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(71) Applicants:
- **JIJ-plast**
  25373 Helsingborg (SE)
- **Heatex AB**
  231 65 Trelleborg (SE)

(72) Inventors:
- **Swantesson, Mikael**
  216 22 Limhamn (SE)
- **Delin, Stina**
  252 71 Råå (SE)

(74) Representative: **Ström & Gulliksson AB**
Box 4188
203 13 Malmö (SE)

(54) **A hub for a thermal wheel of a rotary heat exchanger**

(57) A hub (100) for a thermal wheel of a rotary heat exchanger is provided. The hub (100) has a cylindrical and longitudinal body (110, 120), having a centrally aligned and longitudinally extending lumen or through hole (116) for receiving a support axis, said support axis suspending the thermal wheel of the rotary heat exchanger, wherein at least the surface of the cylindrical and longitudinal body (110, 120) facing the support axis is of a polymeric material.

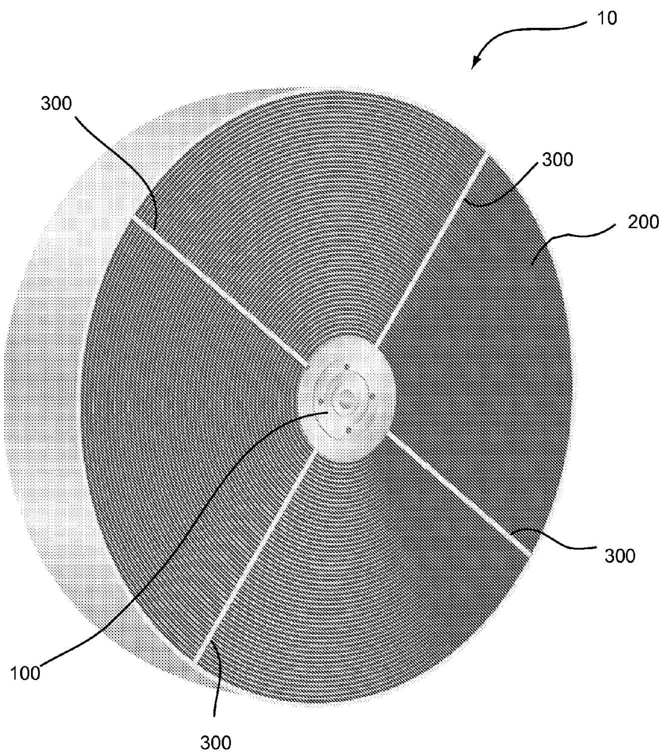

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a hub. More particularly, the present invention relates to a hub arranged to transmit rotational movement to a thermal wheel of a rotary heat exchanger.

PRIOR ART

[0002] Hubs are commonly used for allowing a wheel to rotate relative a fixed support. In many applications, bearings may be assembled to form a hub for allowing the wheel to rotate at low friction relative the stationary support.

[0003] In the field of rotary heat exchangers, i.e. heat exchangers having a thermal wheel, hubs are inserted at the rotational axis of the rotating thermal wheel to allow them to rotate during use. As of today, such hubs may have metal ball bearings or slide bearings for enabling such rotation. Rotary heat exchangers of this type are readily available from a number of manufacturers.

[0004] The diameters of commercially available rotary heat exchangers are typically between 500 and 2500 mm. As the size of the thermal wheel increases the demands on the hub does too..

[0005] However, using bearings of known types for forming hubs of a rotary heat exchanger has a number of disadvantages. Hubs having metal ball bearings and/or slide bearings are often very complex constructions, having small tolerances and being made to a particular size of the thermal wheel to fit properly. Moreover such hubs are heavy, leading to increased energy consumption during operation. Also, ball bearings of small diameters are more prone to decreased bearing capacity during prolonged use, due to the proportional negative effect of adhering dust, dirt etc.

[0006] As thermal wheels may vary between different standard thicknesses, a distributor or manufacturer of hubs must hold hubs of all sizes in stock for fast delivery. This elevates storage charges, thus leading to more expensive hubs.

