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(54) DEVICE FOR ROTATABLY SUPPORTING A SECTION OF A SHAFT OF A ROLLER OF A CONVEYING SYSTEM, CORRESPONDING ASSEMBLY, CONVEYING SYSTEM AND APPARATUS FOR WET-CHEMICAL TREATMENT OF WORKPIECES

(57) A device for rotatably supporting a section of a shaft (4) of a roller (2) of a conveying system in a bath of an apparatus for wet-chemical treatment of workpieces comprises at least one body (14). A space for receiving the shaft section is formed in the at least one body (14). The space comprises a first section (17) having a cross-section, centred on a reference axis (15), of which a perimeter lies on a circle over at least a majority of the perimeter; and a second section (18), extending in axial direction from the first section (17) to an axial end of the space. The second section (18) has, at multiple, e.g. all, axial positions, a respective cross-section of which a boundary, at at least one particular angular position (ϕ_0), is at a radial distance to the reference axis (15) equal to a length (Ri) of the radius of the circle and has a radius of curvature extending from the reference axis (15) to the boundary. The respective cross-sections of the second section (18) have, over at least a range of angular positions ($[-\phi_1,\phi_1]$) other than the particular angular positions (ϕ_0), a radial extent from the reference axis (15) that is increased with respect to the radial extent of the cross-section of the first section (17) at corresponding angular positions.

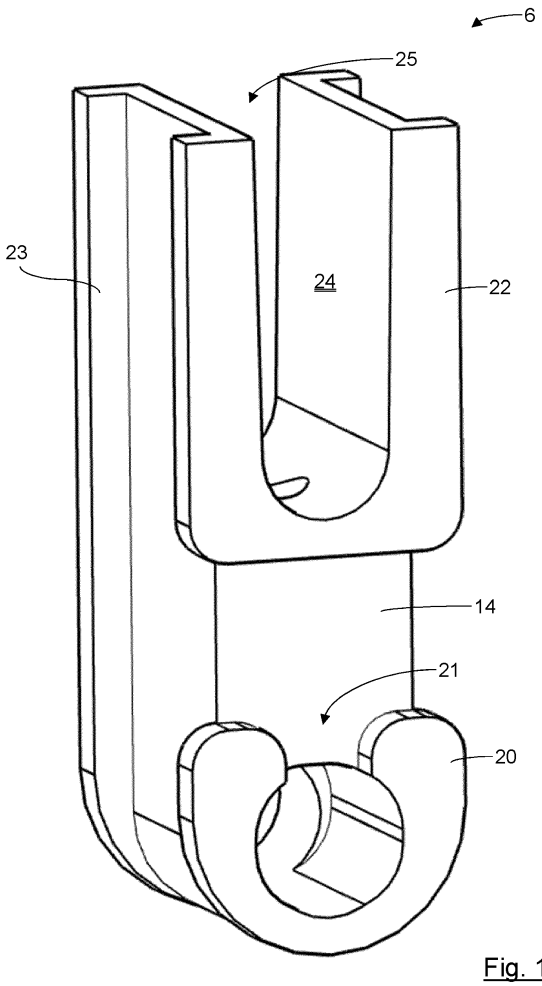

Fig. 13

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Description

Technical Field

[0001] The invention relates to a device for rotatably supporting a section of a shaft of a roller of a conveying system in a bath of an apparatus for wet-chemical treatment of workpieces, which device comprises at least one body,

wherein a space for receiving the shaft section is formed in the at least one body,
wherein the space comprises:

a first section having a cross-section, centred on a reference axis, of which a perimeter lies on a circle over at least a majority of the perimeter; and
a second section, extending in axial direction from the first section to an axial end of the space, and
wherein the second section has, at multiple, e. g. all, axial positions, a respective cross-section of which a boundary, at at least one particular angular position, is at a radial distance to the reference axis equal to a length of the radius of the circle and has a radius of curvature extending from the reference axis to the boundary.

[0002] The invention also relates to an assembly for mounting in a conveying system, comprising:

at least one roller having a shaft; and
at least one device according to any one of the preceding claims for supporting a section of the shaft of the roller in a bath of an apparatus for wet-chemical treatment of workpieces.

[0003] The invention also relates to a system for conveying workpieces through a bath of an apparatus for wet-chemical treatment of workpieces, which system comprises at least one assembly comprising:

at least one roller having a shaft; and
at least one device for supporting a section of the shaft of the roller in the bath.

[0004] The invention also relates to an apparatus for wet-chemical treatment of workpieces, e.g. for surface plating, comprising a vessel for forming a treatment bath and a system for conveying the workpieces through the bath.

Background Art

[0005] CN 212668376 U discloses a roller conveying mechanism and conveying device. The roller conveying mechanism includes a roller and a rotating shaft. Two supporting sleeves are respectively sleeved on both ends of the rotating shaft and the two supporting sleeves respectively rotate and support both ends of the shaft. When the supporting sleeve is worn, the supporting sleeve can be replaced, which can reduce the wear during rotation of the shaft. It appears that the sleeve passes through a bearing obtained by providing two bores with slightly displaced central axes that extend through the entire bearing. A problem with this is that the processing liquid can pass through the bearing in relatively large quantities and reach a gear provided on the other side of the bearing. This is generally undesirable. Where the wet-chemical treatment comprises electrodeless plating, a phenomenon called plate-out can arise, whereby plating material is deposited on, in this case, the gear. In addition, replacement of the sleeve requires taking the conveying mechanism out of service.

[0006] CN 215491814 U discloses a support limiting structure comprising a first side wall, a second side wall, which is arranged opposite the first side wall, and a circular support, formed between the first side wall and the second side wall. The support limiting structure may further include a bottom wall, fixedly connected to the first side wall and the second side wall and disposed at a bottom of a channel for a circular shaft. The bottom wall blocks a circular shaft from moving downwards out of the channel. The bottom wall has a slot communicating with the channel for preventing liquid from accumulating on the upper surface of the bottom wall, and the slot can facilitate drainage. A problem with the slot is that the vertical position of the shaft is not very well-defined, which can be a problem for a roller shaft carrying a workpiece. The vertical position may need to be well-defined for treatment purposes. Moreover, a large number of roller assemblies are normally arranged in series in a conveying system of this kind. At least the lower, supporting rollers should not differ appreciably in vertical position, in order to avoid damaging delicate workpieces.

[0007] WO 03/069965 A1 discloses a device for transporting flat workpieces in conveyorised lines. In a preferred application, printed circuit boards and printed circuit foils are transported for processing in wet-chemical (horizontal or vertical) conveyorised processing lines. The device comprises at least one pair of rollers that are disposed on a respective side of a plane of transportation and face each other for transporting the workpieces, as well as transport drives associated with the rollers. A lower roller of the pair is carried in a stationary lower bearing, which determines the height at which the workpiece is positioned. The upper roller is freely carried in a manner that it is capable of automatically adjusting to the thickness of the workpiece. Thrust bearings serve this purpose. A problem of the stationary lower bearing is that there is relatively little liquid in the bearing when the shaft is stationary. Where the wet-chemical treatment comprises electrodeless plating, plate-out on the roller shaft and bearing can occur. The deposited material has to be removed from time to time, meaning that the assembly

comprising the roller shaft and bearing has to be removed and the processing apparatus temporarily taken out of service. In other types of processing, the bearing can run dry, giving rise to increased wear.

Summary of Invention

[0008] It is an object of the invention to provide a device, assembly, system and apparatus of the types mentioned above, that require relatively little maintenance to remain operational.

[0009] This object is achieved according to a first aspect by the device according to the invention, which is characterised in that the respective cross-sections of the second section have, over at least a range of angular positions other than the particular angular positions, a radial extent from the reference axis that is increased with respect to the radial extent of the cross-section of the first section at corresponding angular positions.

