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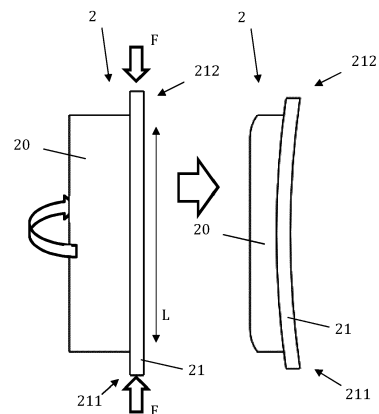
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(54) **BLADE FOR AN IMPELLER**

(57) The invention relates to a blade for an impeller, in particular for a radial flow impeller, comprising a lamella (20), which is at least partly reversibly elastically deformable, and a backbone (21) extending in a longitudinal direction (L), which backbone (21) is mounted to or formed integrally with a side (200, 201, 202, 203) of the lamella (20), wherein the backbone (21) has a first end (211) and a second end (212), which first end (211) and second end (212) are reversibly displaceable in the longitudinal direction (L) towards each other under a lateral deflection of the backbone (21), wherein the lamella (20) is configured such that the lateral deflection of the backbone (21) causes a lateral deformation of the lamella (20) and a flap motion of the lamella (20) about an axis parallel to the longitudinal direction (L). The invention further relates to impellers, in particular radial flow impellers, comprising several blades, and to turbomachines having an impeller, in particular axial or centrifugal fans or axial or centrifugal pumps. In addition, the invention relates to a household appliance comprising a turbomachine having an impeller.



**Fig. 4**

## Description

### TECHNICAL FIELD AND PRIOR ART

**[0001]** The invention relates to a blade for an impeller, in particular for a radial flow impeller. The invention further relates to impellers, in particular radial flow impellers, comprising several blades, and to turbomachines having an impeller, in particular axial or centrifugal fans or axial or centrifugal pumps. In addition, the invention relates to a household appliance comprising a turbomachine having an impeller.

**[0002]** Fans and pumps, in particular centrifugal fans and pumps are widely used in household appliances for conveying air and/or water. An impeller for a fan or pump comprises several blades. The impeller blades can have different profiles. In particular for centrifugal flow machines several different fan types are known including flat blades, negative blades and positive blades. The different fan types have different advantages, for example a high degree of efficiency or a self-cleaning effect. The choice of a specific fan type is made by the person skilled in the art in consideration of several factors including a field of application, a conveying direction and a conveyed medium. In addition, the number and size of the blades are typically suitably selected for the desired application. For conveying different media and/or in different conveying directions in one household appliance, generally two different fans or pumps are provided.

**[0003]** US 2014/193260 A1 discloses an impeller having a plurality of blades which are designed, at least in regions, to be elastic and have a fixed mounting arranged in a region located near the impeller axis of rotation. The blades can bend elastically radially outward from this fixed mounting counter to a spring force, so that the blades are deformable or moveable between a first position adapted to convey air, and a second position adapted to convey a medium having a higher density such as a liquid in particular water.

### SUMMARY OF THE INVENTION

**[0004]** It is the object of the invention to provide a blade for an impeller, an impeller, and a turbomachine having an impeller which can be adapted in operation for an improved performance under different conditions. It is further the object to provide a household appliance comprising such a turbomachine.

**[0005]** According to a first aspect, a blade for an impeller, in particular for a radial flow impeller, is provided, wherein the blade comprises a lamella, which lamella is at least partly reversibly elastically deformable, wherein the blade further comprises a backbone extending in a longitudinal direction, which backbone is mounted to or formed integrally with a side of the lamella, wherein the backbone has a first end and a second end, which first end and second end are reversibly displaceable in the longitudinal direction towards each other under a lateral

deflection of the backbone, wherein the lamella is configured such that the lateral deflection of the backbone causes a lateral deformation of the lamella and a flap motion of the lamella about an axis parallel to the longitudinal direction.

**[0006]** In other words, moving the first end and the second end of the backbone towards each other causes a lateral-torsional buckling of the blade resulting in a modified profile of the blade. This lateral-torsional buckling is reversible and repeatable. In embodiments, the profile of the blade is adjustable such that the blade upon its deformation at least assumes the form of a flat blade and one of a negative blade and a positive blade. Generally, the profile of the blade is continuously variable by compressing the backbone up to a flap motion of 90°.

**[0007]** In the context of the application, a lamella is defined as a thin plate-like structure. In embodiments of the invention, the lamella in its flat state has a rectangular shape with two long sides and two short sides. In this case, the backbone in one embodiment is arranged at a long side of the lamella. However, in other embodiments, the lamella has other shapes. For ensuring a desired lateral-torsional buckling, the backbone in embodiments of the invention is chosen to have a higher stiffness than the lamella. In one embodiment, the backbone is in the form of a rod.

**[0008]** It will be understood by the skilled person, that in the context of the application, the expressions first and second are used to distinguish between different elements and do not imply any particular order or sequence.

**[0009]** In one embodiment, the backbone is predeflected, such that the backbone has a lateral deflection when the lamella is in an initial state, in particular a flat initial state. In this case, in one embodiment, the shape of the lamella is adapted to the predeflection of the backbone, wherein in one embodiment a side of the lamella to which the backbone is mounted or with which the backbone is formed integrally, is curved to match the predeflection of the backbone. In one embodiment, in the initial state the lamella is flat, wherein the lamella projects from the backbone in the direction of an apex of the deflection.

**[0010]** In alternative or in addition, in embodiments of the invention, a proximal area of the lamella adjacent to the backbone has a lower stiffness than a distal area of the lamella. By providing a lower stiffness in the proximal area of the lamella, a preferred direction for the lateral deformation and flap motion of the lamella can be set. In one embodiment, the stiffness is decreased in the proximal area by slots extending crosswise to the backbone.

**[0011]** In one embodiment, the lamella and the backbone are made from the same material, wherein for example a thickness of the lamella differs from that of the backbone to achieve differing stiffness properties. In other embodiments, the lamella and the backbone are made from different materials.

