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(71) Applicant: **Valentini, Guido**
20122 Milano (IT)

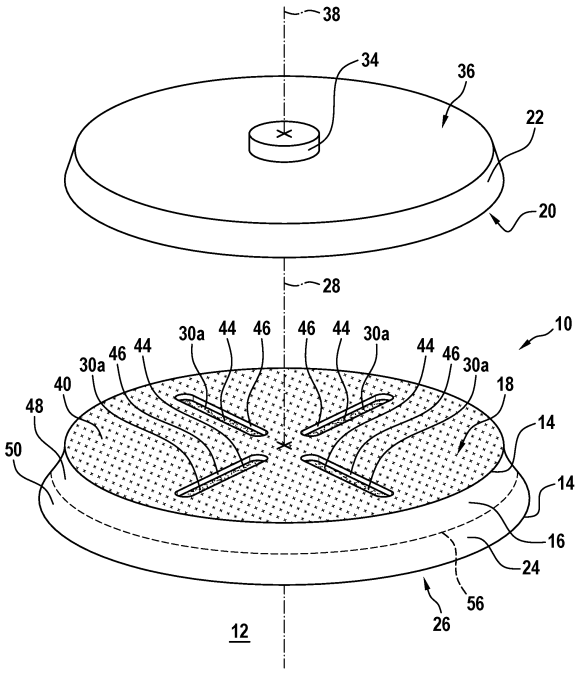
(72) Inventor: **Valentini, Guido**
20122 Milano (IT)

(74) Representative: **Wörz, Volker Alfred**
Wörz Patentanwälte PartG mbB
Gablenberger Hauptstraße 32
70186 Stuttgart (DE)

(54) POLISHING PAD FOR POLISHING A SURFACE OF A WORKPIECE

(57) The invention refers to a polishing pad (10) for polishing a surface (12) of a workpiece, configured for use with a polishing power tool. The polishing pad (10) has a rotational axis (28) and a plate-like form with a circular outer circumference (14), an upper region (16) with a top surface (18) for releasable attachment to a bottom surface (20) of a backing plate (22) of the polishing power tool, and a lower region (24) with a bottom surface (26) forming a working surface for performing a polishing task on the surface (12) of the workpiece to be polished during intended use of the polishing pad (10). At least the upper region (16) is made of a foamed material (48). It is suggested that the polishing pad (10) comprises depressions or recesses (30) formed in the foamed material (48) of the upper region (16) of the polishing pad (10) at a distance from the rotational axis (28) and the bottom surface (26) forms a continuous working surface without depressions or recesses.

Fig. 1



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Description

[0001] The present invention refers to a polishing pad for polishing a surface of a workpiece, configured for use with a polishing power tool. The polishing pad has a rotational axis and an essentially plate-like form with a circular outer circumference, an upper region with a top surface adapted for releasable attachment to a bottom surface of a backing plate of the polishing power tool, and a lower region with a bottom surface forming a working surface adapted for performing a polishing task on the surface of the workpiece to be polished during intended use of the polishing pad. At least the upper region of the polishing pad is made of a foamed material.

[0002] Polishing pads for rotary, random orbital or gear-driven polishing power tools are typically made of various materials designed to provide different levels of cutting and finishing capabilities. One material commonly used for polishing applications is a foamed material. Foam polishing pads come in different thicknesses and densities, which affect their cutting and finishing abilities. Foam polishing pads are versatile and can be used for both cutting and finishing stages of polishing. Foam polishing pads may also come in different diameters depending on the diameters of a backing plate of the polishing power tool, to which they are releasably attached. In foam polishing pads the upper region and the lower region are made of foamed material having the same or different properties or characteristics (i.e., type of material, open or closed cell structure, size of the cells, etc.).

[0003] Furthermore, so-called hybrid pads combine different materials, such as a foam and microfiber or foam and wool, to provide a balance between cutting and finishing capabilities. They can be versatile and suitable for various polishing tasks. Usually, the microfiber or wool comes in a material layer which is attached to a bottom side of the foamed material of the upper region of the polishing pad. Attachment of the microfiber or wool layer to the bottom side of the foamed material may be achieved in various ways, comprising gluing, welding or co-moulding.

[0004] The foamed material is usually a foamed plastic or synthetic material. It may have an open or closed cell structure and different cell sizes depending on the desired/intended polishing application.

[0005] The releasable attachment of the polishing pad to the bottom surface of a backing plate of the polishing power tool may be realized in various ways. One common way is the use of a hook and loop fastening system comprising two mating layers, one with hooks and the other with loops. The hooks and loops interlock to create a strong bond when pressed together and can be easily separated by pulling them apart.

[0006] In the prior art, polishing pads are known which have a central through hole extending through the entire polishing pad from the top surface of the upper region of the polishing pad to the bottom surface of the lower region of the polishing pad along and around the rotational axis. This through hole is often referred to as a hollow chamber providing enhanced heat dissipation during the polishing process. As the polishing pad rotates or moves across the surface being polished, the hollow chamber allows air circulation, preventing excessive heat build-up in the center of the polishing pad. This helps in preventing overheating and potential damage to the surface being polished, which could lead to a damage of the surface and/or the working surface of the polishing pad and/or to excessive heating and draying and finally even hardening of a polishing liquid or polishing paste.

[0007] During the polishing process with a hand-held polishing power tool, the backing plate of the power tool and the polishing pad attached to the bottom surface of the backing plate rotate at rather high speeds of up to 10.000 rpm. These fast-rotating masses may create a considerable amount of vibrations which are transferred to the user holding the polishing power tool. Strong vibrations of the power tool may be perceived as disturbing or annoying by a user of the power tool and may even cause damage to the user's health. Therefore, it is desirable to reduce the amount of vibrations of a polishing power tool during its intended use.

[0008] One possibility to reduce the amount of vibrations of a polishing power tool is to reduce the weight of the rotating masses. One element having a large influence on the weight of the rotating masses is the polishing pad attached to the bottom surface of the backing plate of the power tool. This is especially true if the polishing pad is not attached exactly centrally to the bottom surface of the backing plate, but with a slight eccentricity. Therefore, it is particularly desirable to reduce the weight of the polishing pad.

[0009] On the other hand, the weight of the polishing pad cannot be reduced without further ado, as this could possibly reduce the stability and rigidity of the polishing pad. On the one hand, a polishing pad must have sufficient stability, especially in the radial direction, to prevent deformation of the polishing pad or even warping in the outer edge area of the polishing pad during fast rotation of the polishing pad. On the other hand, a polishing pad must have sufficient stability in the axial direction (parallel to the rotational axis) so that the user can exert a certain amount of pressure in the axial direction on the power tool and thus on the polishing pad in order to be able to process or polish the surface of the workpiece to be processed in the desired manner. Thus, there is a conflict of objectives between a low weight of the polishing pad on the one hand and sufficient stability and rigidity of the polishing pad on the other hand.

[0010] The object of the present invention is to solve this conflict of objectives.

[0011] In order to solve this object, a polishing pad with the features and characteristics according to claim 1 is suggested. In particular, starting from the polishing pad of the above-identified kind, it is suggested that

the polishing pad comprises at least one depression or recess being formed only in the foamed material of the upper region of the polishing pad in at a distance from the rotational axis of the polishing pad and the bottom surface forms a continuous working surface without depressions or recesses except for - if present - a central through hole extending from the top surface of the upper region of the polishing pad to the bottom surface of the lower region of the polishing pad along and around the rotational axis.

[0012] Obviously, if present, the central through hole extending from the top surface of the upper region of the polishing pad to the bottom surface of the lower region of the polishing pad along and around the rotational axis, cannot be considered a depression or recess in the sense of the present invention because it is also present in the lower region of the polishing pad. The bottom surface forming a continuous working surface has the advantage that the entire bottom surface is available as working surface during operation of the power tool and intended use of the polishing pad.