[0010] The device may be one of a pair, arranged at either axial end of the rotatably supported shaft. The device may be embodied as a replaceable insert for a conveying system or be a fixed component of such a conveying system. The device comprises at least one body defining a space for receiving a section of the shaft near an axial end of the shaft. The space may be defined in one body or a component formed by multiple bodies joined together, e.g. by bonding or welding. Most embodiments can be made in one piece, such that the device comprises one body in which the space for receiving the shaft is formed. The first section of the space has a cross-section at each of a range of axial positions, for example along the entire length in axial direction, of which cross-section the perimeter is circular. The perimeter has a closed shape. Non-functional deviations of the perimeter from the circular shape are possible. This means only that scratches or shallow grooves may be present in the interior wall surface of the at least one body bounding the first space, through which no appreciable flows of liquid in axial direction are possible. Otherwise, the perimeter lies on the circle over a majority of the perimeter, e.g. at least 95% or at least 99 % of the length of the perimeter.

[0011] The length of the radius of the cross-section of the first section (the distance from the axis to the interior surface of the body that bounds the first section of the space for receiving the shaft) will generally have a value only slightly larger than that of the shaft section received therein. Thus, the shaft is positioned reliably and accurately with little play in vertical and horizontal directions transverse to the reference axis when the device is mounted with the reference axis oriented horizontally.

[0012] In use, the majority of the shaft will extend in axial direction into the surroundings of the device from the second section. Only a relatively short section will extend in axial direction into the surroundings of the device from the first section. That relatively short section may be provided with a gear to drive the shaft. The relatively long section will support the workpieces as they are conveyed through the bath. The relatively narrow gap in the first section between the interior surface defining the space and the exterior surface of the shaft section arranged in the first section provides a relatively high flow resistance, so that large flows of liquid in axial direction completely through the device are prevented.

[0013] On the other hand, the second section is enlarged in radial direction, so that more liquid can envelop the shaft section accommodated in the second section of the space for receiving the shaft. This helps reduce plate-out. Furthermore, more liquid can reach the transition from the second to the first section, so that the first section will not easily run dry, for example when the shaft is idle. This helps prevent wear. The second section has, at each axial position, a respective cross-section of which a boundary, at at least one particular angular position, is at a radial distance to the reference axis equal to a length of the radius of the circle (on which the perimeter of the cross-section of the first section lies). At that particular angular position, the boundary also forms a circle segment with a radius of curvature extending from the reference axis to the boundary. This radius of curvature is thus the same as that of the circle. The particular angular position marks the bottom of the second space when the device is in an operative position, with the reference axis extending horizontally. A shaft with the corresponding radius can be rotatably supported there in the operative position. Thus, the shaft is supported in one direction along the length of both the first and second section. This is the direction in which, in use, the weight of the workpieces is carried when the device is in the operative position with the reference axis oriented horizontally. The length over which the shaft section is supported is relatively long with regard to the dimension of the at least one body in the axial direction. The shaft will therefore not sag appreciably under load.

[0014] It is observed that the radial extent of the cross-sections of the space in the second section being increased over at least a range of angular positions other than the particular angular position with respect to the radial extent of the cross-section in the first section means that there is a change in cross-section at the transition between the first and second section. In this manner, the device is distinguished from a device comprising a single bore with a slight un-roundness due to manufacturing tolerances.

[0015] The cross-section of the second section may have a constant shape at every axial position in the second section or may vary. The boundary of the cross-section need not be a closed shape at every axial position in the second section.

[0016] The term angular position has the ordinary meaning associated with that term when defining positions in a cylindrical co-ordinate system. In this case, the cylindrical co-ordinate system has the reference axis as a main axis.

[0017] In an embodiment of the device, the particular

angular positions comprise an angular position of a lowest point of the boundary of the cross-section of the second section when the device is oriented with the reference axis oriented horizontally to support the shaft section at the particular angular position.

[0018] Ordinarily, the section of the shaft received in the space will have a circle-cylindrical shape with a radius marginally smaller than that of the cross-section of the first section of the space. The shaft is supported at the particular angular position (and over a range around that particular angular position) by a correspondingly shaped boundary section. This embodiment is of particular use where the roller carries the weight of the workpieces.

[0019] In an embodiment, the first section is cylindrical with a cylinder axis coinciding with the reference axis.

[0020] This means that the cross-section of the first section is uniform over the range of axial positions over which the first section extends. The shaft is held in position relatively well.

[0021] In an embodiment of the device, the at least one body defines at least one breach through the at least one body for fluidly interconnecting an exterior of the at least one body and the second section, the breach extending at an angle greater than zero with respect to the reference axis.

[0022] The breach therefore extends transversely to the reference axis. The angle may be 90°, so that the breach extends in radial direction. The direction in which the breach extends corresponds to the direction of flow of liquid. This embodiment is useful for ensuring that enough liquid can reach the second section of the space in the presence of the shaft section, in particular where the shaft section has an axial positioning feature that abuts the device axially. Such a feature may tend to close off the second section of the space axially. The breach allows liquid nevertheless to enter the second section of the space. At least one of the at least one breaches may be in the form of a channel.

[0023] In an example of any embodiment in which the at least one body defines at least one breach through the at least one body for fluidly interconnecting an exterior of the at least one body and the second section, the breach extending at an angle greater than zero with respect to the reference axis, the breaches are at least two in number.

[0024] This allows liquid to flow through the second section of the space in the presence of the shaft section. Liquid can enter through one of the breaches and exit through another. The orientation of the breaches, e.g. with respect to the vertical, may be such as to promote a particular direction of flow. Alternatively or additionally, the shaft may be provided with flow-enhancing features, e.g. features that allow the shaft to function as an impeller or at least to entrain liquid as the shaft rotates.

[0025] In an example of any embodiment in which the at least one body defines at least one breach through the at least one body for fluidly interconnecting an exterior of the at least one body and the second section, the breach extending at an angle greater than zero with respect to the reference axis, at least a sub-section of the second section of the space, located at the axial end of the space, is defined in a section of the at least one body protruding in at least axial direction with respect to an adjacent part of the at least one body and provided with at least one of the at least one breaches.

[0026] Being provided in a section of the at least one body protruding in at least axial direction with respect to an adjacent part of the at least one body, the breach can be relatively short. Because the sub-section of the second section of the space is located at the axial end of the space, liquid passing through the breach also passes through the second section of the space from or to an axial end thereof. There are few or no zones of stagnation.

[0027] In a particular variant of this embodiment, the protruding section further protrudes in opposite lateral directions with respect to the adjacent part of the at least one body to form a flange.

[0028] The flange may engage a positioning feature on the shaft section to limit axial movement of the shaft. The flange may also or alternatively co-operate with a matching feature of a mounting structure to mount the device without fasteners. The flange need not protrude laterally over 360°, i.e. need not be annular in shape. Laterally in this case also covers downwards protrusion.

[0029] In an embodiment of the device, the at least one body is provided with a flange on an opposite side in axial direction to a side on which the axial end of the space to which the second section extends is located.

[0030] The flange is formed by a protruding ridge, rib or rim. The direction of protrusion is transverse to the reference axis. The flange need not protrude over 360°, i.e. have an annular shape. Where this is not the case, the flange may be comprised of discrete sections. The flange may engage a positioning feature on the shaft section to limit axial movement of the shaft. The flange may also or alternatively co-operate with a matching feature of a mounting structure to mount the device without fasteners.

[0031] In an embodiment, the device is configured to support a section of a shaft of a second roller for rotation about a further reference axis parallel to the reference axis, a further space for receiving the shaft section of the second roller being defined by the at least one body.

[0032] This embodiment is suitable for use in a conveying system for conveying planar workpieces, e.g. a horizontal conveying system. The workpieces can then be conveyed between the rollers. At least one of the rollers will be a driven roller. Conveying the workpieces between rollers helps avoid slip. In the case of very thin workpieces, they may be held flat to avoid buckling and thus provide relatively uniform surface treatment.

