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(54) BACKING PAD FOR A HAND-GUIDED POLISHING OR SANDING POWER TOOL

(57) The invention refers to a backing pad (2) for a hand-guided polishing or sanding power tool, comprising
- a support layer (4) made of a rigid material, the support layer (4) comprising a connection element (6) on its top surface (8) for connection of the backing pad (2) to a driving shaft (18) or an eccentric element of the polishing or sanding power tool,
- a damping layer (10) made of a resilient material, the damping layer (10) being fixedly attached to a bottom surface (12) of the support layer (4), and
- an adhesive layer (14) for releasable attachment of a polishing or sanding member to the backing pad (2), the adhesive layer (14) being fixedly attached to a bottom surface (16) of the damping layer (10)

It is suggested that the bottom surface (12) of the support layer (4) is provided with reinforcement elements (24, 26, 28; 46; 50, 52) for enhancing flexural rigidity of the support layer (4), and the bottom surface (12) of the support layer (4) is further provided with recesses (30) formed between and at least partially limited by the reinforcement elements (24, 26, 28; 46; 50, 52), wherein during manufacture of the backing pad (2) the resilient material of the damping layer (10) enters into the recesses (30) and after curing of the resilient material entirely fills the recesses (30).

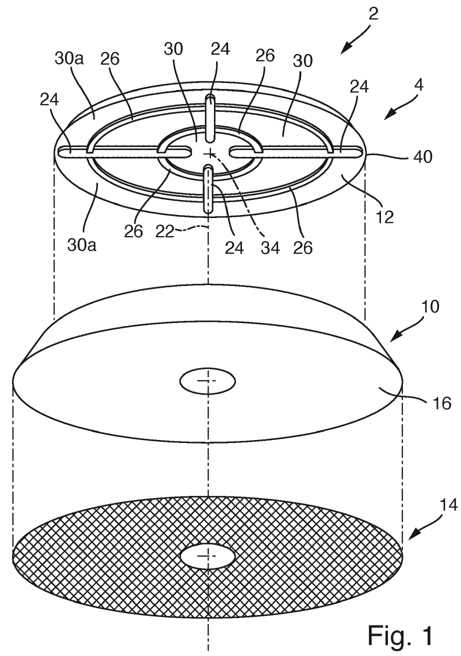

Fig. 1

EP 4 056 316 A1

Description

[0001] The present invention refers to a backing pad for a hand-guided polishing or sanding power tool, comprising

- a support layer made of a rigid material, the support layer comprising a connection element on its top surface for connection of the backing pad to a drive shaft or an eccentric element of the polishing or sanding power tool,
- a damping layer made of a resilient material, the damping layer being fixedly attached to a bottom surface of the support layer, and
- an adhesive layer for releasable attachment of a polishing or sanding member to the backing pad, the adhesive layer being fixedly attached to a bottom surface of the damping layer.

[0002] Hand-guided polishing or sanding power tools are commonly used in the field of sanding or polishing of surfaces of vehicle bodies, boat or ship hulls or airplane fuselages. Depending on the intended use of the tools, the type of processing and/or the user's preferences, the power tools can be operated electrically (with rechargeable batteries or with mains power supply connection) or pneumatically. The polishing or sanding power tools comprise an electric or pneumatic motor with a drive shaft. The drive shaft is connected to an attachment member in a torque-proof manner either directly or indirectly, e.g. by means of a bevel gear arrangement and/or a reducer gear arrangement. The attachment member may comprise an external thread, an adapter element and/or an eccentric element. A backing pad is releasably attached with its connection element to the attachment member. Known backing pads comprise a rigid support layer, usually made of glass fibre reinforced plastic material, comprising the connection element on its top surface for releasable attachment to the power tool. Fixedly attached to the bottom surface of the support layer, e.g. by means of co-moulding, is a damping layer made of resilient material, e.g. polyurethane. In the prior art the bottom surface of the support layer is an even surface. Attached to the bottom surface of the damping layer is an adhesive layer, e.g. comprising a hook-and-loop fastener, for releasable attachment of a polishing or sanding member, e.g. a polishing pad or a sheet-like sanding paper or sanding fabric.

[0003] A problem with the conventional backing pads is the fact that they tend to warp during intended use due to the rather high rotational speeds at which the backing pads are usually operated and due to an eccentric movement of the backing pad during its intended use, if used with an eccentric power tool effecting a random orbital or a roto-orbital working movement. Warping means that the backing pad tends to through waves in its plane of extension. This leads to a situation in which the backing pad or the polishing or sanding member, respectively, does no longer lie evenly with its entire bottom surface on the surface to be worked, resulting in an unsatisfactory efficiency and quality of the working process. Furthermore, in order to reduce the warp effect, the support layer of conventional backing pads is made of a rather expensive glass fibre reinforced plastic material. Finally, under some circumstances the damping layer can come off the support layer.

[0004] Therefore, it is an object of the present invention to provide for a backing pad which has an enhanced stiffness and flexural rigidity without increasing the overall weight of the backing pad, which has a safer and a tighter attachment of the damping layer to the support layer and which at the same time is more cost efficient than the known backing pads.

[0005] In order to solve this object, a backing pad with the features of claim 1 is suggested. In particular, starting from the backing pad of the above identified kind, it is suggested that the bottom surface of the support layer is provided with reinforcement elements for enhancing flexural rigidity of the support layer, and the bottom surface of the support layer is further provided with recesses formed between and at least partially limited by the elements, wherein during manufacture of the backing pad the resilient material of the damping layer enters into the recesses and after curing of the resilient material entirely fills the recesses.

[0006] The claimed structure of the backing pad, in particular of its support layer, has the advantage that the stiffness of the support layer and with it the flexural rigidity of the entire backing pad is significantly enhanced. The reinforcement elements clearly reduce the previously described warp effect of the backing pad during its intended use. This is in particular true when the backing pad is operated at rather high rotational speeds and when the backing pad effects an eccentric movement during its intended use. In particular, the reinforcement elements significantly reduce the tendency of the backing pad to through waves in its plane of extension during its intended use. As a result, during intended use of the backing pad it lies evenly with its entire bottom surface on the surface to be worked, resulting in a particularly high efficiency and quality of the polishing or sanding process. The intended use of the backing pad in the sense of the present invention means that the backing pad is attached to a polishing or sanding power tool and carries a polishing or sanding member on the bottom surface of the adhesive layer and that the power tool is operated at a speed commonly used for working surfaces of a workpiece (e.g. a vehicle, boat airplane or the like).

[0007] Reduction of the warp effect and the higher stiffness of the backing pad is mainly caused by a much better and firmer interference and mechanical anchoring between the damping layer and the support layer of the backing pad. This is due to the reinforcement elements of the support layer immersing into the damping layer and being completely surrounded by the cured material of the damping layer.

[0008] Furthermore, due to the better stiffness and flexural rigidity of the backing pad according to the present invention, the support layer does not necessarily have to be made of the rather expensive glass fibre reinforced plastic material. Rather, it is possible to make the support layer of a conventional much cheaper and possibly easier to handle plastic material and still maintaining an acceptable amount of stiffness and flexural rigidity. This results in a very cost efficient backing pad which still has a high amount of stiffness and flexural rigidity.

[0009] It is particularly advantageous in the backing pad according to the invention that due to the three-dimensional extension of the reinforcement elements on the bottom surface of the support layer and the material of the damping layer entering into the recesses provided between the reinforcement elements, the interconnection between the damping layer and the support layer is not only effective in a two-dimensional horizontal plane extending between the extension of the support layer and the damping layer, but rather in three dimensions. This significantly reduces torsion of the backing pad during intended use. The form and the structure of the reinforcement elements is such that forces acting locally on the backing pad during the intended use of the power tool, to which the backing pad is attached, are absorbed and spread over a larger area of the backing pad. The forces acting on the backing pad are, for example, due to pressure applied by a user on the power tool and thus on the backing pad during intended use of the power tool. This leads to a reduction of static deformation of the backing pad during intended use. Furthermore, the form and the structure of the reinforcement elements is such that vibrations are absorbed to a great extent in all directions, i.e. in the radial, axial and transversal direction. To this end, the reinforcement elements may have a form similar to a noise cancelling wall. This reduces dynamic deformation of the backing pad during intended use.

[0010] Finally, the reinforcement elements and the recesses in between with the resilient material of the damping layer entering into the recesses during manufacture of the backing pad and after curing of the resilient material entirely filling the recesses, provides for a much safer and more reliable attachment of the damping layer to the support layer. With the claimed structure of the bottom surface of the support layer, it is almost impossible that the damping layer will come off the support layer during intended use of the backing pad.

[0011] The reinforcement elements may have any desired three-dimensional form rising from the bottom surface of the support layer into the damping layer and forming recesses in between which are filled by the material of the damping layer. Preferably, the reinforcement elements comprise a plurality of discrete elements which have a larger extension in their base than in their distal end. For example, it is suggested, that the reinforcement elements comprise a plurality of discrete pyramid-shaped elements having a base surface in the form of a circle, a triangle, a rectangle, in particular a square, or any other polygonal form, in particular an equilateral polygonal form.

[0012] Alternatively, it is suggested that the reinforcement elements comprise reinforcement ribs. The exact structure of the bottom surface of the support layer with the reinforcement ribs can have many possible specific designs in order to achieve the desired results and advantages of the invention. According to a preferred embodiment of the present invention it is suggested that the reinforcement ribs have an at least discrete rotationally symmetric design in respect to a center of the support layer in at least some rotational angles about the center of the support layer. For example, the reinforcement ribs may have a rotationally symmetric design in respect to the center of the support layer in rotational angles of 180° and 360° or 120°, 240° and 360° or 90°, 180°, 270° and 360° or 60°, 120°, 180°, 240°, 300° and 360° or 45°, 90°, 135°, 180°, 225°, 270°, 315° and 360° or 30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300°, 330° and 360°. Alternatively, the reinforcement ribs may also have a full rotationally symmetric design in respect to the center of the support layer in any rotational angle. The at least discrete rotational symmetry of the reinforcement ribs guarantees a stiffness and flexural rigidity of the support layer and the backing pad, respectively, in different directions.

[0013] According to a preferred embodiment of the invention, it is suggested that the reinforcement ribs comprise a plurality of polygonal geometric elements, each element having an essentially polygonal rib design and neighbouring elements being located next to each other and/or offset in respect to each other. The polygonal geometric elements may have any given form, e.g. with triangular, rectangular, square, pentagonal, hexagonal, octagonal, circular, oval external walls protruding from the bottom surface of the support layer and forming the reinforcement ribs. The polygonal geometric elements are preferably evenly distributed on the bottom surface of the support layer. The polygonal geometric elements may be located one immediately next to the other, two neighbouring elements sharing at least part of the same external walls. Alternatively, the polygonal geometric elements may be located spaced apart from each other. Preferably, distances between neighbouring polygonal geometric elements are the same for all polygonal geometric elements.

