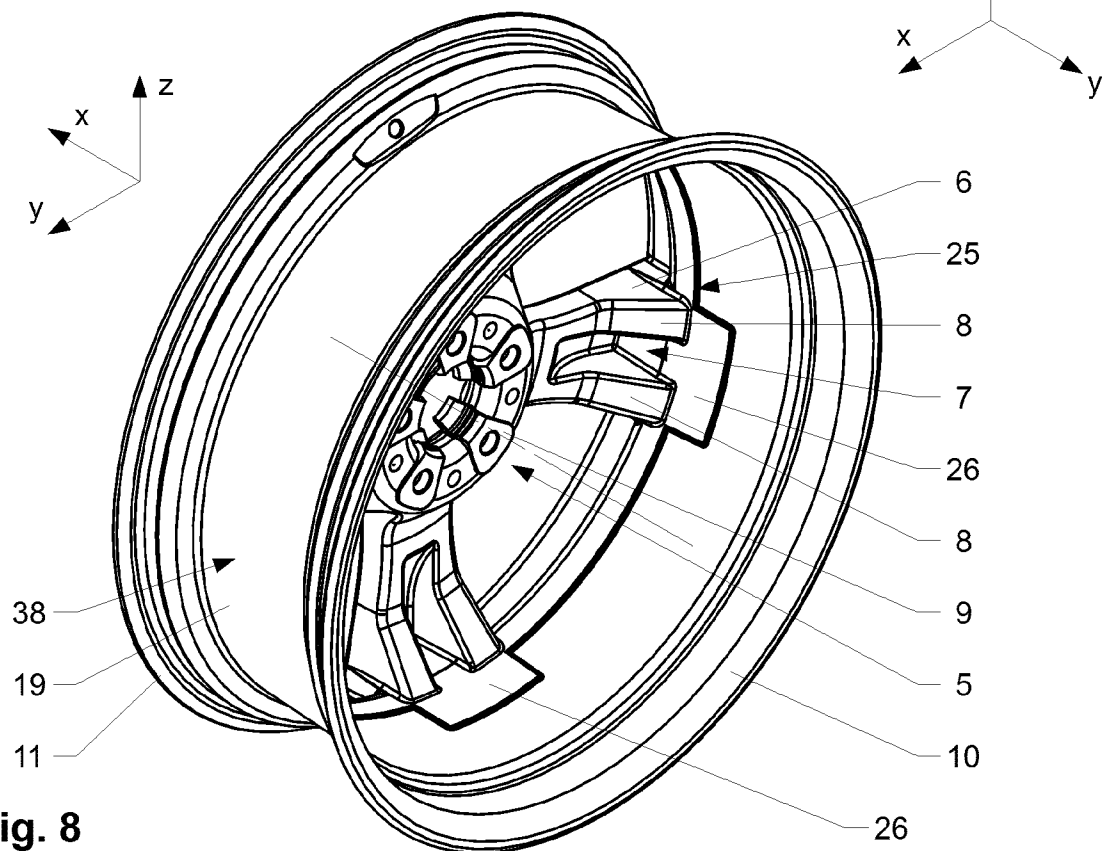
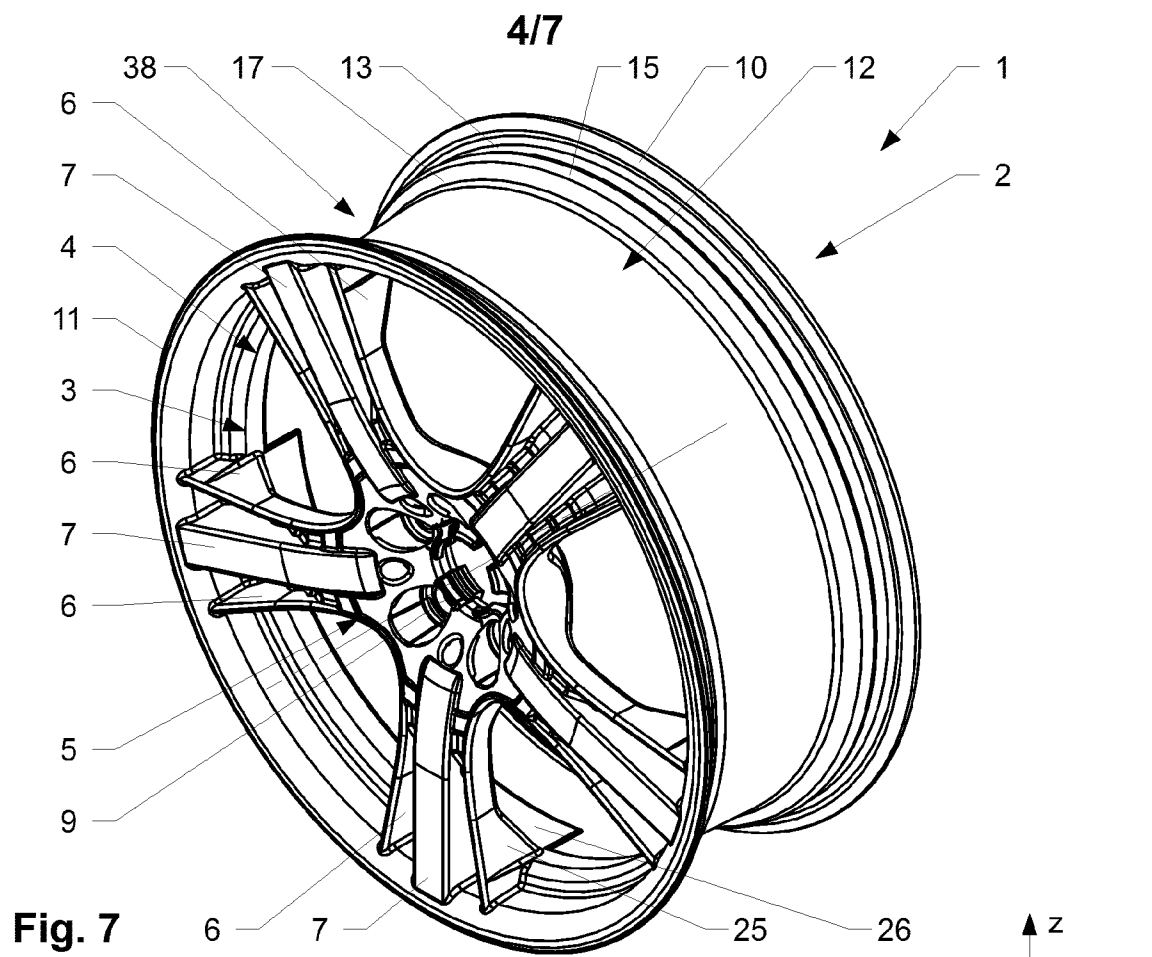
