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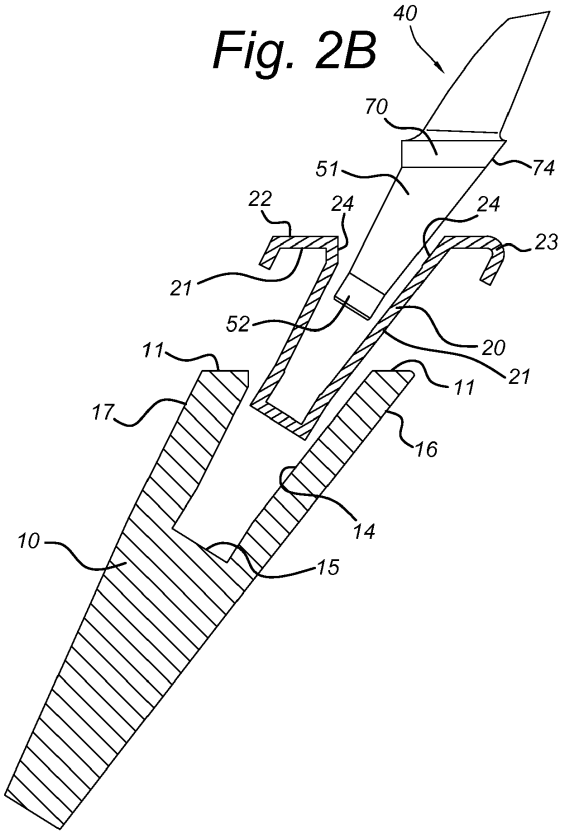
(54) **CUTTER HEAD AND TOOTH SYSTEM**

(57) The present invention provides an cutter head with a blade that is provided with a recess, and a tool which can be inserted in said recess in the blade through a tool holder in such a manner that the tool is completely spaced apart from the blade. The tool holder is preferably formed from a sheet of metal having a substantially uniform thickness. The tool itself, which is preferably an elongated tool, is not axially supported on the top side of the blade, but instead is supported, via the tool holder, on the inner surface of the recess in the blade. The invention further provides a tool and a method of attaching such a tool to a blade of a cutter head.

Fig. 2B



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Description

Field of the invention

[0001] The present invention relates to a cutter head for an excavating device, comprising: at least one blade with a top side and a recess in said top side, said recess having an inner surface; a tool, such as a tooth with a cutting edge; a tool holder adapted for holding said tool and comprising a wall extending from said top side at least partially into the recess, said wall having a first side which at least partially abuts the inner surface of the recess. The invention further relates to a tool for use in such a cutter head, and a method of attaching a tool to a blade of a cutter head.

Background art

[0002] US patent application publication no US 2007/0245602 A1 describes known tooth systems comprising two main connection parts in the form of a "female" and a "male" part that together form a full, assembled "tooth" in a series of adjacently arranged teeth along, for example, the blades of a cutter head. Such a "tooth" comprises a forward wear-part in the form of a replaceable tooth portion with a (cutting) point and comprising a rear leg for mounting in a specially-designed groove at a rear, stationary holder, which suitably is firmly fixed to, for example by hammering, to the cutter head. To achieve a dynamic yet reliable attachment of the replaceable tooth point to the holder, the connection parts also comprise a connection system common to the parts and with a detachable locking mechanism. Every such connection system has a distinctively characteristic geometry, comprising the surfaces and the form of the legs and grooves named above, in order to thereby attempt to have the wear-part of each "tooth" held effectively and safely in place in a function-sufficient manner that embodies minimal wear to the wear-part until, due to inevitable wear, the wear-part must be replaced.

[0003] In order to reduce wear between different connection parts caused by hammering and/or caused by too large surface loads on the tooth's system's joint between the holder and the tooth point, US 2007/0245602 A1 proposes an improved tooth system for a cutter head, which tooth system is of the type embodying a holder located on the cutter head and a front tooth portion that is detachably arranged on and in relation to the holder, wherein the tooth portion is in the form of a replaceable wear and/or replacement part designed for the actual earth moving and embodies a rear leg and the holder embodies a cavity designed to receive the leg in interaction with the tooth portion and thereby achieve a unified joint for assimilation of occurring loads via a predetermined connection geometry embodying special, opposite, mutually interacting contact surfaces and, at least initially, clearance surfaces that are arranged along the tooth portion and holder. Generally the tool holder will be mounted, e.g. by welding or using a bolt-connection, on a blade of the cutter head, which blade typically has a helical shape.

[0004] Despite the improvements provided by US 2007/0245602 A1 replacement of the holder and the tool remains expensive, not only due to the time lost but also due to the material parts that have to be discarded.

[0005] It is an object of the present invention to provide a cutter head and tooth system which allow easy replacement of the tool and/or tool holder.

[0006] It is a further object of the invention to provide a cutter head and tooth system in which the amount of material that has to be discarded upon replacement of the tool is reduced.

Summary of the invention

[0007] To this end, the present invention provides a cutter head for an excavating device, comprising: at least one blade with a top side and a recess in said top side, said recess having an inner surface; a tool; a tool holder adapted for holding said tool and comprising a wall extending from said top side at least partially into the recess, said wall having a first side which at least partially abuts the inner surface of the recess; wherein said wall further comprises a second side opposite from said first side and comprising one or more engagement surfaces arranged at or near the top side at least partially within the recess; wherein said tool comprises: a first section comprising a shaft which extends into the recess; a second section which protrudes in a direction away from the blade and said top side and comprising a cutting edge; and an intermediate section between the first section and the second section, said intermediate section and comprising one or more outer contact surfaces, each adapted for engagement with a corresponding engagement surface of the wall. During use of the cutter device the tool is supported at its outer contact surface by the tool holder, and is preferably also supported near the distal end of the shaft. In order to keep the tool securely fixed in place on the blade, a connector may be provided, e.g. comprising a bolt connector, and/or a clamping mechanism. Additionally or alternatively, a portion of the shaft may be clamped within the recess.

[0008] Advantageously, during use of the cutter head, the tool can be held by the holder without being axially supported by the top side of the blade. As the tool is supported within the recess of the blade with its shaft held within the recess, the tool can be constructed free from axial support structures, such as wings or the like, for directly or indirectly axially supporting the tool on the top side of the blade. That is, neither the tool nor the tool holder needs to be provided with such axial support structures for axially supporting the tool on the top side of the blade. It will be appreciated that a tool and tool holder without such axial support structures require less material than a tool and tool holder which do have such axial support structures. Besides the savings in material that

the present invention allows, the resulting tool and tool holder typically weigh less than a tool and tool holding which do have such axial support structures, and are therefore more ergonomical in use. Moreover, as the tool holder is substantially or even completely supported on the inner wall of the recess in the blade, the tool holder is adapted to be used with a blade having a top side that is not completely smooth and/or planar. The need for planing the top side of the blade, at least where the tool holder covers said top side, to within precise specifications is thus often reduced. For instance, the tool holder may be adapted to extend with a portion thereof which is substantially parallel to the top side of the blade, at a distance of between 0 and 1 cm, preferably at a distance of at least 0,4 cm.

[0009] Besides holding the tool, the tool holder also protects that portion of the top side of the blade over which it extends from material, such as rock or sand, that has been excavated by the cutter head. The tool holder, which may consist of only the wall, thus serves a dual purpose of holding the tool and preventing damage to the top side of the blade from which the tool protrudes. To protect the blade from being damaged by the tool, direct contact between the tool and the blade, in particular between the shaft of tool and the inner wall of the recess, is preferably avoided, at least during use of the cutter head. When the tool needs to be replaced, e.g. due to wear or damage thereof, it can be pulled out of the recess along a longitudinal direction of the shaft, of course after first disconnecting the connector, if any.

[0010] In an embodiment the one or more outer contact surfaces and corresponding engagement surfaces together are adapted for making sliding contact with each other and aligning the tool in the tool holder when the shaft of the tool is being urged into the recess. The tool may be urged into the recess by means of a connector, and/or during use when a force exerted on the cutting edge of the tool has a component which urges the tool into the recess. Besides urging the tool into the recess, no further alignment needs to be carried out for correctly positioning the tool in the holder.

[0011] In an embodiment, the one or more outer contact surfaces and corresponding engagement surfaces are parallel surfaces which taper toward the bottom of the recess, preferably wherein said parallel surfaces extend at angle of between 10 and 35 degrees relative to the top side, more preferably at an angle of 17,5 degrees. When the tool is placed in the tool holder the outer contact surfaces of the tool and the corresponding engagement surfaces cause the tool to align within the holder when the tool is urged into the recess, e.g. due to gravity and/or by means of a connector attached to the tool and the blade which urges the tool into the recess. Preferably, the tool comprises at least 3 planar outer contact surfaces, more preferably 4 planar outer contact surfaces, all facing away from each other.

[0012] In an embodiment said one or more outer contact surfaces are adapted for engagement with their corresponding engagement surfaces substantially without play when the tool is urged into the recess. Thus, when the tool is urged into the recess and each of the one or more outer contact surfaces engages the corresponding engagement surface, rotation of the contact surfaces relative to the engagement surfaces is prevented. This results in accurate positioning of the tool in the tool holder when translational movement of the tool relative to the engagement surfaces is substantially prevented when the tool is urged into the recess.