**[0012]** In one embodiment, the lamella and/or the backbone are made of metal material, in particular made of a metal sheet or a metal tube. In one embodiment, the

metal material is a super-elastic material as distributed for example under the tradename Nitinol by the company Euroflex GmbH. In one embodiment, the complete blade is manufactured in metal using punching technique. In this case, a different stiffness of the backbone and the lamella can be achieved by appropriate deformation, which results in different material properties. In one embodiment, the backbone is strain-hardened during the punching process. For a predeflection, the backbone in one embodiment is simultaneously brought into a curved shape. In addition, in embodiments of the invention, beads are provided. In alternative or in addition, a stiffness of the lamella is modified in the punching process. For example, in embodiments of the lamella, slots are provided for a modification of the stiffness. In one embodiment, the lamella is provided in its proximal area adjacent to the backbone with a number of slots, in particular with a number of parallel slots extending crosswise to the longitudinal direction of the backbone. In an alternative embodiment, the blades are manufactured from a tube which is cold drawn.

**[0013]** In one embodiment, the lamella is provided with a heating conductor. The heating conductor allows the conveyed medium, in particular air, to be heated directly when passing the blades. The heating effect in one embodiment is used to trigger a deformation of the blades, for example in case of a heating effect, flat blades are advantageous to avoid that dust, lint, fibers and/or flocks will stick to the blades when heating the blades. In embodiments, flexible heating conductors, for example embroidered wires, are provided, which within limits can compensate for the deformation of the blades. In alternative or in addition, the heating conductor is in one embodiment provided at the distal area of the lamella, i.e. in an area of low deformation.

**[0014]** In another embodiment, the lamella and/or the backbone are made of plastic material, in particular made using two or more different plastic materials. In one embodiment, the complete blade is manufactured in plastic, in particular using 3D printing, for example multi-material printing. For multi-material printing, two or more different plastic materials having different material properties are printed simultaneously. Depending on the ratio of the at least two materials, it is possible to change from a stiff or rigid to a flexible structure in the component.

**[0015]** According to a second aspect, an impeller comprising at least one blade having an adaptable profile is provided. The impeller in embodiments of the invention is a radial flow impeller. However, the invention is not limited to radial flow impellers. The impeller in advantageous embodiments has a number of blades with an adaptable profile, wherein the number of blades can be chosen by the skilled person according to the operation conditions. The impeller is in particular advantageous for applications in which a flow direction is reversed.

**[0016]** The impeller in one embodiment comprises a first side plate and a second side plate, which are distanced from each other in the longitudinal direction of the

at least one blade, wherein the first end of the backbone is mounted to the first side plate and the second end of the backbone is mounted to the second side plate. In one embodiment, the blades are moveable for a compression with respect to the blades.

**[0017]** In other embodiments, at least one of the first side plate and the second side plate is mounted displaceable in the longitudinal direction of the blade. In this case, the first end and the second end of the backbones are mounted to the first side plate and the second side plate for a deformation of the blades upon a relative movement of side plates.

**[0018]** In one embodiment, the impeller is configured for a displacement of at least one of the first side plate and the second side plate in response to a temperature change. As generally known, flat blades are advantageous to avoid dust, lint, fluffs, fibers and/or flocks from caking or sticking to the blades. This is in particular important when conveying hot air, which might ignite inflammable material sticking to the blades. Therefore, in one embodiment, a temperature sensor, a temperature sensitive shape memory material or any other temperature-sensitive means is provided, which will cause an adaption of a blade profile to a prevailing temperature.

**[0019]** In one embodiment, at least one spring element made of shape memory material is provided for causing a displacement of at least one of the first side plate and the second side plate in the longitudinal direction of the blade towards and/or away from each other.

**[0020]** As mentioned above, generally, the profile of the blade is continuously variable by compressing the backbone up to a flap motion of 90° of the lamella. In one embodiment, a distance between the first side plate and the second side plate is continuously adjustable, wherein in particular at least one predefined intermediate stop position is provided between a maximum distance and a minimum distance of the first side plate and the second side plate. This allows the impeller to assume defined shapes.

**[0021]** In one embodiment, the impeller is a split impeller, having inner blades and outer blades, wherein at least the outer blades are deformable for adjusting a blade geometry of the impeller. When providing a slit impeller, in one embodiment, the blades having a fixed profile are provided with heating elements, wherein a profile of the blades of other rim is adjustable to adapt the impeller to different working conditions, thereby improving its efficiency. In one embodiment, the blades having a fixed profile are mounted in the first side plate and/or the second side plate such that said side plate is displaceable with respect to the blades. In other embodiments, the side plate is a split side plate, wherein only a region of the side plate to which the deformable blades are mounted is displaced.

**[0022]** According to a third aspect, a turbomachine, in particular a centrifugal fan or a centrifugal pump, with an impeller is provided. The use of such a turbomachine is advantageous in various different fields having varying

boundary conditions and/or when conveying different media and/or media having varying properties and/or two-phase mixtures or aerosols. In one embodiment, the turbomachine is adapted to allow a rotation of the impeller in opposite directions.

**[0023]** According to a fourth aspect, a household appliance comprising a turbomachine is provided. The household appliance in one embodiment is a condense dryer. However, the invention is not limited to condense dryers, and an impeller with deformable blades may also be used in a washing machine or a dishwasher. In one embodiment, the impeller is mounted to a housing of the appliance and driven conjointly with the drum of the condense dryer or washing machine, wherein a rotational speed in one embodiment is adapted using a belt or gearbox. In other embodiments, the impeller is mounted to the drum and rotated with the drum.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0024]** In the following, embodiments of the invention will be described in detail with reference to the drawings. Throughout the drawings, the same elements will be denoted by the same reference numerals. The drawings schematically show

- Fig. 1 a centrifugal fan with different types of blades;
- Fig. 2 a top view of a blade for an impeller;
- Fig. 3 a side view of the blade of Fig. 2;
- Fig. 4 in a side view a lateral-torsional buckling of the blade of Fig. 2 subjected to compression forces;
- Fig. 5 a side view of an impeller comprising several blades in a first state;
- Fig. 6 a top view of the impeller of Fig. 5 in the first state;
- Fig. 7 a side view of the impeller of Fig. 5 in a second state;
- Fig. 8 a top view of the impeller of Fig. 5 in the second state;
- Fig. 9 a side view of a second embodiment of a blade;
- Fig. 10 a side view of a third embodiment of a blade;
- Fig. 11 a side view of a fourth embodiment of a blade;
- Fig. 12 a top view of a second embodiment of an impeller, and

Fig. 13 a household appliance with a turbomachine comprising an impeller.

#### DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

**[0025]** Fig. 1 schematically shows a centrifugal fan 100 with five different types of blades 11, 12, 13, 14, 15, 16. The figure is only for illustration purposes. As generally known to the skilled person, centrifugal fans are provided with a plurality of blades 11, 12, 13, 14, 15, 16 of the same type. The type of blade 11, 12, 13, 14, 15, 16 is chosen by the skilled person in consideration of the intended use of the fan 100. For example, a first type of blades is a backward-curved blade 11, which is advantageous due to a high efficiency. On the other hand, radial blades 15 are advantageous for applications with reverse flow. Backward-inclined blades 16 are advantageous to avoid caking.

**[0026]** In accordance with the invention, a blade with a lamella, which is at least partly reversibly elastically deformable is provided, which allows for an adjustment of the blade type to different operating conditions.

**[0027]** Figs. 2 and 3 schematically show a blade 2 with a lamella 20 in a top view and a side view, respectively.

**[0028]** The lamella 20 shown in Figs. 2 and 3 has a rectangular basic shape with four sides 200, 201, 202, 203. However, this shape is only by way of example.

**[0029]** The blade 2 further comprises a backbone 21 extending in a longitudinal direction L, which backbone 21 is mounted to or formed integrally with one side 200 of the lamella 20. The backbone 21 has a first end 211 and a second end 212, wherein a displacement of the first end 211 and the second end 212 towards each other causes a lateral-torsional buckling of the blade 2.

**[0030]** Fig. 4 shows schematically in a side view a lateral-torsional buckling of the blade 2 of Fig. 2 subjected to compression forces F applied to the first end 211 and the second end 212. As schematically shown in Fig. 4, upon application of the compression force F, the first end 211 and the second end 212 are reversibly displaceable in the longitudinal direction L towards each other under a lateral deflection of the backbone 21. The lamella 20, which is attached to or formed integrally with the backbone 21, is configured such that the lateral deflection of the backbone 21 causes a lateral deformation of the lamella 20 and a flap motion of the lamella 20 about an axis parallel to the longitudinal direction L. Hence, by applying a compression force F to the backbone 20, the shape of the blade 2 can be modified for example for adapting the blade 2 to different operating conditions.

**[0031]** Figs. 5 and 6 schematically show in a side view and a top view an impeller 3 comprising several blades 20 in a first state, wherein lamellae 20 of the blades 2 extend in a radial direction. Figs. 7 and 8 schematically show in a side view and a top view the impeller 3 of Figs. 5 and 6 in a second state, wherein the blades are backward curved.

**[0032]** The impeller 3 comprises a first side plate 31 and a second side plate 32, which are distanced from each other in the longitudinal direction L of the blades 2 wherein the first end 211 (see Figs. 2 to 4) of the backbone 21 is mounted to the first side plate 31 and the second end 32 (see Figs. 2 to 4) of the backbone 21 is mounted to the second side plate 32. By applying forces F to the first side plate 31 and the second side plate 32 the first side plate 31 and the second side plate 32 are moved towards each other, thereby causing a deformation of the backbones 21 of the blades 2, which causes a lateral deformation of the lamellae 20 and a flap motion of the lamellae 20 about associated axes parallel to the longitudinal direction L.

**[0033]** Hence, by applying a compression force to the impeller, the form of the blades 2 can be modified, wherein after the compression force is no longer applied, the blade 2 can return to its initial shape either. A compression force can be applied for example by means of an actuator (not shown). In one embodiment, a return movement is also induced by an actuator applying a force in the opposite direction. In another embodiment, a return movement is realized by means of restoration forces of spring elements (not shown) provided between the first side plate 31 and a second side plate 32. The form of the blades 2 in the first state and the second state as shown in Figs. 5 to 8 are only by way of example and other forms are conceivable and can be chosen by the skilled person in accordance with an intended use of the impeller, for example in accordance with a medium conveyed by the impeller, a direction of rotation and/or other boundary conditions, for example a temperature of the medium conveyed.

**[0034]** In one embodiment, only one of the first side plate 31 and the second side plate 32 is mounted moveably in the longitudinal direction L of the blades 2, whereas the other side plate is mounted stationary. In other embodiments, both side plates 31, 32 are mounted moveably in the longitudinal direction L of the blades 2.

**[0035]** In embodiments of the invention, a distance between the first side plate 31 and the second side plate 32 is continuously adjustable, for example using actuator or a spring element assembly comprising at least one spring element made of shape memory material. In order to realize a number of predefined blade profiles, in one embodiment at least one predefined intermediate stop position is defined between a maximum distance and a minimum distance of the first side plate 31 and the second side plate 32, wherein for example a mechanical and/or electronical endstop (not shown) is provided for limiting a movement of at least one of the first side plate 31 and the second side plate 32 in order to reliably obtain the at least predefined intermediate stop position. A movement beyond the endstop, in particular beyond a mechanical endstop, in one embodiment is possible by applying a higher force. In other embodiments, the endstop, in particular an electromechanical endstop can be deactivated for a movement beyond the endstop.

**[0036]** Fig. 9 to 11 show further embodiments of a blade 2 having a backbone 21 and a lamella 20 similar to the blade 2 shown in Fig. 3, wherein for the same or similar elements the same reference numbers are used.

