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(54) **HAND HELD OR HAND GUIDED SANDING OR POLISHING POWER TOOL AND BACKING PAD FOR USE IN SUCH A POWER TOOL**

(57) The invention refers to a hand held or hand guided sanding or polishing power tool (1). The tool (1) comprises a motor operated electrically or pneumatically, a tool shaft (21) directly or indirectly driven by the motor, an eccentric element (19) attached to the tool shaft (21) in a torque proof manner, a backing pad (9; 9a) with a bottom surface (15) adapted for releasable attachment of a sanding or polishing element (12; 12a) and with a rotary shaft (17) attached to the center on a top side (24) of the backing pad (9; 9a), wherein the rotary shaft (17) is mounted to the eccentric element (19) in a freely rotatable manner, with a rotational axis (18) of the rotary shaft (17) spaced apart from a rotational axis (10; 10a) of the tool shaft (21). It is proposed that a multi-angle joint (25) is located between the backing pad (9; 9a) and the eccentric element (19), in order to allow swivelling of the backing pad (9; 9a) into orientations inclined to an original plane extending perpendicular in respect to the rotational axis (10; 10a) of the tool shaft (21).

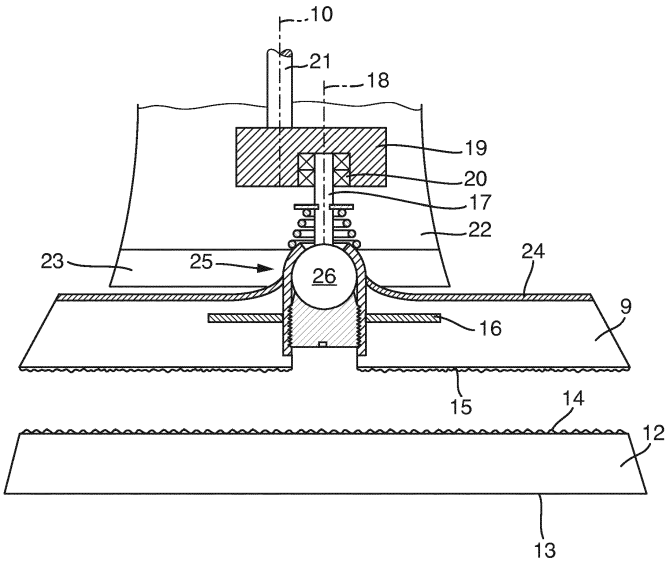

Fig. 3

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Description

[0001] The invention relates to a hand held or hand guided sanding or polishing power tool according to the features of the preamble of claim 1. Furthermore, the invention refers to a backing pad for such a power tool according to the preamble of claim 16.

[0002] Such power tools are well-known in the prior art. For example, a polishing power tool named "HR15II/STD RANDOM ORBITAL POLISHER LHR15 Mark II BIGFOOT" is manufactured and sold by RUPES S.p.A.; Via Marconi, 3 A; 20080 Vermezzo (MI); Italy. The backing pad of the known polishing power tool performs a random orbital working movement. Like in all known hand held or hand guided sanding or polishing power tools, the backing pad is located in a fixed orientation in respect to the tool shaft, in particular in a plane extending perpendicular in respect to a rotational axis of the tool shaft.

[0003] Furthermore, a polishing power tool comprising two separate backing pads is known in the prior art. Such a polisher named "CYCLO" is manufactured and sold by RUPES USA, Inc.; 531 South Taylor Avenue; Louisville; CO 80027; U.S.A. The backing pads of the Cyclo polisher rotate in opposite directions thereby compensating most of the unbalanced masses and reducing vibrations to a minimum.

[0004] Furthermore, due to the simultaneous operation of two backing pads, the Cyclo polisher can polish larger surfaces much faster than conventional polishers. The two backing pads of the Cyclo polisher are also located in a fixed orientation in respect to the tool shafts, in particular in a common plane extending perpendicular in respect to rotational axes of the tool shafts.

[0005] The fixed orientation of the one or more backing pads in the known polishers can provide difficulties when polishing (convex or concave) arched surfaces of vehicle bodies or hulls of boats, ships or aircraft. In polishing tools provided with only one backing pad, the entire tool has to be swivelled along the arched surface to be polished in order to orientate the rotational axis of the tool shaft essentially perpendicular to the arched surface and to maintain the entire working surface of a polishing pad attached to the backing pad in even and steady contact with the arched surface to be polished. The difficulties may be even larger when using polishing tools provided with two backing pads because the even working surface defined by the two polishing pads attached to the two backing pads is much larger enhancing the probability that the working surface of at least one of the backing pads is not in even contact with the surface to be polished.

[0006] To this end it is an object of the present invention to provide for a hand held or hand guided sanding or polishing power tool, which simplifies and improves sanding or polishing of surfaces, in particular of arched surfaces.

[0007] This object is solved by a hand held or hand guided sanding or polishing power tool comprising a combination of the features of claim 1. In particular, starting from the known sanding or polishing power tools of the above-mentioned kind, it is suggested that a multi-angle joint is located between the backing pad and the eccentric element, in order to allow swivelling of the backing pad into orientations inclined to an original plane extending perpendicular in respect to the rotational axis of the tool shaft.

[0008] The hand held or hand guided sanding or polishing power tool comprises a motor which can be electrically or pneumatically operated. Depending on the type of operation of the motor, the power tool is an electric power tool or a pneumatic power tool. The power tool further comprises a tool shaft, which can be directly attached to a motor shaft of the motor thereby directly driving the tool shaft. Alternatively, the tool shaft can be indirectly attached to the motor shaft by means of a gear arrangement, which preferably provides for reduction of the rotational speed of the tool shaft in respect to the motor shaft, thereby enhancing the torque which can be applied by the backing pad or the sanding or polishing element, respectively. Further, the gear arrangement can provide for a transfer of the rotational movement of the motor shaft to the tool shaft, if the rotational axes of the motor shaft and the tool shaft are located in an angle in respect to one another, preferably in an angle of 90° or more, resulting in an angular sanding or polishing power tool.

[0009] Furthermore, the power tool comprises a backing pad with a bottom surface adapted for releasable attachment of a sanding or polishing element. The sanding element can be, for example, a sanding paper. The polishing element can be, for example, a foam or sponge pad, a microfiber pad or a wool pad. The sanding or polishing element can be attached to the bottom surface of the backing pad, for example, by means of a hook-and-loop fastener, wherein a top surface of the sanding or polishing element is provided with a first component (e. g. hooks) and the bottom surface of the backing pad with a second component (e.g. loops) of the hook-and-loop fastener. The backing pad is indirectly attached to the tool shaft by means of an eccentric element.

[0010] The eccentric element is usually attached to the tool shaft in a torque proof manner. The backing pad is provided with a rotary shaft in the centre and on a top side of the backing pad. The rotary shaft is either fixedly or (e.g. by means of a screw) releasably attached to the top side of the backing pad, preferably in a torque proof manner. The rotary shaft is mounted to the eccentric element in a freely rotatable manner, with a rotational axis of the rotary shaft spaced apart from a rotational axis of the tool shaft. During operation of the power tool the eccentric element is rotated about the rotational axis of the tool shaft. The rotary shaft of the backing pad is rotated about the rotational axis of the tool shaft, too. At the same time the backing pad may freely rotate about its rotational axis in respect to the eccentric element.

[0011] Hence, by means of the eccentric element, a

random orbital movement of the backing pad is realised.