[0013] The one or more depressions or recesses are provided in the upper region of the polishing pad only. The one or more depressions or recesses do not extend into the lower region of the polishing pad The lower region of the polishing pad, in particular the bottom surface of the lower region, is left without any such depression or recess. The polishing pad is attached with its top surface to the bottom surface of the backing plate of the power tool, for instance by means of a hook and loop fastening system. This fastens the polishing pad to the backing plate not only in the axial direction extending parallel to the rotational axis of the polishing pad but also in a radial direction. Thus, attachment of the polishing pad to the backing plate together with the cellular structure of the remaining foamed material of the upper region of the polishing pad provides for a very good stability and rigidity (or a structural rigidity) of the polishing pad despite the one or more depressions or recesses provided in the polishing pad. This high degree of stability and rigidity (or a structural rigidity) of the polishing pad is achieved by the fact that the one or more depressions or recesses are provided in the upper region of the polishing pad only combined with the attachment of the polishing pad to the backing plate at the top surface of the upper region close to where the one or more depressions or recesses are provided.

[0014] Depending on the type of polishing power tool or the type of backing plate drive (e.g., directly or by means of an eccentric element or a gear arrangement, in particular a planetary gear arrangement), respectively, the polishing pad attached to the backing plate may perform a rotational, a random-orbital or a gear-driven working movement about a rotational axis of the driving shaft of the power tool. When performing a rotational movement, the rotational axis of the polishing pad and the rotational axis of the driving shaft are essentially congruent. When performing a random-orbital or a gear-driven movement, the rotational axis of the polishing pad and the rotational axis of the driving shaft extend essentially parallel in respect to each other and spaced apart from each other. When performing a random-orbital movement, the backing plate is held freely rotatable in respect to an eccentric element which is attached to the driving shaft in a torque-proof manner. When performing a gear-driven movement the backing plate is indirectly attached to the driving shaft by means of a gear arrangement, in particular a planetary gear arrangement, and the rotation of the backing plate about its rotational axis essentially corresponding to the rotational axis of the polishing pad attached to the bottom surface of the backing plate has a given ratio in respect to the rotation of the driving shaft about its rotational axis.

[0015] Apart from the better heat dissipating characteristics due to the at least one depression or recess provided in the upper region of the polishing pad, the polishing pad according to the invention has several other advantages. The presence of the at least one depression or recess provided in the upper region of the polishing pad reduces the overall weight of the polishing pad. This can make it easier to handle and manoeuvre during polishing, resulting in improved user control and reduced fatigue. The at least one depression or recess provided in the upper region of the polishing pad can also enhance the performance of the polishing pad during its intended use. They can aid in distributing and retaining polishing compounds or abrasive materials more effectively, ensuring consistent coverage and reducing the risk of product waste.

[0016] The at least one depression or recess can be introduced into the upper region of the polishing pad after manufacturing of the upper region or the polishing pad, respectively. This could be realised by heated punches which are pressed from above into the upper region of the finished polishing pad to locally displace or melt away material to form the at least one depression or recess there. Alternatively, this could also be achieved by selective removal of foamed material in the upper region of the polishing pad, e.g., by milling or laser machining.

[0017] Alternatively, the at least one depression or recess can be introduced into the upper region of the polishing pad during manufacturing of the upper region or the polishing pad, respectively. This could be achieved, for instance, by means of moulds or slides which can be inserted into an injection mould before the foamed plastic material is injected. After curing of the foamed material, at the places where the moulds or slides are placed, the at least one depression or recess will be created in the upper region of the polishing pad.

[0018] Preferably, in a view parallel to the rotational axis of the polishing pad, the polishing pad has the form of a circular disc. In a cross-sectional view of the polishing pad, the lateral external surfaces of the polishing pad may form a straight line extending essentially perpendicular to the surface extension of the polishing pad, they may be

rounded (i.e., have the form of a semicircle or a semioval) or they may have any other desired cross-sectional shape.

[0019] According to a preferred embodiment of the present invention it is suggested that the bottom surface of the lower region of the polishing pad comprises a foamed material, a microfiber material or a wool material. Thus, the present invention refers to different types of polishing pads which all comprise an upper region made of a foamed material and a lower region comprising different types of polishing material. Polishing pads having a polishing material in the lower region different from the foamed material of the upper region are also referred to as hybrid polishing pads.

[0020] It is suggested that, in the case where the bottom surface of the lower region of the polishing pad comprises a foamed material, the entire lower region of the polishing pad is made of the foamed material, preferably made in one part with the foamed material of the upper region of the polishing pad. In case the lower region of the polishing pad is made of a foamed material different from the foamed material of the upper region, the two regions of foamed material may be attached to each other, e.g., by means of gluing, welding or co-moulding. In case the lower region of the polishing pad is made of the same type of foamed material (e.g., the same material having the same cell structure and sizes) as the foamed material of the upper region, the two regions of foamed material can be manufactured in a single moulding process from the same foamed material.

[0021] Preferably, in the case where the bottom surface of the lower region of the polishing pad comprises a microfiber material or a wool material, the microfiber material or the wool material is embodied as a material layer which is attached to a bottom side of the foamed material of the upper region of the polishing pad, comprising attachment by gluing, welding or co-moulding. During manufacturing of the polishing pad by means of a co-moulding process, first the material layer of microfiber or wool can be inserted into an injection mould which then is over-moulded with the foamed material. After curing of the foamed material, the material layer is fixedly attached to the foamed material of the upper region of the polishing pad.

[0022] According to another preferred embodiment, it is suggested that the polishing pad comprises one or more circular ring-shaped depressions or recesses arranged, preferably concentrically, in the upper region of the polishing pad around the rotational axis and spaced apart from each other in a radial direction.

[0023] Alternatively, it is suggested that the polishing pad comprises a plurality of depressions or recesses arranged around the rotational axis and spaced apart from each other in a circumferential direction. In a view parallel to the rotational axis of the polishing pad, the depressions or recesses may have almost any desired form. Preferably, the plurality of depressions or recesses have the same form. Further, preferably, the plurality of depressions or recesses are all arranged in the same distances to the rotational axis. Further, preferably, the plurality of depressions or recesses are all spaced apart from each other by the same distances to respective circumferentially adjacent depressions or recesses.

[0024] According to another preferred embodiment of the present invention, it is suggested that the polishing pad comprises a layer of hooks or loops of a hook and loop fastening system, the hook and loop fastening system being adapted for releasable attachment of the polishing pad to the bottom surface of the backing plate of the polishing power tool, the layer of hooks or loops forming the top surface of the upper region of the polishing pad, wherein the at least one depression or recess extends through the layer of hooks or loops into the foamed material of the upper region of the polishing pad. In this embodiment, the at least one depression or recess opens towards the top surface. The respective layer of hooks or loops provided on the top side of the upper region of the polishing pad extends around the opening of the at least one depression or recess. Thus, those parts of the upper region arranged next to the at least one depression or recess and delimiting the at least one depression or recess laterally, can be attached to the bottom surface of the backing plate by means of the hook and loop fastening system. This provides for additional structural rigidity within the upper region of the polishing pad despite the at least one depression or recess arranged therein. When the polishing pad of this embodiment is attached to the bottom surface of the baking plate, the layer of hooks or loops provided on the bottom surface of the backing plate, acts as a cover for the at least one depression or recess arranged in the upper region of the polishing pad. For instance, the at least one depression or recess could be easily filled with a polishing compound or the like and then attached to the bottom surface of the backing plate, preventing an unintentional running out of the polishing compound out of the at least one depression or recess.

[0025] According to yet another preferred embodiment of the present invention it is suggested that the at least one depression or recess opens into the top surface of the upper region of the polishing pad, wherein the at least one opening of one or more of the at least one depressions or recesses is provided with a cover. Thus, according to this embodiment, the at least one depression or recess is covered by a cover even if the polishing pad is not attached to the bottom surface of the backing plate. The cover may be constituted by various elements or components of the polishing pad or separate therefrom. In particular, the at least one depression or recess may be fully or completely covered or covered only partially, e.g., leaving an opening or a slit in the cover for inserting, in particular injecting, a polishing compound into the at least one depression or recess.

[0026] Preferably, the polishing pad comprises a continuous layer of hooks or loops of a hook and loop fastening system forming the top surface of the upper

region of the polishing pad, the hook and loop fastening system adapted for releasable attachment of the polishing pad to the bottom surface of the backing plate of the polishing power tool, wherein the at least one opening of the at least one depression or recess is covered by the continuous layer of hooks or loops of the hook and loop fastening system forming the top surface of the upper region of the polishing pad.