[0013] In an embodiment the shaft has a circumferential outer surface which is spaced apart from the wall and from the inner surface of the recess along a greater part the longitudinal axis of said shaft. Thus, at least during insertion of the shaft there is some play, e.g. a gap of between 5-15 mm or more, on all sides between the circumferential outer surface of the shaft and the wall and/or the inner surface of the recess. This allows easy insertion of the tool into the recess and helps prevent the shaft from becoming stuck in the recess. Preferably, the said shaft, at its distal end, comprises a bevelled edge for facilitating insertion of the distal end into the recess.

[0014] In an embodiment the shaft has a longitudinal axis which intersects an end surface of the shaft, wherein said end surface is spaced apart from the wall and from the inner surface of the recess along the longitudinal axis. Thus, even when the outer contact surfaces and/or corresponding engagement surfaces become somewhat worn down during use, the tool can be urged further into the recess in such a manner that the outer contact surfaces and/or corresponding engagement surfaces maintain alignment of the tool in the tool holder.

[0015] In an embodiment the shaft extends into the recess with some play. This prevents the inner surface of the recess and/or the wall from clamping against the outer circumferential surface of the shaft when the shaft is urged into the recess. When the shaft of the tool is not being urged into the recess, the amount of play allows the shaft to be easily removed from the recess. Herein, some play may be formed by a gap at least 0,4 mm, preferably at least 0,5 mm, between the circumferential outer surface of the shaft and the wall and/or inner surface of the recess when seen in cross-section through a plane which contains the longitudinal axis of the shaft, at least on one side of said plane. When the shaft is urged into the recess, there may be some contact between the outer circumference of the shaft and the wall, for instance a line contact, on the other side of said plane.

[0016] In an embodiment the wall extends along the entire length of the shaft into the recess, with its first side abutting the inner surface of the recess. The wall thus protects the inner surface of the recess in the blade from contact with the shaft along the length of the shaft. The blade is typically made from a softer material than the wall, and the wall in turn is generally made from a softer material than the tool.

[0017] In an embodiment, the tool is formed as a monolithic unit, preferably a cast-iron or cast-steel monolithic

unit. This provides high structural strength to the tool.

[0018] In an embodiment, the tool has an elongate shape, with the first section and/or the second section continuously tapering to the intermediate section.

[0019] In an embodiment, when projected on an axis parallel to the longitudinal axis of the second section, the second section has a length of at least one third the total length of tool, preferably at least half of said total length.

[0020] In an embodiment, said wall has a substantially uniform thickness, at least within the recess. Preferably the wall has a substantially uniform thickness, i.e. closest distance between its first side and its second side through the material of the wall, over substantially the entire surface of the wall. The wall of the tool holder, and even the entire tool holder, may thus be made or, or consist of from a metal plate that has been shaped to fit the recess and accommodate the shaft and intermediate section of the tool.

[0021] In an embodiment said wall is folded about an edge of the blade at a location spaced apart from said recess. Preferably, the wall is folded about two opposing edges of the blade which are spaced apart from the recess. The wall thus helps to protect the top side of the blade from material that is excavated during use.

[0022] In an embodiment, the shaft, at its outer circumferential surface at a portion near its distal end, is spaced apart from the second side of the wall by a first distance of between 0,2 mm and 0,8 mm, preferably 0,5 mm, on at least one side of a plane which contains the longitudinal axis of the shaft. This again facilitates removal of the tool from the tool holder while at the same time limiting movement of the shaft in a plane transverse to its longitudinal direction.

[0023] In a further embodiment the shaft, at its outer circumference between the intermediate portion and said portion near its distal end, is circumferentially spaced apart from the second side of the wall by second distance greater than said first distance, wherein said second distance preferably is at least 0,9 mm, more preferably at least 1,5 cm. It is thus ensured that the shaft is spaced apart from the wall along the length of the shaft from the intermediate section to said portion near the distal end.

[0024] In an embodiment the shafts extends through a through-opening in said wall, wherein at the bottom of the recess a bush is provided having an outer surface abutting the inner surface of the recess, wherein the distal end of said shaft is received in said bush with some play. Herein, some play may be formed by a gap at least 0,2 mm, preferably at least 0,5 mm, more preferably at least 1 mm, between the circumferential outer surface of the distal end of the shaft and the bush when seen in cross-section through a plane which contains the longitudinal axis of the shaft, at least on one side of said plane. For instance, when the distal end of the shaft has a cylindrical outer surface with a first diameter, e.g. 50 mm, then the bush may have a cylindrical inner diameter which is greater by at least 1 mm, e.g. 51 mm.

[0025] In an embodiment the tool is not axially supported on the top side and/or the second section of said tool is completely spaced apart from said blade and from the tool holder. Thus, substantially no force is exerted by the tool on top side of the blade in a direction from the second section towards the first section.

[0026] In an embodiment the top side around said recess extends in a first plane, wherein the cross-sectional area of said intermediate section in the first plane is smaller than or equal to the cross-sectional area of the recess in said first plane, and greater than any cross-sectional area of the second section in planes parallel to said first plane. The second section of the tool, which extends on a side of the first plane facing away from the blade, can thus be of a simple and lightweight construction. For instance, the second section may be formed in such a manner that, when during use a force is applied on the cutting edge of the tool, stress within the second section is highest at the point where the force is applied and decreases gradually and substantially continuously in a direction along the longitudinal axis of the second section away from said edge. The skilled person may check whether this is the case for instance using finite element analysis in which it is simulated that a force is applied to the cutting edge of the tool while tool is held in place at its outer contact surfaces. During use of such a tool, the stress within the second section is generally highest closest to the cutting edge. Consequently, when the stress is greater than the second section can withstand, only a small portion of the second section that is close to the edge will typically break off. The tool thus needs to be replaced less often, and the moment at which the tool should be replaced is more predictable, than when a tool is used which is directly or indirectly axially supported on the top surface of a blade.

[0027] Preferably, the cross-sectional areas of the second section are substantially continuously smooth along their circumference, e.g. have an ellipsoid shape or other shape free from sharp corners, possibly except at the cutting edge. If a second section is formed in this manner and a force is applied to the cutting edge during use, stress with the second section may be substantially gradually distributed over the second section, with the stress being the greatest closest to the edge, and reducing proportional to a distance from the edge.

[0028] In an embodiment each of said one or more engagement surfaces is substantially parallel to and oppositely facing from its corresponding contact surface.

[0029] In an embodiment the cutter head further comprising a connector adapted for removably connecting the tool via said tool holder to the blade. As the tool is supported by the blade via the tool holder, connecting the tool to the blade also results in connecting the tool holder to the blade. The connector preferably comprises a biasing member, e.g. a spring and/or a member made from an elastically deformable plastic or rubber, arranged for urging the tool into the recess when connecting the tool to the blade.

[0030] According to a second aspect, the present in-

vention provides a tool for a cutter head, preferably a cutter head as described herein, said tool having an elongate shape and comprising: a first section with a shaft to be accommodated in a recess of a blade of the cutter head; a second section which protrudes in a direction away from the shaft and comprising a cutting edge; and an intermediate section between the first section and the second section, said intermediate section comprising one or more outer contact surfaces, each adapted for substantially completely supporting said tool on the blade at a position in the recess, and without substantially axially supporting the tool on said top side of the blade. The tool preferably comprises one or more features of the tool of the cutter blade as described earlier herein. As the top side of the blade substantially does not axially support the tool, the tool holder, at least on the top side of the blade, can be of a light weight construction.

[0031] In an embodiment the one or more outer contact surface comprises sides which taper towards said first section and which coincide with the sides of a frustum, preferably a convex frustum such as non-right circular frustum, an ellipsoid frustum or a frustum with a convex polygonal base, more preferably a frustum having a triangular base. This shape has been found to provide proper alignment of the tool with respect to the tool holder when the tool is urged into the recess.

[0032] In an embodiment, when viewed in cross-section through a plane normal to a longitudinal axis of said first section, the size of the outer contour of said outer contact surface decreases along said longitudinal axis towards the distal end of the second section. For instance, the area of the cross-section through a plane normal to the longitudinal axis of the first section at a level of the intermediate section proximate to the second section is larger than at a level of the intermediate section proximate to the first section. This allows the tool to be "dropped" into the recess and self-align under the influence of gravity when the shaft and recess are arranged substantially vertically.

[0033] According to a third aspect, the present invention provides a method of attaching an elongated tool to a blade of a cutter head wherein said blade is provided with a recess, the method comprising: inserting said tool through a tool holder into the recess of said blade in such a manner that a first section of said tool extends into said recess and a second section of said tool protrudes away from said supporting surface and away from the recess; and fixing said tool to said blade by connecting a connecting member to said second section and to said blade. Preferably, the blade is a blade of a cutter head as described herein, and the tool is a tool as described herein. Fixing the tool to the blade may also comprise fixing the tool holder to the blade, as the tool holder is effectively clamped between the intermediate section of the tool and the blade when the tool is urged into the recess.

[0034] In an embodiment, the tool holder comprises, or consists of, a wall which extends at least partially into the recess and/or a bush at the bottom of the recess adapted for accomodating a distal end of the shaft therein, wherein said shaft is surrounded by said tool holder and/or said bush with some play and in such a manner that the tool remains spaced apart from the inner surface of the recess.

[0035] According to a fourth aspect, the present invention provides a blade of a cutter head for an excavating device, wherein the blade is a blade as described herein and is provided with a tool holder and tool as described herein.