[0012] With the backing pad oriented in an original plane extending perpendicular in respect to the rotational axis of the tool shaft, the rotational axes of the tool shaft and the rotary shaft extend parallel to one another. Due to the multi-angle joint, which is located between the backing pad and the eccentric element, the backing pad may freely swivel into orientations inclined to the original plane. Despite the inclination of the backing pad, the random orbital movement of the backing pad is maintained during operation of the power tool. Due to the inclination of the backing pad the bottom working surface of the sanding or polishing element can be maintained in even and steady contact with an arched surface to be sanded or polished. In particular, there is no need for the entire power tool to be swivelled along the arched surface. The present invention allows a much easier operation of the power tool thereby maintaining the bottom working surface of the sanding or polishing element in steady contact with the surface to be sanded or polished even if the surface has a curved course. The user can maintain the power tool in a steady orientation independent of any arched form of the surface to be sanded or polished. Due to the fact that the bottom working surface of the sanding or polishing element is maintained in steady contact with the surface to be sanded or polished independent of the orientation of the rest of the power tool, a much better result of the sanding or polishing process can be achieved.

[0013] According to a preferred embodiment of the present invention, it is suggested that the power tool comprises a further tool shaft directly or indirectly driven by the motor during operation of the power tool, a further eccentric element attached to the further tool shaft in a torque proof manner, and a further backing pad with a bottom surface adapted for releasable attachment of a further sanding or polishing element and with a further rotary shaft attached to the center and on a top side of the further backing pad. The further rotary shaft is mounted to the further eccentric element in a freely rotatable manner, with a further rotational axis of the further rotary shaft spaced apart from a rotational axis of the tool shaft. This embodiment refers to a sanding or polishing power tool comprising two separate backing pads operated simultaneously.

[0014] The present invention is particularly advantageous for such sanding or polishing power tools. It has proved to be sufficient if only one of the two backing pads can be swivelled into orientations inclined to the original plane extending perpendicular in respect to the rotational axis of the tool shaft. In that case the power tool is preferably held in such an orientation that the bottom working surface of the sanding or polishing element attached to the backing pad with the fixed orientation, which cannot be swivelled into inclined orientations in respect to the original plane, is in steady and even contact with the surface to be sanded or polished. In that case a longitudinal axis of the tool shaft of the backing pad with the fixed orientation runs perpendicular to the surface to be sanded or polished. If the surface has an arched shape, the other backing pad, which can be swivelled into inclined orientations, will follow the arched surface and will be swivelled into an inclined orientation assuring a steady and even contact of the bottom working surfaces of both sanding or polishing pads attached to the backing pads. Hence, the present invention in particular provides for an easier use of a sanding or polishing power tool of the Cyclo-type, thereby providing for better sanding or polishing results.

[0015] Preferably, a further multi-angle joint is located between the further backing pad and the further eccentric element, in order to allow swivelling of the further backing pad into orientations inclined to an original plane extending perpendicular in respect to the rotational axis of the tool shaft. According to this embodiment, both backing pads of the sanding or polishing power tool can be swivelled into orientations inclined in respect to the original plane. This has the advantage that the power tool does not necessarily have to be held in such an orientation that the longitudinal axis of the tool shaft of one of the backing pads (with the fixed orientation) runs perpendicular to the surface to be sanded or polished. Furthermore, in this embodiment the bottom working surfaces of the sanding or polishing elements attached to the two backing pads can be kept in even and steady contact with the surface to be sanded or polished, even if the surface has a strong curvature or arch.

[0016] In the power tool of the Cyclo-type, it may be advantageous to locate a gear arrangement between a motor shaft of the motor and both tool shafts, in order to simultaneously drive both tool shafts during operation of the power tool. The gear arrangement provides for an even distribution of the rotational speed and the torque of the motor shaft to the two tool shafts. Preferably, the gear arrangement is designed such that it reduces the rotational speed of the tool shafts in respect to the rotational speed of the motor shaft, thereby enhancing the torque which can be applied by the tool shafts and the backing pads, respectively. Finally, it is suggested that the gear arrangement is designed such that it transmits the rotation of the motor shaft to the tool shafts in such a manner that the tool shafts rotate in opposite directions, thereby compensating unbalanced masses and eliminating vibrations.

[0017] According to a preferred embodiment of the present invention it is suggested that at least one of the multi-angle joints is embodied as a ball-and-socket joint. Preferably, all multi-angle joints of the power tool are embodied as ball-and-socket joints. A ball-and-socket joint has the advantage that it is simple and robust in its design and that it may be realised with small dimensions and light weight. Furthermore, a ball-and-socket joint allows swivelling of the backing pad in any orientation in the entire 360° space around the rotational axis of the rotary shaft.

[0018] Preferably, the at least one ball-and-socket joint

comprises a spherical ball element, which is embodied at or attached to a distal end of a rotary shaft of a respective backing pad provided with the ball-and-socket joint, the distal end of the rotary shaft directed towards the respective backing pad. Furthermore, it is suggested that the at least one ball-and-socket joint comprises a socket element having a spherical inner surface corresponding to an outer spherical surface of a corresponding ball element. The socket element is adapted for receiving and holding the corresponding ball element. The socket element is designed on or attached to the top side and in the center of the respective backing pad. In this embodiment, the rotary shaft of the backing pad having a variable orientation is attached to the backing pad by means of the ball-and-socket joint. This has the advantage that only the backing pad with the rotary shaft attached thereto has to be designed in a specific manner in order to realise the present invention. The rest of the power tool may be designed in a conventional manner. The rotary shaft of the backing pad having a variable orientation is simply attached to the eccentric element in a freely rotatable manner just like the rotary shaft of conventional backing pads having a fixed orientation.

[0019] It is suggested that the socket element of the at least one ball-and-socket joint has an insertion opening located opposite to the spherical inner surface and adapted for insertion of a corresponding ball element into the socket element. Preferably, the insertion opening of the socket element opens into the bottom surface of the respective backing pad. According to this embodiment the ball element of the ball-and-socket joint can be inserted into the corresponding socket element from the bottom of the backing pad. The ball element may be held inside the socket element, for example, by means of a snap-in connection.

[0020] It is further suggested that the socket element of the at least one ball-and-socket joint has a receiving opening located opposite to the insertion opening for receiving the rotary shaft attached to a corresponding ball element, which is inserted into the socket element. Preferably, the receiving opening has a larger diameter than the rotary shaft attached to the corresponding ball element. When the ball element is inserted into the corresponding socket element, the rotary shaft attached to the ball element is inserted into the receiving opening of the socket element. Due to the diameter of the receiving opening being larger than the diameter of the rotary shaft, the ball element can be moved by a certain degree in any desired direction in respect to the socket element. The movement of the ball element is restricted by the rotary shaft abutting against the internal edge of the receiving opening. For realizing the present invention, it is not necessary that the ball element may be moved by a full 90° in each direction. Rather, the present invention has the described advantages already if an inclination of the backing pad of less than 20°, particularly a few degrees in each direction can be realised.

[0021] It is suggested that the at least one ball-and-socket joint comprises a securing element for securing the ball element within the corresponding socket element after insertion of the ball element through the insertion opening. Securing of the ball element within the socket element can be effected in at least two ways. According to a first possibility, the insertion opening could be closed at least partially by the securing element after insertion of the ball element therein. Such a securing element is preferably inserted into the socket element through the insertion opening and detachably fixed therein. The securing element could be designed in the form of a Seeger ring attached to an internal circumferential groove in the socket element. Alternatively, the securing element could also be designed as a plug element press-fitted or screwed into the insertion opening. The plug-type securing element could have a gliding surface facing the ball element. After insertion into the socket element the securing element closes at least part of the insertion opening thereby avoiding the ball element from sliding out of the socket element. As a second possibility the securing element could be attached to the external circumference of the rotary shaft after the insertion of the rotary shaft into the receiving opening (and consequently after insertion of the ball element into the socket element). The diameter of the securing element is larger than the diameter of the receiving opening, thereby preventing the rotary shaft from sliding out of the receiving opening (and consequently the ball element from slipping out of the socket element). A combination of the two types of securing elements would also be conceivable. The securing element of the second type can be designed in the form of a Seeger ring attached to a circumferential groove on the rotary shaft after insertion of the ball element into the socket element.