**[0037]** In contrast to the embodiment shown in Fig. 3, in the embodiment shown in Fig. 9 the backbone 21 is predeflected, such that the backbone 21 has a lateral deflection when the lamella 20 is in an initial state shown in Fig. 9. The predeflection is advantageous for ensuring a desired deformation of the blade 2.

**[0038]** The blade 2 as shown in Figs. 2 to 4 and 9 on embodiments of the invention are manufactured of plastic material, for example using 3D printing techniques. In one embodiment, the blades are manufactured using multi-material printing techniques, wherein two or more different plastic materials, having different material properties, are printed simultaneously. Depending on a ratio of the at least two plastic materials, it is possible to form a blade 2 having a comparatively rigid backbone 21 and a comparatively flexible lamella 20.

**[0039]** Fig. 10 shows a blade 2 with a backbone 21 and a lamella 20, which blade 2 is manufactured in metal for example using a punching technique. In one embodiment, different stiffness of the backbone 21 and the lamella 20 are achieved by a suitable deformation of the metal material, for example providing beads. In alternative or in addition, in one embodiment the backbone 21 is strain-hardened during or after a punching step. In addition, the backbone 21 can also be brought into a curved shape.

**[0040]** In the embodiment shown, a number of parallel slots 207 are provided in a proximal area 205 of the lamella 20 adjacent to the backbone 21, which slots 207 extend crosswise to the longitudinal direction L. Due to the slots 207, the proximal area 205 has a lower stiffness than a distal area 206 of the lamella 20 and a preferential direction for the deformation of the lamella 20 is achieved.

**[0041]** Fig. 11 shows a blade 2 with a backbone 21 and a lamella 20 similar to Fig. 10, which blade 2 is manufactured in metal for example using a punching technique. In the embodiment shown in Fig. 11, the lamella 20 is provided with a heating conductor 24. The heating conductor allows the conveyed medium, in particular air, to be heated directly when passing the blade 2. In the embodiment shown in Fig. 11, the heating conductor 24 is provided at the distal area 206 of the lamella 20, i.e. in an area of low deformation.

**[0042]** Fig. 12 shows in a top view a second embodiment of an impeller 103, wherein the impeller 103 shown in Fig. 12 is a split impeller 103, having inner blades 102 and outer blades 2. In the embodiment shown, the outer blades 2 are deformable for adjusting a blade geometry of the impeller 103, whereas the inner blades 102 have a fixed profile.

**[0043]** Fig. 13 schematically shows a household appliance 4, for example a dishwasher or a dryer, with cleaning compartment 40 to which a medium, for example air, is conveyed using a turbomachine 5, for example a cen-

trifugal fan, comprising an impeller 3 as shown in Figs 5 to 8 or 12.

**[0044]** Supply air is conveyed to the cleaning compartment 40 via an air intake duct 41 and outgoing air is discharged to the outside via an exhaust air duct 42. A circulation of the air is achieved by means of the turbomachine 5

**[0045]** Upstream of the turbomachine a device 43 such as a filter, condensation unit or a heat pump is provided, wherein the circulated air either passes through the device 43 or is conveyed through a bypass 44. In one embodiment, a blade profile of the blades of the turbomachine is adjusted depending on whether or not the circulated air passes through the device 43.

**[0046]** The blades and impellers according to the invention are not limited to the embodiments described by way of example and illustrated in the drawings. Alternatives and combinations of the described and illustrated embodiments that fall under the claims are also possible.

## Claims

1. A blade for an impeller, in particular for a radial flow impeller, the blade (2) comprising a lamella (20), which is at least partly reversibly elastically deformable, **characterized in that** the blade (2) further comprises a backbone (21) extending in a longitudinal direction (L), which backbone (21) is mounted to or formed integrally with a side (200, 201, 202, 203) of the lamella (20), wherein the backbone (21) has a first end (211) and a second end (212), which first end (211) and second end (212) are reversibly displaceable in the longitudinal direction (L) towards each other under a lateral deflection of the backbone (21), wherein the lamella (20) is configured such that the lateral deflection of the backbone (21) causes a lateral deformation of the lamella (20) and a flap motion of the lamella (20) about an axis parallel to the longitudinal direction (L).
2. The blade according to claim 1, **characterized in that** the backbone (21) is predeflected, such that the backbone (21) has a lateral deflection when the lamella (20) is in an initial state.
3. The blade according to claim 1 or 2, **characterized in that** a proximal area (205) of the lamella (20) adjacent to the backbone (21) has a lower stiffness than a distal area (206) of the lamella.
4. The blade according to any one of claims 1, 2 or 3, **characterized in that** the lamella (20) and/or the backbone (21) are made of metal material, in particular made of a metal sheet or a metal tube.
5. The blade according to any one of claims 1 to 4, **characterized in that** the lamella (20) is provided with a heading conductor (24), wherein in particular the heading conductor (24) is provided at the distal area (206) of the lamella (20).
6. The blade according to any one of claims 1 to 5, **characterized in that** the lamella (20) and/or the backbone (21) are made of plastic material, in particular made using two or more different plastic materials.
7. An impeller, in particular a radial flow impeller comprising at least one blade (2) according to any one of claims 1 to 6.
8. The impeller according to claim 7 comprising a first side plate (31) and a second side plate (32), which are distanced from each other in the longitudinal direction (L) of the at least one blade (2), wherein the first end (211) of the backbone (21) is mounted to the first side plate (31) and the second end (32) of the backbone (21) is mounted to the second side plate (32).
9. The impeller according to claim 8, **characterized in that** at least one of the first side plate (31) and the second side plate (32) is mounted displaceable in the longitudinal direction (L) of the blade (2).
10. The impeller according to claim 9, **characterized in that** the impeller (3) is configured for a displacement of at least one of the first side plate (31) and the second side plate (32) in response to a temperature change.
11. The impeller according to any one of claims 9 or 10, **characterized in that** at least one spring element made of shape memory material is provided for causing a displacement of at least one of the first side plate (31) and the second side plate (32) in the longitudinal direction (L) of the blade (2) towards and/or away from each other.
12. The impeller according to any one of claims 9 to 11, **characterized in that** a distance between the first side plate (31) and the second side plate (32) is continuously adjustable, wherein in particular at least one predefined intermediate stop position is provided between a maximum distance and a minimum distance of the first side plate (31) and the second side plate (32).
13. The impeller according to any one of claims 7 to 12, wherein the impeller is a split impeller (103), having inner blades (102) and outer blades (2), and wherein at least the outer blades (2) are deformable for adjusting a blade profile.
14. A turbomachine, in particular a centrifugal fan or a

centrifugal pump, with an impeller (3, 103) according to any one of claims 7 to 13.