[0033] In a particular example of this embodiment, when the device is oriented with the reference axis oriented horizontally to support the shaft section at the particular angular position, the space for receiving the shaft

section is at a lower level, e.g. underneath, the further space.

[0034] The space comprising the first and second sections is thus the space for accommodating a section of the lower of the two shafts. This is the shaft of the load-bearing roller in a horizontal conveying system. That shaft is supported over a relatively large extent in axial direction. By contrast, the further space may be shorter in axial direction than the combination of the first and second sections. Even where this is not the case, the further space need not be completely submerged in the liquid of the treatment bath, in use, and it is less important that the second shaft be supported at a particular height. Therefore, the further space need not comprise a section shaped like the first section of the space that is arranged to receive a section of the lower shaft.

[0035] In an example of any embodiment in which the device is configured to support a section of a shaft of a second roller for rotation about a further reference axis parallel to the reference axis, a further space for receiving the shaft section of the second roller being defined by the at least one body, the further space and the second section are fluidly interconnected by at least one channel formed in the at least one body.

[0036] This allows to establish a flow of liquid through the second section of the space for receiving the shaft section. Where the second section is at a lower level than the further space, in use, the liquid flow will be established through gravity. Since the second roller will generally not be load-bearing, the shaft of the second roller will not be pressed quite so firmly against the surface in which a window into the channel is formed. Therefore, the channel can be a generally straight channel. Alternatively, the channel can open into the further space through a lateral aperture in the interior surface bounding the further space. The straight channel is easier to form, however, in particular in a moulded body. In embodiment in which the at least one body defines at least one breach through the at least one body for fluidly interconnecting an exterior of the at least one body and the second section, the breach extending at an angle greater than zero with respect to the reference axis, the channel may correspond to one of the at least one breaches.

[0037] In an example of any embodiment in which the device is configured to support a section of a shaft of a second roller for rotation about a further reference axis parallel to the reference axis, a further space for receiving the shaft section of the second roller being defined by the at least one body, the further space is elongated in a direction transverse to the reference axis and extending away from the space for receiving the shaft section.

[0038] The elongated shape allows for some movement of the section of the shaft of the second roller to accommodate workpieces of differing thickness.

[0039] In an example of any embodiment in which the device is configured to support a section of a shaft of a second roller for rotation about a further reference axis parallel to the reference axis, a further space for receiving the shaft section of the second roller being defined by the at least one body, the further space has a boundary defined by an interior surface of the at least one body, which boundary is U-shaped, seen in axial direction, and the shaft section of the second roller is insertable into the further space between limbs of the U-shape.

[0040] This means that, when the device is oriented with the reference axis oriented horizontally to support the shaft section at the particular angular position, the further space is open at the top. The shaft of the second roller can simply be dropped into the further space. This simplifies mounting. Furthermore, the second roller can be used as required. If the workpieces are too thick or do not need to be held between rollers, the second roller can be lifted out of the conveying system without the use of any tools.

[0041] According to another aspect, the assembly according to the invention for mounting in a conveying system comprises at least one roller having a shaft and at least one device according to the invention for supporting a section of the shaft of the roller in a bath of an apparatus for wet-chemical treatment of workpieces.

[0042] Generally, the assembly will comprise a pair of devices, each in accordance with the invention, to support two respective sections of each roller shaft. The devices may be identical, mirror images of each other or differently shaped except for having similar spaces for receiving a section of one of the shafts. The assembly may be replaceable, e.g. in a toolless manner, or the assembly may be permanently mounted in the conveying system. Thus, the device for supporting the roller shaft section may be integrated into a larger structure or embodied as a replaceable insert.

[0043] In an embodiment of the assembly, the shaft is provided with a positioning sleeve axially abutting the device for rotatably supporting a section of the shaft.

[0044] In this embodiment, the first section of the space for receiving the roller shaft section limits the movement of the roller shaft in the manner of a cylindrical joint. A face of the device, e.g. a face of the at least one body, limits the axial movement of the roller shaft.

[0045] In an embodiment of the assembly, the shaft carries at least one gear at an axial end section protruding in axial direction from a side of the device for rotatably supporting a section of the shaft that is axially closer to the first section of the space than to the second section of the space.

[0046] The first section of the space for receiving the roller shaft section limits the amount of liquid that can reach the gear, thus aiding in reducing plate-out onto the gear. The gear may be suitable for co-operating with a gear on a drive shaft for causing at least the roller to rotate. The gear may mesh with a gear on a further roller shaft also rotatably supported by the same device. The shaft may carry two gears of which one performs the first of these two functions and the other the second.

[0047] According to another aspect, the system according to the invention for conveying workpieces

through a bath of an apparatus for wet-chemical treatment of workpieces comprises at least one assembly, e. g. an assembly according to the invention, the assembly comprising: at least one roller having a shaft; and at least one device according to the invention for supporting a section of the shaft of the roller in the bath.

[0048] An embodiment of the system comprises at least one mounting structure for receiving an insert comprising the device for supporting the section of the shaft of the roller in the bath.

[0049] The insert may correspond to the device, i.e. comprise no further components.

[0050] In an example of any embodiment comprising at least one mounting structure for receiving an insert comprising the device for supporting the section of the shaft of the roller in the bath, the mounting structure and the insert have interlocking shapes for fixing the insert in position in at least axial direction in the mounting structure.

[0051] Thus, replacement of the insert or the assembly comprising the insert and roller can be accomplished quickly without using tools. There are no fasteners that need to be loosened and tightened and that could be dropped into the bath.

[0052] According to another aspect, the apparatus according to the invention for wet-chemical treatment of workpieces, e.g. for surface plating, comprises a vessel for forming a treatment bath and a system according to the invention for conveying the workpieces through the bath.

Brief Description of Drawings

[0053] The invention will be explained in further detail with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of an assembly of two rollers and two bearing inserts for mounting in a conveying system;

Fig. 2 is a perspective view of a first end of the assembly of Fig. 1;

Fig. 3 is a perspective view of a second, opposite end of the assembly of Figs. 1 and 2;

Fig. 4 is a perspective view of the second end from a different angle;

Fig. 5 is a perspective view of one of the bearing inserts;

Fig. 6 is a side view in perspective projection of the bearing insert of Fig. 5;

Fig. 7 is a top view in perspective projection of the bearing insert of Figs. 5 and 6;

Fig. 8 is a rear view in perspective projection of the bearing insert of Figs. 5-7;

Fig. 9 is a front view in perspective projection of the bearing insert of Figs. 5-8;

Fig. 10 is a front view in parallel projection of the bearing insert of Figs. 5-9;

Fig. 11 is a detailed view in parallel projection of part of the front side of the bearing insert of Figs. 5-10;

Fig. 12 is a cross-sectional view of the bearing insert of Figs. 5-11; and

Fig. 13 is a perspective view of the bearing insert of Figs. 5-12.

[0054] An assembly 1 (Fig.1) for mounting in a conveying system for conveying workpieces through a bath (not shown) of an apparatus for wet-chemical treatment of workpieces (not shown) is shown here as a replaceable unit. In the conveying system, a whole series of such assemblies 1 will be mounted in the direction in which the workpieces are conveyed, in use. The assembly 1 will be mounted so as to be at least partially submerged in the liquid of the bath. The workpieces may be planar workpieces, e.g. boards, for example printed circuit boards, panels, e.g. glass panels such as for display devices, wafers or foils. The workpieces may be relatively thin, e.g. with a thickness from about 25 □m. A width of the workpieces (with respect to the transport direction) may be in the order of 50 - 1000 mm, e.g. between 100 and 800 mm. The treatment may differ from bath to bath in the apparatus. One of the treatments may be electrodeless surface plating, e.g. with copper. Other treatments include desmear process.