[0027] In order to further increase the structural rigidity of the polishing pad, in particular in an axial direction extending parallel to the rotational axis of the polishing pad, while at the same time maintaining the advantage of a weight reduction due to the at least one depression or recess provided in the upper region of the polishing pad, it is suggested that at least one gas-filled bag made of a flexible gas-tight material is arranged in one or more of the at least one depressions or recesses. The at least one depression or recess with at least one gas-filled bag located therein forms a gas-filled chamber in the upper region of the polishing pad. Similar to the air cushioning effect know from shoe soles, the gas-filled chambers provide for an increase structural rigidity of the polishing pad in particular in its upper region and in particular after attachment to the bottom surface of the backing plate. This embodiment may be particularly advantageous due to its ability to provide the polishing pad with sufficient stability in the axial direction so that, during intended use of the polishing pad, the user can exert a certain amount of pressure in the axial direction on the power tool and thus on the polishing pad in order to be able to process or polish the surface of the workpiece to be processed in the desired manner.

[0028] In accordance with what has been said before, it is further suggested that one or more of the at least one depressions or recesses are filled with a polishing compound (e.g., a polishing liquid or a polishing paste) of such low viscosity as to allow, during intended use of the polishing pad, the polishing compound to pass through a cell structure of the foamed material of the upper region of the polishing pad and through a material of the lower region of the polishing pad and to reach the surface of the workpiece to be polished. Thus, the at least one depression or recess can be used as a reservoir for polishing compound or the like which gradually releases the polishing compound onto the surface of the workpiece to be polished during intended use of the polishing pad. The speed of delivery of the polishing compound can be adjusted or predetermined by a defined characteristic of the material of the upper region and/or of the lower region of the polishing pad or by the choice of a polishing compound with a corresponding viscosity depending on the material of the polishing pad. Further, by pressing or squeezing the polishing pad in the axial direction, a certain amount of polishing compound can be released onto the working surface. Thus, the polishing pad can also be used as a dosimeter.

[0029] During intended use of the polishing pad, it is driven to rotate about its rotational axis and/or about a rotational axis of a driving shaft of the power tool at rather high speeds. This entails the risk that the polishing compound or other fluid contained in the at least one depression or recess is thrown radially outwards by the centrifugal force and is released to surface regions surrounding the actual surface of the workpiece to be polished. However, the polishing compound or other fluid is in particular helpful if released through the bottom working surface of the bottom region of the polishing pad, in order to be directly released to the surface of the workpiece to be polished.

[0030] In order to achieve this, it is suggested that the lateral walls of one or more of the at least one depressions or recesses have only a limited permeability to fluid compared to a permeability to fluid of the untreated foamed material of the upper region of the polishing pad, or the lateral walls of one or more of the at least one depressions or recesses are embodied fluid tight. This has the advantage that less or even none of the polishing compound or other fluid contained in the at least one depression or recess is thrown radially outwards by the centrifugal force during the intended use of the polishing pad. A major part if not all of the polishing compound or other fluid contained in the at least one depression or recess is directly released to the surface of the workpiece to be polished through the bottom working surface of the bottom region of the polishing pad, in particular through gravitational force.

[0031] Finally, it is suggested that the lateral walls of the one or more of the at least one depressions or recesses having a limited permeability or being fluid tight are formed by heating the lateral walls at least partially leading to an at least partial collapse of the cell structure in the heated parts of the lateral walls. Depending on how far or how much the foamed material of the upper region of the polishing pad is melted in the lateral walls during the heating process, the lateral walls become more or less permeable to fluids of a certain viscosity. Heating of the lateral walls may be achieved, for instance, by heated punches which are pressed against the lateral walls or by laser heating. It may be sufficient if only those lateral walls are provided with a reduced permeability to fluids of a certain viscosity which are directed radially outwards, i.e., away from the rotational axis of the polishing pad, as the centrifugal force will throw the polishing compound or other fluid contained in the at least one depression or recess only through those lateral walls.

[0032] Further features, characteristics and advantages of the present invention will become apparent from the following detailed description when taken together with the drawings. It is emphasized that each of the features shown in the drawings may be relevant for the present invention even if not explicitly mentioned in the following detailed description. Furthermore, each of the features shown in one of the drawings may be combined with each of the features of another drawing in order to form a combination of features relevant for the present invention, even if such a combination is not explicitly

mentioned in the following detailed description. The drawings show:

Figure 1 a first embodiment of the polishing pad according to the present invention in a perspective view;

Figure 2 a second embodiment of the polishing pad according to the present invention in a perspective view;

Figure 3 a third embodiment of the polishing pad according to the present invention in a perspective view;

Figure 4 a fourth embodiment of the polishing pad according to the present invention in a perspective view;

Figure 5 a fifth embodiment of the polishing pad according to the present invention in a perspective view; and

Figure 6 a bottom surface of a polishing pad according to the present invention, forming a continuous wording surface.

[0033] Fig. 1 shows a polishing pad 10 according to the present invention, for polishing a surface 12 of a workpiece. The polishing pad 10 has a rotational axis 28 and is adapted for use with a polishing power tool (not shown). In particular, the polishing pad 10 has an essentially plate-like form with a circular outer circumference 14 and an upper region 16 with a top surface 18 adapted for releasable attachment to a bottom surface 20 of a backing plate 22 of the polishing power tool. Further, the polishing pad 10 has a lower region 24 with a bottom surface 26 forming a working surface adapted for performing a polishing task on the surface 12 of the workpiece to be polished during intended use of the polishing pad 10. At least the upper region 16 of the polishing pad 10 is made of a foamed material 48. In the Figs. 1-4, the upper region 16 and the lower region 24 are separated by a virtual dashed line 56. The dashed line 56 represents a bottom side of the foamed material 48 of the upper region 16 and/or an upper side of a material 50, 52, 54 of the lower region 18. To this end, it is emphasized that the thickness (in an axial direction extending parallel to a rotational axis 28 of the polishing pad 10) of the lower region 18 may be rather small compared to the thickness of the upper region 16, in particular, if the lower region 18 comprises a layer of microfiber 52 or wool 54 (see Fig. 2). Of course, in the real polishing pad 10 the separation of the upper region 16 and the lower region 24 may not be immediately visible from outside, in particular if both are made of a foamed material 48, 50.

[0034] The backing plate 22 has an essentially disc shaped circular form and is provided with a rotational axis 38. The backing plate 22 is preferably made of a rigid or semi-rigid plastic material and serves for supporting and driving the polishing pad 10 attached thereto. It may have a metal insert for stability reasons, the metal insert comprising in particular an attachment region 34 where the backing plate 22 is attached to a driving shaft or part of an eccentric element of the power tool (not shown). The attachment region 34 is preferably made of metal and arranged in the centre of a top surface 36 of the backing plate 22. Of course, the backing plate 22 could also be provided without any metal insert and the attachment region 34 could be made of a rigid plastic material.

[0035] The attachment region 34 is shown only schematically in Figs. 1-4. It may comprise a recess (not shown), into which a protruding element attached to a distal end of the driving shaft or to part of the eccentric element or making part thereof is insertable in the axial direction extending parallel to the rotational axis 38. The recess and the protruding element have corresponding internal/ external circumferences, which preferably are not rotationally symmetric in respect to the rotational axis 38 of the backing plate 22. In particular, the recess and the respective protruding element may have a circumference in the form of a polygonal, particularly preferred of a hexagonal. The attachment region 34 and the corresponding region of the driving shaft or part of the eccentric element are preferably designed such that a torque can be transmitted from the driving shaft or part of the eccentric element to the backing plate 22. The part of the eccentric element, to which the backing plate 22 may be attached, is preferably a pin which is held in the rest of the eccentric element in a freely rotatable manner. The eccentric element in turn is attached in a torque proof manner to the distal end of the driving shaft of the power tool eccentrically to the rotational axis 38 of the backing plate 22.

[0036] The backing plate 22 may be held in respect to the driving shaft or part of the eccentric element of the power tool in the axial direction by means of a screw or any other type of fastening member, which may be inserted from the bottom surface 20 through a central hole (not shown) extending through the backing plate 22 along the rotational axis 38 and which exits the backing plate 22 on the top surface 36 where it is screwed into the driving shaft or part of the eccentric element. Alternatively, the backing plate 22 may be held in respect to the driving shaft or part of the eccentric element of the power tool in the axial direction by means of magnetic force.