15. A household appliance comprising a turbomachine according to claim 14.

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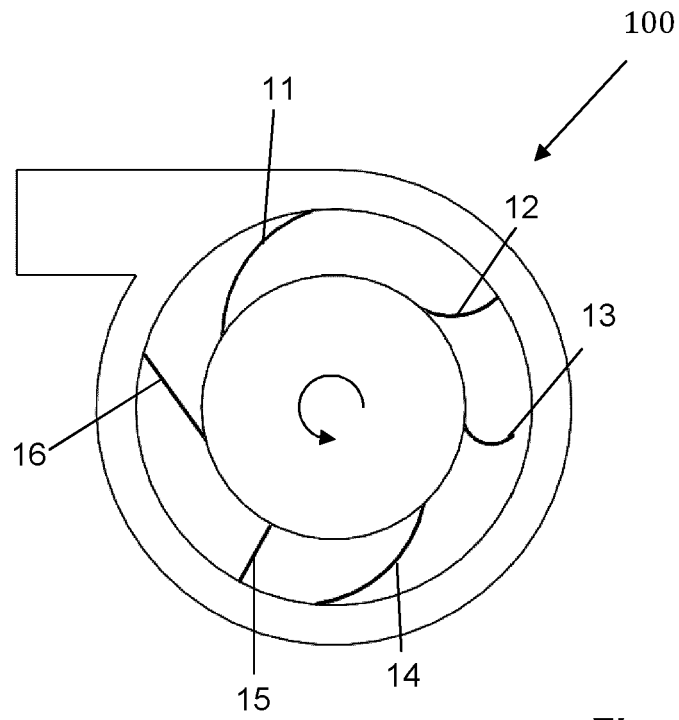
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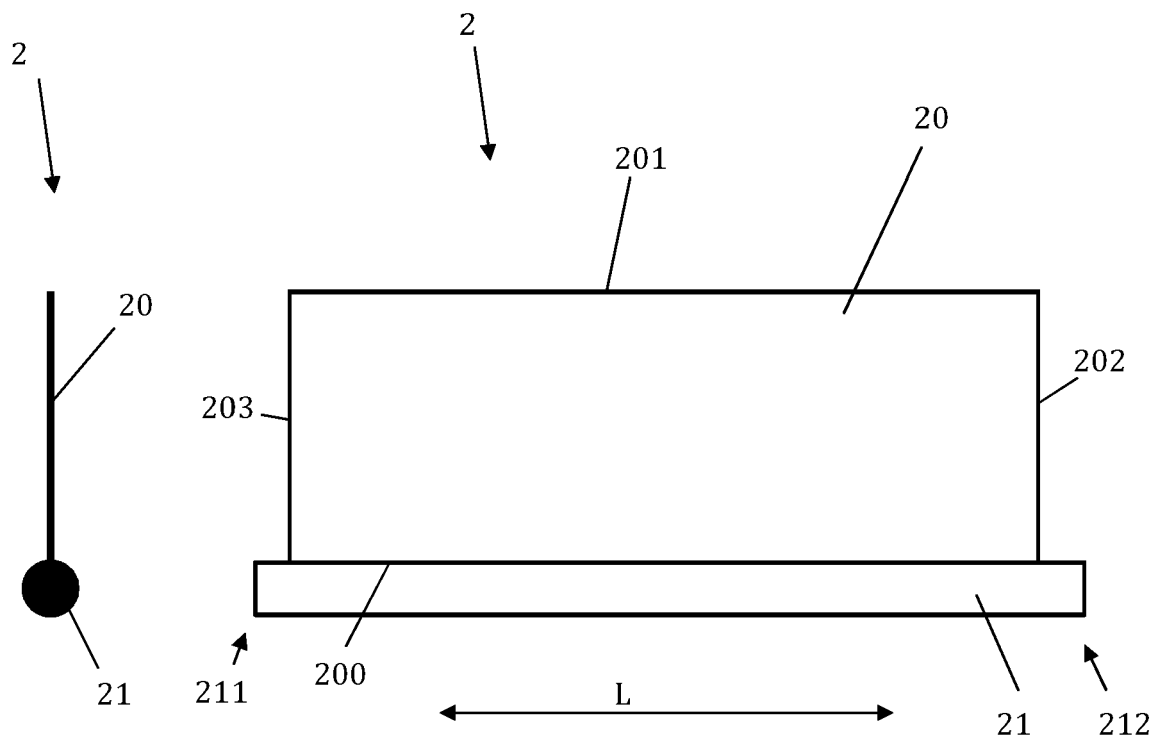
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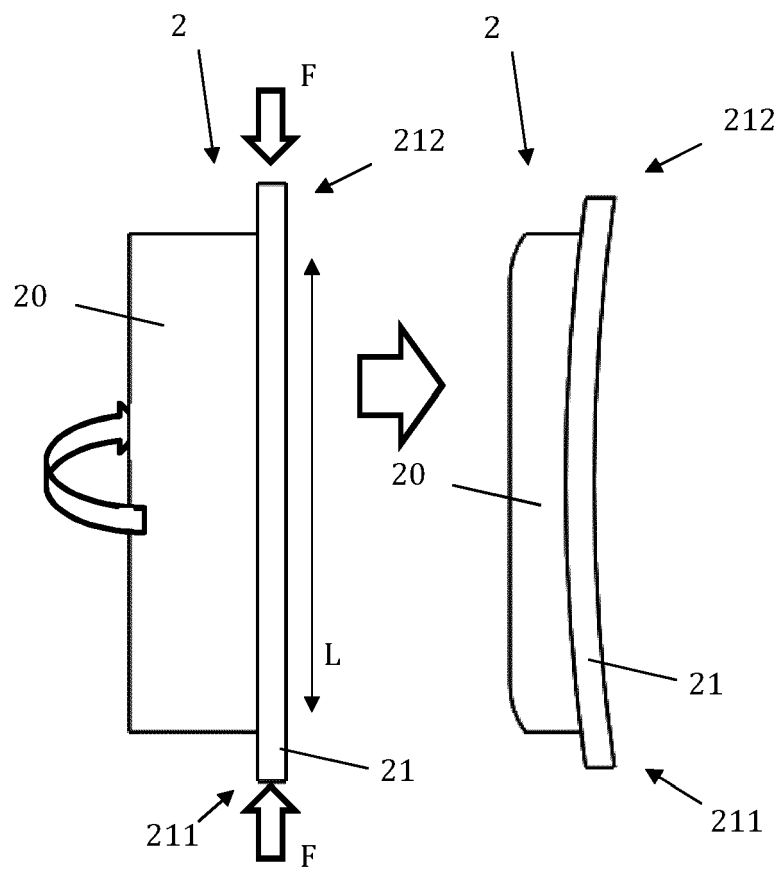