[0014] According to another preferred embodiment of the invention, it is suggested that the reinforcement ribs comprise a honeycomb structure with a plurality of external walls forming honeycombs located next to each other, the external walls of each honeycomb forming an essentially equilateral hexagonal rib design and neighbouring honeycombs sharing a common external wall. Such a honeycomb structure has a discrete rotational symmetry in the rotational angles of 180° and 360°. It can provide for a particularly stiff and flexural rigid support layer and backing pad, respectively. Furthermore, the essentially hexagonal recesses in each of the honeycombs provide for a particularly safe, durable and reliable connection between the damping layer and the support layer after curing of the resilient material of the damping layer which during manufacture of the backing pad previously entered into the recesses.

[0015] According to another preferred embodiment of the invention, it is suggested that the reinforcement ribs comprise a circular cobweb structure extending about a center of the support layer, the cobweb structure having first reinforcement ribs extending in a radial direction from the center of the support layer or parallel to the radial direction and second reinforcement ribs extending in a circumferential direction around the center of the support layer, the second reinforcement ribs running essentially perpendicular to the respective first reinforcement ribs at the points of intersection with the first reinforcement ribs. Of course, if the first reinforcement ribs extend parallel to the radial direction, the second reinforcement ribs will not run exactly perpendicular to the first reinforcement ribs in their points of intersection. Hence, the wording "essentially perpendicular" comprises angles of approximately 50° to 130°., preferably between 70° and 110°. The cob web structure has proved to provide for a particularly stiff and flexural rigid support layer and backing pad, respectively.

[0016] The first reinforcement ribs extending in a radial direction may extend along the entire distance between a center of the support layer and an outer edge of the support layer. Preferably, the reinforcement ribs comprise first reinforcement ribs extending in a radial direction from a center of the support layer or parallel to the radial direction along at least part of a distance between the center of the support layer and an outer edge of the support layer. Hence, the first reinforcement ribs may start in a distance to the center of the support layer and/or end in a distance to the outer edge of the support layer.

[0017] Preferably, the first reinforcement ribs are equally spaced apart in respect to each other in a circumferential direction. This provides for reinforcement ribs evenly distributed on the bottom surface of the support layer and for an amount of stiffness and flexural rigidity of the support layer and the backing pad, respectively, evenly distributed in discrete rotational angles about the center of the support layer.

[0018] Furthermore, it is suggested that the reinforcement ribs comprise second reinforcement ribs extending in a circumferential direction around a center of the support layer. Preferably, the second reinforcement ribs extend coaxially around the center of the support layer. This provides for an even and uniform distribution of the weight of the backing pad in respect to the center of the support layer resulting in a minimum of vibrations during rotation of the backing pad about its rotational axis running through the center of the support layer. Neighbouring second reinforcement ribs are spaced apart from each other in a radial direction, preferably by an equal distance. Of course, it would also be possible to design the reinforcement rib structure such that neighbouring second circumferential reinforcement ribs towards the center of the support layer have a larger distance than neighbouring second circumferential reinforcement ribs towards the outer edge of the support layer or vice versa.

[0019] Moreover, it is suggested that the reinforcement ribs comprise third reinforcement ribs which are embodied as circular, semi-circular or oval ribs located at least at some intersection points between radially extending first reinforcement ribs or first reinforcement ribs extending parallel to a radial direction and circumferentially extending second reinforcement ribs, wherein the intersection points form centers of the third reinforcement ribs. The third reinforcement ribs add additional stiffness and flexural rigidity to the support layer and the backing pad, respectively. They could also have the form of any polygon, in particular having more than three sides and corners. For example, the third reinforcement ribs could have the form of a rhombus with four sides and four corners. Of course, towards the center and towards the outer edge of the support layer the third reinforcement ribs may have the form of a semi-circle or a semi-oval.

[0020] The reinforcement rib structure could be designed such that neighbouring third reinforcement ribs touch in a common point or region of external walls forming the third reinforcement ribs. Preferably, the third reinforcement ribs of neighbouring intersection points are spaced apart from each other.

[0021] The reinforcement rib structure could be designed such that at least some of the third reinforcement ribs have a different form and/or diameter. For example, it could be possible that the third reinforcement ribs towards the center of the support layer are smaller than those located towards the outer edge of the support layer. Preferably, the third reinforcement ribs have the same form and/or the same diameter throughout the entire bottom surface of the support layer.

[0022] In a top view, the backing pad may have any given form, in particular rectangular or delta-shaped. Those backing pads will not rotate about a central axis of rotation but simply perform a purely orbital working movement. To this end, they would be attached to an orbital polishing or sanding power tool. Preferably, in a top view the backing pad has a circular shape. Such a backing pad may perform a purely orbital, a random-orbital or a roto-orbital (gear driven) working movement depending on the type of polishing or sanding power tool it is attached to.

[0023] As a result of the better stiffness and flexural rigidity of the backing pad according to the invention, it is possible to manufacture the support layer of a less stiff and rigid and possibly cheaper material without losing stiffness and flexural rigidity in respect to the conventional backing pads made without reinforcement ribs but from a stiffer and more rigid material such as glass fibre reinforced plastic material. To this end it is suggested that the support layer is made of plastic material, in particular of a thermoplastic material, with or without reinforcing fibres contained therein. Typical examples for such a thermoplastic material are polyamides, in particular aliphatic polyamides such as nylon polymers. Preferably, a polyacrylamide material such as Ixef® PARA is used for manufacturing the support layer. If desired, but not necessarily, the thermoplastic material, polyamide material or the polyacrylamide material may contain 50-60% fiber reinforcement, in particular glass fiber reinforcement, giving the support layer a remarkable strength and rigidity. Due to the reinforcement ribs the overall thickness of the backing pad may be reduced without any detriment in respect of stiffness and flexural rigidity compared to the conventional backing pads. This is particularly the case, when the plastic material is fiber reinforced.

[0024] Finally, it is suggested that the damping layer is made of polyurethane, in particular a polyurethane foam rubber.

[0025] Manufacturing of the backing pad may be performed in the following manner: First, a connection element for connection of the backing pad to a driving shaft or an eccentric element of a polishing or sanding power tool may be inserted into the bottom of an injection mould. Then, the heated material of the support layer is injected into the injection mould, surrounding at least part of the connection element. The bottom surface of the support layer faces upwards in the injection mould. The reinforcement ribs are created, for example, by closing the injection mould with a lid having channels embodied therein corresponding to the reinforcement ribs. The lid is pressed onto the material of the support layer whereby the material enters into the channels thereby forming the reinforcement ribs. Thereafter, the heated material of the damping layer is injected into the injection mould on top of the bottom surface of the support layer. A lid must be removed previously from the injection mould. Due to the fluid or viscous condition of the heated material of the damping layer, it enters into the recesses between the reinforcement ribs and fills them out completely. Finally, the adhesive layer is positioned on the bottom surface of the damping layer. The materials of the backing pad are then cured, possibly under heat supply and/or pressure. After curing of the materials the damping layer is fixedly attached to the bottom surface of the support layer and the adhesive layer is fixedly attached to the bottom surface of the damping layer.

[0026] Further features and advantages of the present invention will be described in further detail hereinafter with reference to the accompanying drawings. Each of the features shown in the drawings and/or described hereinafter may form part of the present invention on its own or in any possible combination with any of the other features shown in the drawings and/or described hereinafter even if that combination is not shown in the drawings and/or explicitly mentioned in the following description. The drawings show:

Figure 1 an embodiment of a backing pad according to the present invention in an exploded perspective view from below;

Figure 2 an embodiment of a backing pad according to the present invention in a perspective view from above;

Figure 3 a schematic view of a bottom surface of a support layer of an embodiment of a backing pad according to the present invention;

Figure 4 a schematic view of a bottom surface of a support layer of an embodiment of a backing pad according to the present invention;

Figure 5 a schematic view of a bottom surface of a support layer of an embodiment of a backing pad according to the present invention;

Figure 6 a schematic view of a bottom surface of a support layer of an embodiment of a backing pad according to the present invention;

Figure 7 a conventional backing pad in a side view during intended use of the backing pad;

Figure 8 a conventional backing pad in a side view during intended use of the backing pad;

Figure 9 a schematic view of a bottom surface of a support layer of an embodiment of a backing pad according to the present invention;

Figure 10 a schematic view of a bottom surface of a support layer of an embodiment of a backing pad according to the present invention; and

Figure 11 a schematic view of a bottom surface of a support layer of an embodiment of a backing pad according to the present invention.

[0027] Fig. 1 shows an exploded view of a backing pad 2 for a hand-guided polishing or sanding power tool. The backing pad comprises

- a support layer 4 made of a rigid material, the support layer 4 comprising a connection element 6 (see Fig. 2) on its top surface 8 for connection of the backing pad 2 to a drive shaft or an eccentric element of the polishing or sanding power tool,
- a damping layer 10 made of a resilient material, the damping layer 10 being fixedly attached to a bottom surface 12 of the support layer 4, and
- an adhesive layer 14 for releasable attachment of a polishing or sanding member to the backing pad 2, the adhesive layer 14 being fixedly attached to a bottom surface 16 of the damping layer 10.

[0028] The connection element 6 has the form of a recess and has a form which is not rotationally symmetric in respect to a center axis or rotational axis 22 of the backing pad 2. The support layer 4 has an outer edge 40. The damping layer 10 and the adhesive layer 14 may have a central opening 44. Preferably, the connection element 6 is made of or comprises a rigid material, for example a plastic material or metal, in particular steel or aluminium. The adhesive layer 14 may comprise, e.g. a layer of a hook-and-loop fastener, for releasable attachment of a polishing or sanding member to the backing pad 2. The polishing or sanding member may be, e.g. a polishing pad 42 or a sheet-like sanding paper or sanding fabric. The polishing or sanding member may have a central opening corresponding to the central opening 44 of the damping layer 10 and the adhesive layer 14.

[0029] The various layers 4, 10, 14 are preferably not attached to each other after separate manufacture of each of the layers 4, 10, 14, for example by gluing or welding. Rather, it is preferred that the various layers 4, 10, 14 are attached to each other during the manufacturing process of the backing pad 2, e.g. by co-moulding. This has the advantage that the entire backing pad 2 can be manufactured in a single co-moulding process. Due to the moulding process the various layers 4, 10, 14 are attached to each other in a particularly strong, robust and durable manner.