[0037] Alternatively, instead of a recess, the attachment region 34 may comprise a pin (not shown), preferably a threaded pin, extending along the rotational axis 38 of the backing plate 22. The pin is preferably made of metal and part of a metal insert of the backing plate 22. The pin can be inserted into a respective recess, hole or bore provided in a distal end of the driving shaft or in part of an eccentric element. Again, the part of the eccentric element, to which the backing plate 22 may be attached, is preferably a pin which is held in the rest of the eccentric

element in a freely rotatable manner. The distal end of the driving shaft or of the pin held in a freely rotatable manner in the eccentric element are preferably provided with a threaded bore for receiving a threaded pin of the attachment region 34 in a torque proof manner.

[0038] In order to solve a conflict of objectives between a low weight of the polishing pad 10 on the one hand and sufficient stability and rigidity (i.e., structural rigidity) of the polishing pad 10 on the other hand, it is suggested that

> the polishing pad 10 comprises at least one depression or recess 30 being formed in the upper region 16 of the polishing pad 10 in the foamed material 48 at a distance from the rotational axis 28 of the polishing pad 10 and
> the bottom surface 26 forms a continuous working surface without depressions or recesses except for - if present - a central through hole 32 (see Fig. 2) extending from the top surface 18 of the upper region 16 of the polishing pad 10 to the bottom surface 26 of the lower region 24 of the polishing pad 10 along and around the rotational axis 28.

[0039] In the embodiments of Figs. 1-3, there are four distinct depressions or recesses 30a provided in the upper region 16 of the polishing pad 10. Each of the depressions or recesses 30a has a longitudinal extension in the radial direction. Preferably, all depressions or recesses 30a have the same form and size including depth. The depth of the depressions or recesses 30a is such that the depressions or recesses 30a do not reach the lower region 24 and in particular not the bottom surface 26. The entire depressions or recesses 30a extend in the foamed material 48 of the upper region 16 only.

[0040] The form and number of the depressions or recesses 30 may vary in respect to what is shown in the figures. In particular, in a view in the axial direction of the polishing pad 10, a plurality of depressions or recesses 30 may have a circular, an oval, any polygonal, sickle- or banana-formed or any free-form shape. The depressions or recesses 30 may have differing forms compared to each other.

[0041] The depth of the depressions or recesses 30a may vary along the longitudinal extension of the depressions or recesses 30a in the radial direction. Also, the depth of the depressions or recesses 30a could vary in a circumferential direction.

[0042] The depressions or recesses 30 may be made in the upper region 16 of the polishing pad 10 from the top surface 18. Alternatively, the depressions or recesses 30 may be made in the upper region 16 of the polishing pad 10 from a bottom surface (represented by the dashed line 56 in Fig. 1) of the upper region 16, which then may be attached to a top surface (also represented by the dashed line 56 in Figs. 1) of the bottom region 24 of the polishing pad 10, threreby forming the polishing pad 10 according to the invention.

[0043] The depressions or recesses 30 can be introduced into the upper region 16 of the polishing pad 10 after manufacturing of the upper region 16 or the polishing pad 10, respectively. This could be realised by heated punches which are pressed from above into the upper region 16 of the finished polishing pad 10 to locally displace or melt away material and to form the depressions or recesses 30 there. Alternatively, this could also be achieved by selective removal of foamed material 48 in the upper region 16 of the polishing pad 10, e.g., by milling or laser machining.

[0044] Alternatively, the depressions or recesses 30 could be introduced into the upper region 16 of the polishing pad 10 during manufacturing of the upper region 16 or the polishing pad 10, respectively. This could be achieved, for instance, by means of moulds or slides which can be inserted into an injection mould before the heated foamed plastic material 48 is injected. After curing of the foamed material 48, at the places where the moulds or slides are placed, the depressions or recesses 30 will be created in the upper region 16 of the polishing pad 10.

[0045] Preferably, as shown in Figs. 1-3, all depressions or recesses 30a have the same distance to the rotational axis 28. Preferably, the depressions or recesses 30a are equidistantly spaced apart from adjacent depressions or recesses 30a in a circumferential direction. Of course, it would also be possible that the depressions or recesses 30a have differing distances to the rotational axis 28 and/or are disposed at different distances to each other in the circumferential direction.

[0046] The bottom surface 26 is shown in Fig. 6, where it is emphasized that the central through hole 32 shown there is a facultative feature. In Fig. 6 the lower region 24 of the polishing pad 10 comprises a foamed material 50. However, the lower region 24, in particular the bottom surface 26, might just as well comprise other polishing materials such as microfiber 52 or wool 54 (see Fig. 2). It can be clearly seen in Fig. 6 that the bottom surface 26 forms a continuous and even working surface without depressions or recesses except for the central through hole 32.

[0047] In the case where the bottom surface 26 of the lower region 24 of the polishing pad 10 comprises a foamed material 50 (see Figs. 1 and 3-6), the entire lower region 24 of the polishing pad 10 is made of the foamed material 50. Preferably the entire polishing pad 10 is manufactured from the same foamed material 48, 50. To this end, the foamed material 50 of lower region 24 can be made in one part with the foamed material 48 of the upper region 16 of the polishing pad 10. Alternatively, the upper region 16 and the lower region 24 could also be made of separate members of foamed material 48, 50 which are attached to each other, for instance by gluing, welding or co-moulding.

[0048] In the case where the bottom surface 26 of the lower region 24 of the polishing pad 10 comprises a microfiber material 52 or a wool material 54 (see Fig. 2), the microfiber material 52 or the wool material 54 may

be embodied as a material layer which is attached to a bottom side of the foamed material 48 of the upper region 16 of the polishing pad 10, comprising attachment by gluing, welding or co-moulding.

[0049] As shown in Fig. 4, the polishing pad 10 may comprise one or more circular ring-shaped depressions or recesses 30b arranged, preferably concentrically, in the upper region 16 of the polishing pad 10 around the rotational axis 28 and spaced apart from each other in a radial direction.

[0050] The polishing pad 10 may comprise a layer 40 of hooks or loops of a hook and loop fastening system. The hook and loop fastening system is adapted for releasable attachment of the polishing pad 10 to the bottom surface 20 of the backing plate 22 of the polishing power tool. The layer 40 of hooks or loops may form the top surface 18 of the upper region 16 of the polishing pad 10. In the embodiments of Figs. 1 and 2, the at least one depression or recess 30 extends through the layer 40 of hooks or loops into the foamed material 48 of the upper region 16 of the polishing pad 10. The layer 40 of hooks or loops surrounds an opening into the at least one depression or recess 30.

[0051] According to yet another embodiment of the invention, it is suggested that the at least one depression or recess 30 opens into the top surface 18 of the upper region 16 of the polishing pad 10 and the at least one opening of one or more of the at least one depressions or recesses 30 is provided with a cover. In the embodiment of Fig. 3, the openings of the depressions or recesses 30 are all covered by the layer 40 of hooks or loops. Thus, the continuous layer 40 of hooks and loops extends over the entire top surface 18 including the openings of the depressions or recesses 30.

[0052] The cover covering the openings of the depressions or recesses 30 may have one or more holes or slits (not shown) to allow temporary access to the inside of the depressions or recesses 30. The cover may be fixedly attached to the top surface 18 or form the top surface 18, like the layer 40 of hooks or loops in Fig. 3, or it may be removably attached to the top surface 18 or part thereof.

[0053] Further, according to another embodiment of the invention, it is suggested that at least one gas-filled bag 42 made of a flexible gas-tight material is arranged in one or more of the at least one depressions or recesses 30. The gas-filled bag 42 is preferably made of a plastic foil. The at least one depression or recess 30 with the gas-filled bag 42 forms a gas-filled chamber in the polishing pad 10. In the embodiment of Fig. 5, all depressions or recesses 30 are each filled with a single gas-filled bag 42. Preferably, the at least one gas-filled bag 42 fills the entire interior of the depressions or recesses 30. Preferably, the at least one depression or recesses 30 containing each at least one gas-filled bag 42 is covered by a cover, for instance by the layer 40 of hooks or loops as previously described. The at least one gas-filled bag 42 contained in the at least one depression or recess 30 provides for a higher structural stability of the polishing pad 10 despite the at least one depression or recess 30 embodied in the upper region 16 of the polishing pad 10.