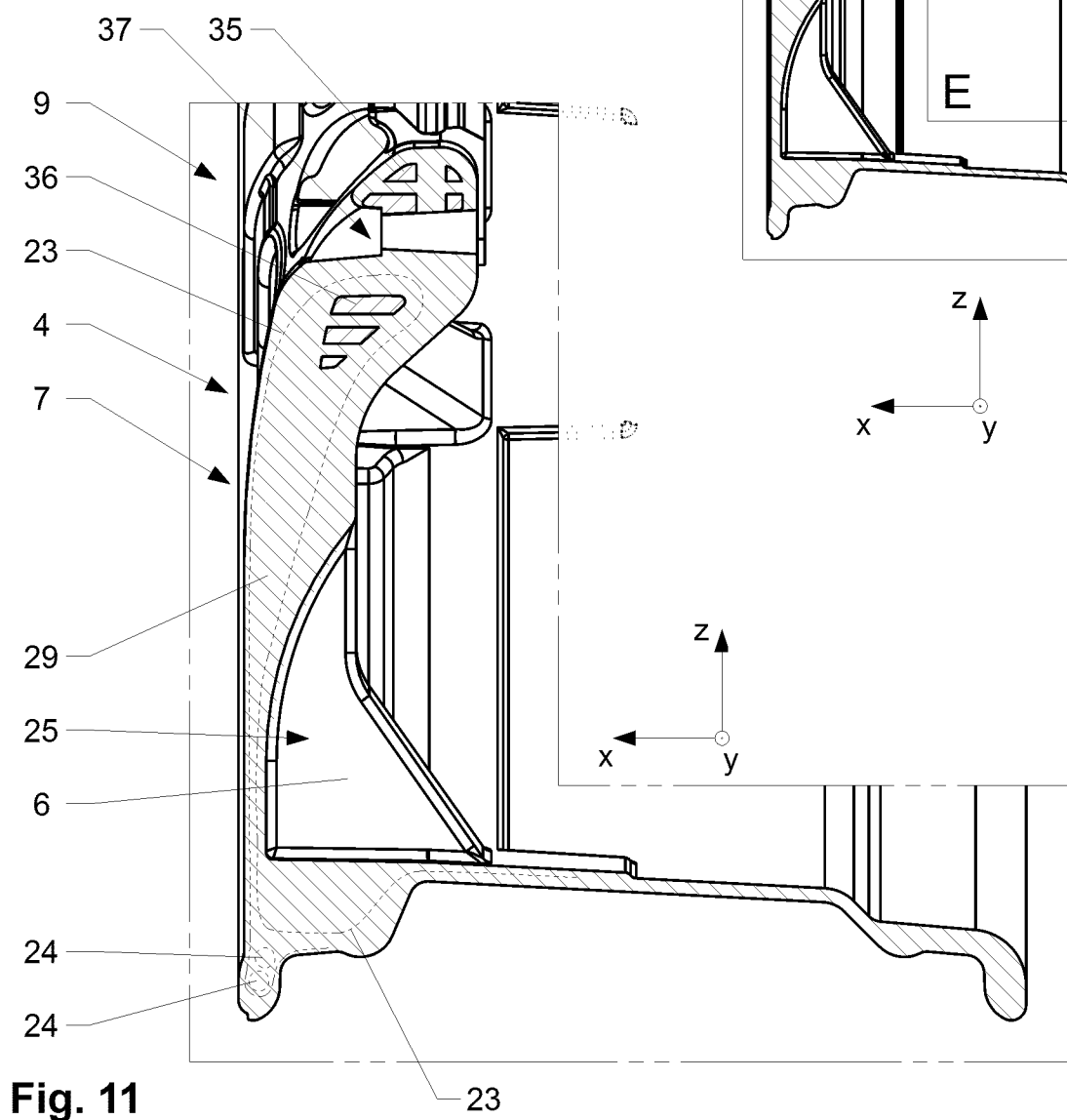