[0055] The assembly 1 comprises a first roller 2 and a second roller 3. In use, the workpieces are transported between the pair formed by the first and second rollers 2,3. The first roller 2 comprises a first shaft 4, to which wheels are mounted for rotation with the first shaft 4. The second roller 3 likewise comprises a second shaft 5 to which wheels are mounted for rotation with the second shaft 5.

[0056] In an alternative embodiment, the rollers 2,3 may each comprise a single full-body roller instead of wheels mounted on a shaft. Such full-body rollers may still have elevations so that the contact area with the workpieces is limited. Wheels on the first shaft 4 may be axially offset with respect to wheels on the second shaft 5, so that an upper side of the workpiece is contacted at different axial locations to a lower side of the workpiece.

[0057] Being replaceable, the assembly 1 comprise first and second bearing inserts 6a,b at opposite ends of the first and second shafts 4,5. The bearing inserts 6a,b are configured to be dropped into mounting structures (not shown) formed at an upper end of a wall of the conveying system.

[0058] Each of the bearing inserts 6a,b comprises, in this case forms, a device for supporting a respective section of both the first shaft 4 and the second shaft 5. The supported sections are close to the axial end of the respective shaft 4,5, but do not extend right up to that axial end.

[0059] The first and second bearing inserts 6a,b are identical in this embodiment. They are symmetrical with respect to a plane of symmetry in which the axes of rotation of the first and second shafts 4,5 lie.

[0060] The first shaft 4 is provided with a bevel gear 7 at one end and a gear wheel 8 at an axial position between the bevel gear 7 and the second bearing insert 6b. The first shaft 4 is provided with a first positioning sleeve 9 (Fig. 2) at an opposite axial end to the axial end at which the bevel gear 7 and gear wheel 8 are provided. In addition, there is a second positioning sleeve 10 (Figs. 3 and 4) abutting the second bearing insert 6b on an opposite side of the second bearing insert 6b to the side on which the bevel gear 7 and gear wheel 8 are provided.

[0061] Similarly, the second shaft 5 is provided with a gear wheel 11. This gear wheel 11 meshes with the gear wheel 8 on the first shaft 4, so that there is no need to provide a bevel gear for the second shaft 5. The rotation of the first and second shafts 4,5 is synchronised by the meshing gear wheels 8,11. The second shaft 5 is also provided with a first positioning sleeve 12 (Fig. 2) at an opposite axial end to the axial end at which the gear wheel 11 is provided. In addition, there is a second positioning sleeve 13 (Figs. 3 and 4) abutting the second bearing insert 6b on an opposite side of the second bearing insert 6b to the side on which the gear wheel 11 is provided.

[0062] Since the first and second bearing inserts 6a,b are identical, the remaining description will not distinguish between the two.

[0063] In the illustrated embodiment, the bearing insert 6 (Figs. 5-13) is formed by a single body 14, e.g. by moulding. The body 14 may be made of an electrically non-conducting material. The body 14 may be made of plastic or ceramic material, for example.

[0064] It is convenient to define a first reference axis 15 and a second reference axis 16 (Fig. 12), coinciding substantially with the axes of rotation of the first and second shafts 4,5. When the assembly 1 is mounted in the conveying system, the first and second reference axes 15,16 will be oriented generally horizontally. It is further possible to define angular positions ϕ (Fig. 11) and axial positions with respect to the first reference axis 15. An angular position ϕ of 0° corresponds to the 12 o'clock position on a clock face, seen in axial direction from the side of the bearing insert 6 on which a majority of the first shaft 4 is located, in use.

[0065] A space for receiving a section of the first shaft 4 is formed in the body 14 (Fig. 12). This space extends in axial direction between opposite sides of the body 14. The space is defined by an interior surface of the body 14. A first section 17 is essentially circle-cylindrical and centred on the first reference axis 15. The first section 17 is bounded by a first interior surface section. The first section 17 has a radius of a first length R_1.

[0066] In the illustrated embodiment, the first section 17 extends in axial direction into the body 14 from an axial end of the space where the space forms an aperture in an exterior surface of the body 14. The first section 17 extends in axial direction up to a transition to a second section 18. In another embodiment, there may be further sections on an opposite side of the first section 17 to the side on which the second section 18 is located.

[0067] The second section 18 extends in axial direction from the transition to the first section 17 to an axial end of the space. The second section 18 is also defined by the interior surface of the body 14, but the relevant section of the interior surface is not closed around the first reference axis 15 at every axial position. Rather, there are breaches into the second section 18, as will be explained. Moreover, the cross-sectional shape deviates from the circular at every axial position, irrespective of whether there is a breach at that axial position.

[0068] At each axial position, the interior surface bounds the second section 18 over a range [ϕ_1, 360°-ϕ_1] of angular positions centred on a particular angular position ϕ_0 corresponding to the six o'clock position on a clock face, i.e. 180° in the illustrated co-ordinate system. This range [ϕ_1, 360°-ϕ_1] is smaller than 180°, e.g. smaller than 90°, in size. Over that range [ϕ_1, 360°-ϕ_1], the second section 18 is just a continuation of the first section 17. At other angular positions, the radial extent of the second section 18 is larger than that of the first section 17 at corresponding angular positions. In other words, at least the upper half of the second section 18 is enlarged in radial direction with respect to the first section 17. Thus, when the cylindrical section of the first shaft 4 is received in the space, there is a larger volume available for liquid to envelop the first shaft 4.

[0069] In the illustrated embodiment, the radius of the second section 18, where this radius is defined by the interior surface of the body 14, has a maximum length R_2 at an angular position 180° removed from the particular angular position ϕ_0 at which the radius has the same length R_1 as in the first section 17.

[0070] The second section 18 extends axially into a sub-section 19 formed in a first flange 20. In use, the second positioning sleeve 10 may abut the first flange 20 axially. This will generally close the second section 18 to liquid in axial direction, so that a breach 21 is defined in the first flange 20 (Figs. 9-11). The breach 21 extends in radial direction, i.e. at an angle of 90° to the first reference axis 15. In the illustrated embodiment, the breach 21 is located at the angular position 180° removed from the particular angular position ϕ_0 at which the radius has the same length r_1 as in the first section 17. As a result, the first flange 20 is horseshoe-shaped, seen in axial direction.

[0071] This location of the breach 21 is appropriate at least in view of the other function of the first flange 20, which is to position the bearing insert 6 in the mounting structure provided for the bearing insert 6 in the conveying system. The first flange 20 provides a shape-lock, allowing the bearing insert 6 to be securely mounted merely by dropping the bearing insert 6 into the mounting structure. The same function is fulfilled by a second flange 22 on the same side of the bearing insert 6 and a third flange 23 on an opposite side of the bearing insert 6, seen in axial direction.

[0072] All the flanges 20,22,23 of the illustrated embodiment are integral parts of the body 14, i.e. made in

one piece with the remainder of the body 14.

[0073] A section of the second shaft 5 is supported for rotation in a different manner than the section of the first shaft 4. An upper section of the body 14 defines an interior surface 24 having a cross-section that is generally U-shaped, seen in axial direction. This interior surface 24 partially bounds a further space 25 for receiving the section of the second shaft 5. In the illustrated embodiment, the cross-section is constant along the axial extent of the further space 25, except for one or more positions at which apertures are defined in the interior surface 24.

[0074] In the illustrated embodiment, there is one such position at which an aperture is defined at the end of a channel 26 interconnecting the further space 25 and the second section 18 of the space for receiving the section of the first shaft 4 (Figs. 7 and 12). Thus, this channel 26 forms a second breach through the body 14 for fluidly interconnecting an exterior of the body 14 (via the further space 25) and the second section 18 of the space for receiving a section of the first shaft 4. An effect is that there is a flow of liquid through the second section 18 and through the channel 26 and the breach 21 defined in the first flange 20.