Short description of drawings

[0036] The present invention will be discussed in more detail below, with reference to the attached drawings, in which

Figs. 1A and 1B schematically show respectively a prior art tooth system, and a cutter head, comprising such a tooth system;

Fig. 2A, 2B, and 2C, 2D respectively show a cross-sectional view of a blade of a cutter head according to the present invention, and an exploded view and two details thereof;

Figs. 3A and 3B respectively show a cross-sectional view of another embodiment of a blade of a cutter head according to the present invention, and an exploded view thereof;

Fig. 4 shows a longitudinal sectional view of a blade of a cutter head according to the invention;

Figs. 5A and 5B show an isometric view of a tool and tool holder according to said second embodiment;

Figs. 6A and 6B show an isometric view and a side view of a tooth according to the present invention.

Figs. 7A-7D show a third embodiment of the present invention, in which a connector is shown which locks the tool into place with respect to the blade.

Description of embodiments

[0037] Figs. 1A and 1B schematically shows a prior art tooth system 301 arranged on a cutter head 302 of a dredger cutter 303. The tooth system 301 comprises two main connection parts in the form of a holder 304 and a wear tooth 305 that together form a unified an assembled tooth system. The cutter head 302 comprises a number of helical blades 306, which protrude from a rotational central hub 307 and backwards in the direction of feed of the cutter head 302 to a uniting back ring forming a rotation body 309. At the back end 310 of the rotation body 309, a suction device 311 may be arranged for removal of loosened earthen masses through an intermediary area or trough 312 that is arranged between the helically shaped blades 306. The holders 304 are suitably fastened to the blade, e.g. with a weld joint or screw fastener, and, as can be seen in Fig. 1A, each wear tooth is supported by a corresponding holder and fixed thereto at a side of the holder facing away from the blade 306.

In the known cutter head a tooth can be replaced, e.g. when worn down, by loosening it from the holder and subsequently fixing another tooth to the holder. The holder has the dual function of keeping the tooth fixed in place on the blade, and protecting the blade from material, such as sand and rock, that has been cut by the teeth. The holder itself is also subject to wear, and may eventually have to be replaced as well, though at a lower rate than the rate of replacement of the teeth.

[0038] Figs. 2A and 2B schematically show respectively a cross-sectional view of a blade 10 of a cutter head 1 according to the present invention, and an exploded view thereof. Figs. 2C and 2D show details of sections II-C and II-D of Fig. 2A. The blade 10, which may take the place of any of the blades 306 in the cutter head 303 of Fig. 1B, has a top side 11 which is outwardly directed, i.e. faces away from the blade rather than towards it, and during use of the cutter head faces towards the material, e.g. rock or sand, that is to be excavated. A recess 13 having a circumferential inner surface 14 is provided in the top side 11 and extends from said top side into the blade. A tool holder 20 comprising a wall 23 which extends from the top side 11 into the recess 13, is provided for holding a tool 40, here in the form of a tooth. The wall 23, which may be formed from a sheet of metal having a thickness of between 0,3 cm and 2,5 cm, preferably about 1,5 cm, has a first side 21 which at least partially abuts the inner surface 14 of the recess 13. At an oppositely facing second side 22 and near the top side 11, the wall comprises 23 an engagement surface 24 which is adapted for engaging an outer contact surface of the tooth. The wall 23 is made from a material which has a higher hardness than the material of the blade. Likewise the tooth 40 is made from a material which has a higher hardness than the material of both the blade and the wall 23. A suitable test method for determining the hardness of the blade, wall and tooth is described in ASTM E10-15a "Standard Test Method for Brinell Hardness of Metallic Materials", with digital object identifier 10.1520/E0010-15A. Thus, the wall protects the blade from material that is excavated, e.g. sand or rock, as well as from the tool itself.

[0039] In the embodiment shown, the wall the top side 11, along circumferential inner surface 14 of the recess to a bottom end 15 of the recess 11. A first side 21 of the wall 23 at least partially abuts the inner surface 14 of the recess, and a second side 22 of the wall remains spaced apart from the inner surface 14 by at least the thickness d1 of the wall 23, which thickness is substantially uniform across the entire wall. At the top side, the first side 21 of the wall lies across the top side 11 and, at least with a portion which extends substantially parallel to the top side, is substantially spaced apart a distance h1 of between 0,4 and 1,2 cm therefrom, as shown in Fig. 2C. The top side of the blade may thus be produced, e.g. by casting the blade, with manufacturing tolerances in the top side of a same distance, and planing of the top side of the blade after casting may be avoided. It will be clear however, that the portion of the wall which extends substantially parallel to the top side may instead abuts said top side. The wall 23 protects the top side of the blade 10 from being worn down by rock and stone excavated by the cutter head. In the embodiment shown, the wall extends at least from an edge between a front side 16 and the top side 11 of the blade, across the top side 11, to an edge between a back side 17 and the top side of the blade 10. Damage to and wear of the top side of the blade, at least in the vicinity of the tooth, is in this manner substantially prevented.

[0040] Fig. 2A shows the tool 40 as it is urged into the recess 13, e.g. using a connector 280 as shown in Fig. 7A. In this position, the tool presses the tool holder 20 into the recess, keeping the tool holder in place relative to the blade 10. The exploded view of Fig. 2B illustrates how both the tool and tool holder may easily be replaced when the tool 40 is no longer being urged into the recess. When the tool is lifted out of the recess 13, the tool holder 20 is no longer held in place thereby and can also be removed from the recess as well. Generally the tool will need to be replaced more often than the tool holder, so that it is not always necessary to remove the tool holder together with the tool.

[0041] The detail of section II-C in Fig. 2C shows a portion of the wall 23 with an engagement surface 24 as well as the intermediate section 70 of the tool 40 with a corresponding contact surface 74. The detail shown of section II-D shown in Fig. 2D shows that a portion 52 near the distal end of the shaft 51 lies against the second side 22 of the wall of the tool holder 20 at one side of a plane which contains the longitudinal axis L of the shaft 51, whereas at the other side of said plane the portion 52 is spaced apart from the wall by a distance d3. This small amount of some play between the shaft and the wall, even when the tool is urged into the recess, prevents the shaft from becoming stuck in the recess, or clamped by the wall, allowing easy removal of both the tools and tool holder from the shaft when required. From Fig. 2C it can be seen that the amount of play at the distal portion is relatively small compared to the distance between the remainder of the shaft 51 and the wall 23. Moreover, though there may be contact, e.g. a line contact which preferably extends parallel to the longitudinal axis L of the shaft, between the wall and the portion 52, the remainder of the shaft remains circumferentially spaced apart from the wall 23. The remaining portion of the shaft 51, which extends from just below intermediate section 70 to the distal end portion 52, is completely spaced apart from the wall 23. On the side where portion 53 is spaced apart from the wall by the distance d3, the remaining portion of the shaft is spaced apart from the wall by a distance d2, which is greater than d3. At the lower end of the recess, the distance between the first side 21 and the second side of the wall, i.e. the thickness of the wall, d1 is about 1,5 cm.

[0042] Figs. 3A and 3B show a second embodiment of the present invention. The blade 10 and tool 40 are the

same as in Figs. 2A-2D, but a different tool holder 120 is shown, having a wall 123 with a first side 121 and a second side 122, and which extends only partially into the recess. The wall 123 is provided with a through-opening 126 through which the tool 40 extends into the recess 13. In order to limit movement of the distal end 52 of the shaft, a bush 160 is provided, which is clamped in the recess. The bush 160 is adapted for receiving the distal end of the shaft 51 therein with some play. As can be seen clearly from fig. 3A, the shaft 51 is spaced apart from the inner circumference 14 along a substantial part of its length. The wall 123, in particular engagement surfaces 124 thereof, and the bush together prevent the shaft from contacting the blade.

[0043] Fig. 4 schematically shows a longitudinal sectional view through a blade 10 with a number of recesses 15 in which a corresponding number of tools extend with their respective shafts. The blade will typically have a helical shape, as is known in the art. Both tool holders 20 of the first embodiment and tool holders 120 are shown used on the same blade. The tool holders 20 and 120 of neighboring tools on a blade together form a substantially contiguous surface on the top side 11 of the blade 10, so that the top side of the blade may be substantially fully covered.

[0044] Figs. 5A and 5B respectively show an isometric view of a tool holder 120 according to the second embodiment, and a cross sectional view thereof. In particular from Fig. 5B it can be seen that the outer contact surfaces 74 of the tool, in conjunction with the engagement surfaces 74 of the tool holder, provide a form of self-alignment of the tool when it is urged into the recess.

[0045] Figs. 6A and 6B show a view of a tool 40 according to the invention. The tool comprises a first section 50, with a substantially conically shaped shaft 51 having a longitudinal axis L. At distal end the shaft is provided with a cylindrical portion to be accommodated with some play either within the wall at the bottom end of the recess or a bush. At said distal end a bevelled circumferential edge 53 is provided to facilitate insertion of the shaft into the bottom part of the wall or into the bush. The second section 60, which comprises the cutting edge, continuously decreases in circumferential area when viewed in planes normal to the longitudinal axis M of the second section in a direction away from the intermediate section 70. Each such circumferential are has a smooth contour, with the possible exception at the cutting edge 61. The tool 40 is free from additional structures such as axial support structures for supporting the tool on the top surface of the blade and which may affect the distribution of stress within the tool. Consequently, when a force is exerted on the cutting edge when the tool is mounted in the blade, stress within the second section decreases substantially continuously with the distance from the cutting edge over the entire second section. This in turn causes the second section to wear gracefully and predictably during use.