[0022] Preferably, the securing element inserted into the insertion opening comprises a spherical gliding surface facing the ball element of the ball-and-socket joint after insertion of the ball element and the securing element into the socket element. For example, the securing element could be realised as a plug element made of resilient material, for example rubber or plastic, which is simply plugged into the insertion opening of the socket element from the bottom of the backing pad. Alternatively, the securing element could be made of metal and screwed into the insertion opening. To this end, the external circumference of the securing element is provided with an external thread corresponding to an internal thread provided in the inner circumference of the insertion opening. Of course, other possibilities of detachably fixing the securing element in the insertion opening are conceivable, too. The gliding surface could have a surface form corresponding to the external surface of the ball element. Further, at least the gliding surface of the securing element could be made of a low-frictional material, for example metal or ceramic. The spherical gliding surface of the securing element provides for a better guiding and movement of the ball element within the socket element. If the surface of the securing element facing the

ball element has a spherical form corresponding to the external spherical form of the ball element, then the ball element is supported almost in the entire 360° space by spherical surfaces. The upper part of the ball element is supported by the spherical surface of the socket element surrounding the receiving opening and the bottom part of the ball element is supported by the spherical gliding surface of the securing element.

[0023] Preferably, the securing element comprises a screw element having an external thread and wherein the socket element comprises a corresponding internal thread in an annular surface region directed towards the insertion opening. According to this embodiment the threaded securing element can be screwed into the socket element through the insertion opening from the bottom of the backing pad. This allows for safe and reliable attachment of the securing element to the socket element. Furthermore, the threaded connection between the securing element and the socket element allows an easy adjustment of how far the securing element reaches into the socket element towards the ball element. Thereby, a holding force with which the ball element is held within the socket element can be adjusted. Preferably, the securing element applies no holding force at all to the ball element, thereby allowing free movement of the ball element within the socket element.

[0024] According to another preferred embodiment of the present invention it is suggested that the at least one multi-angle joint comprises a resilient return member exerting a force onto a respective backing pad provided with the multi-angle joint in order to force it from any inclined orientation towards the original plane. Swivelling of the respective backing pad into any orientation inclined to the original plane is effected against the force of the resilient return member. The backing pad having a variable inclination is forced into an orientation in its original plane by means of the resilient return member. The resilient return member could be, for example, embodied as a bush or ferrule made of a resilient material, e.g. rubber or a soft plastic material, surrounding the rotary shaft. Preferably, the resilient return member acts between the two parts interconnected by the multi-angle joint. In particular, the resilient return member acts between the rotary shaft and the backing pad. To this end, the above-mentioned second type of securing element detachably fixed to the external circumference of the rotary shaft after its insertion through the receiving opening could also form a support shoulder for the resilient return member. In that manner, the resilient return member could be inserted in a pre-tensioned manner between the securing element (fixed to the rotary shaft) and the socket element (fixed the backing pad).

[0025] It is further suggested that the resilient return member comprises a coil spring acting between a rotary shaft of the respective backing pad and the backing pad. In particular, it is suggested that the resilient return member comprises a conical coil spring with a first end having a smaller diameter supported by the rotary shaft and a second end having a larger diameter supported by the corresponding socket element attached to the backing pad.

[0026] In order to provide for a support of the resilient return member by the rotary shaft, it is suggested that the rotary shaft of the respective backing pad comprises a support collar against which a first end of the resilient return member abuts. The support collar and the above-mentioned second type of securing element could be the same element having a securing function (holding the ball element in the socket element) as well as a support function (for the resilient return member). The support collar is preferably formed by a Seeger ring which is detachably fixed to the rotary shaft in an external circumferential groove of the rotary shaft. This has the advantage that the ball element with the rotary shaft attached thereto can be easily mounted in the corresponding socket element thereby introducing the rotary shaft in the receiving opening of the socket member. After introduction of the ball element in the socket element the resilient return member is slid over the rotary shaft and fixed thereto by fastening the Seeger ring in the circumferential groove. Preferably, the resilient return member is fixed under an initial stress to the rotary shaft.

[0027] Further characteristics and advantages of the present invention will be described in further detail in the following description making reference to the accompanying drawings. These show:

- Figure 1 a power tool according to the present invention in a first preferred embodiment;
- Figure 2 a power tool according to the present invention in a second preferred embodiment;
- Figure 3 a backing pad according to the present invention for use in a power tool according to Figs. 1 or 2 in a sectional view;
- Figure 4 a ball-and-socket joint provided between the backing pad of Fig. 3 and an eccentric element in more detailed view;
- Figure 5 components of a multi-angle joint in the form of a ball-and-socket joint; and
- Figure 6 a securing element for securing a ball element within a corresponding socket element of the ball-and-socket joint.

[0028] Fig. 1 shows an example of a hand held or hand guided electric power tool 1 according to the present invention in a perspective view. The power tool 1 is embodied as a random orbital polishing machine (or polisher). The polisher 1 has a housing 2, preferably made of a plastic material. The housing 2 is provided with a handle 3 at its rear end and a grip 4 at its front end in order to allow a user of the tool 1 to hold the tool 1 with both hands and apply a certain amount of pressure on the grip 4 during the intended use of the tool 1. An electric power supply line 5 with an electric plug at its distal end exits the housing 2 at the rear end of the handle 3. At the bottom side of the handle 3 a switch 6 is provided for

activating and deactivating the power tool 1. The switch 6 can be continuously held in its activated position by means of a push button 7. The power tool 1 can be provided with adjustment means (not shown) for setting the rotational speed of the tool's electric motor to a desired value. The housing 2 can be provided with cooling openings 8 for allowing heat from electronic components and/or the electric motor both located inside the housing 2 to dissipate into the environment and/or for allowing cooling air from the environment to enter into the housing 2.

[0029] Instead of the connection of the power tool 1 to a mains power supply by means of the electric cable 5, the tool 1 could additionally or alternatively be equipped with a rechargeable or exchangeable battery (not shown) located at least partially inside the housing 2. In that case the electric energy for driving the electric motor and for operating the other electronic components of the tool 1 would be provided by the battery. If despite the presence of a battery the electric cable 5 was still present, the battery could be charged with an electric current from the mains power supply before, during and/or after operation of the power tool 1. The presence of a battery would allow the use of an electric motor which is not operated at the mains power supply voltage (230V in Europe or 110V in the US and other countries), but rather at a reduced voltage of, for example, 12V, 24V, 36V or 42V depending on the voltage provided by the battery.

[0030] The power tool 1 has a disk-like backing pad 9 rotatable about a rotational axis 10 and performing a working movement 11. The backing pad 9 serves for supporting a polishing element 12 in the form of a foam or sponge pad, a microfiber pad, a wool pad or the like used for polishing the surface of a vehicle body or of boat or aircraft hull with its bottom working surface 13. A polishing paste or liquid may be applied to the working surface 13 in order to achieve better polishing results on the surface to be polished. The polishing element 12 is releasably attached to the backing pad 9. To this end top surface 14 of the polishing element 12 (see Fig. 3) and/or the bottom surface 15 of the backing pad 9 are provided with appropriate fastening means. These may be embodied as hook-and-loop fastener, wherein the top surface 14 of the polishing element 12 is provided with a first component (e.g. hooks) and the bottom surface 15 of the backing pad 9 with a second component (e.g. loops) of the hook-and-loop fastener.