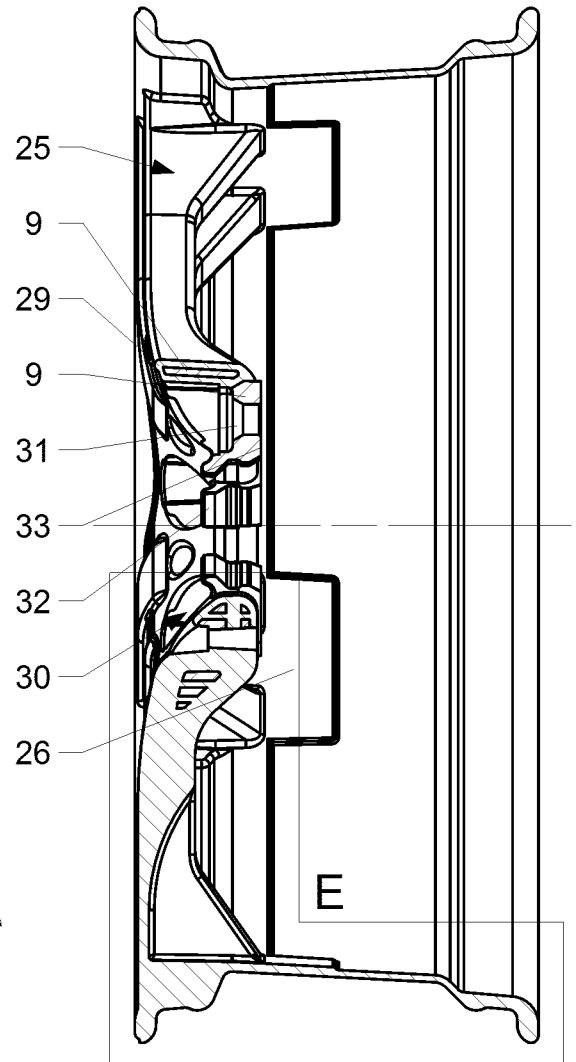
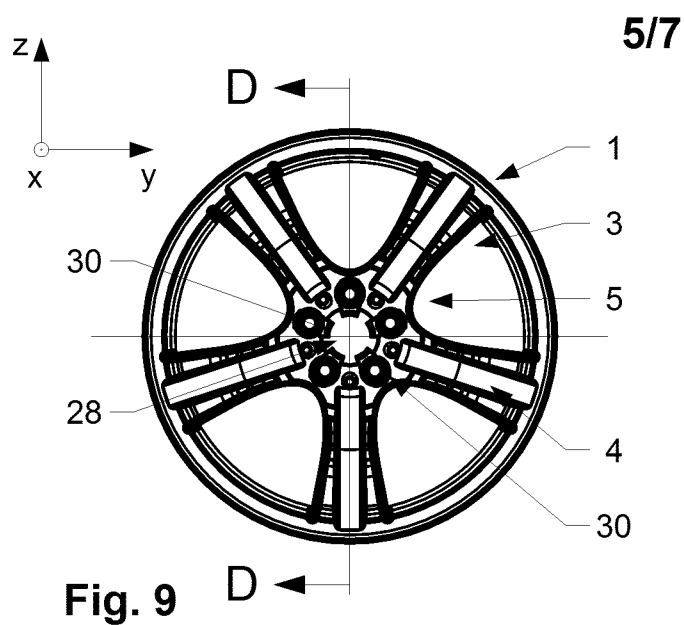