[0046] Figs. 7A and 7B respectively show a top view of a blade 10 of a cutter head according to the invention, and a cross-sectional view thereof along plane VII-B. On top of the blade 10, a tool holder 220 is arranged, which extends partially into a recess 13 in the blade. The tool holder 220 holds a tool 240, in the form of a tooth, which is urged into portion 219a of the recess 13 by a connector 280. The connector comprises a bolt 281 which extends through an attachment arm 258 in the first section 250 of the tool 240, and through a corresponding attachment arm 18 of the blade 10 and which protrudes into the recess 13. A spring 282 continuously urges the tool 240 into the recess 13. When the tool is to be removed from the recess, first the connector is disconnected from arm 18. Subsequently, the tool may be held by the first section 260 and pulled out of the recess if the first section has not been worn down to the level of the intermediate section 270, or otherwise the tool may be scooped out of the recess by means of a hook or the like which is inserted into portion 291 b of the opening to engage the intermediate section 270and/or the first section 250.

[0047] Fig. 7A shows the tool 260 arranged on four engagement surfaces 224a - 224d of the wall 223. These surfaces taper into the recess 13 and cooperate with four corresponding outer contact surfaces to align the tool with respect to the tool holder 220. The top view of the tool 240 of Fig. 7C shows the four corresponding outer contact surfaces 274a - 274d in dotted lines, as these surfaces are hidden from view by the top of the intermediate section 270 of the tool 240. The four outer contact surfaces correspond to the sides of a rectangular frustum which tapers towards the first section 250 of the tool. Each of the contact surfaces is a planar surface at an angle of about 17,5 degrees relative to the longitudinal axis M of the second section of the tool 240.

[0048] Figs. 7C and 7D show top views of the tool 260 and of a portion of the tool holder 220. Opposing sides 225 and 226 of the tool's intermediate section are spaced apart from both the 223 wall and the blade 10, as is apparent from Fig. 7B. Side 225 merges into outer contact surfaces 224a and 224d, and side 226 merges into outer contact surfaces 224b and 224c. Besides portion 219a in the recess, the recess also comprises a portion 219, which optionally be also be provided with an attachment arm (not shown). This optional attachment arm allows the for easily rotating the cutting edge of the tool by 180 degrees.

[0049] In summary, the present invention provides an cutter head with a blade that is provided with a recess, and a tool which can be inserted in said recess in the blade through a tool holder in such a manner that the tool is completely spaced apart from the blade. The tool holder is preferably formed from a sheet of metal having a substantially uniform thickness. The tool itself, which is preferably an elongated tool, is not axially supported on the top side of the blade, but instead is supported, via the tool holder, on the inner surface of the recess in the blade.

Claims

1. Cutter head for an excavating device, comprising:

   at least one blade (10) with a top side (11) and a recess (13) in said top side, said recess having an inner surface (14);
   a tool (40; 240);
   a tool holder (20; 120) adapted for holding said tool and comprising a wall (23; 223) extending from said top side (11) at least partially into the recess (13), said wall having a first side (21; 221) which at least partially abuts the inner surface (14) of the recess (13);
   wherein said wall (23; 223) further comprises a second side (22; 222) opposite from said first side (21; 221) and comprising one or more engagement surfaces (24; 224a,224b,224c,224d) arranged at or near the top side (11) at least partially with the recess;
   wherein said tool (40; 240) comprises:

      a first section (50; 250) comprising a shaft (51; 251) which extends into the recess (13);
      a second section (60; 260) which protrudes in a direction away from the blade (10) and said top side (11) and comprising a cutting edge (61; 261); and
      an intermediate section (70; 270) between the first section (50; 250) and the second section (60; 260), said intermediate section comprising one or more outer contact surfaces (74; 274a, 274b, 274c, 274d), each adapted for engagement with a corresponding engagement surface (24; 224a,224b,224c,224d) of the wall (21; 221).

2. Cutter head according to claim 1, wherein the one or more outer contact surfaces (74274a, 274b, 274c, 274d) and the corresponding engagement surfaces (24; 224a,224b,224c,224d) together are adapted for making sliding contact with each and aligning the tool (40; 240) in the tool holder (20; 220) when the shaft of the tool is being urged into the recess.

3. Cutter head according to claim 2, wherein the one or more outer contact surfaces and corresponding engagement surfaces are parallel surfaces which taper toward the bottom of the recess.

4. Cutter head according to claim 1, 2 or 3, wherein said shaft (51; 251) has a circumferential outer surface which is spaced apart from the wall (23; 223) and from the inner surface (14) of the recess along a greater part the longitudinal axis of said shaft.

5. Cutter head according to any one of the preceding claims, wherein said shaft (51; 251) has a longitudinal axis (L) which intersects an end surface of the shaft, wherein said end surface is spaced apart from the wall and from the inner surface of the recess along the longitudinal axis.

6. Cutter head according to any one of the preceding claims, wherein the shaft (51; 251) extends into the recess (13) with some play.

7. Cutter head according to any one of the preceding claims, wherein said wall (23) extends along the entire length of the shaft (51) into the recess, with its first side abutting the inner surface of the recess.

8. Cutter head according to any one of the preceding claims, wherein the shaft, at its outer circumferential surface at a portion (52; 252) near its distal end, is spaced apart from the second side of the wall by a first distance of between 0,2 mm and 0,6 mm on at least one side of a plane which contains the longitudinal axis (L) of the shaft.

9. Cutter head according to claim 7, wherein said shaft (51), at its outer circumference between the intermediate portion (70) and said portion (52) near its distal end, is circumferentially spaced apart from the second side (22; 122) of the wall by second distance greater than said first distance, wherein said second distance preferably is at least 0,9 mm.

10. Cutter head according to any one of claims 1-6, wherein said shaft extends through a through-opening in said wall, wherein at the bottom of the recess a bush is provided having an outer surface abutting the inner surface of the recess, wherein the distal end of said shaft is received in said bush with some play.

11. Cutter head according to any one of the preceding claims, further comprising a connector (280) adapted for removably connecting the tool via said tool holder to the blade.

12. Cutter head according to any one of the preceding claims, wherein the connector comprises a biasing member, e.g. a spring and/or an member made from an elastically deformable plastic or rubber, arranged for urging the tool into the recess when connecting the tool to the blade.

13. Tool for a cutter head, said tool having an elongate shape and comprising:

   a first section with a shaft to be accommodated in a recess of a blade of the cutter head;
   a second section (60) which protrudes in a direction away from the shaft and comprising a cutting edge (61); and

an intermediate section (70) between the first section (50) and the second section (60), said intermediate section comprising one or more outer contact surfaces (74), each adapted for substantially completely supporting said tool on the blade at a position in the recess, and without substantially axially supporting the tool on said top side of the blade.

14. Tool according to claim 13, wherein the one or more outer contact surfaces (74) comprises sides which taper towards said first section and which coincide with the sides of a frustum, preferably a convex frustum such as non-right circular frustum, an ellipsoid frustum or a frustum with a convex polygonal base, more preferably a frustum having a triangular base.

15. Tool according to claim 13 or 14, wherein, when viewed in cross-section through a plane normal to a longitudinal axis of said first section, the size of the outer contour of said or more outer contact surfaces (74) decreases along said longitudinal axis towards the distal end of the second section.

16. Method of attaching an elongated tool to a blade of a cutter head, wherein said blade is provided with a recess, the method comprising:

inserting said tool through an tool holder into the recess of said blade in such a manner that a first section of said tool extends into said recess and a second section of said tool protrudes away from said supporting surface (12) and away from the recess; and
fixing said tool to said blade by connecting a connecting member to said second section and to said blade.