SUMMARY OF THE INVENTION

[0007] It is an object of the invention to provide a hub that fully or partially overcomes the above-mentioned drawbacks of prior art hubs. Moreover, a further object is to provide a hub that is versatile and may easily be adjusted to fit different sizes of thermal wheels. A yet further object of the present invention is to provide a hub that is less expensive to manufacture, still providing sufficient properties for the particular application. A still further object of the present invention is to provide a hub that allows for reduced energy consumption during operation of the rotary heat exchanger.

[0008] According to a first aspect of the invention, a hub for a thermal wheel of a rotary heat exchanger is provided, having a cylindrical and longitudinal body, having a centrally aligned and longitudinally extending lumen or through hole for receiving a support axis, said support axis suspending the thermal wheel of the rotary heat exchanger, wherein at least the surface of the cylindrical and longitudinal body facing the support axis is of a polymeric material.

[0009] The hub may be entirely made of a polymeric material, which is advantageous in that the hub may be manufactured using simple processes, and in that the material costs are reduced.

[0010] The polymeric material may be a thermoplastic material, and the thermoplastic material may be POM. Hence, the hub may be manufactured by means of injection molding which is a well known and cost effective process.

[0011] The cylindrical and longitudinal body may comprise a cylindrical member extending along a rotational axis of said thermal wheel, said cylindrical member having a first end comprising said lumen or through hole and means for connecting said cylindrical member to a driving system, and an end portion comprising a lumen or through hole for receiving said support axis, said end portion being insertable into said cylindrical member at a second end being opposite the first end. This is advantageous in that manufacturing is facilitated.

[0012] The cylindrical member may comprise a topographical pattern at its interior surface, such that the end portion is prevented from being inserted beyond said pattern. This ensures that mounting may be performed by the end user, since unintended mounting is prevented by the pattern.

[0013] The thickness of the end portion may be either equal or twice the distance between the pattern and the second end. Hence, the end portion may be used to close the open end or to form an intermediate member for connecting two cylindrical bodies.

[0014] The first end of the cylindrical member may comprise a centrally aligned lumen or through hole, and at least one recess arranged off-center. This facilitates mounting of the thermal wheel onto the hub.

[0015] The end portion may comprise a central portion extending from a first side to a second side, at least one sector extending radially from said first side of said central portion, and at least one sector extending radially from said second side of said central portion, wherein the central portion and the sectors are forming a circular end piece. The end portion may further comprise three sectors extending radially from said first side of said central portion and three sectors extending radially from said second side of said central portion, wherein each sector extending radially from said first side is arranged angularly adjacent to two sectors extending radially from said second side. Moreover, each sector extending radially from said first side may be connected to a sector extending radially from said second side by means of a member extending from the first side to the second side. This is advantageous in that the end portion may carry two longitudinal bodies such that the force on the end portion is distributed uniformly on the first and second sides, leading to a rigid and resistant construction.

[0016] The hub may further comprise a second cylindrical member extending along a rotational axis of said thermal wheel, said cylindrical member having a first end comprising said lumen or through hole, wherein said end portion is simultaneously insertable into the cylindrical member and the second cylindrical member thus forming a connection between the cylindrical members. Hence, hubs of different dimensions may be provided in a simple and flexible way.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Hereinafter, the invention will be described with reference to the appended drawings, wherein:

Fig. 1 is a perspective view of a thermal wheel of a rotary heat exchanger.
Fig. 2 is a perspective view of a hub according to an embodiment of the present invention;
Fig. 3 is an exploded view of a hub according to an embodiment of the present invention; and
Fig. 4 is an exploded view of a hub according to a further embodiment of the present invention; and
Fig. 5 is a semi-exploded view of a hub according to a yet further embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0018] With reference to Fig. 1, a thermal wheel 10 of a rotary heat exchanger is shown. The thermal wheel 10 is formed by a central hub 100 and a matrix 200 that is connected to the hub 100. The hub 100 is a longitudinal and tubular body, having a central lumen for receiving a support axis (not shown). The support axis suspends the thermal wheel 10 in an operating position wherein the thermal wheel 10 is allowed to rotate relative the support axis. The hub 100 has an outer surface facing the matrix 200, and the thermal wheel 10 is preferably mounted in a casing (not shown) to form a rotary heat exchanger. Additional components are thus required, including a drive system, sealings, and the provision of a fluid flow. As rotary heat exchangers are well known, the physical principles of operation will not be described in detail.