Fig. 6





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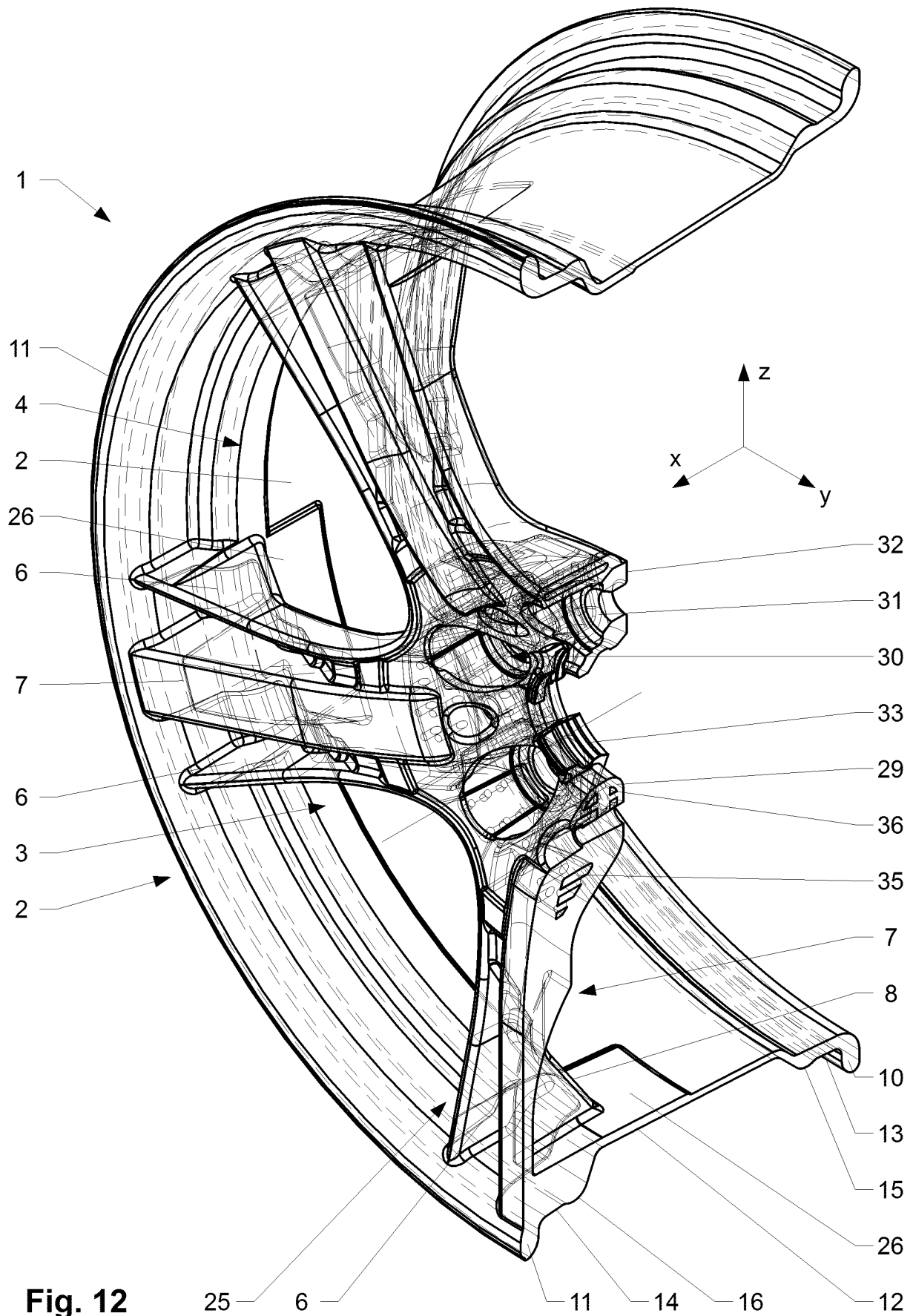