Fig. 1A

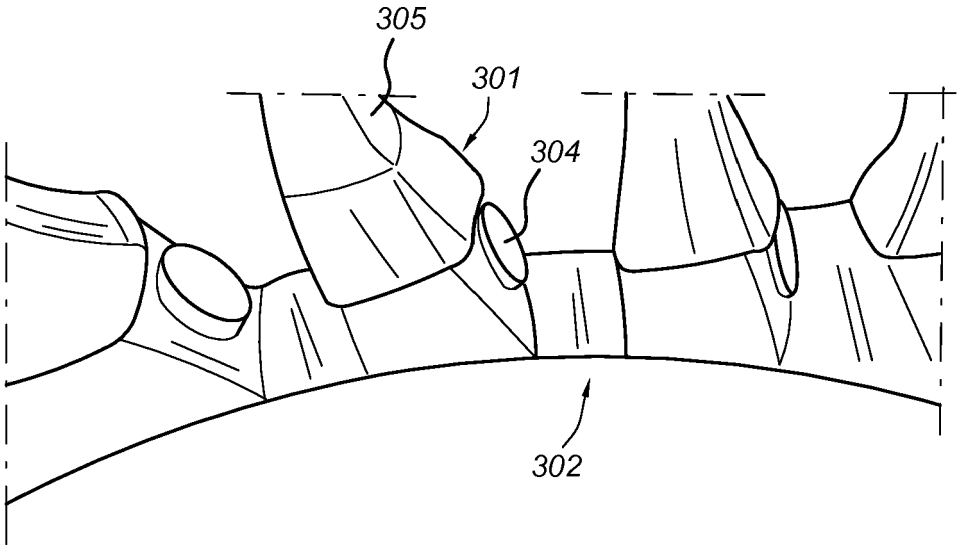


Fig. 1B

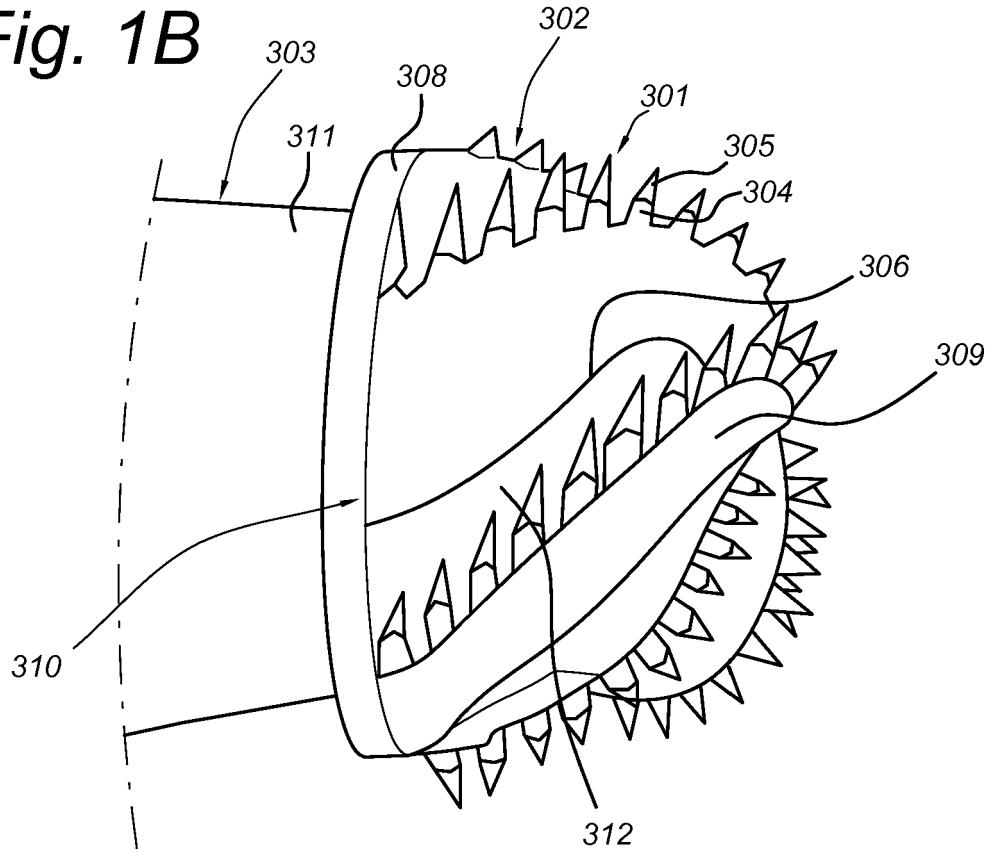
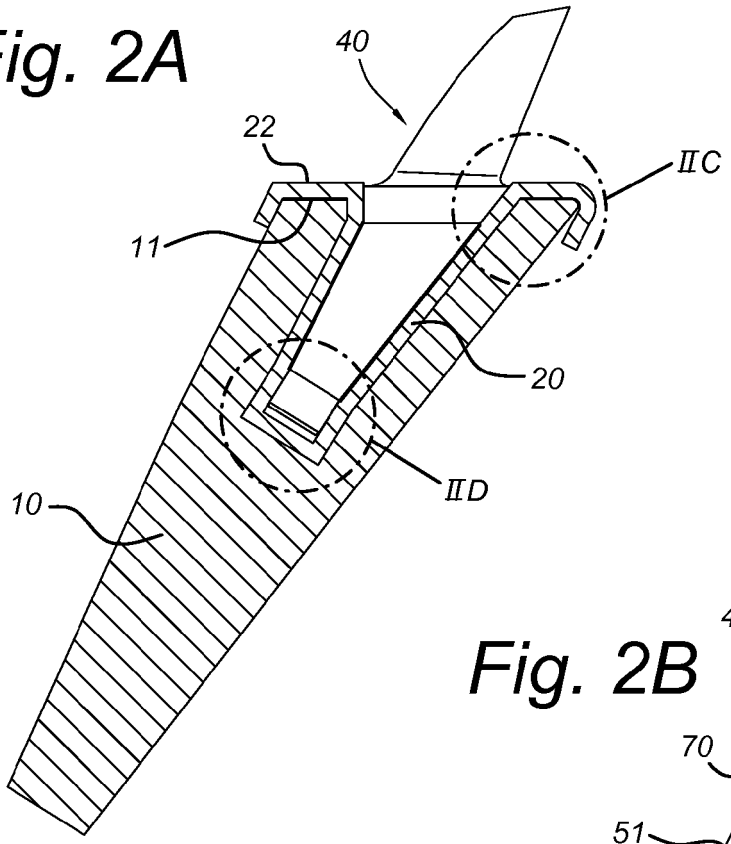


Fig. 2A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20
IID
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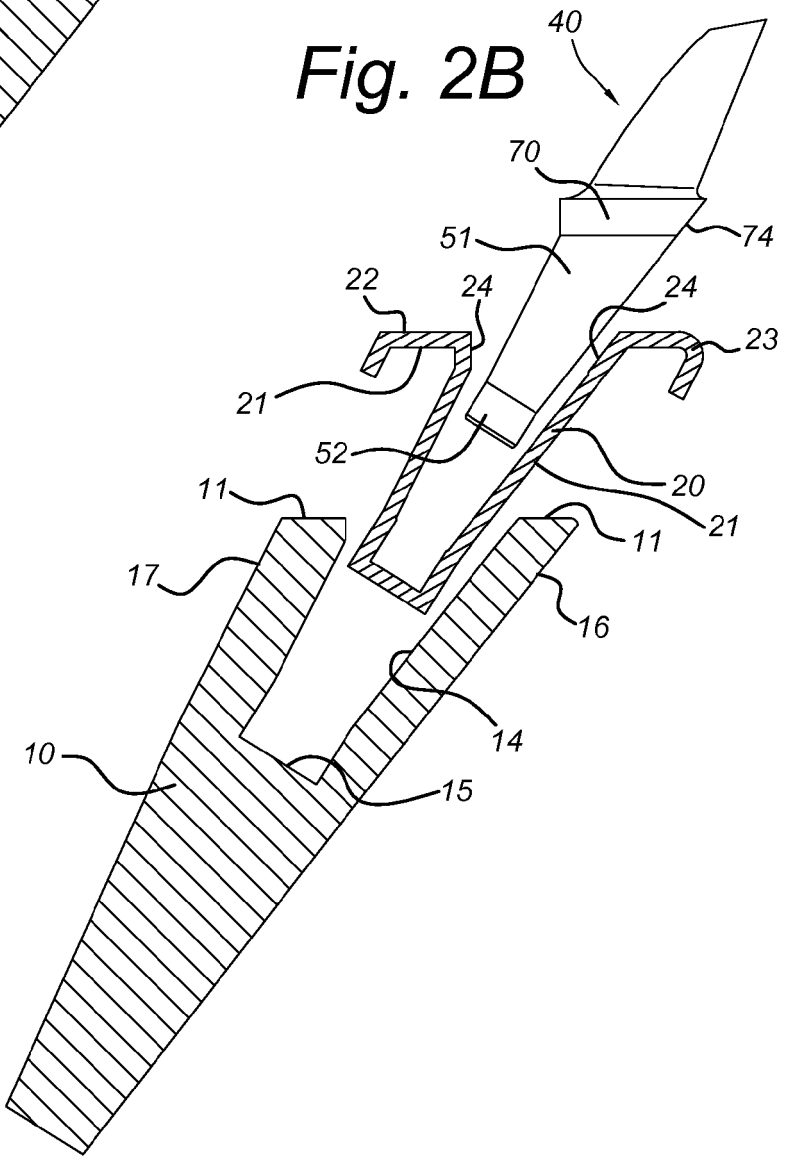
Fig. 2B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14
10
15