[0075] A bottom of the U-shape has the shape of a circle segment, seen in axial direction, with a radius extending from the second reference axis 16 to the interior surface 24. The circle segment extends over 180° or less, but generally more than 90°. The radius may be of the same length r_1 as that of the first section 17 of the space for receiving a section of the first shaft 4, for example.

[0076] It will be appreciated that the further space 25 is elongated in a direction transverse and through the first and second reference axes 15,16, i.e. a direction extending away from the space for receiving a section of the first shaft 4. As a result, the second shaft 5 is able to move between the limbs of the U-shaped interior surface in that direction. The gear wheels 8,11 are provided with teeth with appropriate shapes and dimensions to enable them to mesh over the range of movement. In use in the conveying system, the further space 25 is located above the space for receiving a section of the first shaft 4. The first roller 2 thus bears the load of the workpieces. The second roller 3 holds the workpieces against the first roller 2 to move the workpieces with limited or no slip. The freedom of movement afforded by the elongated shape of the further space 25 allows for a range of workpiece thicknesses to be accommodated. Moreover, the second shaft 5 is lifted somewhat from the interior surface 24, at least at intervals. This frees the aperture into the channel 26, indeed may provide a limited pumping action supporting the flow of liquid past the first shaft 4.

[0077] Irrespective hereof, the orientation of the channel 26 is such that the channel 26 extends substantially vertically, in use, since the further space 25 is located above the second section 18 when the reference axes 15,16 are oriented horizontally.

[0078] The second flange 22 of the second bearing insert 6b co-operates with the gear wheel 11. The third flange 23 of the second bearing insert 6b co-operates with the second positioning sleeve 13. The third flange 23 of the first bearing insert 6a co-operates with the first positioning sleeve 12. Thus, axial movement of the second shaft 5 is limited.

[0079] The first roller 2 is able to support the workpieces and stay in position relatively well. The weight of the first roller 2 is carried in the bearing inserts 6a,b over a relatively long section at either end. Lateral movement is prevented by the interior surface bounding the first section 17 of the space for receiving the shaft section. Plate-out and dry bearing surfaces are prevented by the enlarged second section 18.

[0080] The invention is not limited to the embodiments described above, which may be varied within the scope of the accompanying claims. For example, the second flange 22 need not be U-shaped as illustrated. A pulley can be used to synchronise the rotation of the first and second rollers 2,3, e.g. to allow the assembly 1 to accommodate a larger range of workpiece thicknesses. Instead of providing a pair of rollers 2,3 and a pair of bearing inserts 6a,b per assembly 1, one pair of bearing inserts can support multiple pairs of rollers, e.g. by comprising a set of spaces and further spaces 25 of the configuration described above, located adjacent each other. In other words, two bearing inserts 6 can be integrated to support sections of two pairs of a first shaft 4 and a second shaft 5. Although the assembly 1 described above has two bearing inserts 6a,b with the features described herein in detail, it is possible to provide only one such bearing insert at one axial end of the first roller 2 and a bearing insert with a differently-configured space, e.g. a circle-cylindrical space or a space with a cross-section shaped similarly to that of the second section 18, for receiving a section of the first shaft 4 at the other axial end. This might be sufficient if it is only desired to reduce plate-out at the axial end at which the gear wheel 8 and bevel gear 7 are located, for example.

List of reference numerals

[0081]

1 -	Assembly
2 -	First roller
3 -	Second roller
4 -	First shaft
5 -	Second shaft
6a,b -	Bearing inserts
7 -	Bevel gear
8 -	Gear wheel on first shaft
9 -	First positioning sleeve on first shaft
10 -	Second positioning sleeve on first shaft
11 -	Gear wheel on second shaft
12 -	First positioning sleeve on second shaft
13 -	Second positioning sleeve on second shaft
14 -	Body
15 -	First reference axis

16 - Second reference axis
17 - First section of space
18 - Second section of space
19 - Sub-section
20 - First flange
21 - Breach
22 - Second flange
23 - Third flange
24 - Interior surface
25 - Further space
26 - Channel

Claims

1. Device for rotatably supporting a section of a shaft (4) of a roller (2) of a conveying system in a bath of an apparatus for wet-chemical treatment of workpieces, which device comprises at least one body (14),

wherein a space for receiving the shaft section is formed in the at least one body (14),
wherein the space comprises:

a first section (17) having a cross-section, centred on a reference axis (15), of which a perimeter lies on a circle over at least a majority of the perimeter; and
a second section (18), extending in axial direction from the first section (17) to an axial end of the space, and
wherein the second section (18) has, at multiple, e.g. all, axial positions, a respective cross-section of which a boundary, at at least one particular angular position (ϕ_0), is at a radial distance to the reference axis (15) equal to a length (Ri) of the radius of the circle and has a radius of curvature extending from the reference axis (15) to the boundary, **characterised in that**
the respective cross-sections of the second section (18) have, over at least a range of angular positions ($[-\phi_1,\phi_1]$) other than the particular angular positions (ϕ_0), a radial extent from the reference axis (15) that is increased with respect to the radial extent of the cross-section of the first section (17) at corresponding angular positions.

2. Device according to claim 1,
wherein the particular angular positions comprise an angular position of a lowest point of the boundary of the cross-section of the second section (18) when the device is oriented with the reference axis (15) oriented horizontally to support the shaft section at the particular angular position (ϕ_0).

3. Device according to claim 1 or 2,
wherein the first section (17) is cylindrical with a cylinder axis coinciding with the reference axis (15).

4. Device according to any one of the preceding claims,
wherein the at least one body (14) defines at least one breach (21,26) through the at least one body (14) for fluidly interconnecting an exterior of the at least one body (14) and the second section (18), the breach (21,26) extending at an angle greater than zero with respect to the reference axis (15).

5. Device according to claim 4,
wherein at least a sub-section (19) of the second section (18) of the space, located at the axial end of the space, is defined in a section (20) of the at least one body (14) protruding in at least axial direction with respect to an adjacent part of the at least one body (14) and provided with at least one of the at least one breaches (21).

6. Device according to any one of the preceding claims,
wherein the device is configured to support a section of a shaft (5) of a second roller (3) for rotation about a further reference axis (16) parallel to the reference axis (15), a further space (25) for receiving the shaft section of the second roller (3) being defined by the at least one body (14).

7. Device according to claim 6,
wherein, when the device is oriented with the reference axis (15) oriented horizontally to support the shaft section at the particular angular position (ϕ_0), the space for receiving the shaft section is at a lower level, e.g. underneath, the further space (25).

8. Device according to claim 6 or 7,
wherein the further space (25) and the second section (18) are fluidly interconnected by at least one channel (26) formed in the at least one body (14).

9. Device according to any one of claims 6-8,
wherein the further space (25) is elongated in a direction transverse to the reference axis (15) and extending away from the space for receiving the shaft section.

10. Device according to any one of claims 6-9,

wherein the further space (25) has a boundary defined by an interior surface (24) of the at least one body (14), which boundary is U-shaped seen in axial direction, and
wherein the shaft section of the second roller (3) is insertable into the further space (25) between limbs of the U-shape.

11. Assembly for mounting in a conveying system, com-

prising:

at least one roller (2) having a shaft (4); and
at least one device (6) according to any one of the preceding claims for supporting a section of the shaft (4) of the roller (2) in a bath of an apparatus for wet-chemical treatment of workpieces.

12. Assembly according to claim 11, wherein the shaft (4) is provided with a positioning sleeve (9,10) axially abutting the device (6) for rotatably supporting a section of the shaft (4).

13. Assembly according to claim 11 or 12, wherein the shaft (4) carries at least one gear (7,8) at an axial end section protruding in axial direction from a side of the device (6b) for rotatably supporting a section of the shaft (4) that is axially closer to the first section (17) of the space than to the second section (18) of the space.