[0030] Hand-guided polishing or sanding power tools are commonly used in the field of sanding or polishing of surfaces of vehicle bodies, boat or ship hulls or airplane fuselages. Depending on the intended use of the tools, the type of processing and/or the user's preferences, the power tools can be operated electrically (with rechargeable batteries or with mains power supply connection) or pneumatically and they can make the backing pad 2 perform different types of working movements (e.g. purely rotational, purely orbital, random-orbital or roto-orbital or gear-driven). The polishing or sanding power tools comprise an electric or pneumatic motor with a drive shaft 18 (see Fig. 2). The drive shaft 18 is connected to an attachment member 20 of the power tool in a torque-proof manner either directly or indirectly, e.g. by means of a bevel gear arrangement and/or a reducer gear arrangement located inside a power tool housing. The attachment member 20 serves for releasably attaching the backing pad 2 to the power tool. The attachment member 20 is designed as an adapter element having an external circumferential form corresponding to the internal circumferential form of the recess of the connection element 6. The adapter element 20 can be secured in the recess 6 in an axial direction by means of a screw or the like inserted into a central hole of the backing pad 2 from below, passing through the hole and screwed into a threaded bore opening into the bottom side of the adapter element 20. The central hole of the backing pad 2 preferably extends coaxially to the central opening 44 of the damping layer 10 and the adhesive layer 14. In the manufactured and ready to use backing pad 2, the connection element 6 of the support layer 4 is preferably located above the central opening 44. Although not shown in the figures, the central hole extends through the entire backing pad 2 including the support layer 4 and the connection element 6.

[0031] Alternatively, the attachment member 20 as well as the connection element 6 of the backing pad 2 may be designed differently from what is described above. Any possible configuration of interacting attachment member 20 and connection element 6 is possible. In particular, the attachment element 20 may comprise an external thread, an adapter element and/or an eccentric element. The backing pad 2 is releasably attached with its connection element 6 to the attachment member 20.

[0032] A problem with the conventional backing pads 2 is the fact that they tend to warp during intended use due to the rather high rotational speeds at which the backing pads 2 are usually operated and due to an eccentric movement of the backing pad during its intended use, if used with an eccentric power tool effecting a random orbital or a roto-orbital working movement. Warping means that the backing pad 2 tends to through waves in its plane of extension (see Figs. 7 and 8). This leads to a situation in which the backing pad 2 or the polishing or sanding member, respectively, does no longer lie evenly with its entire bottom surface on a surface 32 to be worked (see Figs. 7 and 8), resulting in an unsatisfactory efficiency and quality of the working process. Furthermore, in order to reduce the warp effect, the support layer 4 of conventional backing pads 2 is made of a rather expensive glass fibre reinforced plastic material. Finally, under some circumstances the damping layer 10 can come off the support layer 4.

[0033] In order to avoid warping of the backing pad 2 during its intended use and in order to improve stiffness and flexural rigidity of the backing pad 2 it is suggested that the bottom surface 12 of the support layer 4 is provided with reinforcement elements in the form of reinforcement ribs 24, 26, 28, and that the bottom surface 12 of the support layer 4 is further provided with recesses 30 formed between and at least partially limited by the reinforcement ribs 24, 26, 28, wherein during manufacture of the backing pad 2 the resilient material of the damping layer 10 enters into the recesses 30 and after curing of the resilient material entirely fills the recesses 30.

[0034] At least partially limited by the reinforcement ribs 24, 26, 28" means that most of the recesses 30 are limited to their sides by respective reinforcement ribs 24, 26, 28. However, in particular towards the outer edge 40 of the support layer 4 or towards the central opening 44 of the backing pad 2, there may be some recesses 30a which are not limited to all sides by reinforcement ribs 24, 26, 28, but which instead open towards the outside/ environment. These recesses 30a are also completely filled with the resilient material of the damping layer 10 during manufacturing of the backing pad 2.

[0035] The structure of the backing pad 2, in particular of its support layer 4 with the reinforcement ribs 24, 26, 28, has the advantage that the stiffness of the support layer 4 and with it the flexural rigidity of the entire backing pad 2 is significantly enhanced. The reinforcement ribs 24, 26, 28 clearly reduce the warp effect of the backing pad 2 during its intended use. This is in particular true when the backing pad 2 is operated at rather high rotational speeds of the drive shaft 18 and when the backing pad 2 effects an eccentric movement (e.g. random orbital or roto-orbital or gear-driven) during its intended use. In particular, the reinforcement ribs 24, 26, 28 significantly reduce the tendency of the backing pad 2 to through waves in its plane of extension during its intended use (see Figs. 7 and 8). As a result, during intended use of the backing pad 2 according to the invention the backing pad 2 lies evenly with its entire bottom surface on the surface 32 to be worked, resulting in a particularly high efficiency and quality of the polishing or sanding process. The intended use of the backing pad 2 in the sense of the present invention means that the backing pad 2 is releasably attached to a polishing or sanding power tool and carries a polishing or sanding member on the bottom surface of the adhesive layer 14 and that the power tool is operated at a speed commonly used for working surfaces of a workpiece (e.g. a vehicle, boat airplane or the like).

[0036] Furthermore, due to the better stiffness and flexural rigidity of the backing pad 2 according to the present invention, the support layer 4 does not necessarily have to be made of the rather expensive glass fibre reinforced plastic material. Rather, it is possible to make the support layer of a conventional much cheaper and possibly easier to handle plastic material (e.g. without any reinforcement fibres) and still maintaining an acceptable amount of stiffness and flexural rigidity. This results in a very cost efficient backing pad 2 which still has a high amount of stiffness and flexural rigidity.

[0037] As a result of the better stiffness and flexural rigidity of the backing pad 2 according to the invention, it is possible to manufacture the support layer 4 of a less stiff and rigid and possibly cheaper material without losing stiffness and flexural rigidity compared to the conventional backing pads made without reinforcement ribs but from a stiffer and more rigid material such as glass fibre reinforced plastic material. To this end it is suggested that the support layer 4 is made of plastic material, in particular of a thermoplastic material. Typical examples for such a thermoplastic material are polyamides, in particular aliphatic polyamides such as nylon polymers. Preferably, a polyacrylamide material such as Ixef® PARA is used for manufacturing the support layer 4. If desired, but not necessarily, the thermoplastic material, polyamide material or the polyacrylamide material may contain up to 50-60% fiber reinforcement, in particular glass fiber reinforcement, giving the support layer 4 a remarkable strength and rigidity clearly exceeding that of conventional glass fiber reinforced backing pads.

[0038] Due to the reinforcement ribs 24, 26, 28 the overall thickness of the backing pad 2 may be reduced without any detriment in respect of stiffness and flexural rigidity compared to the conventional backing pads. This is particularly the case, when the plastic material used for the support layer 4 does not only have the reinforcement ribs 24, 26, 28 but is also fiber reinforced. The damping layer 10 is preferably made of polyurethane, in particular a polyurethane foam rubber.

[0039] The reinforcement ribs 24, 26, 28 and the recesses 30 in between with the resilient material of the damping layer 10 entering into the recesses 30 during manufacture of the backing pad 2 and after curing of the resilient material entirely filling the recesses 30, provides for a much safer and more reliable attachment of the damping layer 10 to the support layer 4. With the proposed structure of the bottom surface 12 of the support layer 4 it is almost impossible that the damping layer 10 will come off the support layer 4 during intended use of the backing pad 2.

[0040] The structure of the bottom surface 12 of the support layer 4 can have many possible specific designs in order to achieve the desired results and advantages of the invention. According to a preferred embodiment it is suggested that the reinforcement ribs 24, 26, 28 have an at least discrete rotationally symmetric design in respect to a center 34 of the support layer 4 in at least some rotational angles about the center 34 of the support layer. The rotational axis 22 passes through the center 34 of the support layer 4. For example, the reinforcement ribs 24, 26, 28 may have a rotationally symmetric design in respect to the center 34 of the support layer 4 in rotational angles of 180° and 360° (see embodiment of Fig. 4) or 120°, 240° and 360° or 90°, 180°, 270° and 360° (see embodiment of Fig. 5) or 60°, 120°, 180°, 240°, 300° and 360° (see embodiment of Fig. 6) or 45°, 90°, 135°, 180°, 225°, 270°, 315° and 360° (see embodiment of Fig. 3) or 30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300°, 330° and 360°. Of course, the reinforcement ribs could also have a full rotationally symmetric design in respect to the center 34 of the support layer 4 in any rotational angle. The at least discrete rotational symmetry of the reinforcement ribs 24, 26, 28 guarantees a stiffness and flexural rigidity of the support layer 4 and the backing pad 2, respectively, in different directions.

[0041] According to a preferred embodiment of the invention shown in Fig. 4, it is suggested that the reinforcement ribs 24, 26, 28 form a plurality of polygonal geometric elements 36, each element 36 having an essentially polygonal rib design and neighbouring elements 36 being located next to each other. Alternatively, neighbouring elements 36 could also be offset in respect to each other. The polygonal geometric elements 36 may have any given form, e.g. with triangular, rectangular, square, pentagonal, hexagonal, octagonal, circular, oval external walls protruding from the bottom surface 12 of the support layer 4 and forming the reinforcement ribs 24, 26, 28. The polygonal geometric elements 36 are preferably evenly distributed on the bottom surface 12 of the support layer 4. As shown in Fig. 4, the polygonal geometric elements 36 may be located one immediately next to the other, two neighbouring elements sharing at least part of the same external walls or ribs 24, 26, 28, respectively. Alternatively, the polygonal geometric elements 36 may be located spaced apart from each other. Preferably, distances between neighbouring polygonal geometric elements 36 are the same for all polygonal geometric elements 36.

[0042] In the embodiment of Fig. 4 the polygonal geometric elements 36 each have the hexagonal form of a honeycomb. All elements 36 together form a honeycomb structure. A plurality of external walls or ribs 24, 26, 28, respectively, forming honeycombs are located next to each other, the external walls 24, 26, 28 of each honeycomb 36 forming an essentially equilateral hexagonal rib design. Neighbouring honeycombs 36 share a common external wall 24, 26, 28. Such a honeycomb structure has a discrete rotational symmetry in the rotational angles of 180° and 360°. It can provide for a particularly stiff and flexural rigid support layer 4 and backing pad 2, respectively. Furthermore, the essentially hexagonal recesses 30 in each of the honeycombs 36 provide for a particularly safe, durable and reliable connection between the damping layer 10 and the support layer 4 after curing of the resilient material of the damping layer 10 which during manufacture of the backing pad 2 previously entered into the recesses 30.