[0019] The drive system (not shown) typically comprises an electrical motor designed to rotate at 0,5 to 20 rounds per minute. The rotational shaft of the electrical motor is connected to a pulley that drives an endless belt. The endless belt is further connected to the thermal wheel 10, either at its periphery or by means of a bearing connected to the hub 100. Hence, when the electrical motor is running the thermal wheel 10 will consequently also rotate. A control system may also be provided for regulating the rotational speed of the thermal wheel 10. This is advantageous in applications where the rotational speed needs monitoring for optimizing the efficiency of the heat exchanger.

[0020] Now referring to Fig. 2, a hub 100 according to an embodiment is shown. The hub 100 has an inner surface, i.e. the surface that during operation is facing the support axis, of a polymeric material. The present inventors have surprisingly found that a hub of a polymeric material still satisfies the bearing demands for small rotational heat exchangers. Thus, ball bearings may be omitted in such small rotational heat exchangers. Conveniently, to avoid complicated laminating steps, the hub 100 is entirely made of a polymeric material. In this way the hub 100 in its entirety or hub parts assembled into the hub 100 may be molded, such as injection molded, resulting in an easy and cost-effective manufacturing process. It is however within the inventive concept to manufacture the hub 100 from a core in another material than polymeric material, whereafter the core is coated with a polymeric material. The polymeric material may suitably be a plastic material. Preferably, the plastic material is a thermoplastic material. When the polymeric material is a thermoplastic material, the material may be reused, once the hub 100 has been worn sufficiently long. Also, thermoplastic materials facilitate the manufacturing process and the quality of the hub, because of the shapability making injection molding possible, which in turn allows for improved surface control and thus decreased risk of uneven running. When the thermoplastic material is an acetal based plastic, such as POM (polyoxymethylene), further beneficial effects are obtained because of (i) the high chemical resistance and resistance to base hydrolysis, leading to reluctant reaction with environmental substances, making the heat exchanger suitable for an improved number of settings; and (ii) the low water absorption, leading to decreased risk of metal oxidation in the interface between the thermal wheel and the hub.

[0021] The hub 100 comprises a longitudinal and cylindrical member 110 having an outer diameter corresponding to the inner diameter of the thermal wheel 10. Hence, the cylindrical member 110 may be inserted and fitted into the thermal wheel 10. The cylindrical member 110 has a first end 112, and an open second end 114. The first end 112 has a centrally aligned and longitudinal extending lumen or through hole 116 and at least one recess 118 being aligned off center. The cylindrical member 110 further comprises a longitudinal slit 119 extending longitudinally from one end to the other on the outside of the cylindrical member 110. The recess 118 and the slit 119 are provided to facilitate mounting and monitoring of the rotational matrix, as will be further described later on.

[0022] With reference to Fig. 3, the hub 100 further comprises a circular end portion 120a being insertable into the open end 114 of the cylindrical member 110. The end portion 120a has a centrally aligned lumen or through hole 122 that is aligned with the through hole of the first end when the end portion 120a is inserted in the cylindrical member 110.

[0023] When the assembled hub is positioned inside the thermal wheel, the hub will allow a rotational movement to be transmitted from the hub to the thermal wheel, or vice versa. The hub is thus connected to a central axis, extending through the hub via the centrally aligned through holes 116, 122. The thermal wheel is thus allowed to rotate relative the support axis by means of the drive system. The drive system may either be connected to the outer periphery of the thermal wheel or to the hub by means of the belt..

[0024] The end portion 120a has a central portion 124 that encloses the through hole 122, which central portion 124 extends from a first side 126 to a second side 128. Sectors 130, 132 are arranged between the central portion 124 and the periphery of the end portion 120. Three sectors 130a, b, and c are arranged at the first side 126 of the end portion 120, extending radially perpendicular to the axis of the through hole 122. Further, three sectors 132a, b, and c are arranged at the second side 128 of the end portion 120, extending radially perpendicular to the axis of the through hole 122. Each sector 130a-c, 132a-c is 60° wide.

[0025] Each sector 130a-c being arranged at the first side 126 is arranged adjacent to two sectors 132a-c being arranged at the second side 128, and being connected to these sectors by means of a connecting member 134 extending perpendicular to the axis of the through hole 122 and perpendicular to the sectors 130, 132.