14. System for conveying workpieces through a bath of an apparatus for wet-chemical treatment of workpieces, which system comprises at least one assembly, e.g. according to any one of claims 11-13, comprising:

at least one roller (2) having a shaft (4); and
at least one device (6) according to any one of claims 1-13 for supporting a section of the shaft (4) of the roller (2) in the bath.

15. Apparatus for wet-chemical treatment of workpieces, e.g. for surface plating, comprising a vessel for forming a treatment bath and a system according to claim 14 for conveying the workpieces through the bath.

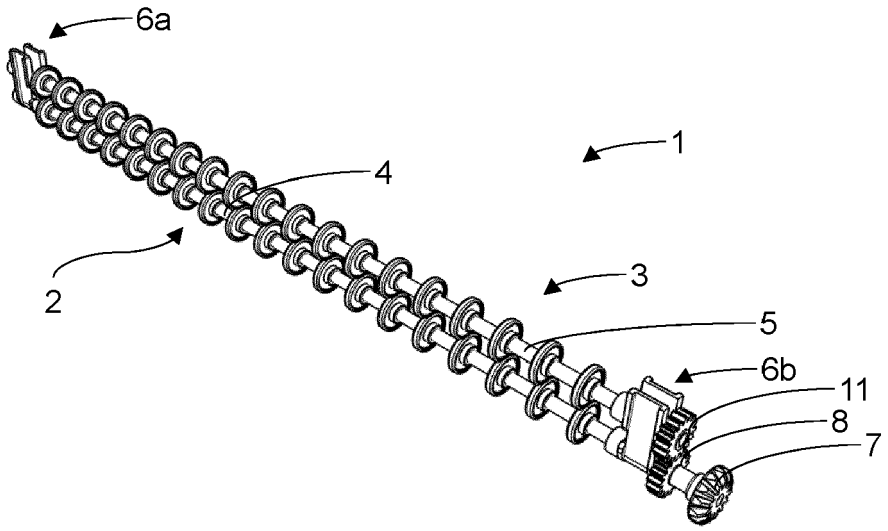

Fig. 1

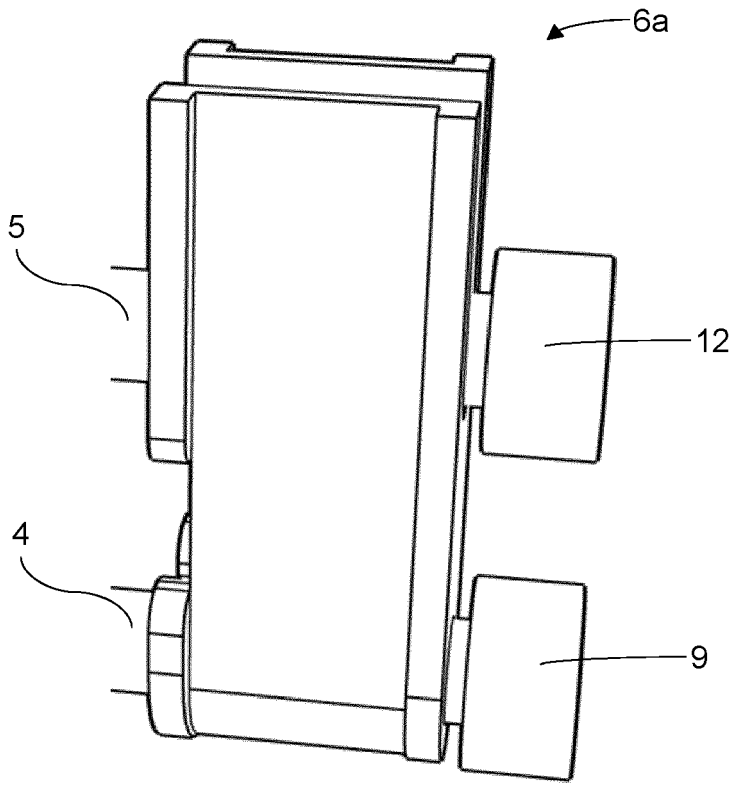

Fig. 2

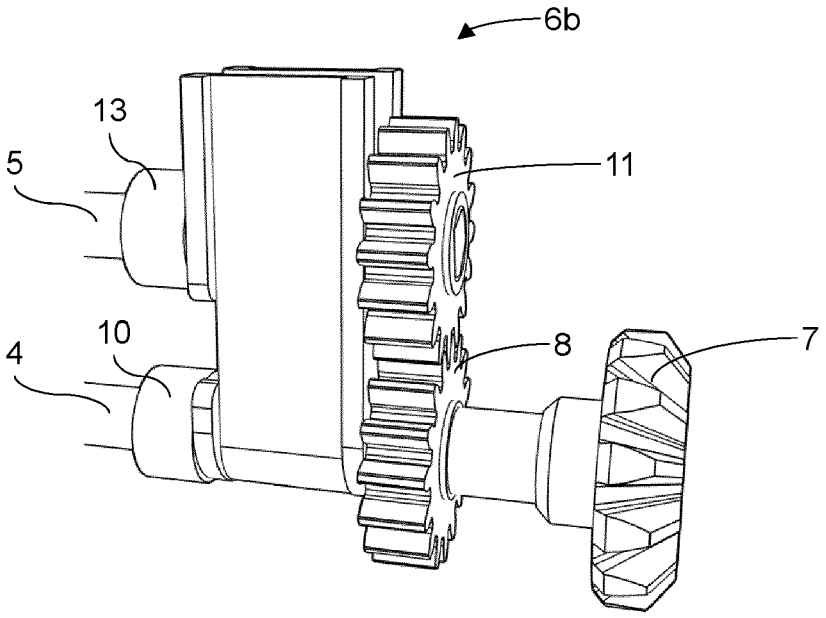

Fig. 3

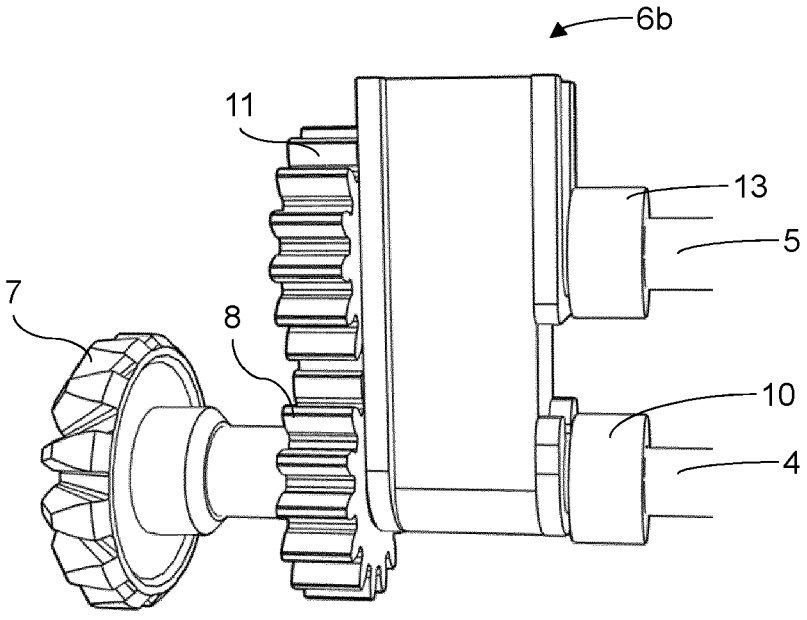

Fig. 4