[0043] According to the embodiment of Fig. 1, the reinforcement elements comprise first reinforcement ribs 24 extending in a radial direction from a center 34 of the support layer 4. The reinforcement elements further comprise second reinforcement ribs 26 having a circular extension extending equidistant to the center 34 and perpendicular to the first reinforcement ribs 24. Recesses 30 are formed between neighbouring first reinforcement ribs 24 and neighbouring second reinforcement ribs 26. Some recesses 30a are not limited to all sides by reinforcement ribs 24, 26, but instead open towards the outside/ environment.

[0044] According to another preferred embodiment of the invention shown in Fig. 6, it is suggested that the reinforcement ribs 24, 26, 28 form a circular cobweb structure extending about a center 34 of the support layer 4. The cobweb structure has first reinforcement ribs 24 extending in a radial direction from the center 34 of the support layer 4 and second reinforcement ribs 26 extending in an essentially circumferential direction around the center 34 of the support layer 4. In this embodiment, the second reinforcement ribs 26 have a linear extension extending perpendicular to an imaginary radial line 38 running in an equidistant manner between two neighbouring first reinforcement ribs 24. The second reinforcement ribs 26 run essentially perpendicular to the respective first reinforcement ribs 24 at the points of intersection with the first reinforcement ribs 24. Of course, due to the linear extension of the second reinforcement ribs 26 they will not run exactly perpendicular to the first reinforcement ribs 24 in their points of intersection. Hence, the wording "essentially perpendicular" comprises angles of approximately 50° to 130°, preferably between 70° and 110°. In the embodiment of Fig. 6 the angle between the first and second reinforcement ribs 24, 26 is about 60°. The cob web structure has proved to provide for a particularly stiff and flexural rigid support layer 4 and backing pad 2, respectively.

[0045] According to the embodiment shown in Fig. 5, the reinforcement ribs 24, 26, 28 comprise first reinforcement ribs 24 extending in a radial direction from a center 34 of the support layer 4 and first reinforcement ribs 24' extending parallel to an imaginary line 41 extending in a radial direction. The imaginary line 41 runs in an equidistant manner between two neighbouring first reinforcement ribs 24. The bottom surface 12 of the support layer 4 of Fig. 5 is divided into four separate quadrants by the first reinforcement ribs 24. Each quadrant comprises an imaginary line 41. The first reinforcement ribs 24' have different extensions depending on the quadrant they are in. In particular, the first reinforcement ribs 24' of a certain quadrant extend parallel to the imaginary line 41 of that quadrant.

[0046] The rib structure of Figs. 1 and 5 further comprises second reinforcement ribs 26 extending in a circumferential direction around the center 34 of the support layer 4. In this embodiment, the second reinforcement ribs 26 have a circular extension extending perpendicular to the first reinforcement ribs 24 and the imaginary radial lines 41 at the respective points of intersection. The second reinforcement ribs 26 do not run exactly perpendicular to the other first reinforcement ribs 24' at the points of intersection. Due to the first reinforcement ribs 24' not extending exactly radially, the second reinforcement ribs 26 will not run exactly perpendicular to the first reinforcement ribs 24' in their points of intersection. The closer the first reinforcement rib 24' of a quadrant is to the imaginary radial line 41 of that quadrant, the closer the angle between the first and second reinforcement ribs 24, 26 is to 90°. Hence, the wording "essentially perpendicular" comprises angles of approximately 50° to 130°, preferably between 70° and 110°.

[0047] The first reinforcement ribs 24 extending in a radial direction may extend along the entire distance between a center 34 of the support layer 4 and an outer edge 40 of the support layer 4. Alternatively, the reinforcement ribs 24, 26, 28 comprise first reinforcement ribs 24 extending in a radial direction from a center 34 of the support layer 4 or parallel to the radial direction along at least part of a distance between the center 34 of the support layer 4 and an outer edge 40 of the support layer 4. Hence, the first reinforcement ribs 24 may start in a distance to the center 34 of the support layer 4 and/or end in a distance to the outer edge 40 of the support layer 4.

[0048] Preferably, the first reinforcement ribs 24 are equally spaced apart in respect to each other in a circumferential direction (see Figs. 1, 3, 5 (regarding the first ribs 24, not the other first ribs 24'), and 6). This provides for reinforcement ribs 24 evenly distributed on the bottom surface 12 of the support layer 4 and for an amount of stiffness and flexural rigidity of the support layer 4 and the backing pad 2, respectively, evenly distributed in discrete rotational angles about the center 34 of the support layer 4.

[0049] Preferably, the second reinforcement ribs 26 extend coaxially around the center 34 of the support layer 4. This provides for an even and uniform distribution of the weight of the backing pad 2 in respect to the center axis 22 of the support layer 4 resulting in a minimum of vibrations during rotation of the backing pad 2 about its rotational axis 22 running through the center 34 of the support layer 4. Neighbouring second reinforcement ribs 26 are spaced apart from each other in a radial direction, preferably by an equal distance. Of course, it would also be possible to design the reinforcement rib structure such that neighbouring second circumferential reinforcement ribs 26 towards the center 34 of the support layer 4 have a larger distance than neighbouring second circumferential reinforcement ribs 26 towards the outer edge 40 of the support layer 4 or vice versa.

[0050] Moreover, the reinforcement ribs 24, 26, 28 may comprise third reinforcement ribs 28 which are embodied as circular, semi-circular or oval ribs located at least at some intersection points between radially extending first reinforcement ribs 24 (see Figs. 3 and 6) or first reinforcement ribs 24' (see Fig. 5) extending parallel to a radial direction 41 and circumferentially extending second reinforcement ribs 26, wherein the intersection points form centers of the third reinforcement ribs 28. The third reinforcement ribs 28 add additional stiffness and flexural rigidity to the support layer 5 and the backing pad 2, respectively.

[0051] In the embodiment of Fig. 3 the third reinforcement ribs 28 mostly have a circular shape. The circular third ribs 28 are located at each point of intersection between the first radial ribs 24 and the second circumferential ribs 26. Of course, towards the center 34 and towards the outer edge 40 of the support layer 4 the third reinforcement ribs 28 may have the form of a semi-circle or a semi-oval (see Fig. 3). The center of the semi-oval external third ribs 28 is constituted by a point of intersection between the first radial ribs 24 and the outer edge 40 of the support layer 4. In the embodiment of Fig. 5 the third reinforcement ribs 28 all have a circular shape. The circular third ribs 28 are located only at some points of intersection between the first radial ribs 24 and the other first ribs 24' extending parallel to a radial imaginary line 41 and at some points of intersection of the other first ribs 24' extending parallel to a radial imaginary line 41 and the second circumferential ribs 26. In the embodiment of Fig. 6 the third reinforcement ribs 28 have an oval shape. The oval third ribs 28 are located only at some points of intersection between the first radial ribs 24 and the second essentially circumferential ribs 26. The third reinforcement ribs 28 could also have the form of any polygon, in particular a polygon having more than three sides and corners. For example, the third reinforcement ribs 28 could have the form of a rhombus with four sides and four corners.

[0052] The reinforcement rib structure could be designed such that neighbouring third reinforcement ribs 28 touch in a common point or region of external walls forming the third reinforcement ribs 28. Preferably, the third reinforcement ribs 28 of neighbouring intersection points are spaced apart from each other.

[0053] The reinforcement rib structure could be designed such that at least some of the third reinforcement ribs 28 have a different form and/or diameter (see Fig. 3). For example, it could be possible that the third reinforcement ribs 28 towards the center 34 of the support layer 4 are smaller than those located towards the outer edge 40 of the support layer 4. Preferably, the third reinforcement ribs 28 have the same form and/or the same diameter throughout the entire bottom surface 12 of the support layer 4 (see Fig. 5).

[0054] In a top view, the backing pad 2 may have any given form, in particular rectangular or delta-shaped. Such backing pads 2 will not rotate about a central axis 22 of rotation but simply perform a purely orbital working movement. To this end, they would be attached to an orbital polishing or sanding power tool. Preferably, in a top view the backing pad 2 has a circular shape. Such a backing pad 2 may perform a purely orbital, a random-orbital or a roto-orbital (gear driven) working movement depending on the type of polishing or sanding power tool it is attached to.

[0055] Manufacturing of the backing pad 2 may be performed in the following manner: First, a connection element 6 for connection of the backing pad 2 to a driving shaft 18 or an eccentric element of a polishing or sanding power tool may be inserted into the bottom of an injection mould. Then, the heated material of the support layer 4 is injected into the injection mould, surrounding at least part of the connection element 6. The bottom surface 12 of the support layer 4 faces upwards in the injection mould. The reinforcement ribs 24, 26, 28 are created, for example, by closing the injection mould with a lid having channels embodied therein corresponding to the reinforcement ribs 24, 26, 28. The lid is pressed onto the material of the support layer 4 whereby the material enters into the channels thereby forming the reinforcement ribs 24, 26, 28. Thereafter, the heated material of the damping layer 10 is injected into the injection mould on top of the bottom surface 12 of the support layer 4. If a lid was used for creating the reinforcement ribs 24, 26, 28, it must be removed before the material of the damping layer 10 can be inserted into the injection mould. Due to the fluid or viscous condition of the heated material of the damping layer 10, it enters into the recesses 30 between the reinforcement ribs 24, 26, 28 and fills them out completely. Finally, the adhesive layer 14 is positioned on the bottom surface 16 of the damping layer 10. The materials of the backing pad 2 are cured, possibly under heat supply and/or pressure. After curing of the materials the damping layer 10 is fixedly attached to the bottom surface 12 of the support layer 4 and the adhesive layer 14 is fixedly attached to the bottom surface 16 of the damping layer 10.

[0056] Fig. 9 shows a different embodiment of the backing pad 2 according to the present invention. In order to avoid warping of the backing pad 2 during its intended use and in order to improve stiffness and flexural rigidity of the backing pad 2 it is suggested that the bottom surface 12 of the support layer 4 is provided with reinforcement elements in the form of reinforcement ribs 24, 26. The bottom surface 12 of the support layer 4 is further provided with recesses 30 formed between and at least partially limited by the reinforcement ribs 24, 26, wherein during manufacture of the backing pad 2 the resilient material of the damping layer 10 enters into the recesses 30 and after curing of the resilient material entirely fills the recesses 30. In contrast to the previously described embodiments, a surface of the reinforcement ribs 24, 26 facing away from the bottom surface 12 of the support layer 4 towards the damping layer 10 does not have an even but rather an undulated extension. In particular, the reinforcement ribs 24, 26 have their largest thickness at their respective intersections.