[0026] The relative dimensions of the end portion 120a may be varied. For example, the radius of the central portion 124 may be made larger and the radius of each sector 130, 132 may be made smaller, correspondingly. This may be advantageous in that the body mass of the end portion 120a is made larger, thus increasing the capability of carrying load. In an alternative embodiment, the central portion 124 may be made smaller such that it merely encloses the through hole 122. This may be advantageous in cases where the load to carry is small, in which case the weight and material costs may be reduced.

[0027] In alternative embodiments, the number of sectors 130, 132 is varied from two and upwards. For such embodiments, the number of sectors 130 extending from the first side 126 equals the number of sectors extending from the second side 128. Further, the angular width of the sectors is substantially the same.

[0028] The periphery of the end portion 120a is adapted to fit the interior surface of the open end 114 of the cylindrical member 110. For this purpose, the inner diameter of the cylindrical member 110 is slightly enlarged at the open end 114 by means of a circumferential edge 115. The interior surface of the open end 114 further comprises a topographical pattern 140 being arranged at the enlarged inner diameter. The pattern 140 has a number of circumferential protrusions 142 being equal to the total number of sectors 130, 132, each protrusion having the same angular width as the sectors 130, 132. The protrusions 142 are spaced apart by a distance being equal to the thickness of the connecting member 134. The width of each protrusion is further designed to be equal, or slightly less, than the axial distance between the interior surfaces of two opposite sectors 130, 132.

[0029] The end portion 120a is designed to fit with the interior surface of the cylindrical member 110 such that the end portion 120a is prevented from moving both axially and radially.

[0030] In a second embodiment, as is shown in Fig. 4, the thickness of the end portion 120b is twice as large as the end portion 120a shown in Fig. 3, i.e. twice as large as the distance between the open end 114 of the cylindrical member 110 and the edge where the inner diameter of the cylindrical member 110 is changed. Hence, when the end portion 120b is inserted into a cylindrical member 110, half of the end portion 120b will extend outside the cylindrical member 110 and this part may thus be inserted into a second cylindrical member 110. This is shown in Fig. 5.

[0031] When two cylindrical members 110 are connected, the intermediate portion 120b is designed to fit with the interior surface of the cylindrical members 110 such that the intermediate portion 120b is prevented from moving both axially and radially. Consequently, the cylindrical members 110 are secured and are not allowed to move relative each other.

[0032] Having access to end portions 120a, b having different thicknesses, hubs of different length may be easily assembled. Consequently, a number of different thermal wheel thicknesses may be fitted easily be combining standard hub parts.

[0033] In the following, a scenario will be described wherein a hub producer is manufacturing cylindrical members 110 having a length of 100 and 150 mm, respectively. End portions 120a, b having a thickness of 10 and 20 mm, respectively are also manufactured. By assembling a cylindrical member and a 10 mm end portion, or by assembling two cylindrical members via a 20 mm end portion hubs of 100, 150, 200, 250 or 300 mm length may be assembled.

[0034] In the following, a method for providing a thermal wheel of a rotary heat exchanger will be described. In a first step, sheets of foil material are provided. Such material may for example be a first planar sheet and a second corrugated sheet, arranged on top of the planar sheet. The material of the sheets may be any material being suitable for thermal wheels, such as pure aluminum, aluminum coated with epoxy for use in corrosive environments, or aluminum being treated chemically for providing a hygroscopic or an adsorptive material. The sheets of material are cut to have a width corresponding to the final thickness of the thermal wheel. In other embodiments, the material of the sheets may be paper or carton, fabric, or polymeric material.

[0035] In a following step, a hub according to what has been described above is provided. The hub is assembled either by a solitary cylindrical member and a corresponding end piece, or by connecting two cylindrical members by means of an intermediate end piece acting as a connecting member.

[0036] The hub is then mounted on a driving device that is connected to the off-center recesses of the closed end of the hub. Further, one free end of the sheets of material is fastened in the longitudinal slit of the cylindrical member.

[0037] When the driving device is activated, the hub will rotate and the sheets of material will be rolled onto the hub. The hub is rotated until the radius of the thermal wheel equals a predetermined value, or when the sheets of material are completely rolled onto the hub. After this, a casing may be provided for preventing the free end of the sheets of material to move away from the thermal wheel. The casing may for example be provided as the outermost revolutions of sheet material being glued together, or as a tape or other polymeric material.