**Fig. 1**

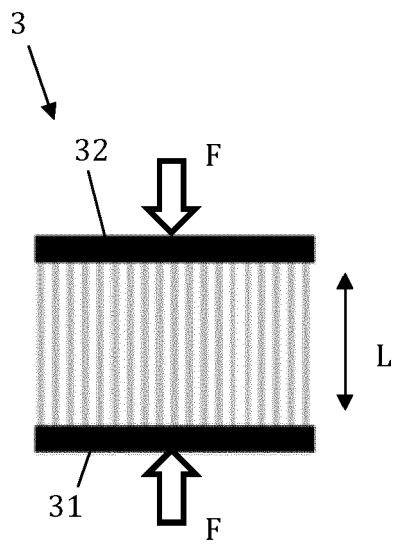


**Fig. 2**

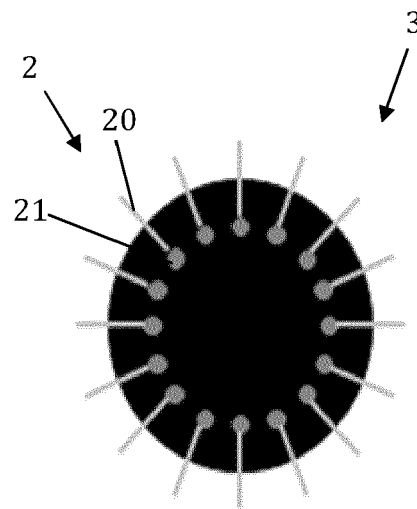
**Fig. 3**



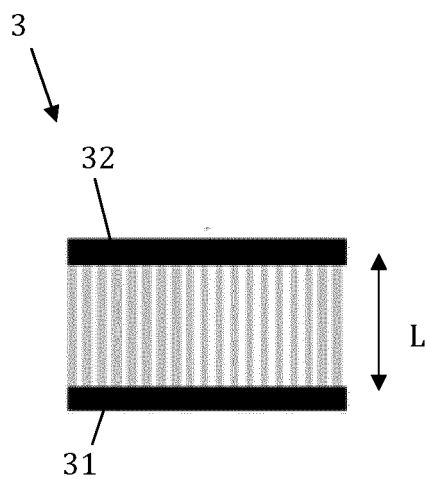
**Fig. 4**



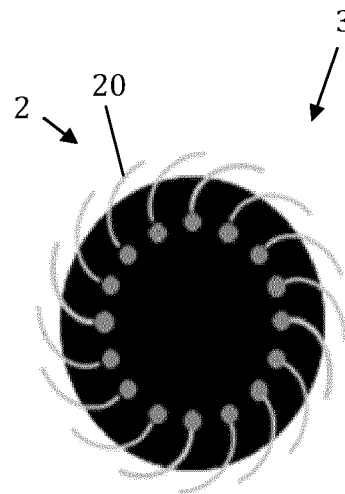
**Fig. 5**



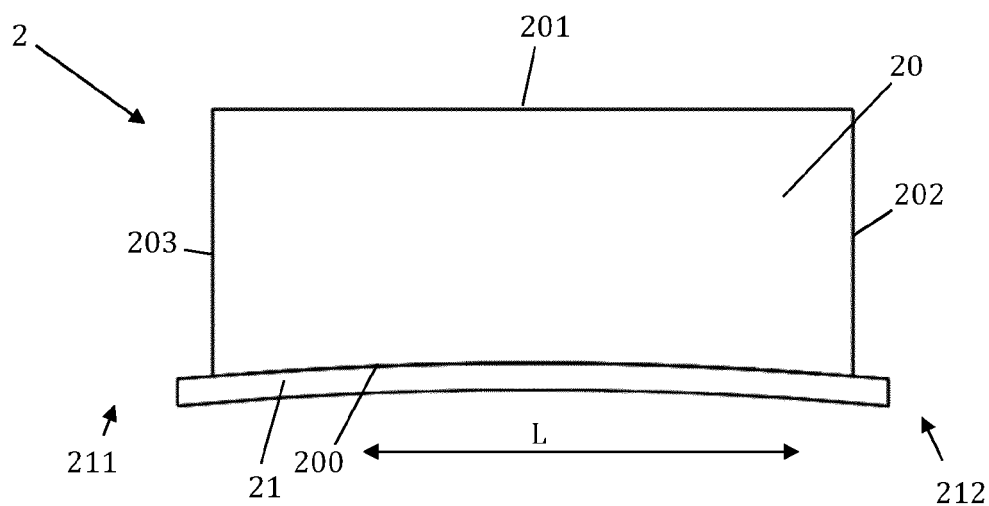
**Fig. 6**



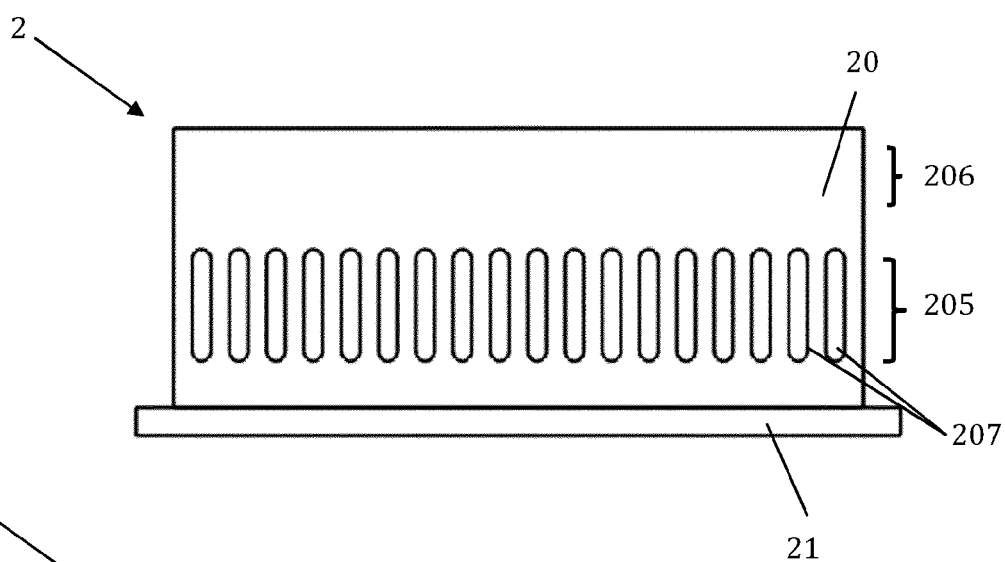
**Fig. 7**



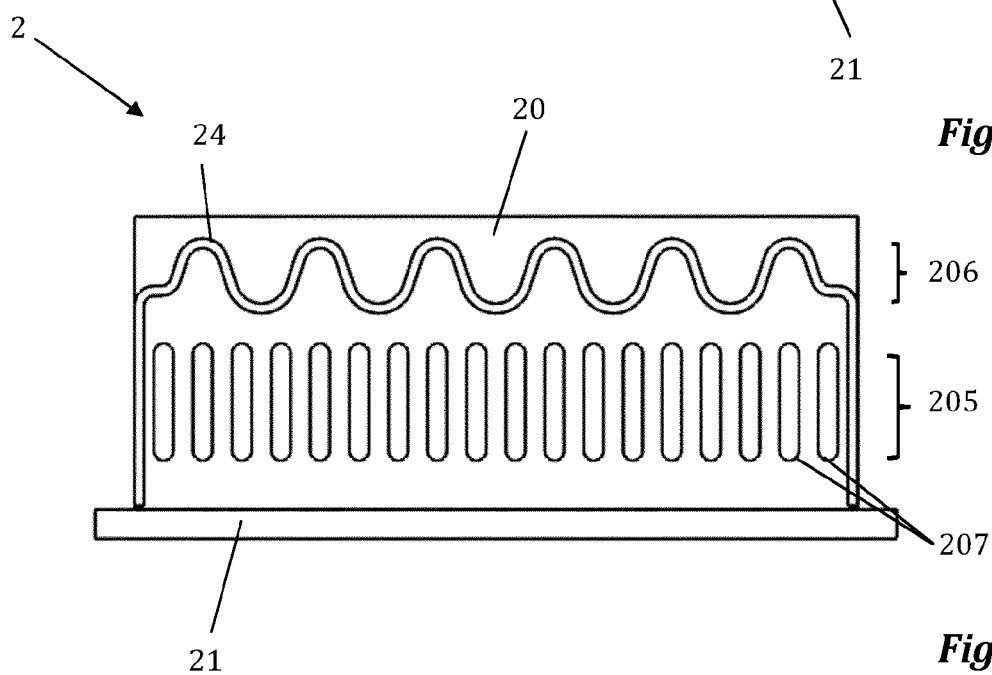
**Fig. 8**



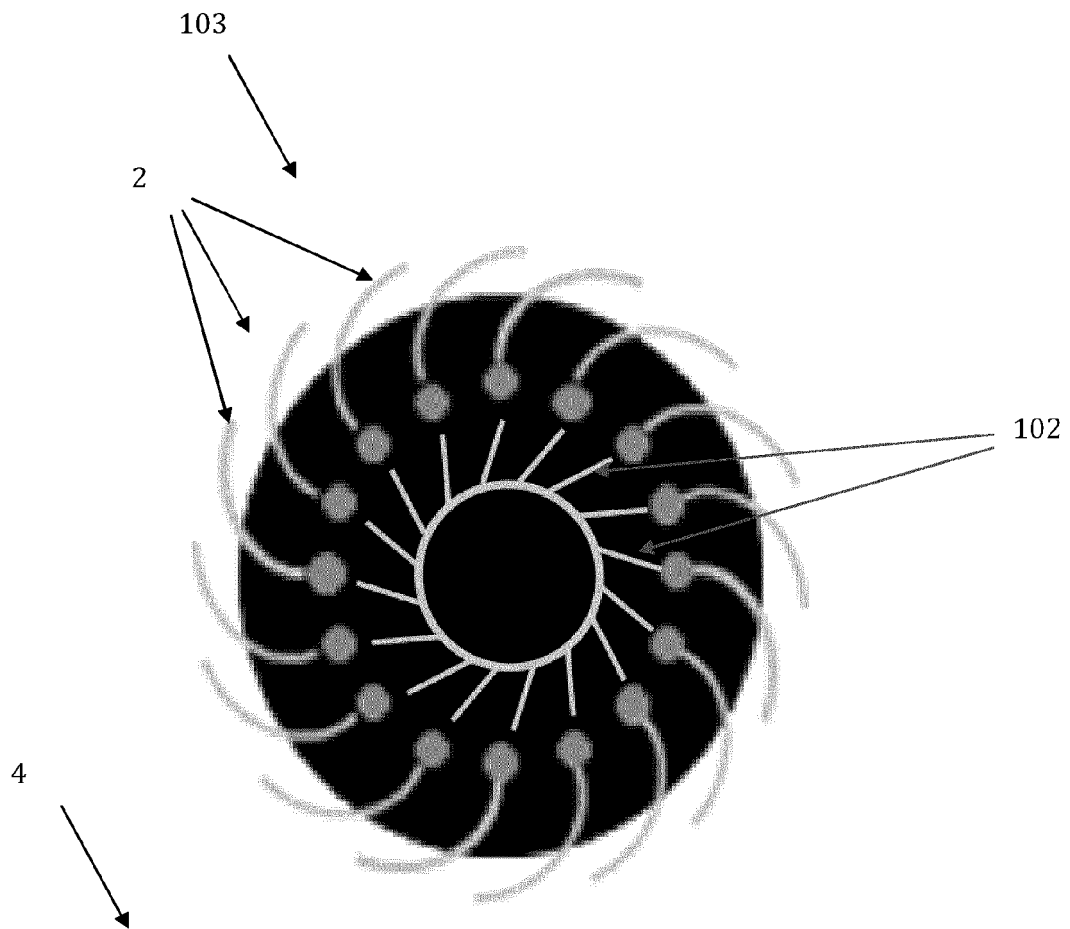
**Fig. 9**



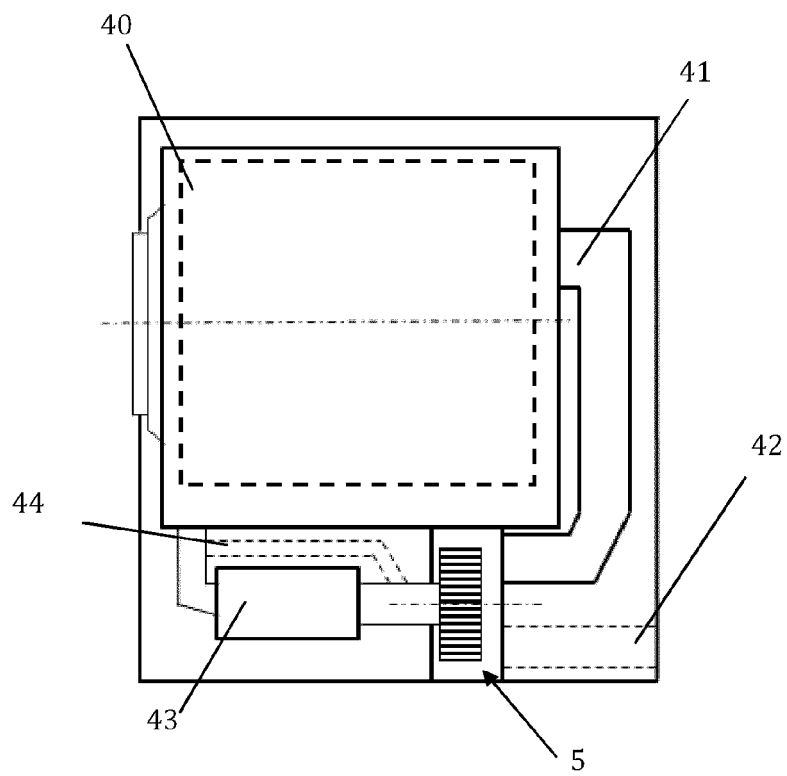
**Fig. 10**



**Fig. 11**



**Fig. 12**



**Fig. 13**



## EUROPEAN SEARCH REPORT

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                            |                                                    |                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                              | Relevant to claim                                  | CLASSIFICATION OF THE APPLICATION (IPC) |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DE 10 2005 038217 A1 (SCHLOETZER OLIVER [DE]) 15 February 2007 (2007-02-15)<br>* paragraphs [0005] - [0011]; figures 1-3 * | 1-15                                               | INV.<br>F04D29/24<br>F04D29/30          |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DE 10 35 313 B (LICENTIA GMBH)<br>31 July 1958 (1958-07-31)<br>* column 2, line 25 - column 4, line 20; figures 1-12 *     | 1,2,4,6,7                                          |                