[0057] According to the embodiment of Fig. 9, the reinforcement elements comprise a plurality of first reinforcement ribs 24 extending in a radial direction from a center 34 of the support layer 4. In this embodiment, a total of 18 first reinforcement ribs 24 are provided spaced apart from each other by 20° each. The reinforcement elements further comprise second reinforcement ribs 26 having a circular extension extending equidistant to the center 34 and perpendicular to the first reinforcement ribs 24. In this embodiment, a total of three second reinforcement ribs 24 are provided. Recesses 30 are formed between neighbouring first reinforcement ribs 24 and neighbouring second reinforcement ribs 26. Some recesses 30a are not limited to all sides by reinforcement ribs 24, 26, but instead open towards the outside/ environment. Only the external second reinforcement rib 26 has a surface with an even extension facing away from the bottom surface 12 of the support layer 4 towards the damping layer 10.

[0058] Fig. 11 shows part of another embodiment of a backing pad 2 according to the invention, where the reinforcement elements comprise a plurality of discrete pyramid-shaped elements 46 having a base surface in the form of a rectangle, in particular a square. Alternatively, the base surface could also have the form of a circle, a triangle, or any other polygonal form, in particular an equilateral polygonal form. Side surfaces of the discrete elements 46 converge towards a tip 48 facing away from the bottom surface 12 of the support layer 4 towards the damping layer 10. Recesses 30 are formed between neighbouring discrete elements 46.

[0059] Fig. 10 shows part of yet another embodiment of a backing pad 2 according to the invention, where the reinforcement elements comprise a plurality of discrete elements 50, 52 forming an undulated surface extension. The discrete elements 50, 52 comprise hills 50 protruding from the bottom surface 12 and valleys 52 in the form of depressions in the bottom surface 12. The discrete elements 50. 52 are similar to the discrete elements 46 of Fig. 11, with all edges rounded, in order to form the undulated structure on the bottom surface 12 of the support layer 4 of the backing pad 2.

Claims

1. A backing pad (2) for a hand-guided polishing or sanding power tool, comprising

   - a support layer (4) made of a rigid material, the support layer (4) comprising a connection element (6) on its top surface (8) for connection of the backing pad (2) to a driving shaft (18) or an eccentric element of the polishing or sanding power tool,
   - a damping layer (10) made of a resilient material, the damping layer (10) being fixedly attached to a bottom surface (12) of the support layer (4), and
   - an adhesive layer (14) for releasable attachment of a polishing or sanding member to the backing pad (2), the adhesive layer (14) being fixedly attached to a bottom surface (16) of the damping layer (10),

   characterized in that
   the bottom surface (12) of the support layer (4) is provided with reinforcement elements (24, 26, 28; 46; 50, 52) for enhancing flexural rigidity of the support layer (4), and the bottom surface (12) of the support layer (4) is further provided with recesses (30) formed between and at least partially limited by the reinforcement elements (24, 26, 28; 46; 50, 52), wherein during manufacture of the backing pad (2) the resilient material of the damping layer (10) enters into the recesses (30) and after curing of the resilient material entirely fills the recesses (30).

2. The backing pad (2) according to claim 1, wherein the reinforcement elements comprise a plurality of discrete pyramid-shaped elements (46; 50, 52) having a base surface in the form of a circle, a triangle, a rectangle, in particular a square, or any other polygonal form, in particular an equilateral polygonal form.

3. The backing pad (2) according to claim 1, wherein the reinforcement elements comprise reinforcement ribs (24, 26, 28).

4. The backing pad (2) according to claim 3, wherein the reinforcement ribs (24, 26, 28) have an at least

discrete rotationally symmetric design in respect to a center (34) of the support layer (4) in at least some rotational angles about the center (34) of the support layer (4).

5. The backing pad (2) according to claim 3 or 4, wherein
the reinforcement ribs (24, 26, 28) comprise a plurality of polygonal geometric elements (36), each element (36) having an essentially polygonal rib design and neighbouring elements (36) being located next to each other and/or offset in respect to each other.

6. The backing pad (2) according to one of the claims 3 to 5, wherein
the reinforcement ribs (24, 26, 28) comprise a honeycomb structure with a plurality of honeycombs (36) located next to each other, each honeycomb (36) having an essentially equilateral hexagonal rib design and neighbouring honeycombs (36) sharing a common rib (24, 26, 28).

7. The backing pad (2) according to one of the claims 3 to 6, wherein
the reinforcement ribs (24, 26, 28) comprise a circular cobweb structure extending about a center (34) of the support layer (4), the cobweb structure having first reinforcement ribs (24) extending in a radial direction from a center (34) of the support layer (4) or parallel to the radial direction and second reinforcement ribs (26) extending in a circumferential direction around the center (34) of the support layer (4), essentially perpendicular to the respective first reinforcement ribs (24) they intersect.

8. The backing pad (2) according to one of the claims 3 to 7, wherein
the reinforcement ribs (24, 26, 28) comprise first reinforcement ribs (24) extending in a radial direction from a center (34) of the support layer (4) or parallel to the radial direction along at least part of a distance between the center (34) of the support layer (4) and an outer edge (40) of the support layer (4).

9. The backing pad (2) according to claim 7 or 8, wherein
the first reinforcement ribs (24) are equally spaced apart in respect to each other in a circumferential direction.

10. The backing pad (2) according to one of the claims 3 to 9, wherein
the reinforcement ribs (24, 26, 28) comprise second reinforcement ribs (26) extending in a circumferential direction around a center (34) of the support layer (4).

11. The backing pad (2) according to claim 7 or 10, wherein
the second reinforcement ribs (26) extend coaxially around the center (34) of the support layer (4).

12. The backing pad (2) according to claim 7, 10 or 11, wherein
neighbouring second reinforcement ribs (26) are spaced apart from each other in a radial direction, preferably by an equal distance.

13. The backing pad (2) according to one of the claims 3 to 12, wherein
the reinforcement ribs (24, 26, 28) comprise third reinforcement ribs (28) which are embodied as circular, semi-circular or oval ribs located at least at some intersection points between radially extending first reinforcement ribs (24) or first reinforcement ribs (24') extending parallel to a radial direction and circumferentially extending second reinforcement ribs (26), wherein the intersection points form centers of the third reinforcement ribs (28).

14. The backing pad (2) according to claim 13, wherein the third reinforcement ribs (28) of neighbouring intersection points are spaced apart from each other.

15. The backing pad (2) according to claim 13 or 14, wherein
the third reinforcement ribs (28) have the same form and/or the same diameter.

16. The backing pad (2) according to one of the preceding claims, wherein
in a top view the backing pad (2) has a circular shape.

17. The backing pad (2) according to one of the preceding claims, wherein
the support layer (4) is made of plastic material, in particular a thermoplastic material, with or without reinforcing fibres contained therein.