Fig. 2C

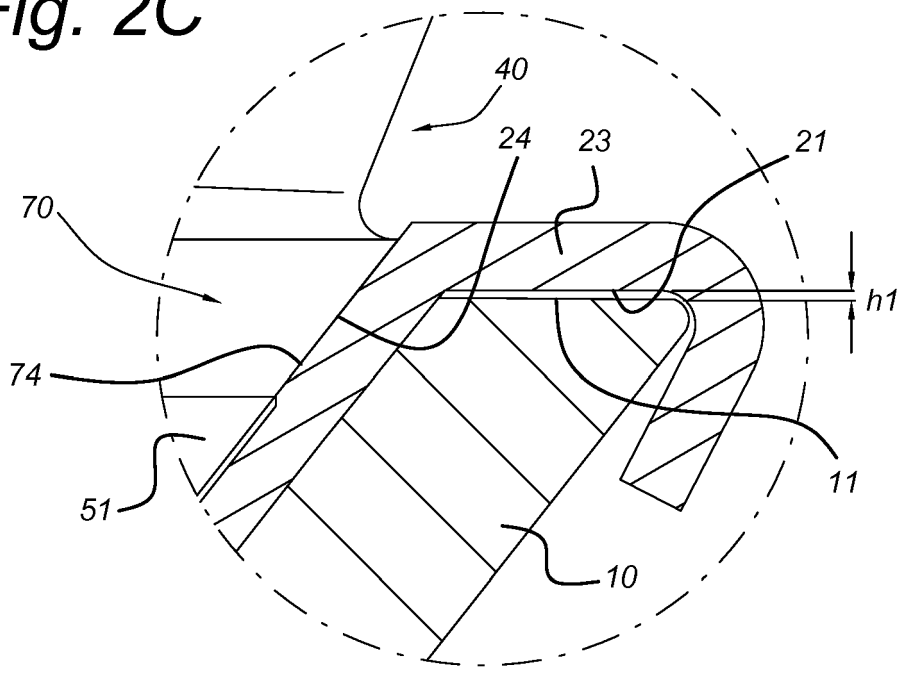


Fig. 2D

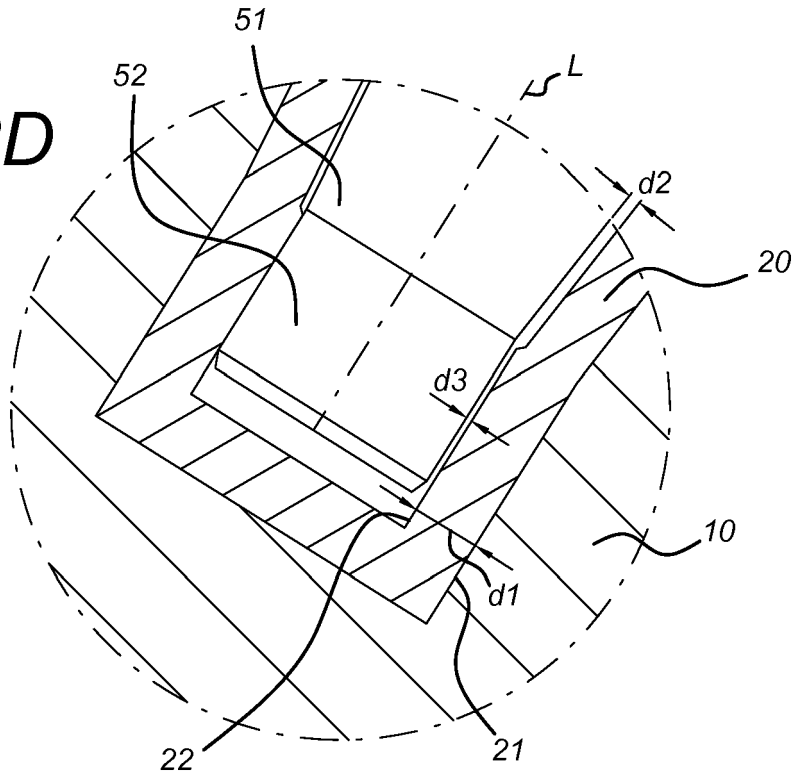
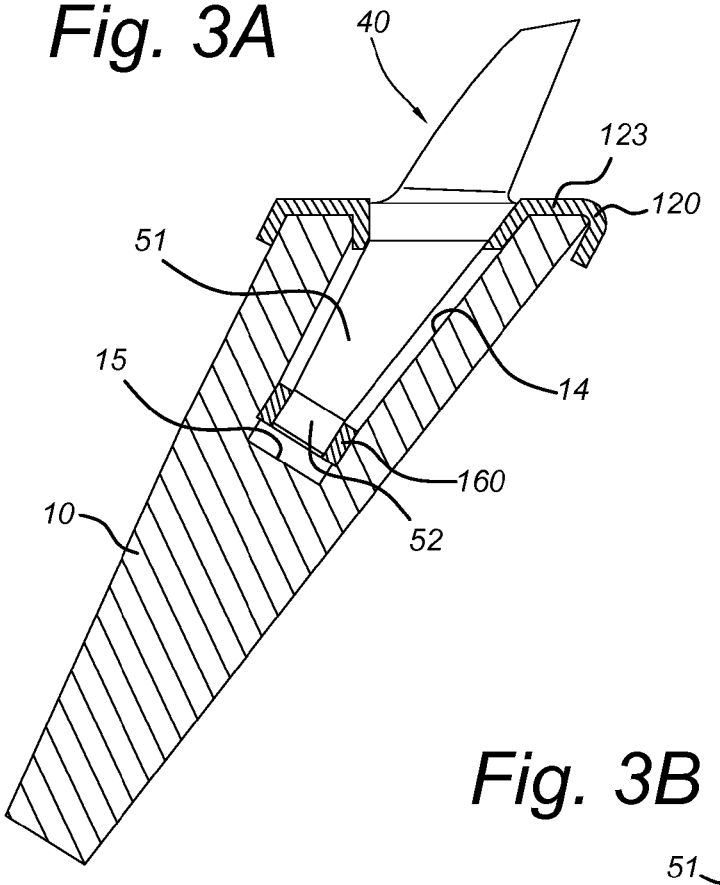


Fig. 3A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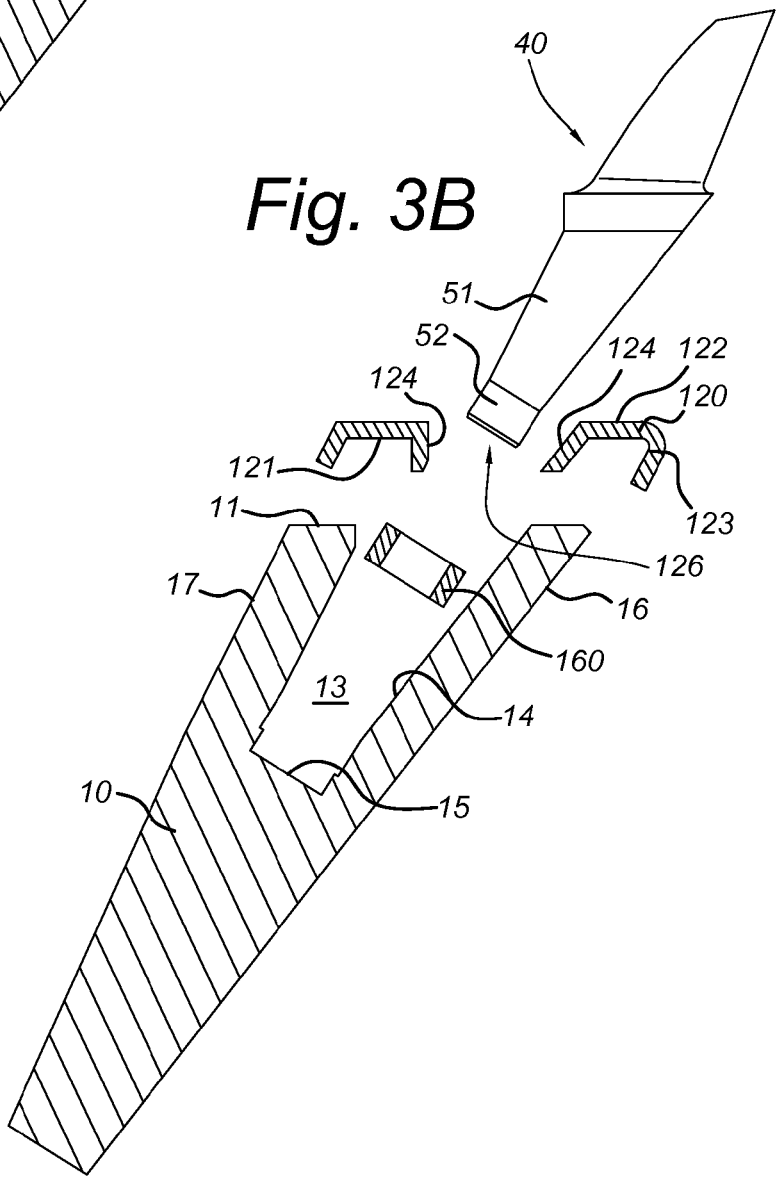
52

Fig. 3B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14
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15