[0031] The backing pad 9 is made of a semi-rigid material, for example a rigid plastic material, which on the one hand is rigid enough to carry and support the soft and flexible polishing element 12 for performing a desired work (e.g. polishing the surface of a vehicle body, a boat or aircraft hull) during the intended use of the power tool 1 and to apply a force to the backing pad 9 and the polishing element 12 in a direction essentially perpendicular to the areal extension of the surface to be polished, and which on the other hand is flexible enough to avoid damage or scratching of the surface to be worked by the polishing element 12. Metal inserts 16 may be provided within or on top of the backing pad 9 in order to enhance its stability. A rotary shaft 17 is attached to a top side 24 and in the centre of the backing pad 9. A rotational axis 18 of the rotary shaft 17 forms the centre axis of the backing pad 9. With other words, the rotational axis 18 runs through the balance point of the backing pad 9 and parallel to the rotational axis 10. In conventional backing pads (not shown) the rotary shaft 17 is fixedly attached to the backing pad 9 in a fixed angle in respect to the areal extension of the backing pad 9, in particular with the rotational axis 18 running in an angle of 90° in respect to the areal extension of the backing pad 9.

[0032] The rotary shaft 17 is mounted to an eccentric element 19 in a manner freely rotatable independently from the rotation of the backing pad 9 about the rotational axis 10. This may be achieved by providing one or more bearings 20 between the rotary shaft 17 and the eccentric element 19. The eccentric element 19 is attached to a tool shaft 21 in a torque proof manner, whereas the rotational axis 10 of the tool shaft 21 and the rotational axis 18 of the rotary shaft 17 run essentially parallel to each other and are spaced apart from one another by a given distance. The tool shaft 21 is directly or indirectly driven by the motor of the power tool 1. Preferably, a gear arrangement is provided between a motor shaft and the tool shaft 21. Given the described design of the backing pad 9 and its attachment to the tool 1, during operation of the power tool 1, the backing pad 9 performs a random orbital working movement 11, the orbit corresponding to the distance between the rotational axes 10, 18.

[0033] The distal end of the tool shaft 21, the eccentric element 19, the rotary shaft 17 and the central part of the backing pad 9 may be covered by a protection hood 22. During operation of the power tool 1, a bottom part 23 of the protection hood 22 may be in contact with at least part of the top side 24 of the backing pad 9, thereby decelerating the rotational speed of the backing pad 9 about the rotational axis 18 (and reducing spinning of the backing pad 9). To this end it is suggested that the bottom part 23 of the protection hood 22 is made of a resilient and/or highly frictional material, such as a rubber or a soft plastic material.

[0034] The power tool 1 shown in Fig. 1 has an electric motor. Of course, the present invention can also be realised in a power tool having a pneumatic motor. In that case, there would be no need for the electric power supply line 5. Instead, the pneumatic power tool would be connected to a compressed air supply, for example by means of a pneumatic hose. Further, the power tool 1 shown in Fig. 1 is a polisher. Of course, the present invention can also be realised in a power tool in the form of a sander. A sander differs from a polisher in particular by the type of working element connected to the bottom surface 15 of the backing pad 9. Instead of a polishing pad 12 a sanding pad or sanding paper is attached to the bottom surface 15. Furthermore, the rotational speed of the backing pad 9 and/or of the motor of a sander could

be adapted to the sanding process so that the sander may rotate at different (in particular lower) speeds than a polisher. The entire description made for polishers is also valid for sanders, respectively.

[0035] Fig. 2 shows a second embodiment of a hand held or hand guided power tool 1 having two separate backing pads 9a, 9b each rotatable about a rotational axis 10a, 10b. In Fig. 2 all those components which are available twice have been assigned the same reference signs as the respective component of Fig. 1, however provided with 'a' for being assigned to the first backing pad 9a and with 'b' for being assigned to the second backing pad 9b. Besides the components provided twice and visible in Fig. 2, the power tool 1 of Fig. 2 also comprises the following internal components twice, which however are not visible in Fig. 2: tool shafts (corresponding to tool shaft 21 in Fig. 3), and eccentric elements (corresponding to eccentric element 19), rotary shaft (corresponding to rotary shaft 17). Preferably, the power tool 1 of Fig. 2 is equipped with only one motor, which drives both tool shafts indirectly by means of a gear arrangement located between the motor shaft and the tool shafts. In particular, the gear arrangement is designed such that the backing pads 9a, 9b rotate in opposite directions about the rotational axes of the respective tool shafts. Each of the backing pads 9a, 9b performs a random orbital working movement 11. The following explanations refer to the power tool 1 of Fig. 1 having only one backing pad 9. However, it is understood that they may also apply to one or both backing pads 9a, 9b of the power tool 1 of Fig. 2.

[0036] According to the present invention the backing pad 9 is attached in a highly flexible manner to the eccentric element 19 allowing swivelling of the backing pad 9 into orientations inclined to an original plane extending perpendicular in respect to the rotational axis 10 of the tool shaft 21. In Fig. 3 the backing pad 9 is shown with its areal extension in the original plane. Preferably, the backing pad 9 may be swivelled in any orientation inclined to the original plane within the 360° space. This is achieved by locating a multi-angle joint between the backing pad 9 and the eccentric element 19. In particular, the multi-angle joint is located between the rotary shaft 17 and the backing pad 9. The multi-angle joint may be embodied as a ball-and-socket joint 25. However, it is understood that the multi-angle joint may be realised in a different manner, too, for example by means of cardan joint. The ball-and-socket joint 25 is shown in more detail in Fig. 4. The following explanations referring to the ball-and-socket joint 25 may also apply to any other type of multi-angle joint.

[0037] Due to the ball-and-socket joint 25, which is located between the backing pad 9 and the eccentric element 19, the backing pad 9 may freely swivel into any orientation inclined to the original plane. Despite the inclination of the backing pad 9, the random orbital movement of the backing pad 9 is maintained during operation of the power tool 1. Due to the inclination of the backing pad 9 the bottom working surface 13 of the polishing element 12, which is attached to the bottom surface 15 of the backing pad 9, can be maintained in an even and steady contact with an arched or slanted surface to be polished. In particular, there is no need for the user to swivel the entire power tool 1 along the arched or slanted surface. Rather, the user can maintain the power tool 1 in an unchanged and steady orientation independent of any arched or slanted form of the surface to be polished. Due to the fact that the bottom working surface 13 of the polishing element 12 is maintained in steady contact with the surface to be polished, a much better (i.e. smoother and uniform) result of the polishing process can be achieved. Regarding the embodiment of Fig. 2, a multi-angle joint (or a ball-and-socket joint 25) can be provided between one backing pad 9a; 9b and the respective eccentric element or between both backing pads 9a, 9b and the respective eccentric elements.

[0038] Now referring to Fig. 4, the ball-and-socket joint 25 comprises a spherical ball element 26, which is embodied at or attached to a distal end of the rotary shaft 17 directed towards the backing pad 9. Further, the ball-and-socket joint 25 comprises a socket element 27 having a spherical inner surface 28 corresponding to an outer spherical surface 29 of the corresponding ball element 26. The socket element 27 is adapted for receiving and holding the ball element 26 so that the ball element 26 can rotate within the socket element 27 in any direction. The socket element 27 is designed on or attached to the top side 24 and in the center of the backing pad 9. In particular, it is suggested that the socket element 27 is moulded into the backing pad 9 during its manufacturing process. In particular, it is suggested that the socket element 27 is attached to or makes part of metal inserts 16 provided in the backing pad 9 for stability reasons. Hence, the rotary shaft 17 is attached to the backing pad 9 in an articulated manner by means of the ball-and-socket joint 25. This has the advantage that only the backing pad 9 with the rotary shaft 17 attached thereto has to be designed in a specific manner in order to realise the present invention. The rest of the power tool 1 may be designed in a conventional manner. The rotary shaft 17 of the backing pad 9 with the variable orientation is simply attached to the eccentric element 19 in a freely rotatable manner just like the rotary shaft of conventional backing pads having a fixed orientation.