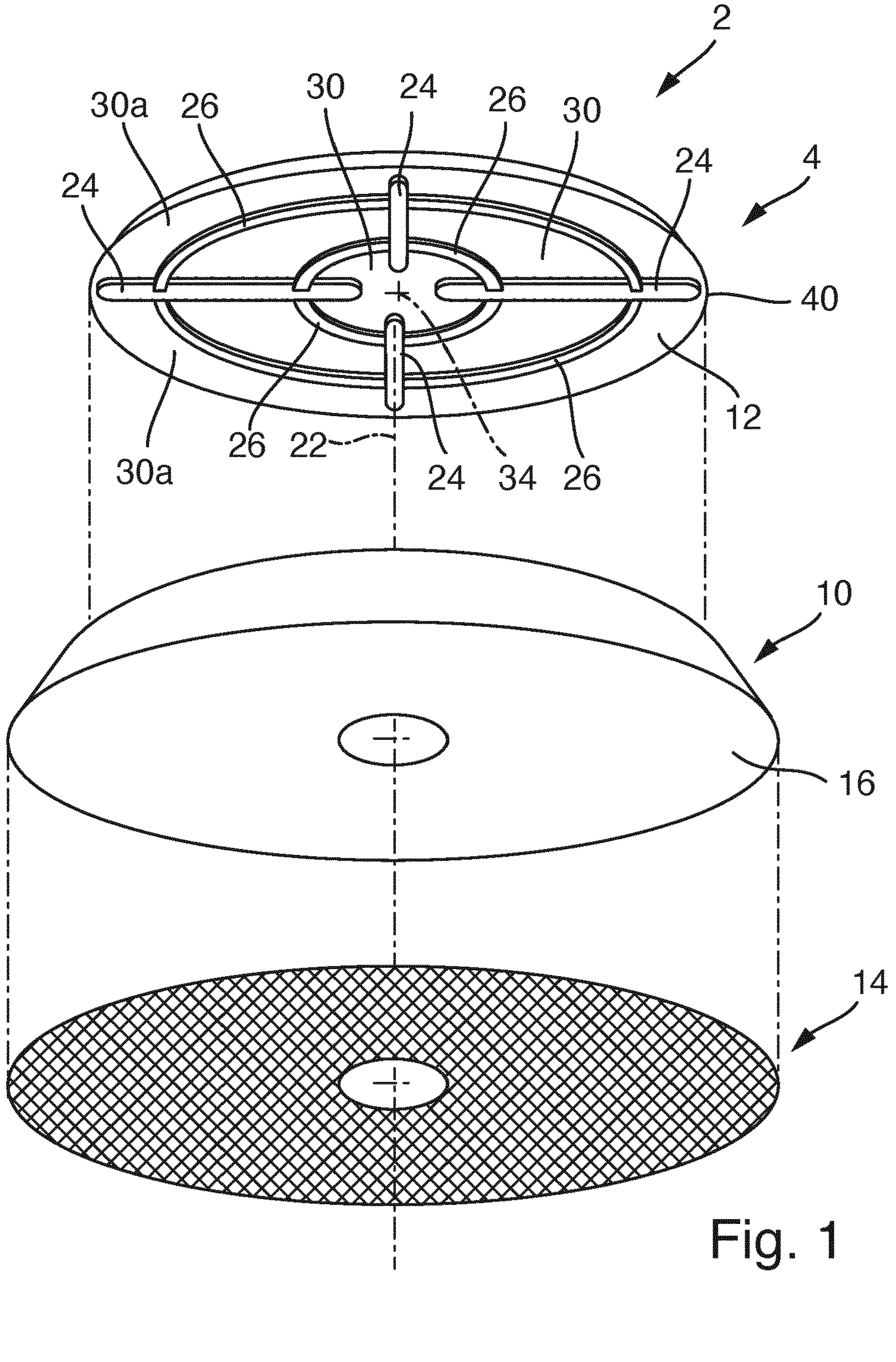

Fig. 1

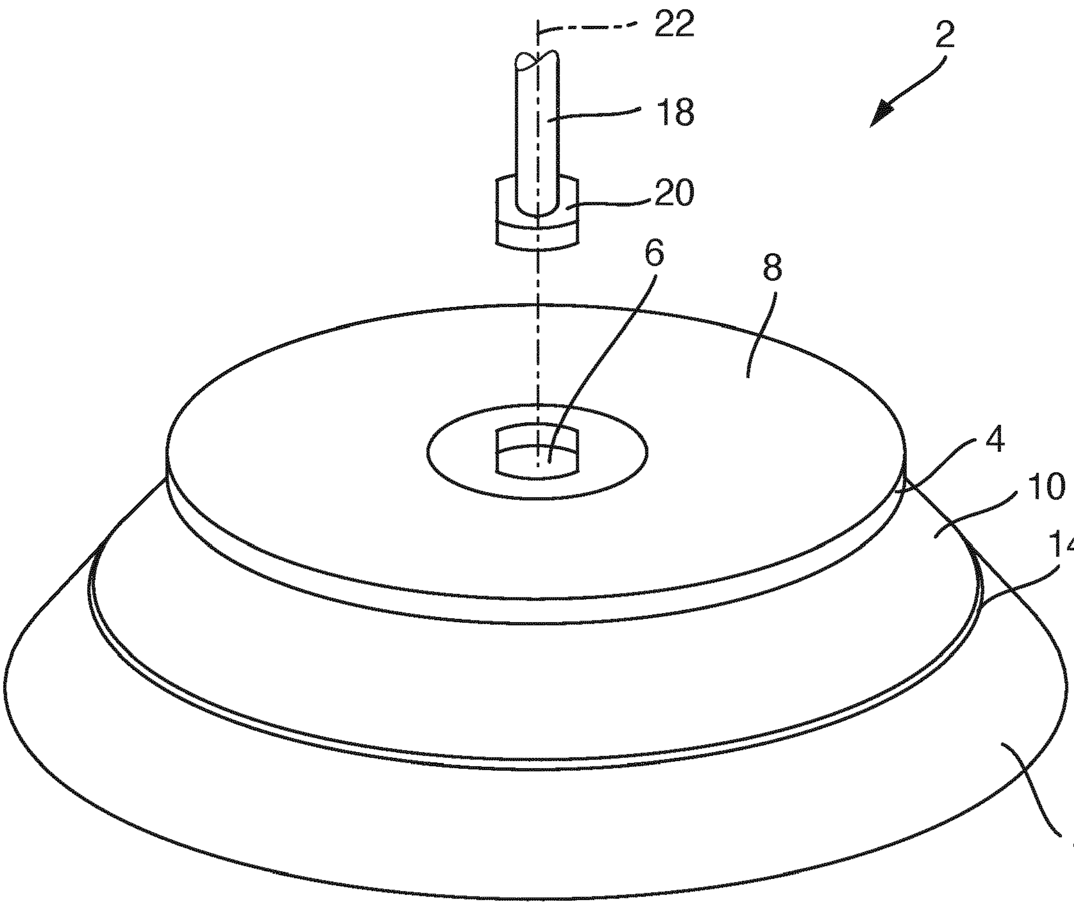

Fig. 2

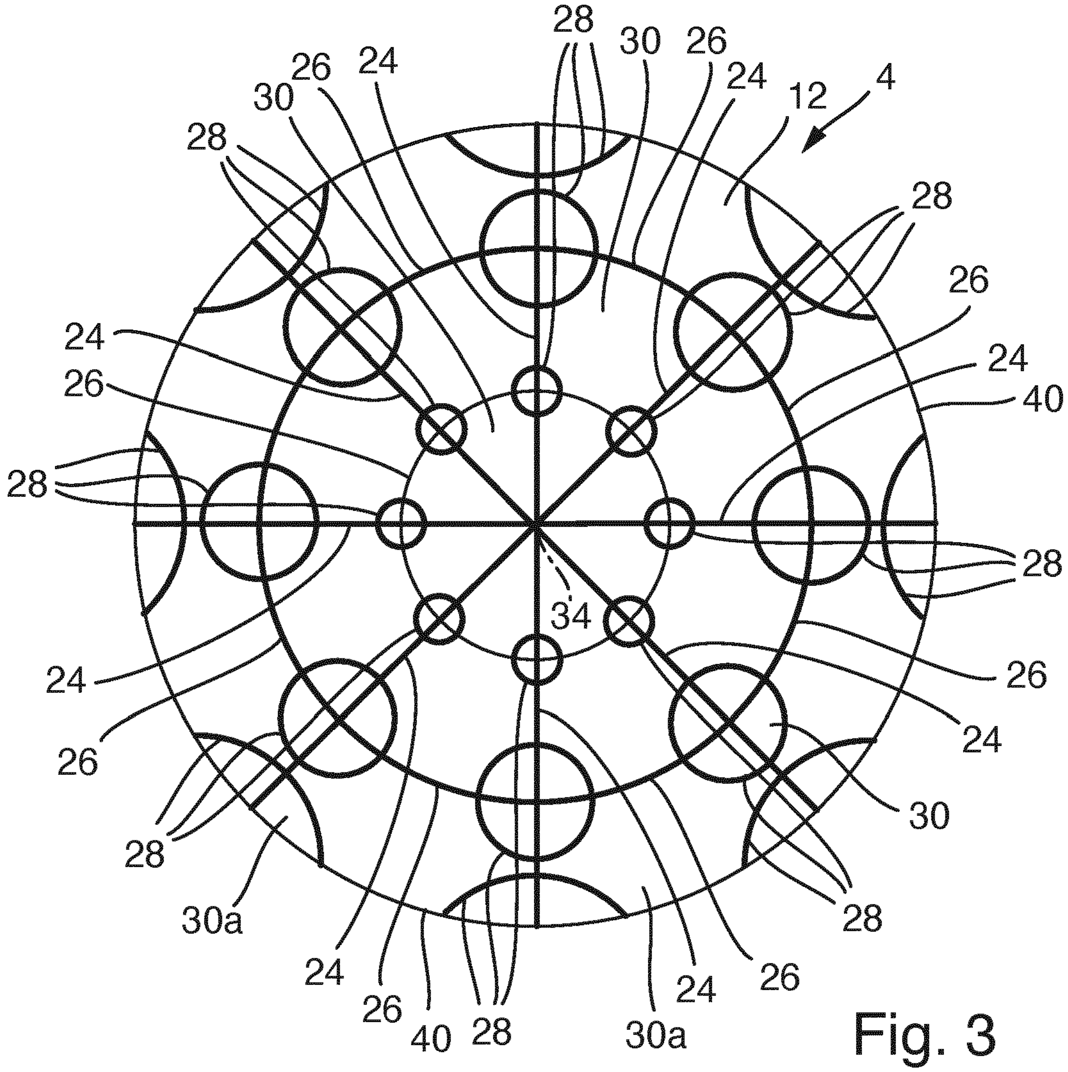
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Fig. 3

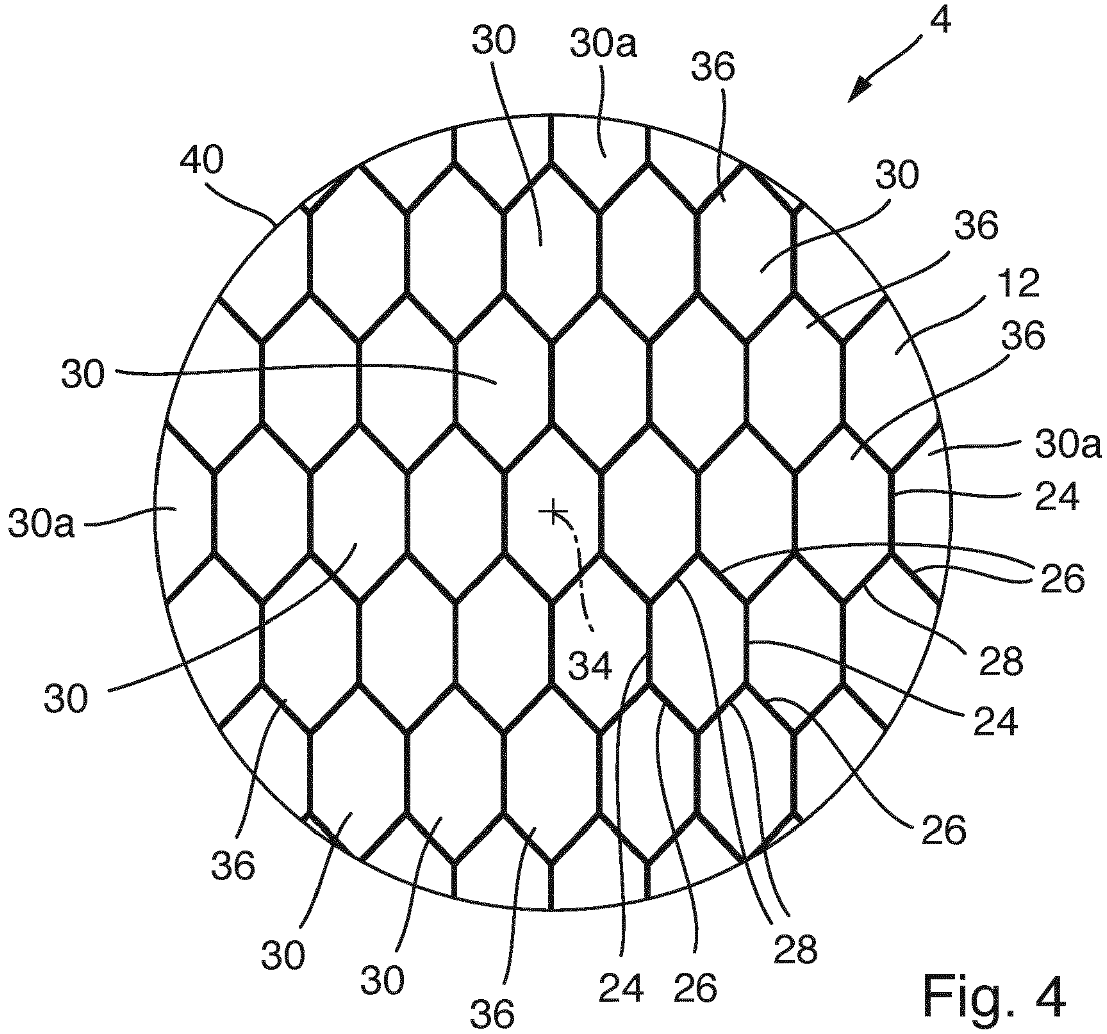
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Fig. 4