[0038] The present invention has been described above with reference to specific embodiments. However, other embodiments than the above described are equally possible within the scope of the invention. The invention is only limited by the appended claims.

Claims

1. A hub (100) for a thermal wheel of a rotary heat exchanger, said hub (100) having a cylindrical and longitudinal body (110, 120), having a centrally aligned and longitudinally extending lumen or through hole (116) for receiving a support axis, said support axis suspending the thermal wheel of the rotary heat exchanger, wherein at least the surface of the cylindrical and longitudinal body (110, 120) facing the support axis is of a polymeric material, wherein the cylindrical and longitudinal body comprises
a cylindrical member (110) extending along a rotational axis of said thermal wheel, said cylindrical member (110) having a first end (112) comprising said lumen or through hole (116) and means (118) for connecting said cylindrical member to a driving system, and
an end portion (120) comprising a lumen or through hole (122) for receiving said support axis, said end portion (120) being insertable into said cylindrical member (110) at a second end (114) being opposite the first end (112).

2. The hub according to claim 1, wherein the hub (100) is entirely made of a polymeric material.

3. The hub according to claim 2, wherein the polymeric material is a thermoplastic material.

4. The hub according to claim 3, wherein the thermoplastic material is POM.

5. The hub according to any one of claims 1 to 4, wherein the cylindrical member (110) comprises a topographical pattern (115, 140) at its interior surface, such that the end portion (120) is prevented from being inserted beyond said pattern (115, 140).

6. The hub according to claim 5, wherein the thickness of the end portion (120) is either equal or twice the distance between the pattern (115, 140) and the second end (114).

7. The hub according to any one of claims 1 to 6, wherein the first end (112) of the cylindrical member (110) comprises a centrally aligned lumen or through hole (116), and at least one recess (118) arranged off-center.

8. The hub according to any one of claims 1 to 7, wherein the end portion (120) comprises a central portion (124) extending from a first side (126) to a second side (128), at least one sector (130) extending radially from said first side (126) of said central portion (124), and at least one sector (132) extending radially from said second side (128) of said central portion (124), wherein the central portion (124) and the sectors (130, 132) are forming a circular end piece (120).

9. The hub according to claim 8, wherein the end portion (120) comprises three sectors (130a-c) extending radially from said first side (126) of said central portion (124) and three sectors (132a-c) extending radially from said second side (128) of said central portion (124), wherein each sector (130a-c) extending radially from said first side (126) is arranged angularly adjacent to two sectors (132a-c) extending radially from said second side (128).

10. The hub according to claims 8 or 9, wherein each sector (130) extending radially from said first side (126) is connected to a sector (132) extending radially from said second side (128) by means of a member (134) extending from the first side (126) to the second side (128).

11. The hub according to any one of claims 1 to 10, further comprising a second cylindrical member (110) extending along a rotational axis of said thermal wheel, said cylindrical member (110) having a first end (112) comprising said lumen or through hole (116), wherein said end portion (120b) is simultaneously insertable into the cylindrical member (110) and the second cylindrical member (110) thus forming a connection between the cylindrical members (110).