[0039] The socket element 27 has an insertion opening 29 located opposite to the spherical inner surface 28 and adapted for insertion of the corresponding ball element 26 into the socket element 27. The insertion opening 29 of the socket element 27 opens into the bottom surface 15 of the backing pad 9 so that the ball element 26 of the ball-and-socket joint 25 can be inserted into the socket element 27 from the bottom of the backing pad 9. In a very simple embodiment, the ball element 26 could be held inside the socket element 27, for example, by means of a snap-in connection. To this end, the inner circumferential surface of the socket element 27 could be designed

with appropriate protruding sections which are overcome by the ball element 26 during its insertion into the socket element 27. However, in the embodiment shown in Figs. 3 and 4, the ball element 26 is held in a different manner inside the socket element 27, which will be described in further detail below.

[0040] Further, the socket element 27 of the ball-and-socket joint 25 has a receiving opening 30 located opposite to the insertion opening 29 for receiving the rotary shaft 17 attached to the corresponding ball element 26 during and after insertion into the socket element 27. The receiving opening 30 has a diameter d1 larger than the diameter d2 of the rotary shaft 17. When the ball element 26 is inserted into the socket element 27, the rotary shaft 17 is inserted into the receiving opening 30. Due to the diameter d1 of the receiving opening 30 being larger than the diameter d2 of the rotary shaft 17, the ball element 26 can be moved in any desired direction in respect to the socket element 27. However, the movement of the ball element 26 is restricted by the rotary shaft 17 abutting against the internal edge of the receiving opening 30. It is sufficient for the present invention if an inclination of the backing pad 9 of less than 20° in each direction in respect to the original plane can be realised. Even an inclination by only a few degrees in each direction may be sufficient in order to achieve the claimed advantages.

[0041] The ball-and-socket joint 25 comprises a securing element for securing the ball element 26 within the corresponding socket element 27 after insertion of the ball element 26 through the insertion opening 29. According to one embodiment, the securing element could be designed in the form of a Seeger ring attached to a circumferential groove provided in the internal surface of the socket element 27, thereby closing at least part of the insertion opening 29 and preventing the inserted ball element 26 from sliding out of the socket element 27 (this embodiment is not shown in the figures). According to another embodiment, the securing element could be designed in the form of a Seeger ring 31 attached to a circumferential groove 32 provided on an external surface of the rotary shaft 17 after insertion of the ball element 26 into the socket element 27. The Seeger ring 31 prevents the rotary shaft 17 from sliding out of the receiving opening 30 and, hence, the ball element 26 from slipping out of the socket element 27.

[0042] A resilient return member 33 may be provided acting between the rotary shaft 17 and the backing pad 9, in particular between the Seeger ring 31 and the socket element 27. In this embodiment, the Seeger ring 31 has a support function for the resilient return member 33 and a securing function for holding the ball element 26 within the socket element 27. The resilient return member 33 is supported by an upper external support surface 34 of the socket element 27 surrounding the receiving opening 30. On the opposite side, the Seeger ring 31 forms a support collar for the resilient return member 33. The resilient return member 33 tensions the ball element 26 against the spherical surface 28 of the socket element 27, thereby holding the ball element 26 inside the socket element 27. Furthermore, the resilient return member 33 has the effect that it exerts a force onto the socket element 27 and the backing pad 9, respectively, in order to force the backing pad 9 from any inclined orientation towards the original plane. Swivelling of the backing pad 9 into any orientation inclined to the original plane is effected against the force of the resilient return member 33. With other words, the backing pad 9 is forced into an orientation in its original plane by means of the resilient return member 33.

[0043] The resilient return member 33 could be, for example, embodied as a bush or ferrule made of a resilient material, e.g. rubber or a soft plastic material, surrounding the rotary shaft 27. The resilient return member 33 acts between the two parts (ball element 26 with rotary shaft 17 and backing pad 9 with socket element 27) interconnected by the ball-and-socket joint 25. In the embodiment shown in the figures, the resilient return member 33 comprises a coil spring acting between the Seeger ring 31 and the rotary shaft 17, respectively, and the socket element 27 and the backing pad 9, respectively. In particular, the resilient return member 33 comprises a conical coil spring with a first end having a smaller diameter supported by the Seeger ring 31 and a second end having a larger diameter supported by the corresponding socket element 27.

[0044] After insertion of the ball element 26 into the socket element 27, a further securing element 35 can be inserted into the insertion opening 29 and detachably fixed therein, thereby closing at least part of the insertion opening 29 and avoiding the ball element 26 from sliding out of the socket element 27 (even if there was no securing Seeger ring 31 present). The further securing element 35 has the advantage that even if an excessive force is applied to the power tool 1 in a direction towards the surface to be worked, the resilient return member 33 cannot be compressed and the backing pad cannot be moved upwards towards the tool housing 2. Again, the further securing element 35 could be designed in the form of a Seeger ring attached to an internal circumferential groove in the socket element (not shown in the figures). In the embodiment shown in the figures the securing element 35 comprises a screw element having an external thread 36. The socket element 27 comprises a corresponding internal thread 37 in an annular surface region directed towards the insertion opening 29. The threaded securing element 35 can be screwed into the socket element 27 through the insertion opening 29 from the bottom of the backing pad 9. This allows for safe and reliable attachment of the further securing element 35 to the socket element 27. Furthermore, the threaded connection between the securing element 35 and the socket element 27 allows an easy adjustment of how far the securing element 35 reaches into the socket element 27 and of a pressure the securing element 35 exerts onto the ball element 26.

[0045] The further securing element 35 preferably

comprises a spherical gliding surface 38 facing the ball element 26 of the ball-and-socket joint 25 after insertion of the ball element 26 and the securing element 35 into the socket element 27. The spherical surface 38 provides for a better guiding and movement of the ball element 26 within the socket element 27. If the gliding surface 38 of the securing element 35 facing the ball element 26 has a spherical form corresponding to the external spherical form 29 of the ball element 26, then the ball element 26 is supported almost in the entire 360° space by spherical surfaces 28, 38. The upper part of the ball element 26 is supported by the spherical surface 28 of the socket element 27 and the bottom part of the ball element 26 is supported by the spherical surface 38 of the securing element 35. The further securing element 35 is provided with an actuating element 40, e.g. a screwdriver slot, on a side accessible from outside the backing pad 9 when the securing element 35 is inserted into the socket element 27, that is on a side opposite to the spherical surface 38.

[0046] For assembly of the ball-and-socket joint 25, first the ball element 26 with the rotary shaft 17 attached thereto is inserted in the corresponding socket element 27 through the insertion opening 29, thereby introducing the rotary shaft 17 into the receiving opening 30 of the socket member 27. After introduction of the ball element 26 in the socket element 27, the resilient return member 33 is slid over the rotary shaft 17 and fixed thereto by fastening the Seeger ring 31 in the circumferential groove 32 on the rotary shaft 17. Preferably, the resilient return member 33 is fixed under an initial stress to the rotary shaft 17. Then, the further securing element 35 is inserted into the insertion opening 29 and screwed into the socket element 27. Such a backing pad 9 with the pre-assembled ball-and-socket joint 25 can be manufactured and marketed as a separate entity independent of the rest of the power tool 1. In particular, such a backing pad 9 could be sold as a spare part for replacement of conventional backing pads having a fixed orientation. Finally, the distal end of the rotary shaft 27 opposite to the ball element 26 is fixed to the bearings 20 of the eccentric element 19 in order to attach the backing pad 9 to the rest of the power tool 1.

Claims

1. Hand held or hand guided sanding or polishing power tool (1) comprising:

   - a motor operated electrically or pneumatically,
   - a tool shaft (21) directly or indirectly driven by the motor during operation of the power tool (1),
   - an eccentric element (19) attached to the tool shaft (21) in a torque proof manner,
   - a backing pad (9; 9a) with a bottom surface (15) adapted for releasable attachment of a sanding or polishing element (12; 12a) and with a rotary shaft (17) attached to the center on a top side (24) of the backing pad (9; 9a),
   - wherein the rotary shaft (17) is mounted to the eccentric element (19) in a freely rotatable manner, with a rotational axis (18) of the rotary shaft (17) spaced apart from a rotational axis (10; 10a) of the tool shaft (21),

   characterized in that
   a multi-angle joint (25) is located between the backing pad (9; 9a) and the eccentric element (19), in order to allow swivelling of the backing pad (9; 9a) into orientations inclined to an original plane extending perpendicular in respect to the rotational axis (10; 10a) of the tool shaft (21).