Fig 4

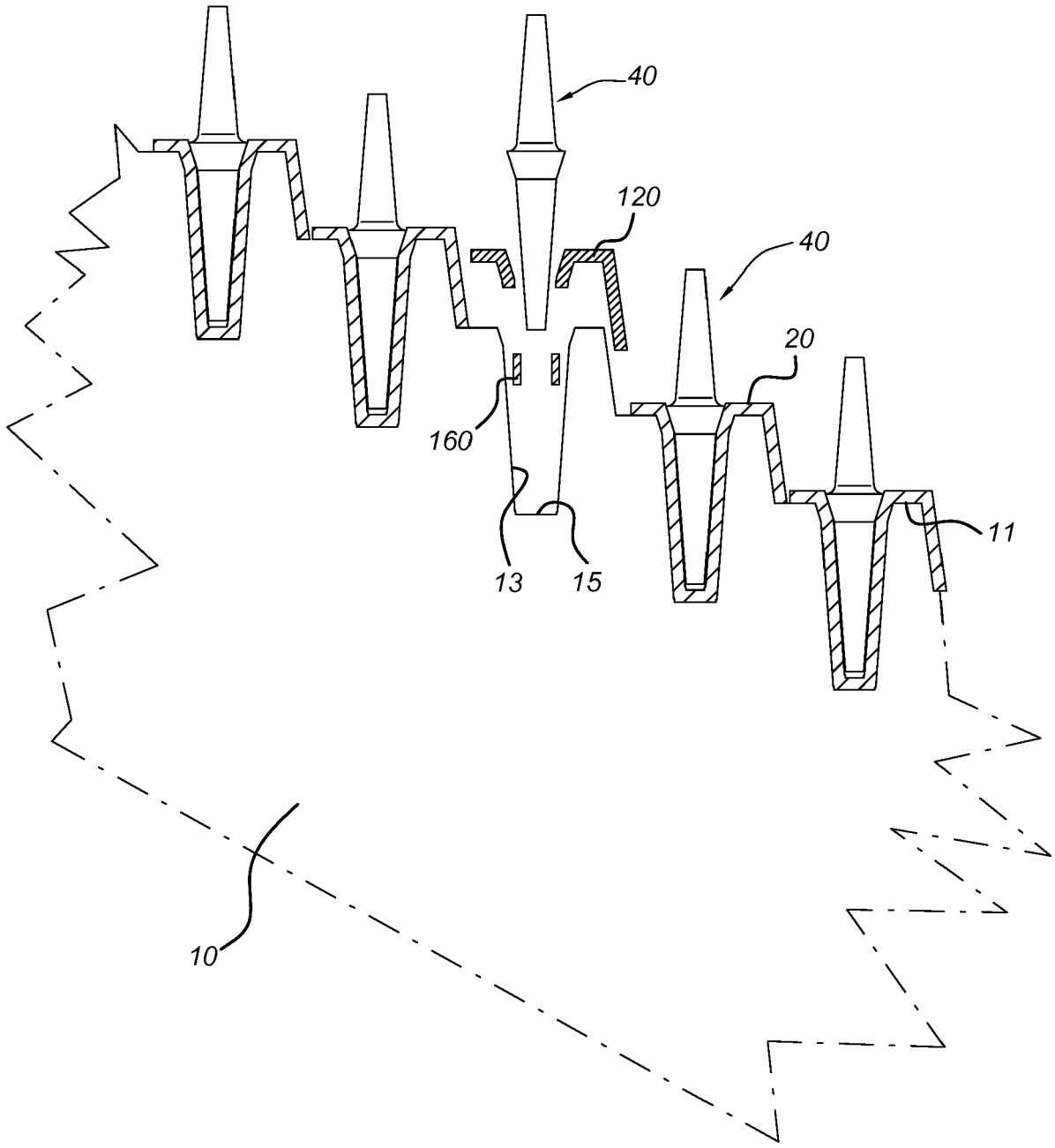


Fig. 5A

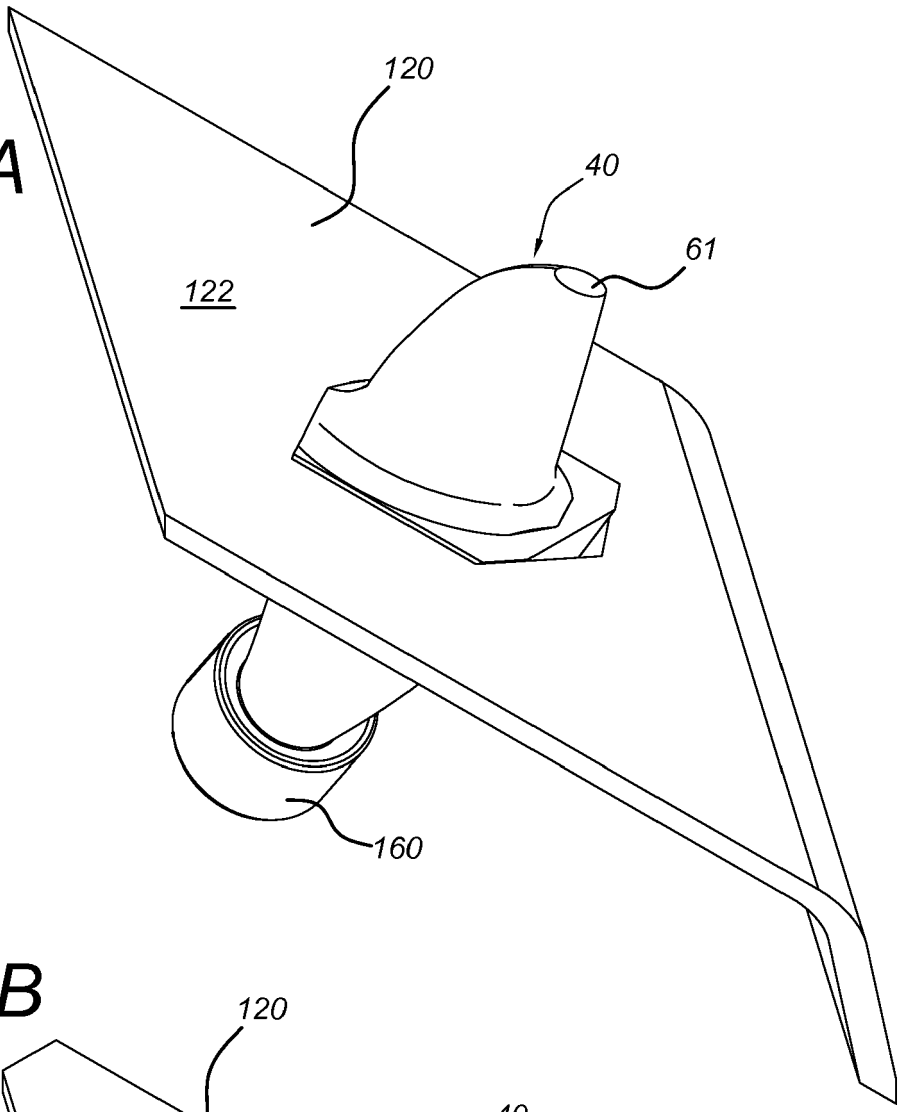


Fig. 5B

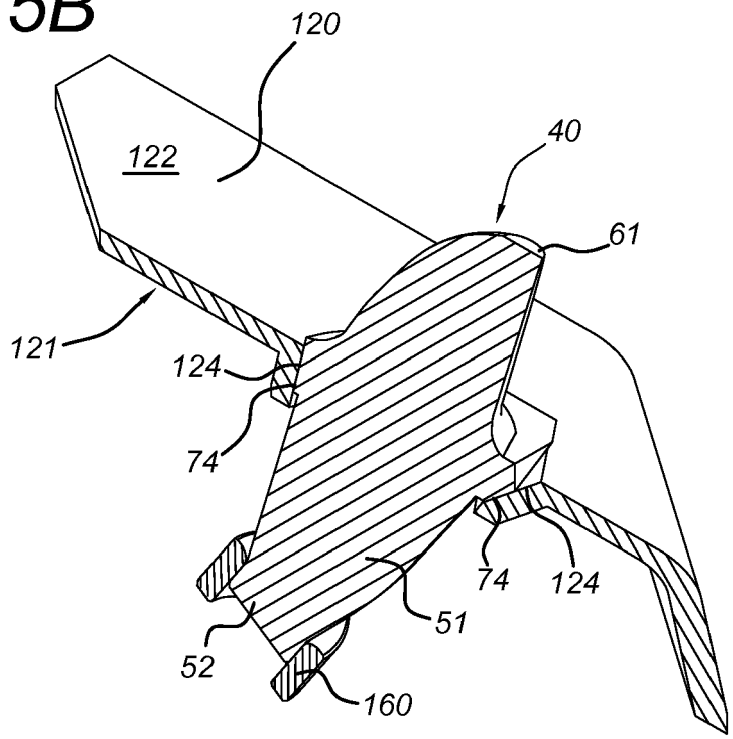


Fig. 6A

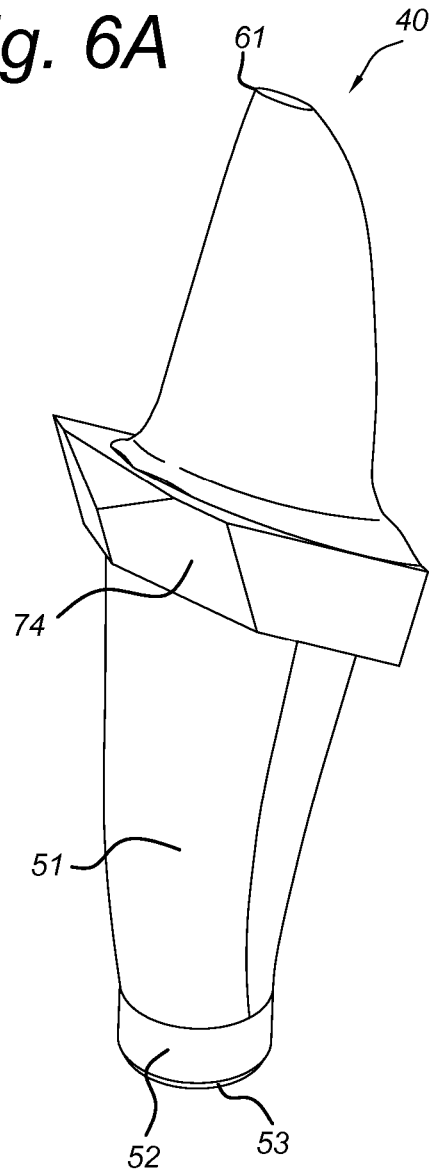


Fig. 6B

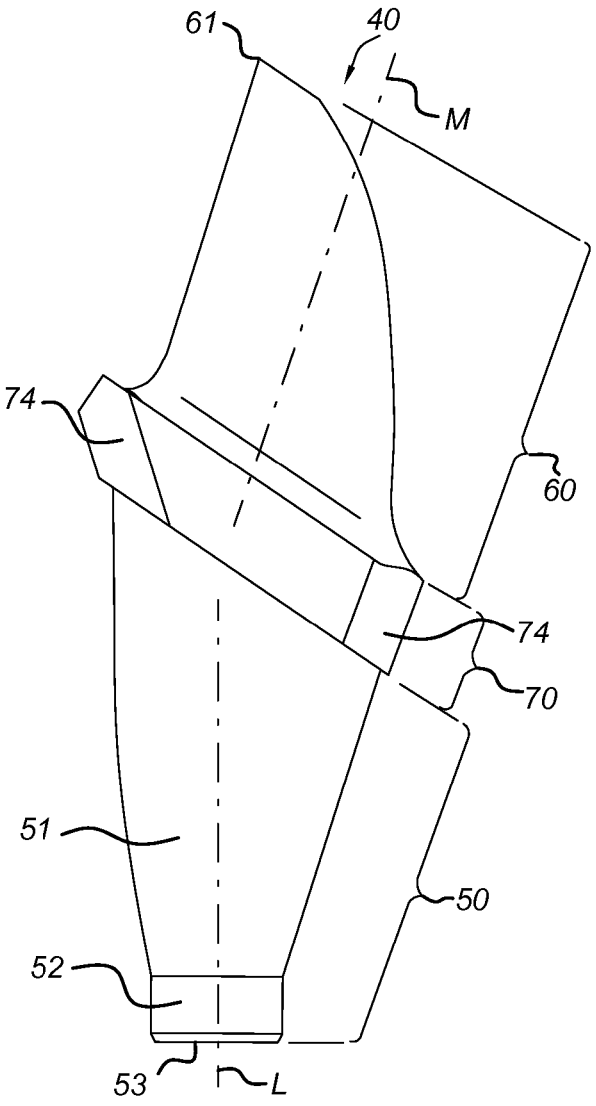
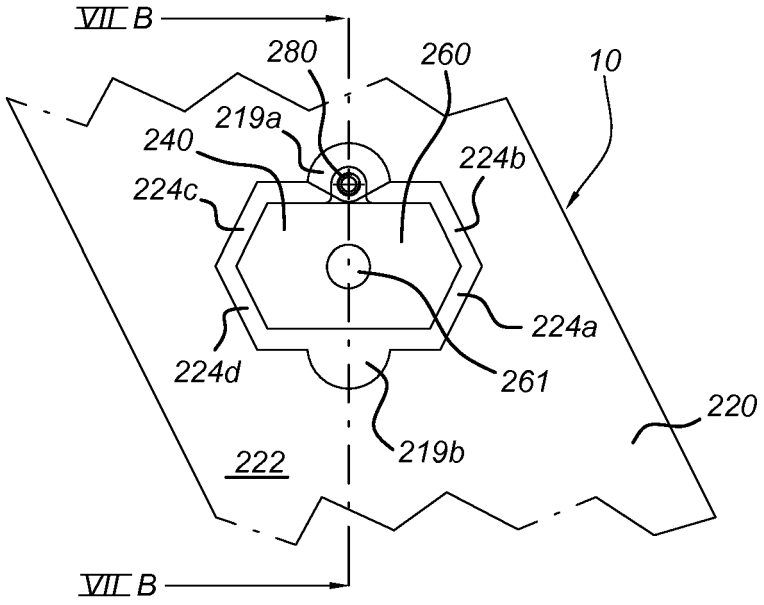


Fig. 7A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219a
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224b
224c
224a
224d
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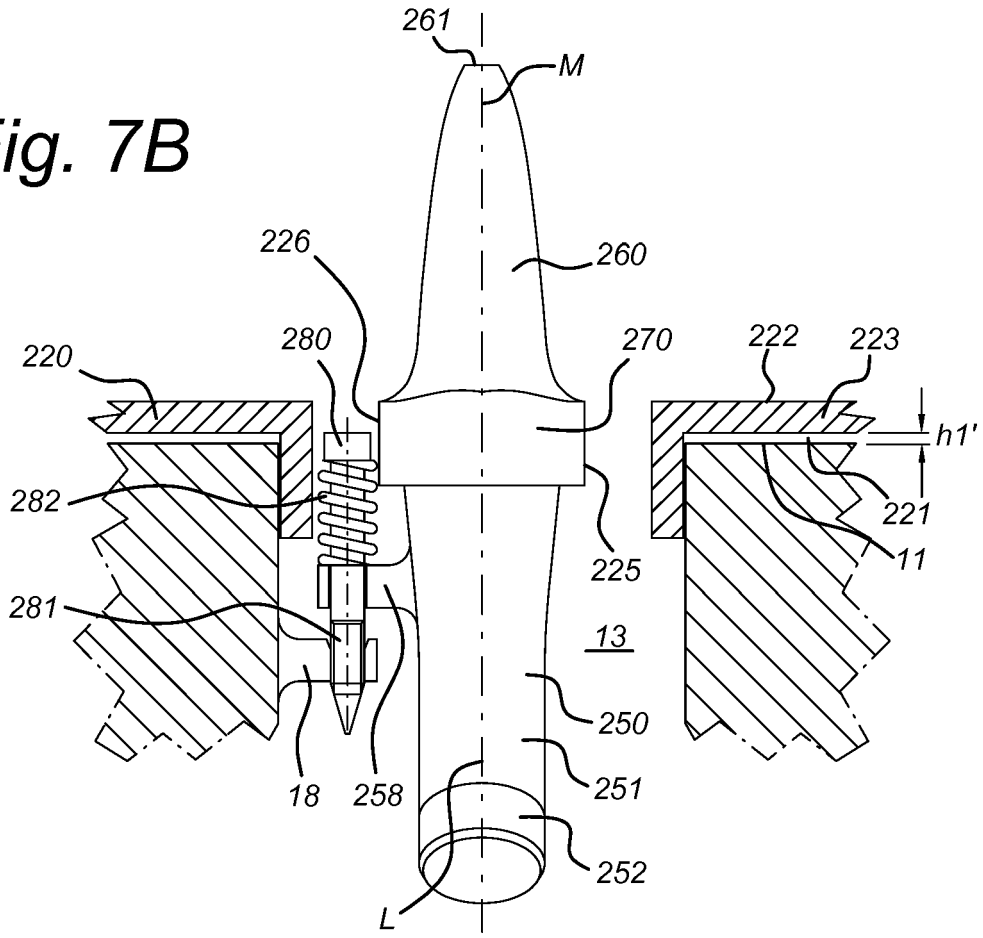
220
219b
222
VII B

Fig. 7B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M
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L

Fig. 7C

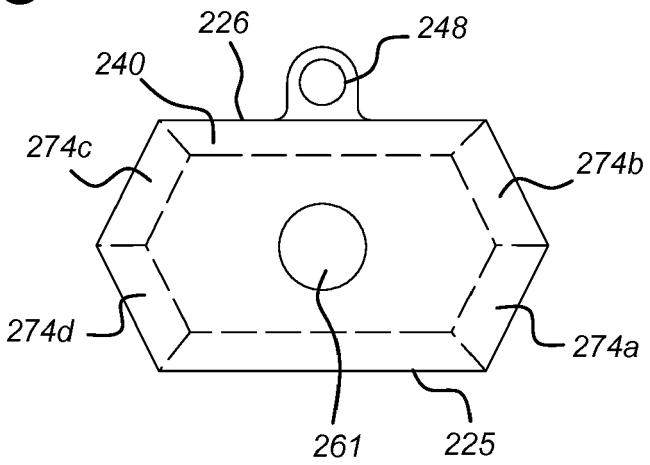
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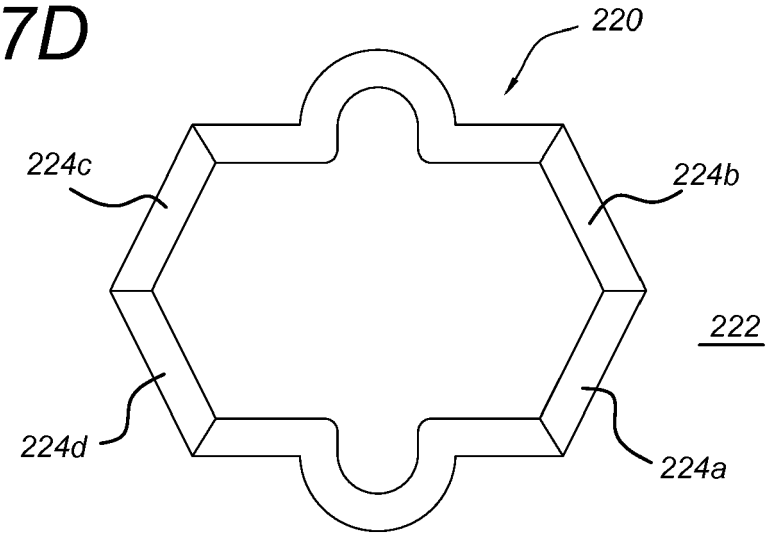
Fig. 7D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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 5061

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X	WO 00/34626 A1 (BOSCH NEILL JONATHAN [ZA]; BOSCH ROBERT HUGH [ZA]; OOSTHUIZEN JOHANNES) 15 June 2000 (2000-06-15) * page 6, line 6 - page 9, line 15; figures 1-16 *	1-16	
X	AU 536 728 B2 (KENNAMETAL INC) 24 May 1984 (1984-05-24) * page 4, line 12 - page 7, line 3; figures 1-10 *	1-16	
X	GB 2 196 669 A (GEWERK EISENHUETTE WESTFALIA) 5 May 1988 (1988-05-05) * the whole document *	1-16	
X	DE 196 11 455 A1 (SASOL MINING PTY LTD [ZA]) 26 September 1996 (1996-09-26) * the whole document *	1-16	TECHNICAL FIELDS SEARCHED (IPC) E02F E21C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 July 2017	Faymann, L

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