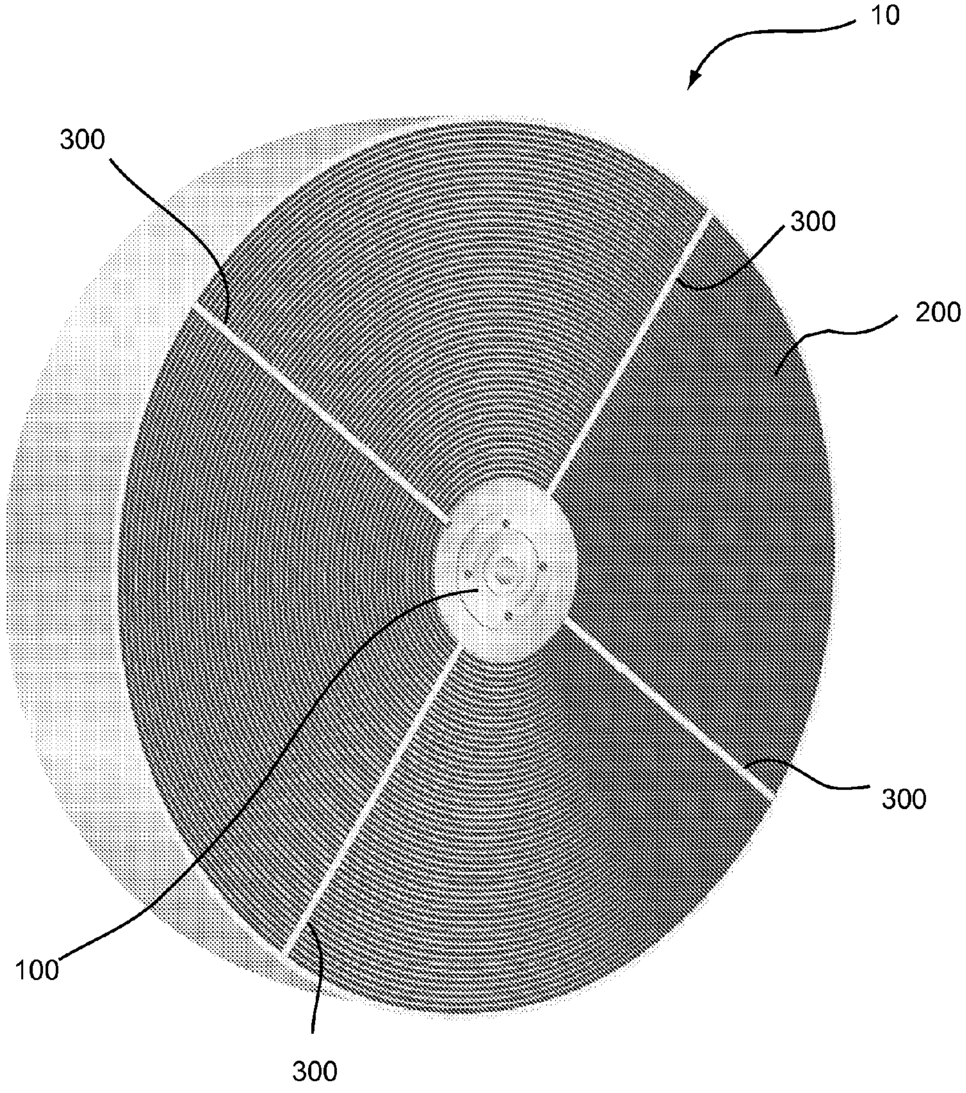


Fig. 1