2. Power tool (1) according to claim 1, wherein the power tool comprises

   - a further tool shaft (21) directly or indirectly driven by the motor during operation of the power tool (1),
   - a further eccentric element (19) attached to the further tool shaft (21) in a torque proof manner,
   - a further backing pad (9; 9b) with a bottom surface (15) adapted for releasable attachment of a further sanding or polishing element (12; 12b) and with a further rotary shaft (17) attached to the center on a top side (24) of the further backing pad (9; 9b),
   - wherein the further rotary shaft (17) is mounted to the further eccentric element (19) in a freely rotatable manner, with a further rotational axis (18) of the further rotary shaft (17) spaced apart from a rotational axis (10; 10b) of the tool shaft (21).

3. Power tool (1) according to claim 2, wherein a further multi-angle joint (25) is located between the further backing pad (9; 9b) and the further eccentric element (19), in order to allow swivelling of the further backing pad (9; 9b) into orientations inclined to an original plane extending perpendicular in respect to the rotational axis (10; 10b) of the tool shaft (21).

4. Power tool (1) according to claim 2 or 3, wherein a gear arrangement is located between a motor shaft of the motor and both tool shafts (21), in order to simultaneously drive both tool shafts (21) during operation of the power tool (1).

5. Power tool (1) according to one of the preceding claims, wherein at least one of the multi-angle joints (25) is embodied as a ball-and-socket joint.

6. Power tool (1) according to claim 5, wherein the at least one ball-and-socket joint (25) comprises a spherical ball element (26), which is embodied at or

attached to a distal end of a rotary shaft (17) of a respective backing pad (9; 9a, 9b) provided with a ball-and-socket joint (25), the distal end of the rotary shaft (17) directed towards the respective backing pad (9; 9a, 9b).

7. Power tool (1) according to claim 6, wherein the at least one ball-and-socket joint (25) comprises a socket element (27) having a spherical inner surface (28) corresponding to an outer spherical surface (29) of a corresponding ball element (26), the socket element (27) being adapted for receiving and holding the corresponding ball element (26), the socket element (27) being designed on or attached to the top side (24) and in the center of the respective backing pad (9; 9a, 9b).

8. Power tool (1) according to claim 7, wherein the socket element (27) of the at least one ball-and-socket joint (25) has an insertion opening (29) located opposite to the spherical inner surface (28) and adapted for insertion of a corresponding ball element (26) into the socket element (27), preferably the insertion opening (29) of the socket element (27) opening into the bottom surface (15) of the respective backing pad (9; 9a, 9b).

9. Power tool (1) according to claim 8, wherein the socket element (27) of the at least one ball-and-socket joint (25) has a receiving opening (30) located opposite to the insertion opening (29) for receiving the rotary shaft (17) attached to a corresponding ball element (26), which is inserted into the socket element (27), preferably a diameter (d1) of the receiving opening (29) being larger than a diameter (d2) of the rotary shaft (17) attached to the corresponding ball element (26).

10. Power tool (1) according to claim 8 or 9, wherein the at least one ball-and-socket joint (25) comprises a securing element (31; 35) for securing the ball element (26) within the corresponding socket element (27) after insertion of the ball element (26) through the insertion opening (29), preferably the securing element (35) being inserted into the socket element (27) through the insertion opening (29) and detachably fixed therein.

11. Power tool (1) according to claim 10, wherein the securing element (35) comprises a spherical gliding surface (38) facing towards the ball element (26) of the ball-and-socket joint (25) after insertion of the ball element (26) and the securing element (35) into the socket element (27).

12. Power tool (1) according to claim 10 or 11, wherein the securing element (35) comprises a screw element having an external thread (36) and wherein the socket element (27) comprises a corresponding internal thread (37) in an annular surface region directed towards the insertion opening (29).

13. Power tool (1) according to one of the claims 1 to 12, wherein the at least one multi-angle joint (25) comprises a resilient return member (33) exerting a force onto a respective backing pad (9; 9a, 9b) provided with the multi-angle joint (25) in order to force it from any inclined orientation towards the original plane, wherein swivelling of the respective backing pad (9; 9a, 9b) into any orientation inclined to the original plane is effected against the force of the resilient return member (33).

14. Power tool (1) according to claim 13, wherein the resilient return member (33) comprises a coil spring acting between a rotary shaft (17) of the respective backing pad (9; 9a, 9b) and the backing pad (9; 9a, 9b), in particular comprising a conical coil spring with a first end having a smaller diameter supported by the rotary shaft (17) and a second end having a larger diameter supported by the corresponding socket element (27) attached to the backing pad (9; 9a, 9b).

15. Power tool (1) according to claim 13 or 14, wherein the rotary shaft (17) of the respective backing pad (9; 9a, 9b) comprises a support collar (31) against which a first end of the resilient return member (33) abuts, wherein the support collar (31) is preferably formed by a Seeger ring which is removably fixed to the rotary shaft (17) in a circumferential groove (32) of the rotary shaft (17).

16. Backing pad (9; 9a, 9b) for use in a hand held or hand guided sanding or polishing power tool (1), the backing pad (9; 9a, 9b) having a bottom surface (15) adapted for releasable attachment of a sanding or polishing element (12; 12a, 12b) and a rotary shaft (17) attached to the center on a top side (24) of the backing pad (9; 9a, 9b), the rotary shaft (17) being adapted for direct or indirect connection to a tool shaft (21) of the power tool (1),
characterized in that
a multi-angle joint (25) is located between the rotary shaft (17) and the backing pad (9; 9a, 9b), in order to allow swivelling of the backing pad (9; 9a, 9b) into orientations inclined to an original plane extending perpendicular in respect to a rotational axis (18) of the rotary shaft (17).