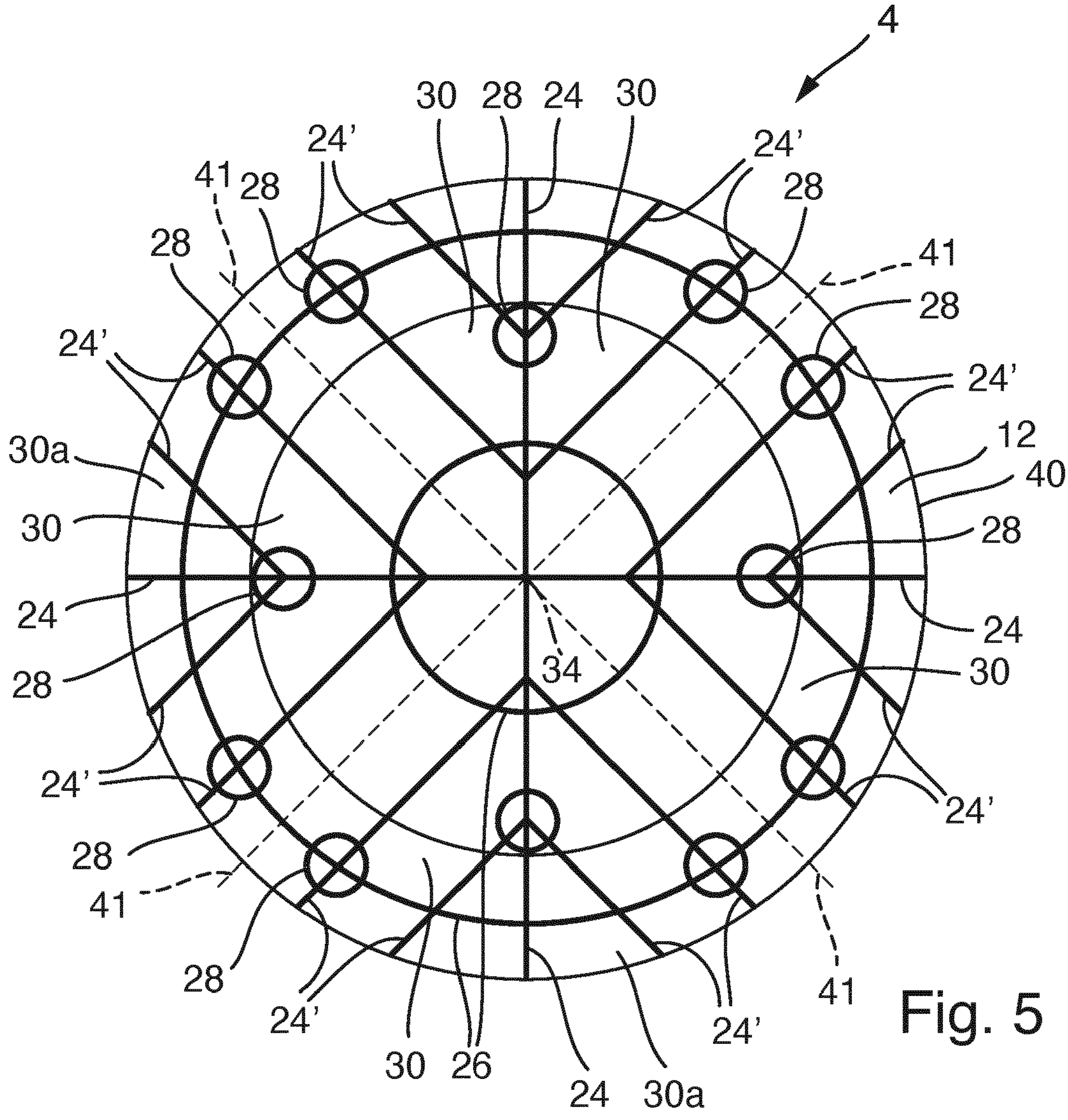
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Fig. 5

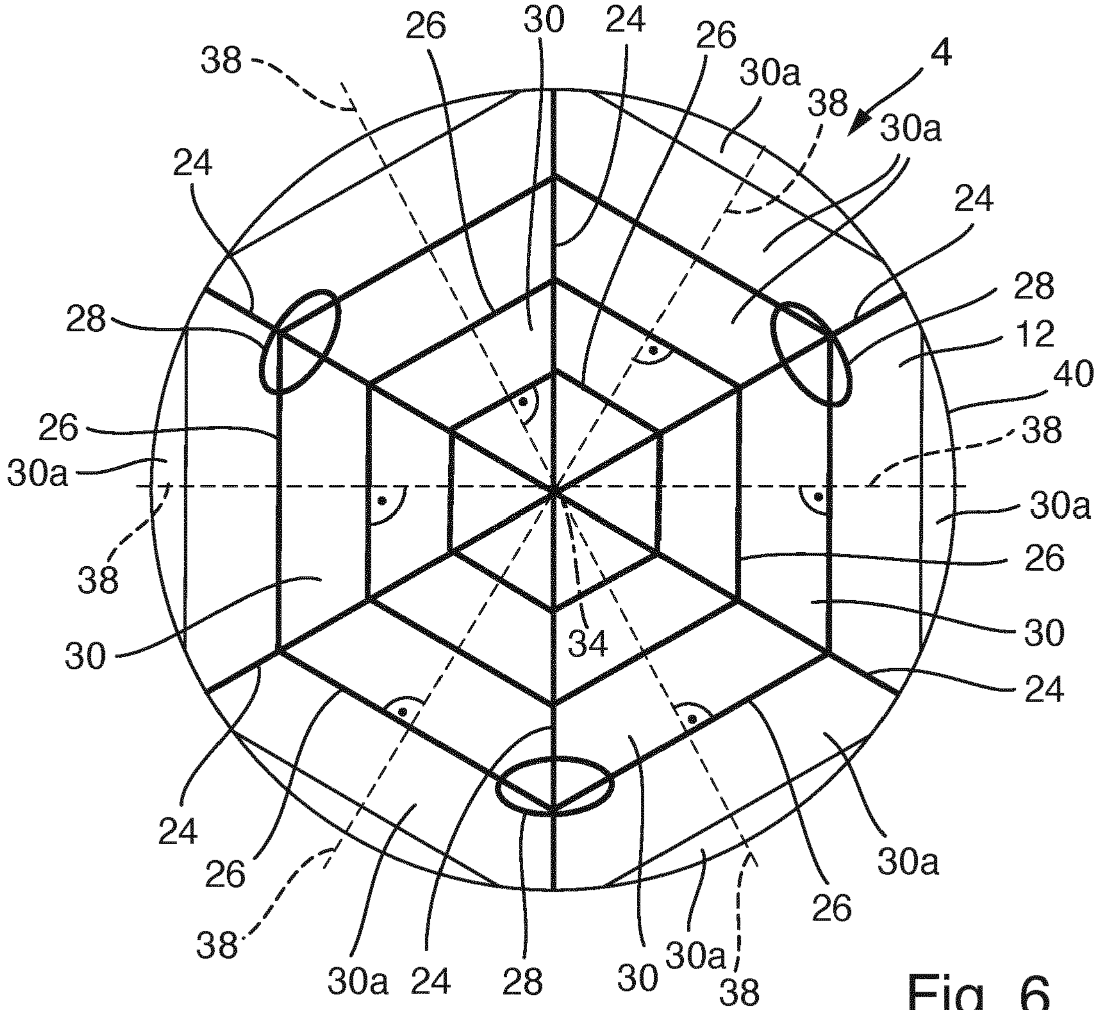
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Fig. 6