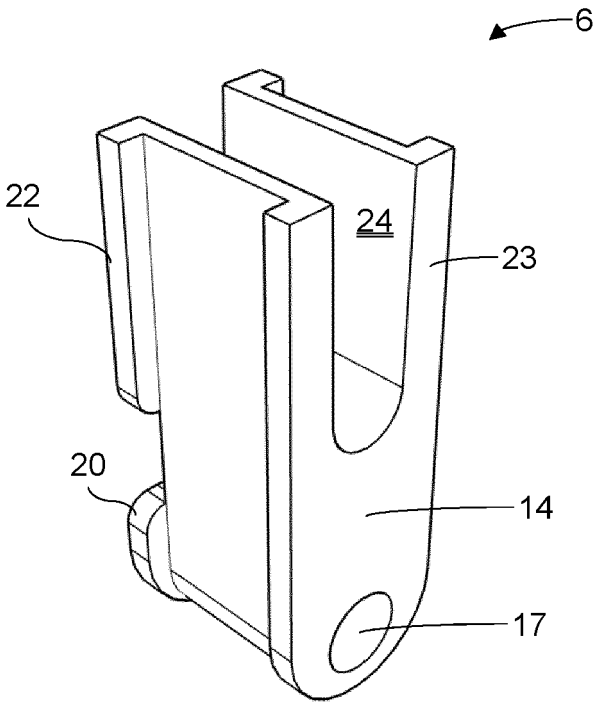

Fig. 5

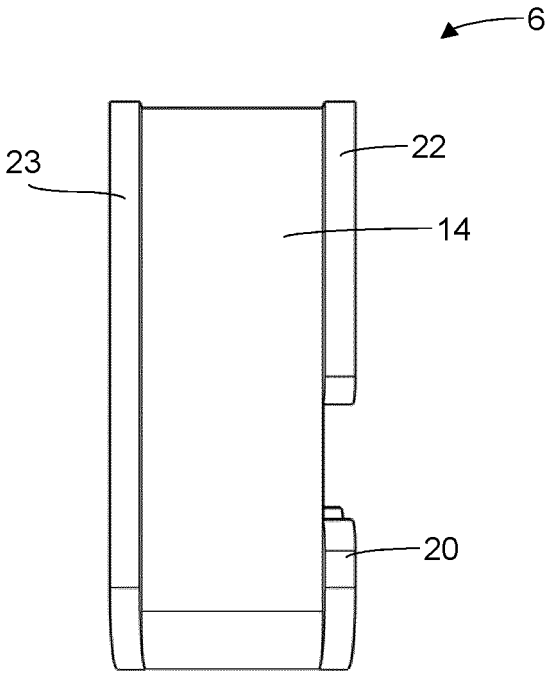

Fig. 6

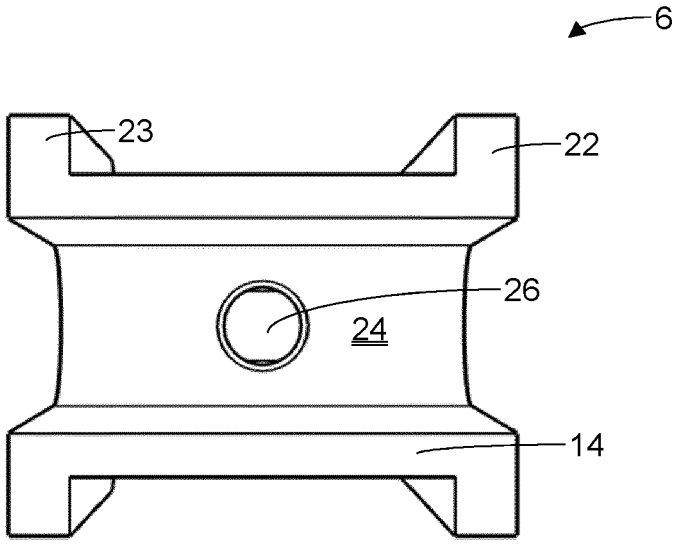

Fig. 7

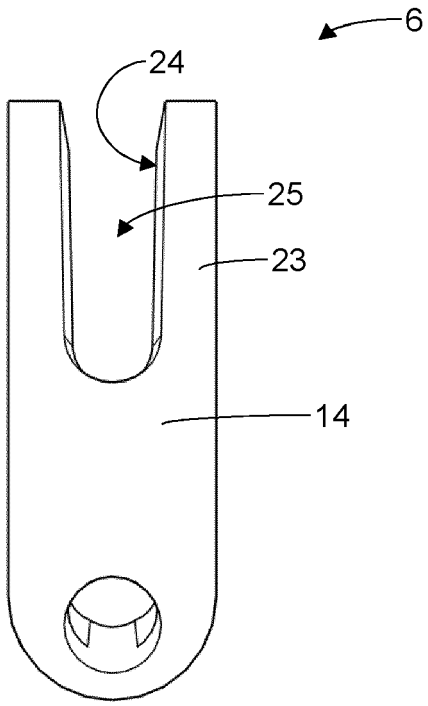

Fig. 8

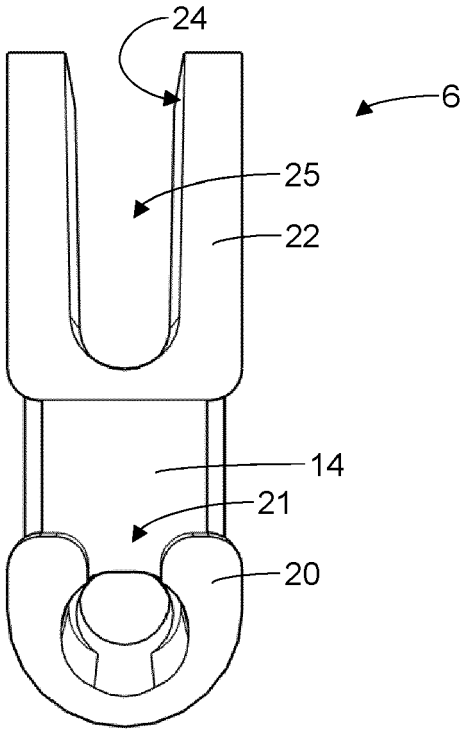

Fig. 9

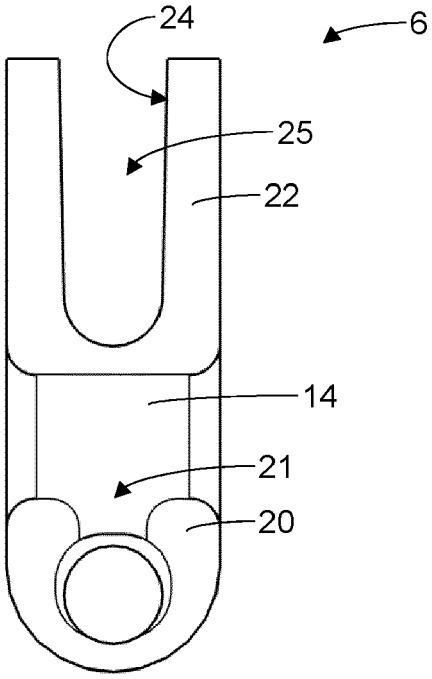

Fig. 10

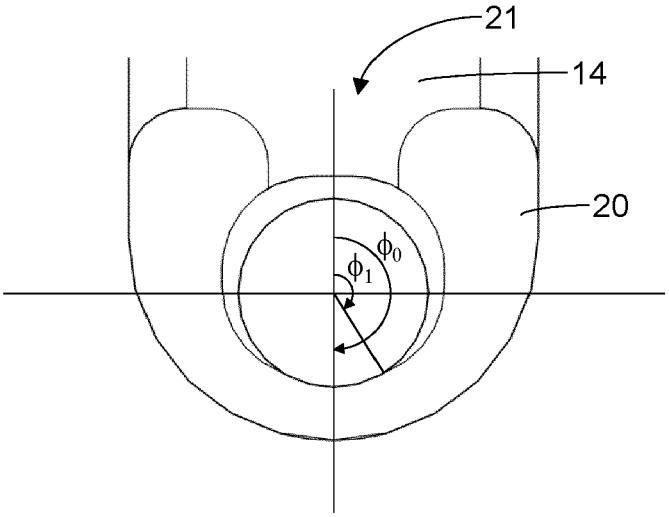

Fig. 11

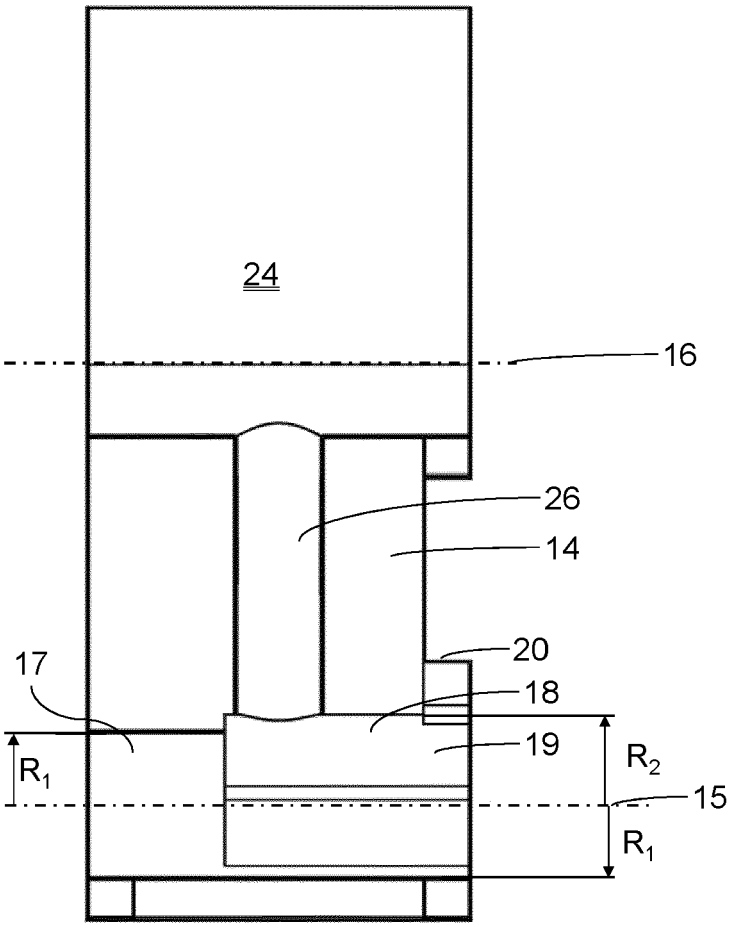

Fig. 12

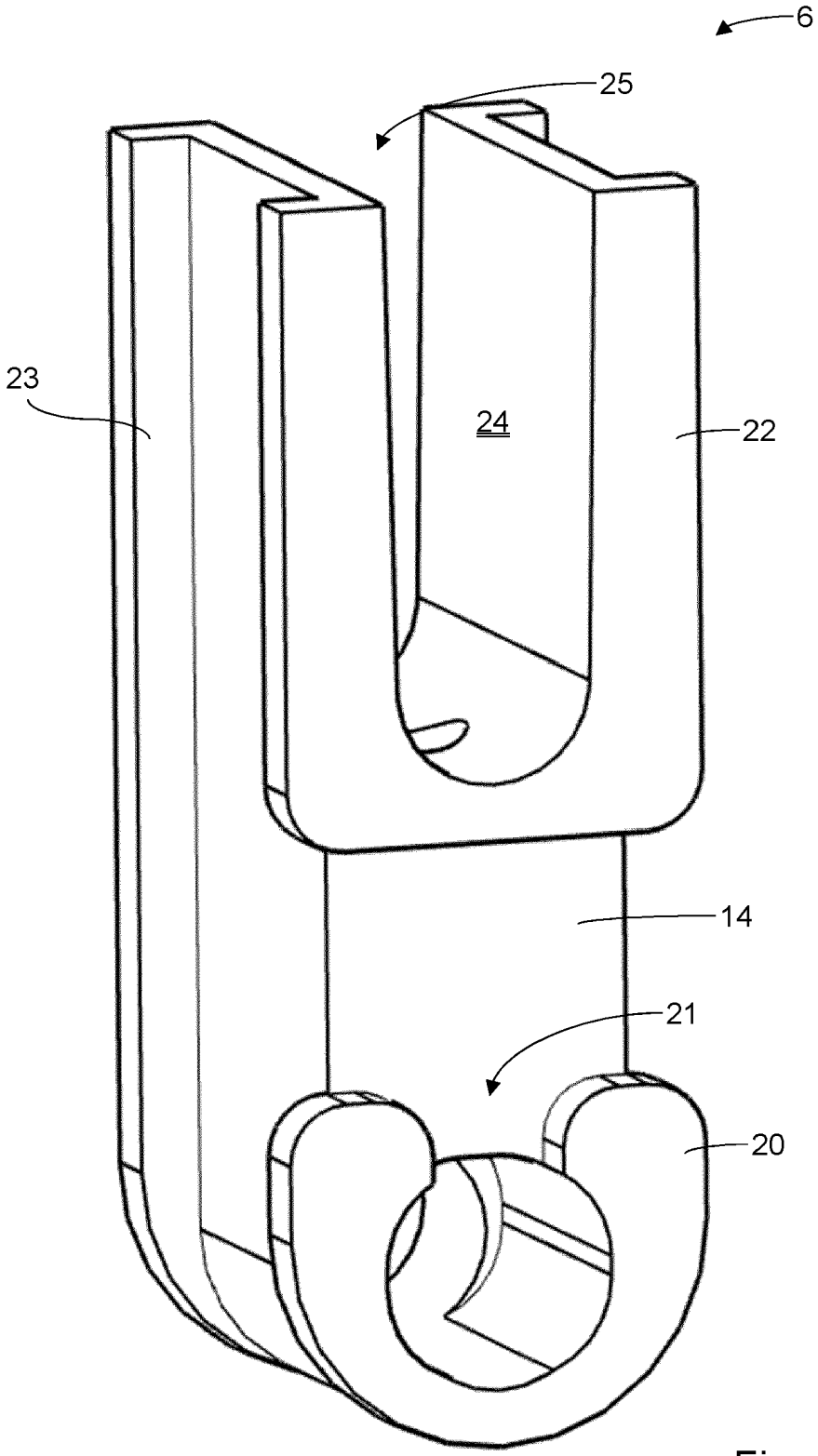

Fig. 13

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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 9748

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	JP 2009 062569 A (NISSHIN STEEL CO LTD; NISSHIN KOKI KK) 26 March 2009 (2009-03-26) * paragraph [0002]; figures 1, 2, 4 * * paragraph [0010] - paragraph [0012] *	1-3,6, 11,12, 14,15	INV. C25D17/06 B65G39/02 H05K3/00
X Y	CN 201 838 616 U (WUXI SUNTECH POWER CO LTD ET AL.) 18 May 2011 (2011-05-18) * paragraph [0001] - paragraph [0002]; figures 5, 6 * * paragraph [0036] - paragraph [0038] *	4,5,7 8-10,13	
Y	CN 208 353 722 U (GUANGZHOU FASTPRINT CIRCUIT TECH CO LTD ET AL.) 8 January 2019 (2019-01-08) * paragraph [0022] - paragraph [0034]; figures 1-8 * * paragraph [0039] - paragraph [0045] * * paragraph [0048] *	9,10,13	
Y	KR 101 898 167 B1 (POSCO [KR]) 13 September 2018 (2018-09-13) * paragraph [0008]; figures 1-4 * * paragraph [0024] - paragraph [0030] * * paragraph [0039] *	8	TECHNICAL FIELDS SEARCHED (IPC) C25D B65G H05K H01L B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	31 January 2023	Telias, Gabriela

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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