Fig. 12

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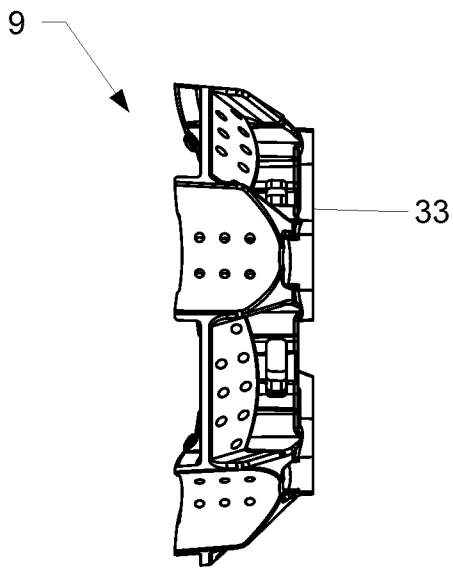


Fig. 13

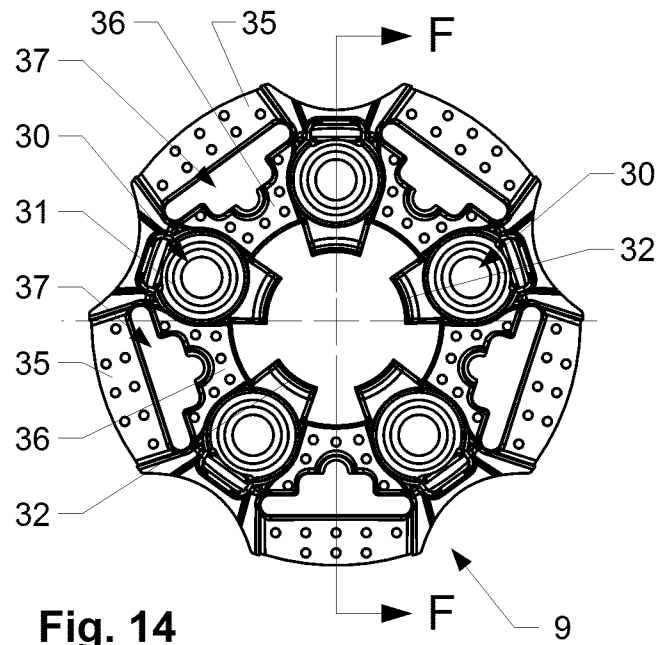


Fig. 14

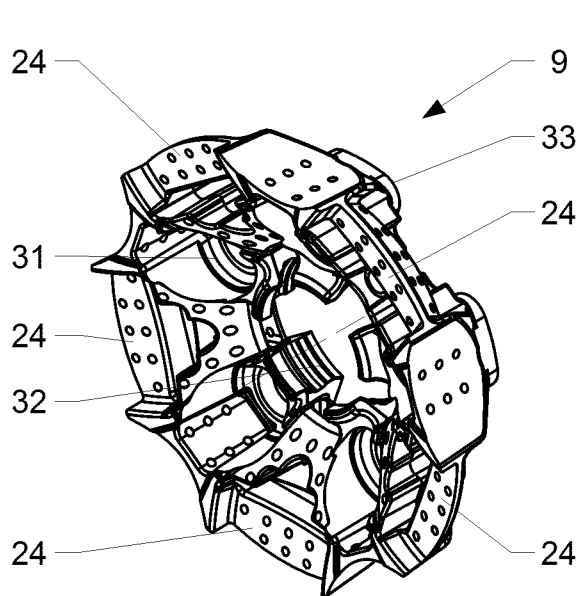


Fig. 15

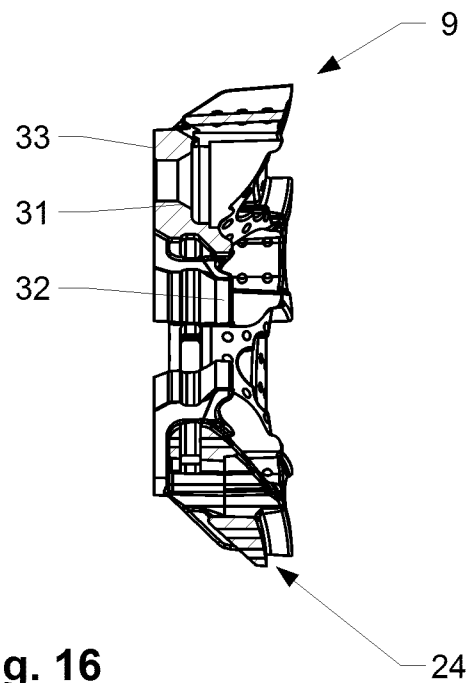


Fig. 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/064781

A. CLASSIFICATION OF SUBJECT MATTER INV. B60B1/14 B29C70/44 B29C70/24 B60B5/02 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) B60B B29C		
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 03/061933 A1 (HIGHFLYER INVEST 5 PROPRIETARY [ZA]; ADRIAN CHRISTIAN ANDREAS [ZA]) 31 July 2003 (2003-07-31)	1-6, 16-21
Y	page 11 - page 13; figures 2,3 -----	7-13
Y	US 3 917 352 A (GAGEBY STEVEN DOUGLAS) 4 November 1975 (1975-11-04) figures 25-27 -----	7-10
Y	US 2013/026816 A1 (KIA HAMID G [US] ET AL) 31 January 2013 (2013-01-31) the whole document -----	11-13
A	WO 2013/083729 A2 (MUBEA CARBO TECH GMBH [AT]) 13 June 2013 (2013-06-13) page 12, line 1 - line 8 -----	1-21
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "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 25 September 2014	Date of mailing of the international search report 09/10/2014	
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 Cipriano, Pedro	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/064781

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 03061933	A1	31-07-2003	EP 1487623 A1 22-12-2004 JP 2005515093 A 26-05-2005 US 2005121970 A1 09-06-2005 WO 03061933 A1 31-07-2003
US 3917352	A	04-11-1975	NONE
US 2013026816	A1	31-01-2013	DE 102012213050 A1 31-01-2013 US 2013026816 A1 31-01-2013
WO 2013083729	A2	13-06-2013	CN 103974834 A 06-08-2014 EP 2788200 A2 15-10-2014 WO 2013083729 A2 13-06-2013