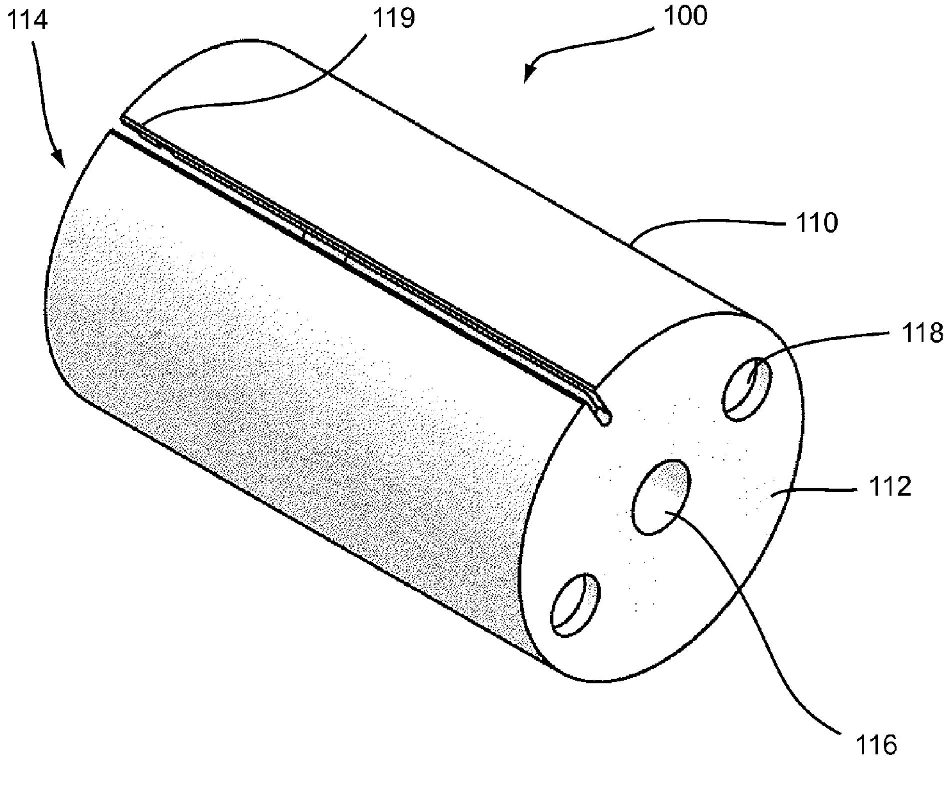
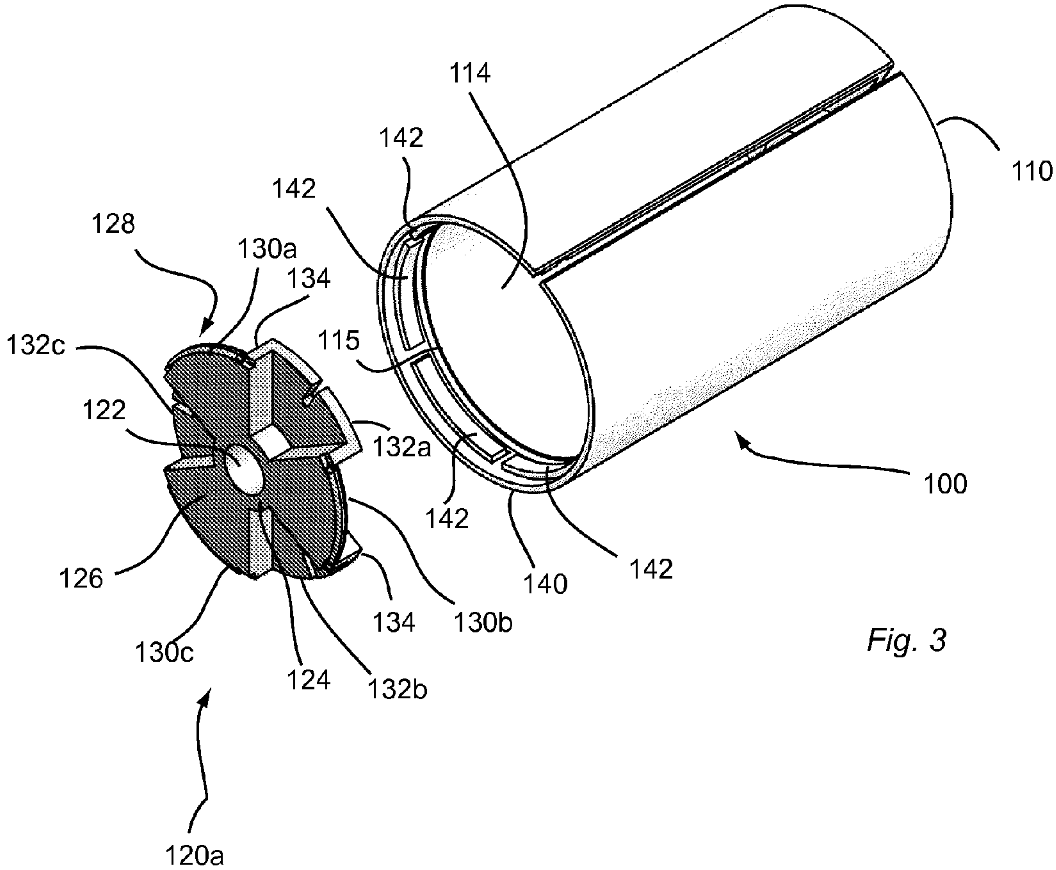