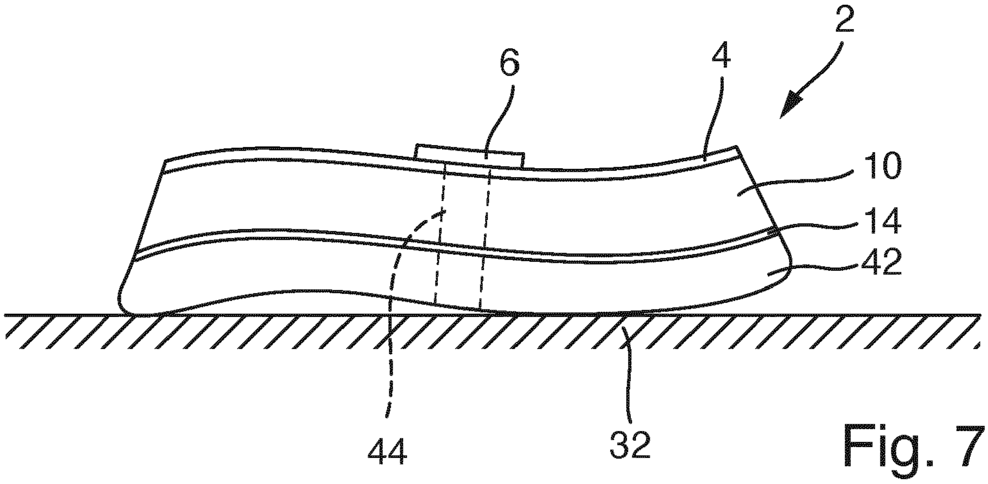

Fig. 7

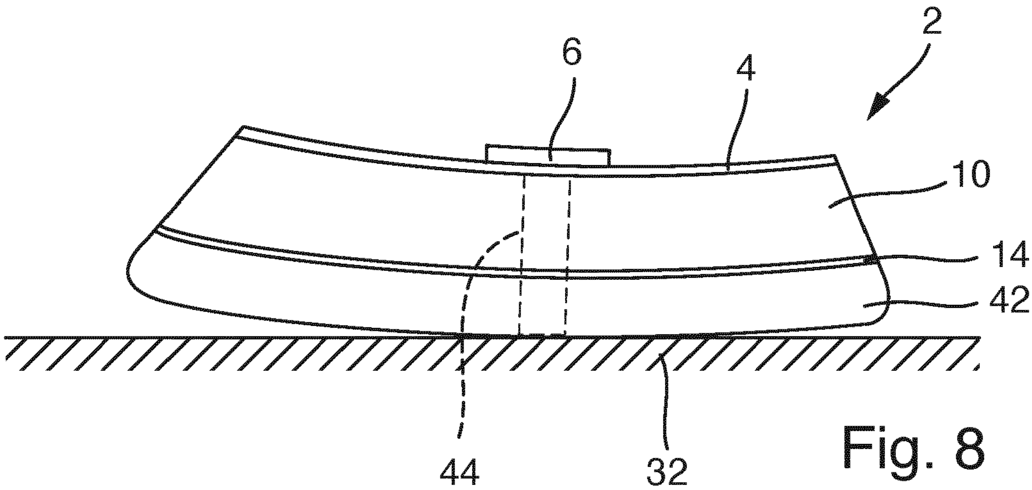

Fig. 8

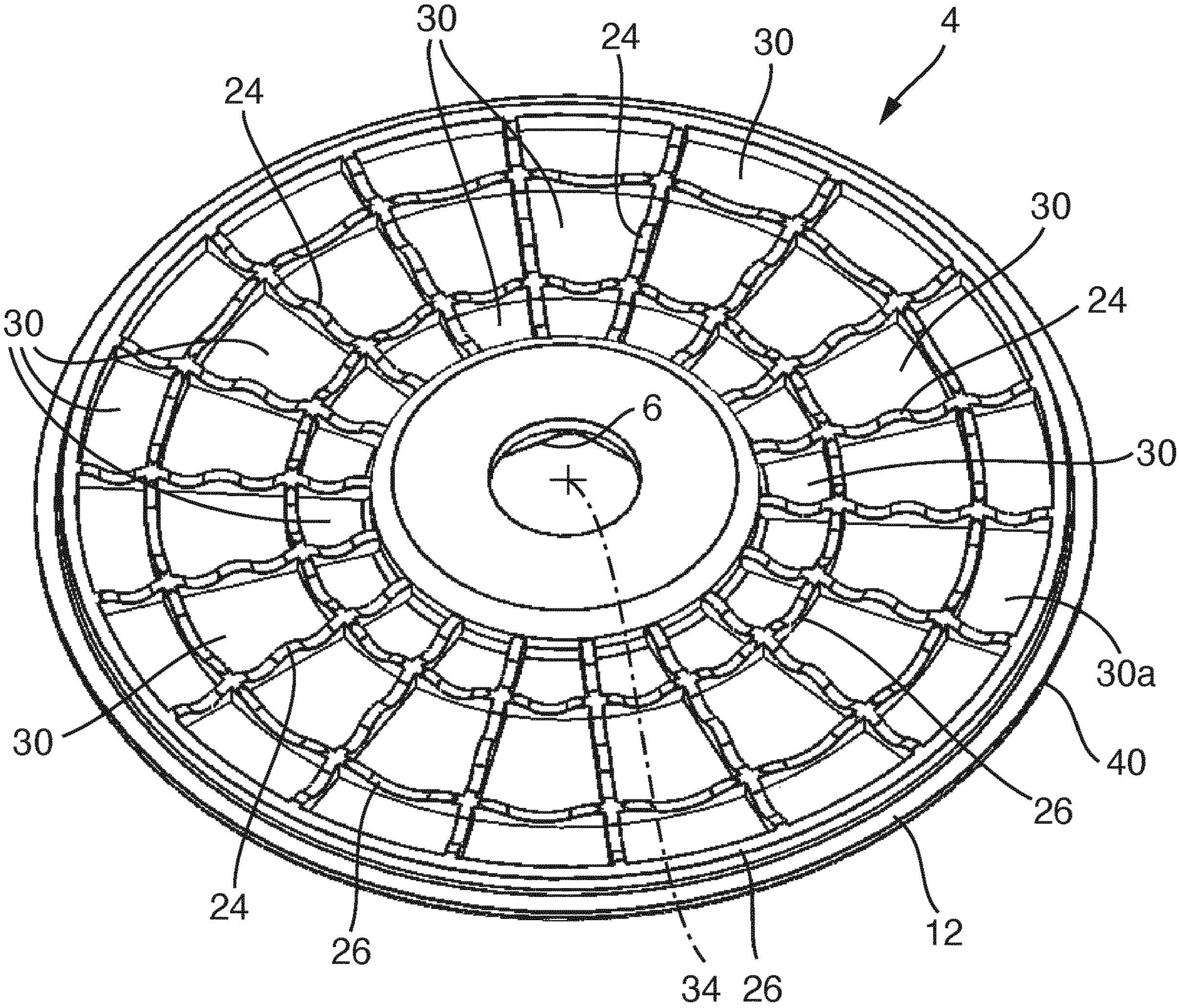

Fig. 9

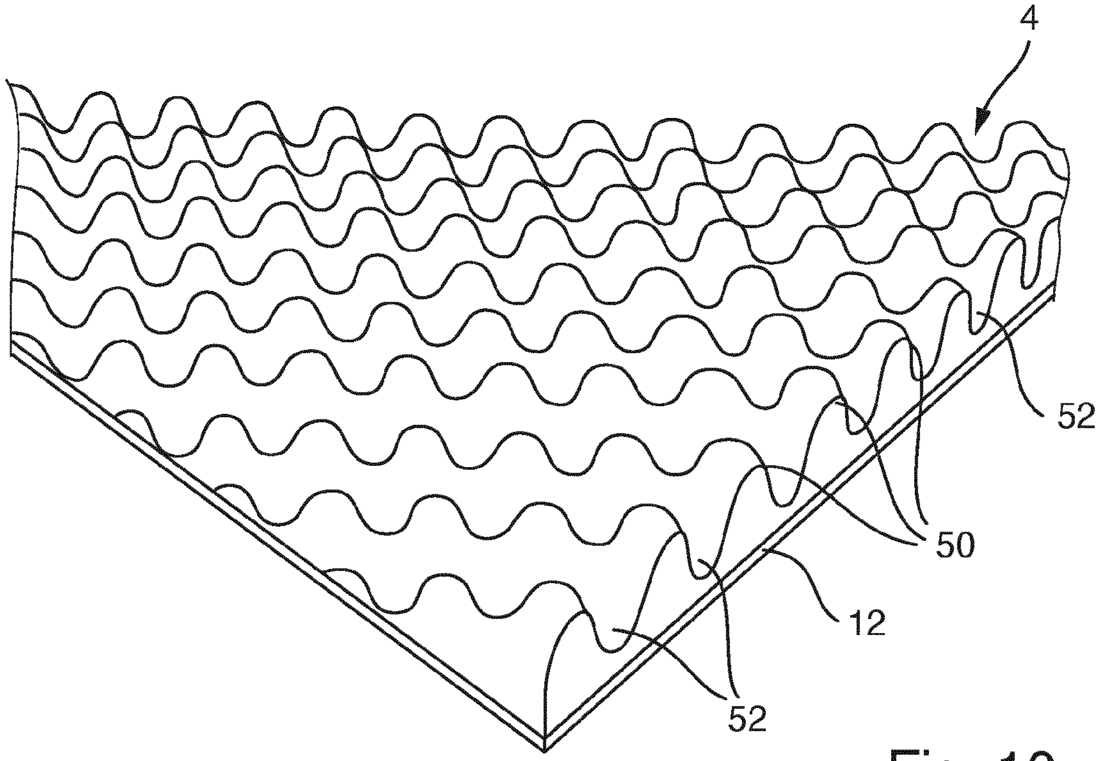

Fig. 10

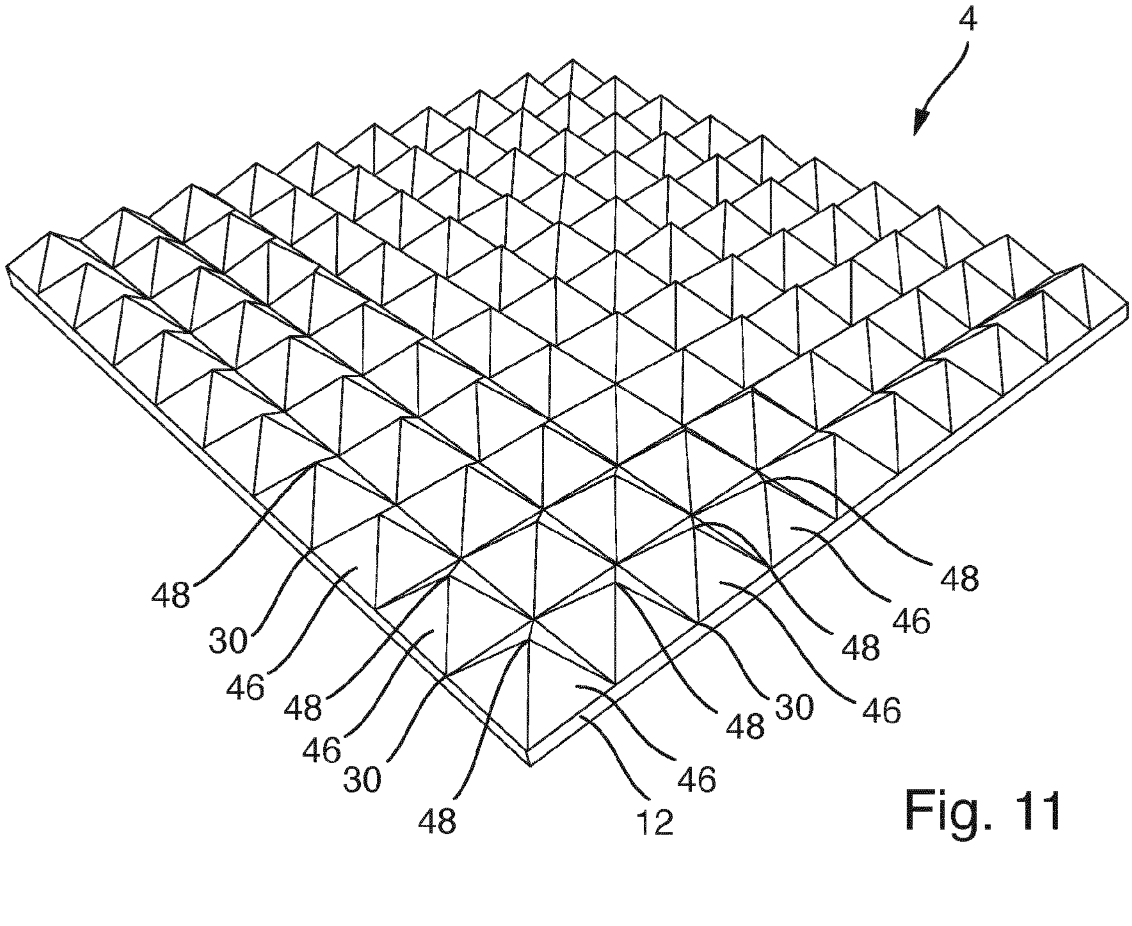

Fig. 11

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 August 2021	Stanic, Franjo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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