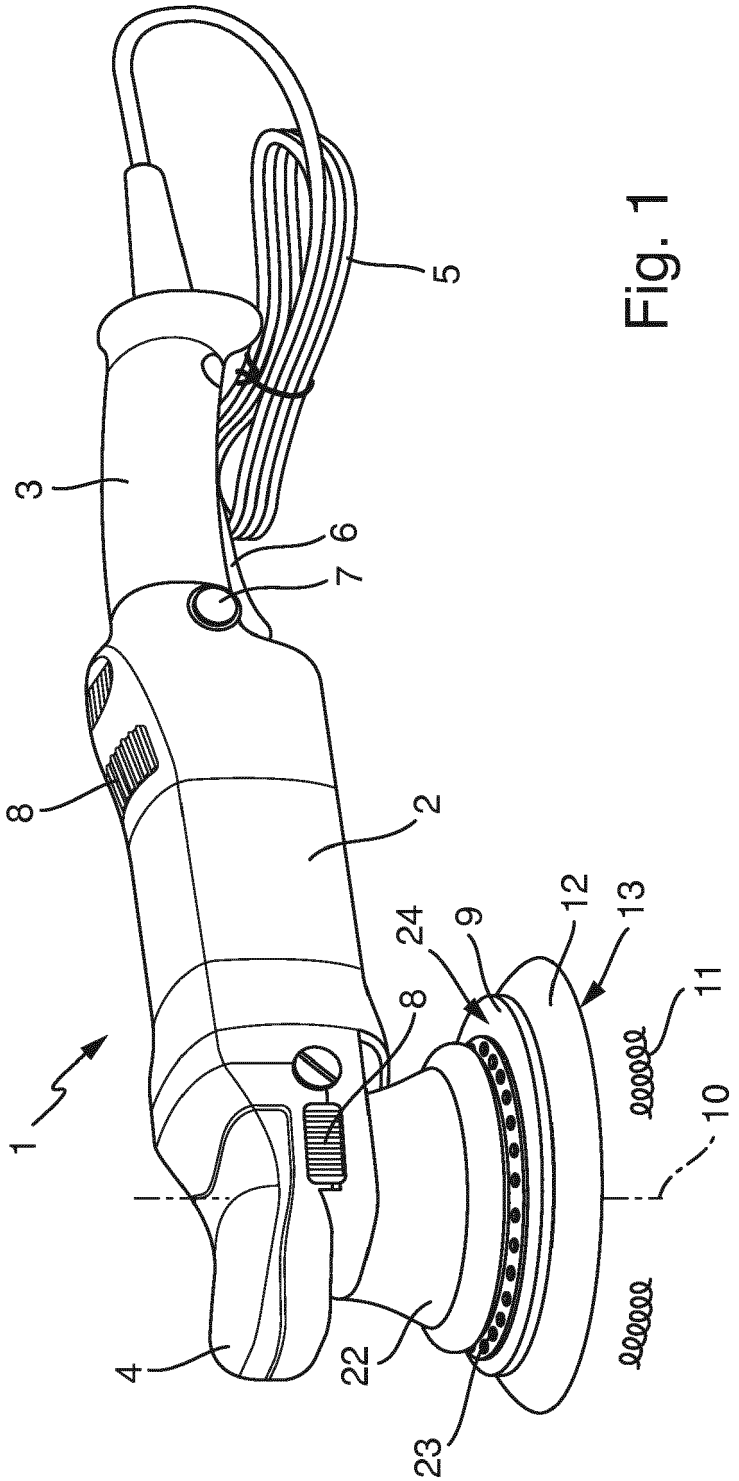

Fig. 1

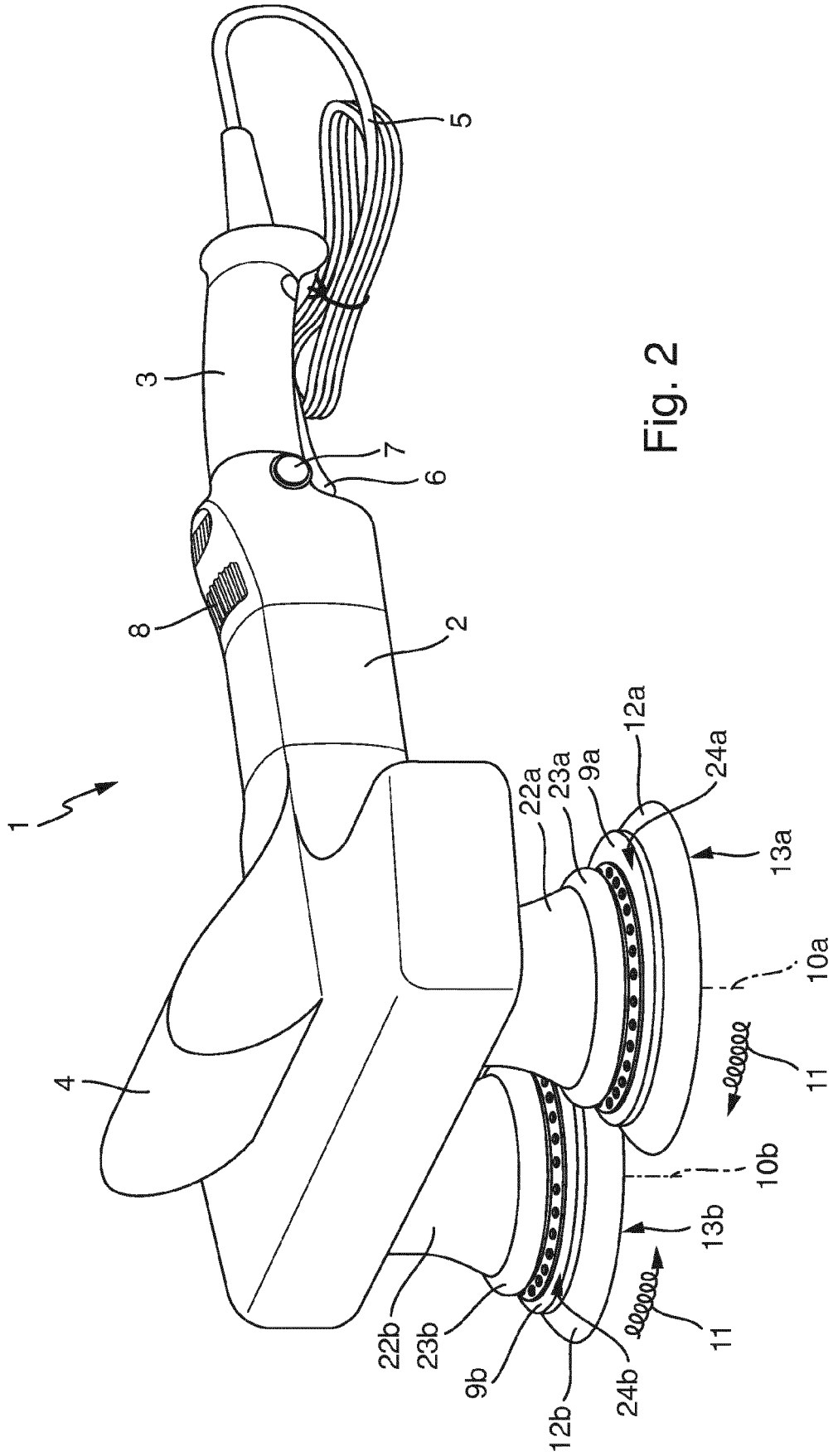
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Fig. 2