[0054] It can be taken from Fig. 1 that one or more of the at least one depressions or recesses 30 are filled with a polishing compound 44 of such low viscosity as to allow, during intended use of the polishing pad 10, the polishing compound 44 to pass through a cell structure of the foamed material 48 of the upper region 16 of the polishing pad 10 and through a material 50, 52, 54 of the lower region 24 of the polishing pad 10 and to reach the surface 12 of the workpiece to be polished. The polishing compound 44 may be, for instance, a polishing liquid or a polishing paste with or without abrasive particles or pigments, e.g., in the size of micrometres. In order to provide for a defined throughput of the polishing compound 44 through the lower region 24 onto the working surface 12, it may be preferably to perforate the lower region 24 either in its entire thickness or only in part thereof, e.g., in an upper surface (extending in a plane represented by the dashed line 56) of the lower region 24. A perforation is in particular advantageous if the lower region 24 comprises a layer of microfiber material 52 or of wool material 54.

[0055] Intended use of the polishing pad 10 will comprise its repeated regional elastic compression and expansion, thereby promoting the transfer of the polishing compound 44 from the at least one depression or recess 30 towards the bottom surface 26 and onto the surface 12 to be polished.

[0056] Channels for conveying the polishing compound 44 may be provided in the polishing pad 10. The channels preferably interconnect the at least one depression or recess 30 and the bottom surface 26 of the lower region 24 of the polishing pad 10. If the extension of the channels has a component in the radial direction towards an outer circumference 14 of the polishing pad 10, the transfer of the polishing compound 44 from the at least one depression or recess 30 to the bottom surface 26 of the polishing pad 10 may be additionally promoted by the centrifugal force due to rotation of the polishing pad 10 during intended use.

[0057] It is suggested that lateral walls 46 of one or more of the at least one depressions or recesses 30 have only a limited permeability to fluid compared to a permeability to fluid of the untreated foamed material 48 of the upper region 16 of the polishing pad 10, or the lateral walls 46 of one or more of the at least one depressions or recesses 30 are embodied fluid tight. The lateral walls 46 delimit the depressions or recesses 30 towards the sides, i.e., towards a direction extending parallel to a surface extension of the polishing pad 10. The foam material of the upper region 16 generally has an open cell structure in order to permit passage of the fluid, e.g., the polishing compound 44, towards the surface 12 to be polished. In the region of the lateral walls 46 the permeability of the foam material to fluids is reduced.

[0058] The lateral walls 46 of the one or more of the at least one depressions or recesses 30 having a limited permeability or being fluid tight are formed by heating the

lateral walls 46 at least partially leading to an at least partial collapse of the cell structure of the foamed material 48 of the upper region 16 of the polishing pad 10 in the heated parts of the lateral walls 46. Of course, other ways of achieving the reduced permeability to fluids in the region of the lateral walls 46 are conceivable, too. For instance, the lateral walls 46 could be covered by an impermeable foil or coated with a paint or varnish.

Claims

1. Polishing pad (10) for polishing a surface (12) of a workpiece, adapted for use with a polishing power tool, the polishing pad (10) having a rotational axis (28) and an essentially plate-like form with a circular outer circumference (14), an upper region (16) with a top surface (18) adapted for releasable attachment to a bottom surface (20) of a backing plate (22) of the polishing power tool, and a lower region (24) with a bottom surface (26) forming a working surface adapted for performing a polishing task on the surface (12) of the workpiece to be polished during intended use of the polishing pad (10), at least the upper region (16) of the polishing pad (10) being made of a foamed material (48),
characterized in that

   the polishing pad (10) comprises at least one depression or recess (30) being formed only in the foamed material (48) of the upper region (16) of the polishing pad (10) at a distance from the rotational axis (28) of the polishing pad (10) and the bottom surface (26) forms a continuous working surface without depressions or recesses except for - if present - a central through hole (32) extending from the top surface (18) of the upper region (16) of the polishing pad (10) to the bottom surface (26) of the lower region (24) of the polishing pad (10) along and around the rotational axis (28).

2. Polishing pad (10) according to claim 1, wherein the bottom surface (26) of the lower region (24) of the polishing pad (10) comprises a foamed material (50), a microfiber material (52) or a wool material (54).

3. Polishing pad (10) according to claim 2, wherein, in the case where the bottom surface (26) of the lower region (24) of the polishing pad (10) comprises a foamed material (50), the entire lower region (24) of the polishing pad (10) is made of the foamed material (50), preferably made in one part with the foamed material (48) of the upper region (16) of the polishing pad (10).

4. Polishing pad (10) according to claim 2, wherein, in the case where the bottom surface (26) of the lower region (24) of the polishing pad (10) comprises a microfiber material (52) or a wool material (54), the microfiber material (52) or the wool material (54) is embodied as a material layer which is attached to a bottom side (56) of the foamed material (48) of the upper region (16) of the polishing pad (10), comprising attachment by gluing, welding or co-moulding.

5. Polishing pad (10) according to one of the preceding claims, wherein the polishing pad (10) comprises one or more circular ring-shaped depressions or recesses (30b) arranged, preferably concentrically, in the upper region (16) of the polishing pad (10) around the rotational axis (28) and spaced apart from each other in a radial direction.

6. Polishing pad (10) according to one of the preceding claims 1 to 4, wherein the polishing pad (10) comprises a plurality of depressions or recesses (30a), preferably having the same form, arranged around the rotational axis (28), preferably in the same distances to the rotational axis (28), and spaced apart from each other in a circumferential direction, preferably by the same distances to respective circumferentially adjacent depressions or recesses (30a).

7. Polishing pad (10) according to one of the preceding claims, wherein the polishing pad (10) comprises a layer (40) of hooks or loops of a hook and loop fastening system, the hook and loop fastening system being adapted for releasable attachment of the polishing pad (10) to the bottom surface (20) of the backing plate (22) of the polishing power tool, the layer (40) of hooks or loops forming the top surface (18) of the upper region (16) of the polishing pad (10), and wherein the at least one depression or recess (30) extends through the layer (40) of hooks or loops into the foamed material (48) of the upper region (16) of the polishing pad (10).

8. Polishing pad (10) according to one of the preceding claims, wherein the at least one depression or recess (30) opens into the top surface (18) of the upper region (16) of the polishing pad (10), and wherein the at least one opening of one or more of the at least one depressions or recesses (30) is provided with a cover.

9. Polishing pad (10) according to claim 8, wherein the polishing pad (10) comprises a continuous layer (40) of hooks or loops of a hook and loop fastening system, forming the top surface (18) of the upper region (16) of the polishing pad (10), the hook and loop fastening system adapted for releasable attachment of the polishing pad (10) to the bottom surface (20) of the backing plate (22) of the polishing power tool, and wherein the at least one opening of the at least one depression or recess (30) is covered by the

continuous layer (40) of hooks or loops of the hook and loop fastening system.

10. Polishing pad (10) according to one of the preceding claims, wherein at least one gas-filled bag (42) made of a flexible gas-tight material is arranged in one or more of the at least one depressions or recesses (30).

11. Polishing pad (10) according to one of the preceding claims, wherein one or more of the at least one depressions or recesses (30) are filled with a polishing compound (44) of such low viscosity as to allow, during intended use of the polishing pad (10), the polishing compound (44) to pass through a cell structure of the foamed material (48) of the upper region (16) of the polishing pad (10) and through a material (50, 52, 54) of the lower region (24) of the polishing pad (10) and to reach the surface (12) of the workpiece to be polished.

12. Polishing pad (10) according to one of the preceding claims, wherein lateral walls (46) of one or more of the at least one depressions or recesses (30) have only a limited permeability to fluid compared to a permeability to fluid of the untreated foamed material (48) of the upper region (16) of the polishing pad (10), or the lateral walls (46) of one or more of the at least one depressions or recesses (30) are embodied fluid tight.