Fig. 2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110
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130a
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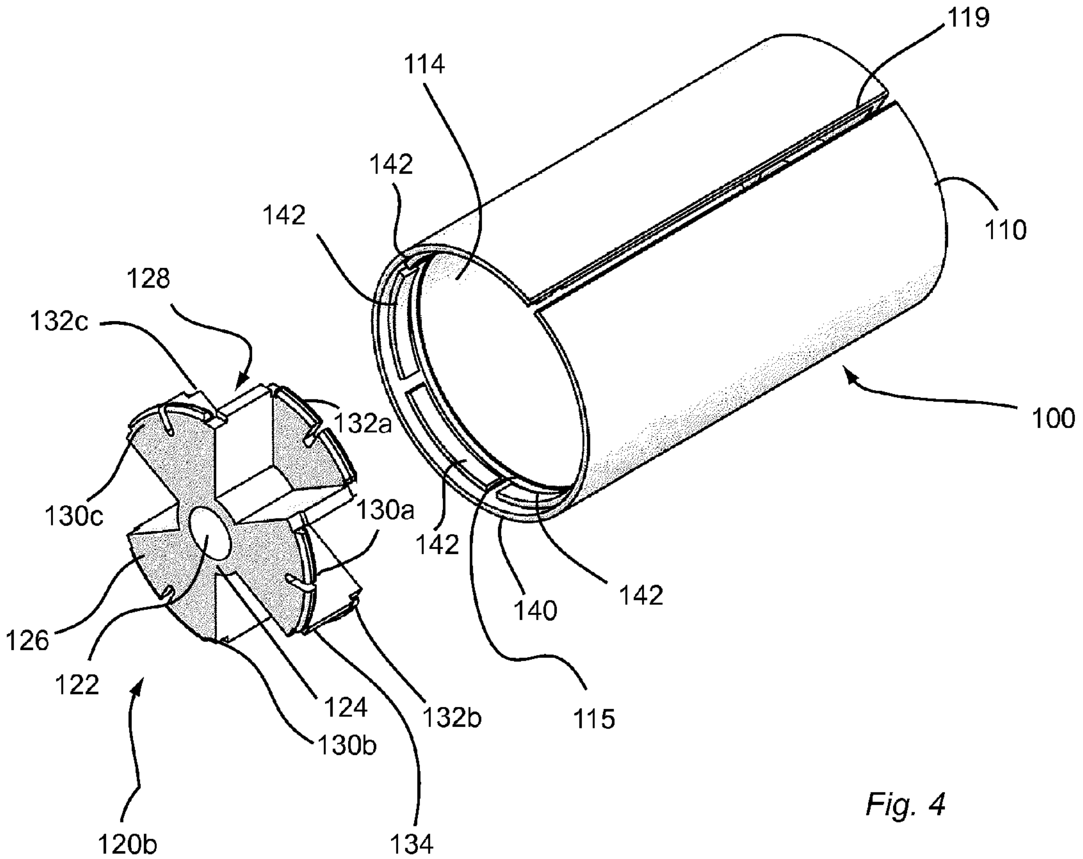
124
132b
120a

Fig. 3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130b
120b
134

Fig. 4

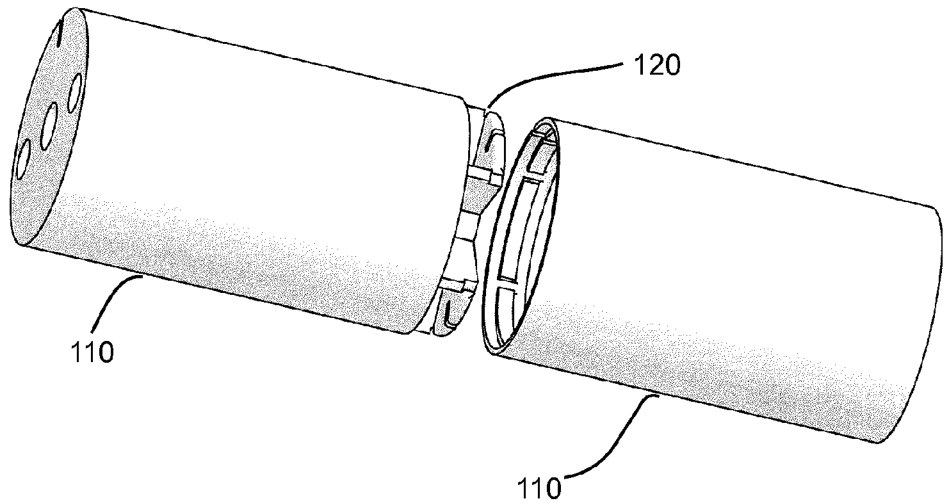

Fig. 5