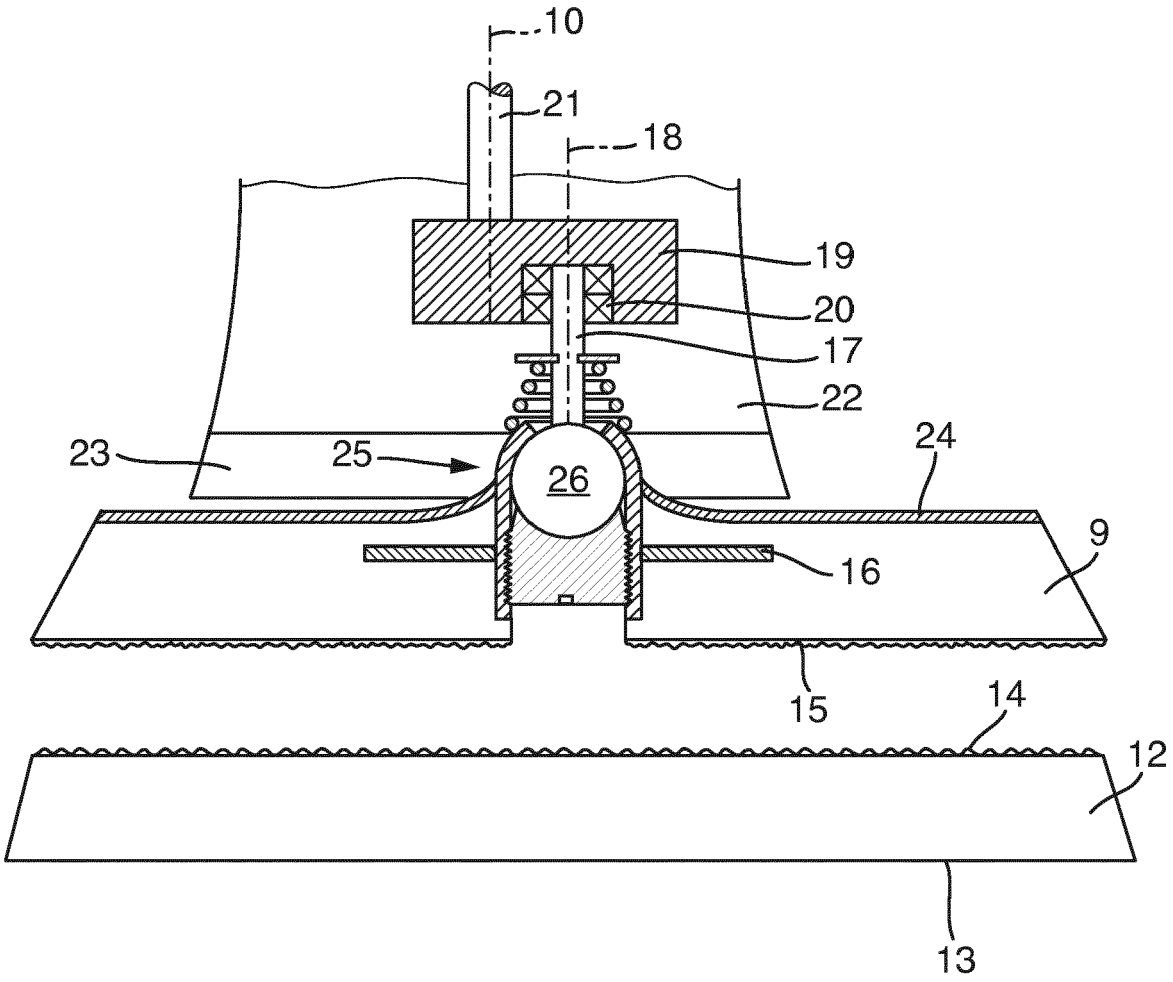

Fig. 3

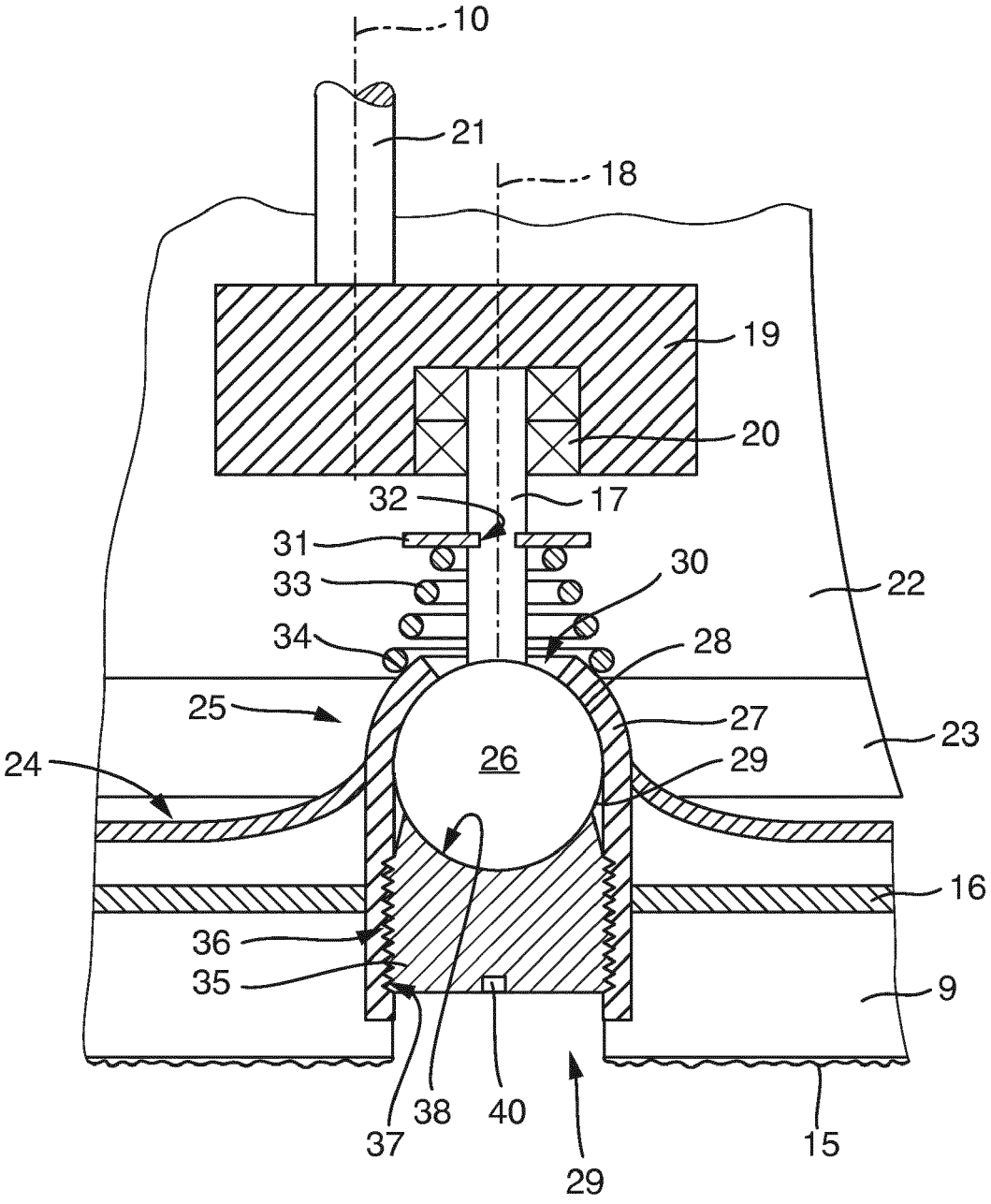
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Fig. 4

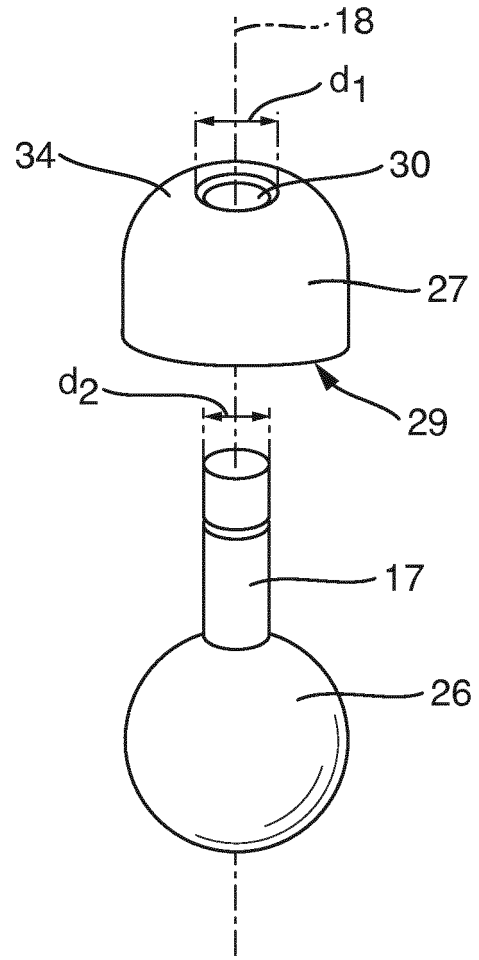

Fig. 5

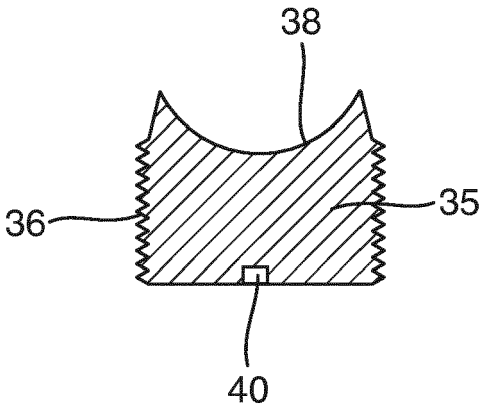

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 18 18 3965

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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B24B
B24D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 January 2019	Koller, Stefan

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