13. Polishing pad (10) according to claim 12, wherein the lateral walls (46) of the one or more of the at least one depressions or recesses (30) having a limited permeability to fluid or being fluid tight are formed by heating the lateral walls (46) at least partially leading to an at least partial collapse of the cell structure in the heated parts of the lateral walls (46).

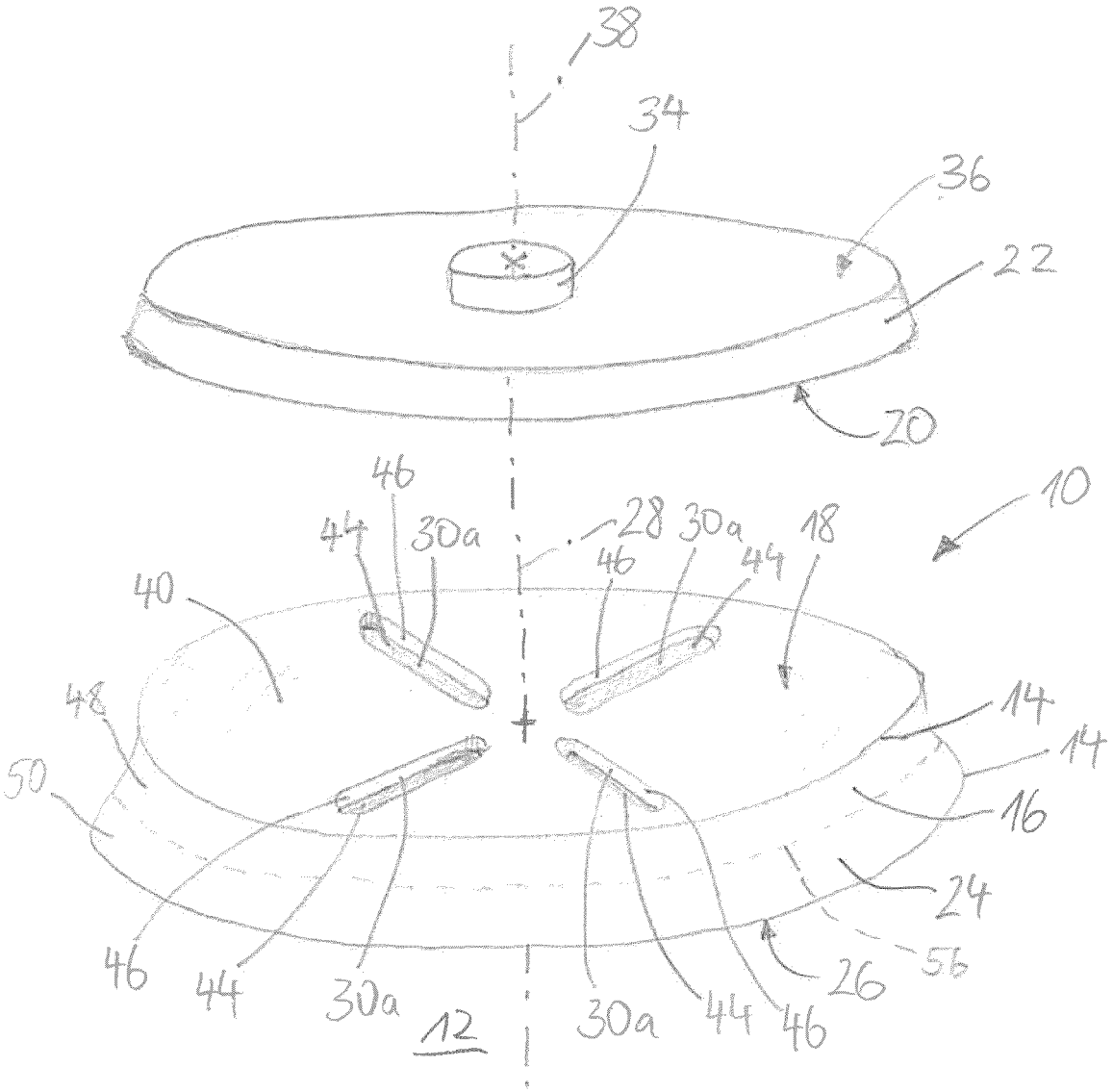
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Fig. 1