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 5 993 158 A (YOUNG RICHARD NILS [US])<br>30 November 1999 (1999-11-30)<br>* column 7, lines 5-44; figures 1,2,4c *      | 3,14,15                                            |                                         |
| A,D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | US 2014/193260 A1 (BLOCK VOLKER [DE] ET AL) 10 July 2014 (2014-07-10)<br>* paragraphs [0033], [0034]; figure 2 *           | 8                                                  |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            |                                                    | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                            |                                                    | F04D                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                            |                                                    |                                         |
| Place of search<br>The Hague                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                            | Date of completion of the search<br>10 August 2020 | Examiner<br>Nobre Correia, S            |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                            |                                                    |                                         |

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ON EUROPEAN PATENT APPLICATION NO.**

EP 20 15 9221

5

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The members are as contained in the European Patent Office EDP file on  
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| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                    | Publication<br>date                                                |
|-------------------------------------------|---------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| DE 102005038217 A1                        | 15-02-2007          | NONE                                                                                          |                                                                    |
| DE 1035313 B                              | 31-07-1958          | NONE                                                                                          |                                                                    |
| US 5993158 A                              | 30-11-1999          | AU 1091299 A<br>EP 1023220 A1<br>US 5993158 A<br>WO 9920523 A1                                | 10-05-1999<br>02-08-2000<br>30-11-1999<br>29-04-1999               |
| US 2014193260 A1                          | 10-07-2014          | CN 103702601 A<br>DE 102011078017 B3<br>EP 2723224 A1<br>US 2014193260 A1<br>WO 2012175652 A1 | 02-04-2014<br>21-06-2012<br>30-04-2014<br>10-07-2014<br>27-12-2012 |

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- US 2014193260 A1 [0003]