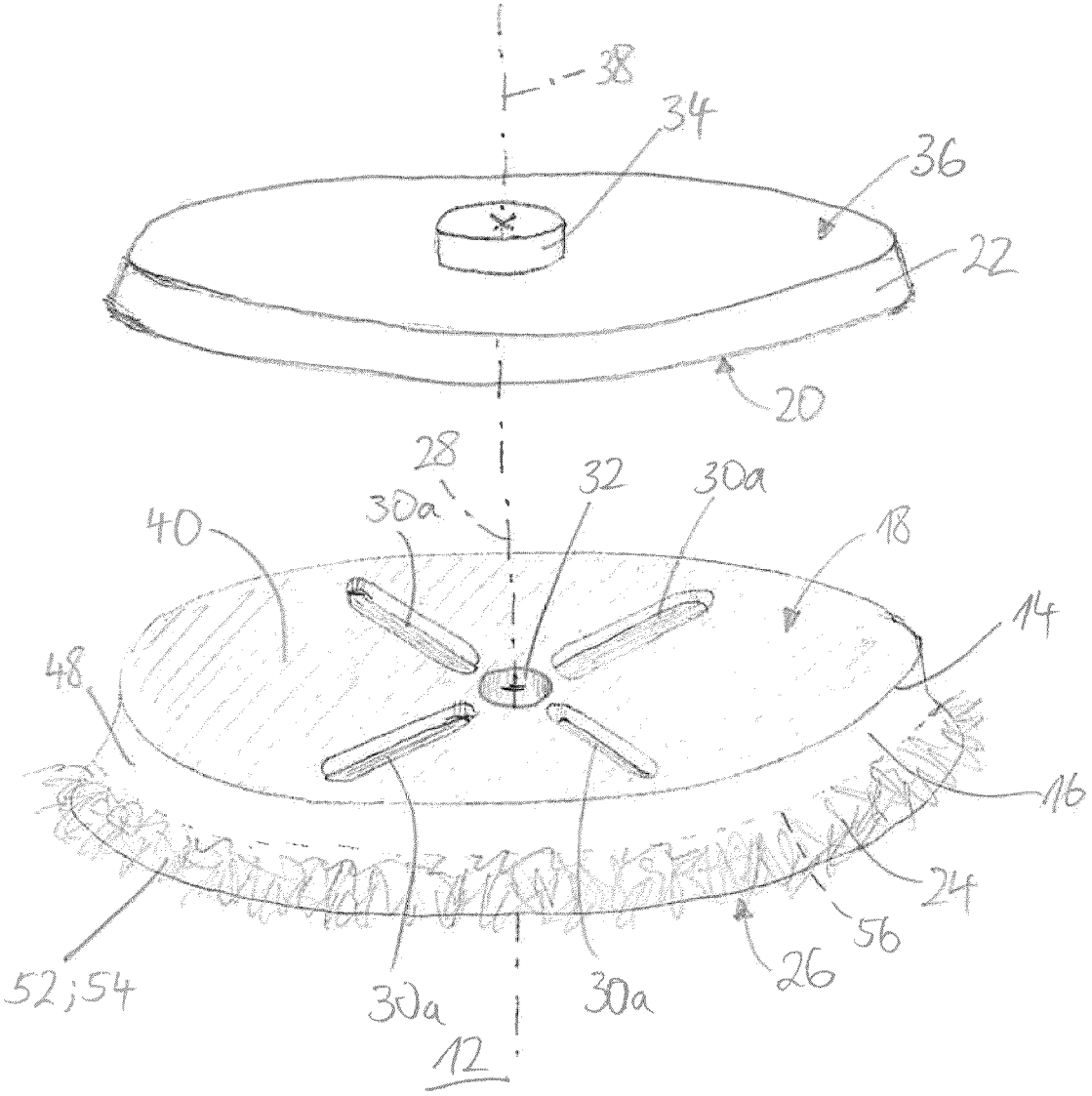

Fig. 2

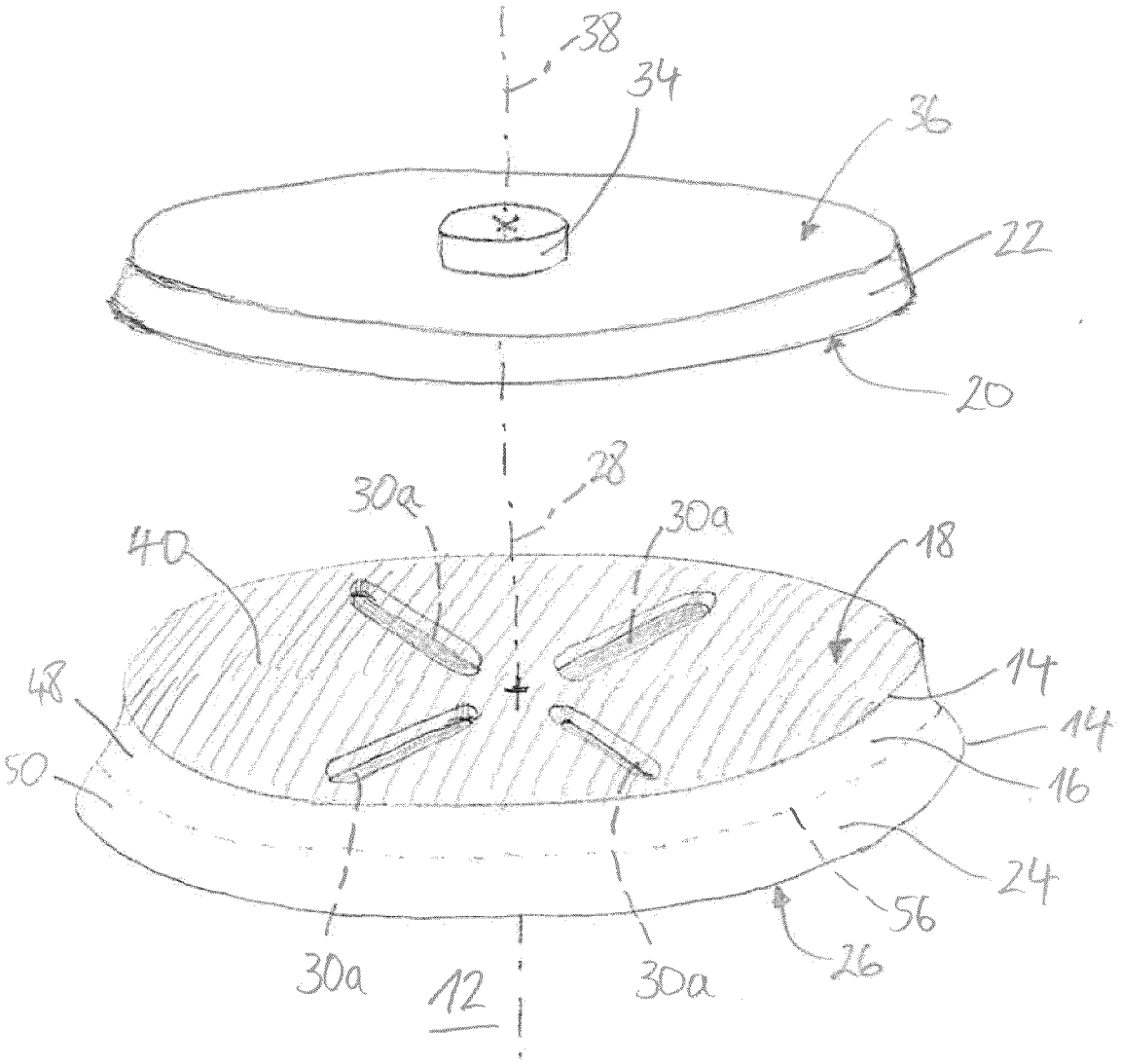

Fig. 3

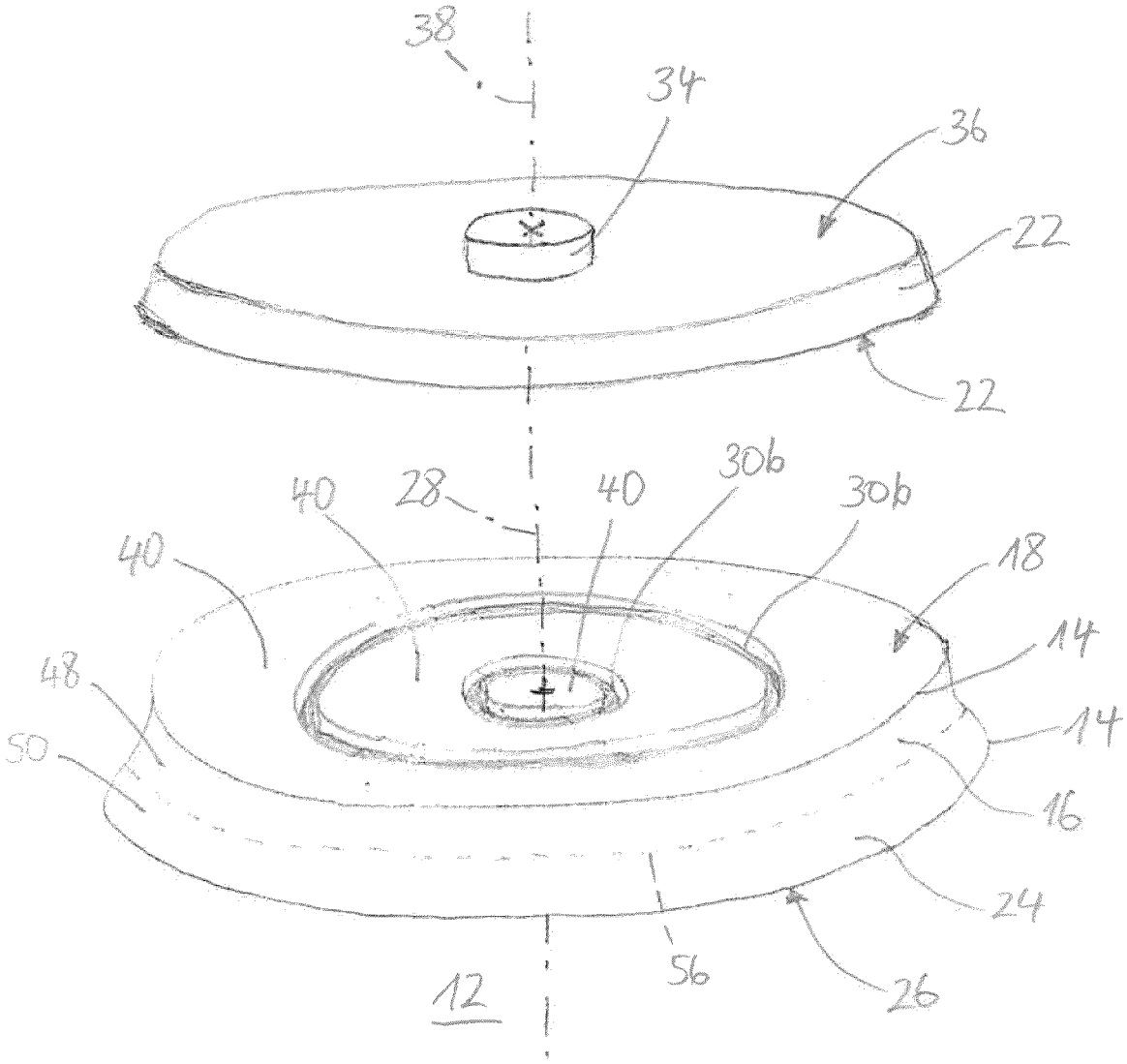

Fig. 4

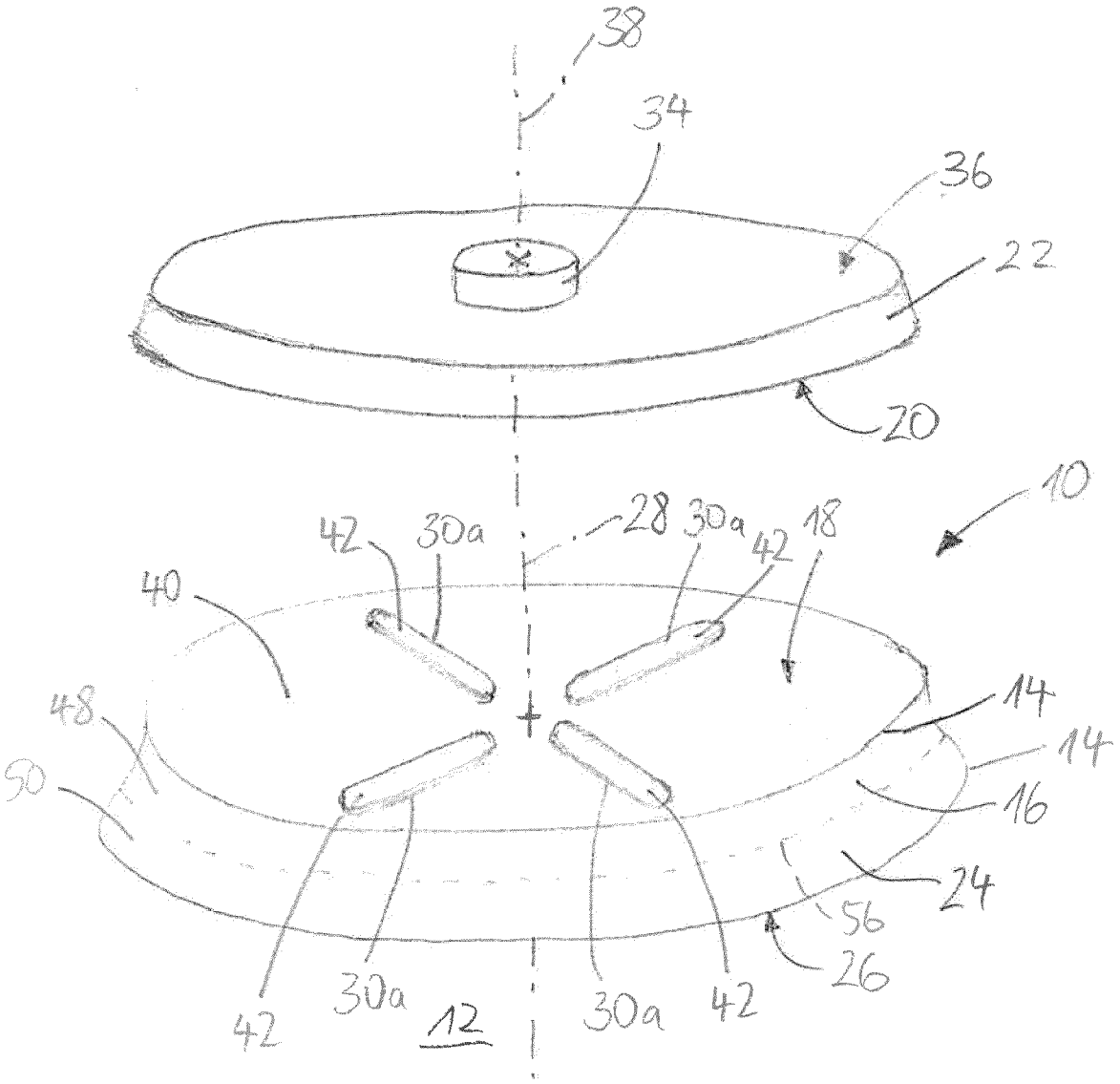
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Fig. 5

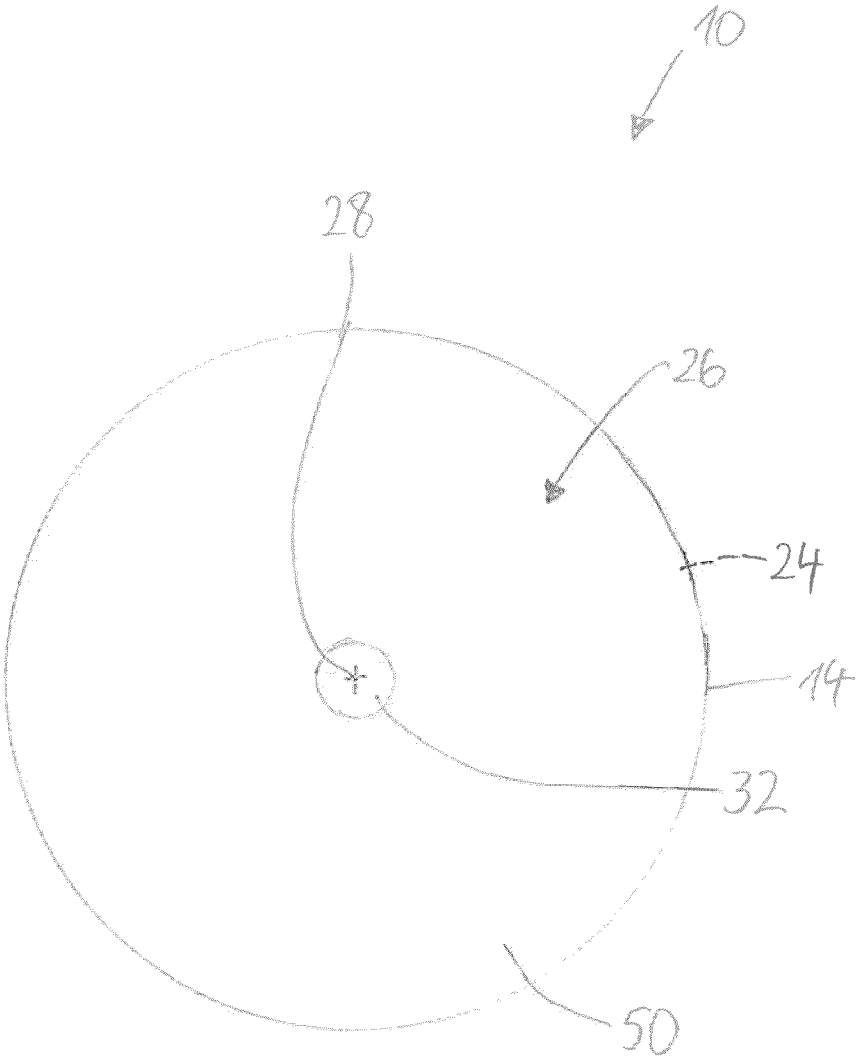

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 3677

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 421 179 A1 (VALENTINI GUIDO [IT]) 2 January 2019 (2019-01-02)	1-5,7,8	INV. B24B37/22
A	* figures 2,3,4 * * lines 0021, 0026, 0027 * * Groove 12a, different purpose, same subject-matter *	6,9	B24D3/02 B24D13/14 B24B23/00 B24B37/24
X	US 2013/012107 A1 (KAZUNO ATSUSHI [JP]) 10 January 2013 (2013-01-10) * figures 2,3,7,9 * * paragraphs [0088] - [0100] * * paragraph [0051] *	1-9	

TECHNICAL FIELDS SEARCHED (IPC)

B24B
B24D

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	27 December 2023	Herrero Ramos, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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Application Number
EP 23 18 3677

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

6-9(completely); 1-5(partially)

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 23 18 3677

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 6-9(completely); 1-5(partially)

1st invention: Polishing pad comprising the features of any of claims 1-5, comprising a plurality of depressions or recesses (30a), arranged around the rotational axis (28), and spaced apart from each other in a circumferential direction.
Problem solved: reduce the amount of vibrations of the polishing power tool during use.

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2. claims: 10(completely); 1-5(partially)

2nd invention: Polishing pad comprising the features of any of claims 1-5, wherein at least one gas-filled bag (42) made of a flexible gas-tight material is arranged in one or more of the at least one depressions or recesses (30).
Problem solved: increase structural rigidity of the polishing pad in the axial direction.

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3. claims: 11-13(completely); 1-5(partially)

3rd invention: Polishing pad comprising the features of any of claims 1-5, wherein the one depresion (30) is filled with a polishing compound (44) of such low viscosity as to allow, during intended use of the polishing pad (10), the polishing compound (44) to pass through a cell structure of the foamed material (48) of the upper region (16) of the polishing pad (10) and through a material (50, 52, 54) of the lower region (24) of the polishing pad (10) and to reach the surface (12) of the workpiece to be polished.
Problem solved: to ensure delivery of polishing compound to the surface of the workpiece.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 18 3677

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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27-12-2023

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