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(54) **CONNECTION OF A PROSTHESIS STRUCTURE WITH AN IMPLANT STRUCTURE**

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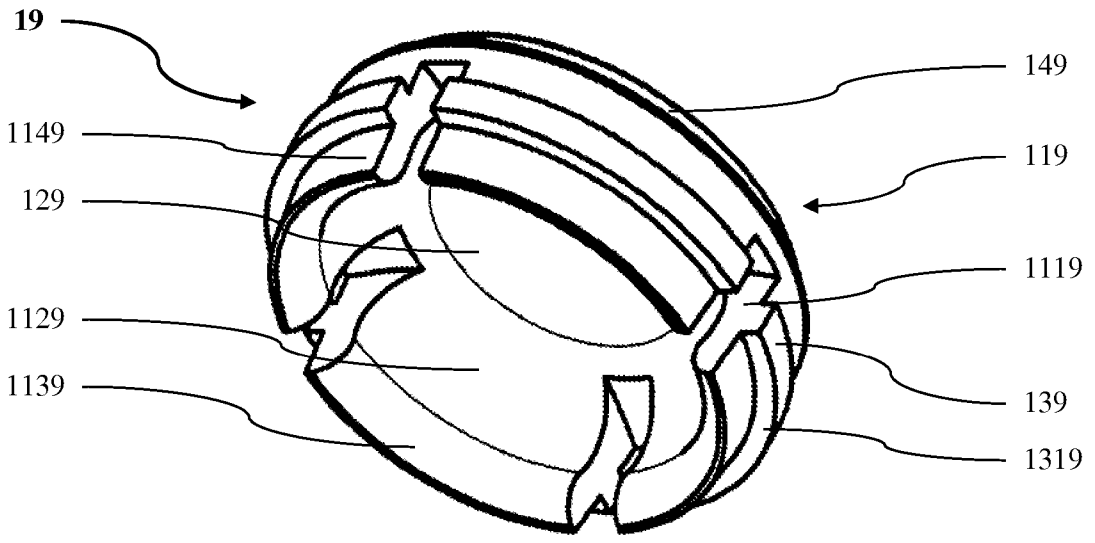
(57) **ABSTRACT**

A connection device for connecting a prosthesis structure with an implant structure comprises a holding shell and a retention insert. The retention insert comprises an end side and a substantially ring-shaped retention rim projecting therefrom. The holding shell comprises an end side and a substantially ring-shaped holding rim projecting therefrom. The holding rim and the end side of the holding shell form a retainer in which the retention insert can be arranged such that an outer surface of the retention rim is adjacent to an inner surface of the holding rim. Moreover, the outer surface of the retention rim is at least partly spaced from and adjacent to the inner surface of the holding rim when the retention insert is arranged in the retainer of the holding shell and when essentially no radial forces are acting on the holding rim and on the retention rim. In that the adjacent outer surface of the retention rim and inner surface of the holding rim are at least partly not contacting each other but are spaced from each other when essentially no radial forces are acting on the holding rim and on the retention rim, it can, i.a., be achieved that the retention insert is connected relatively loosely with the holding shell when the connection device has not yet been placed on the implant structure. This loose connection can allow the retention insert to be relatively easily removed from the holding shell and inserted in the holding shell without having to be substantially deformed or strained in any other way. Thus, it is possible to insert and remove the retention insert gently, which can improve the flexibility and lifetime of the connection device.



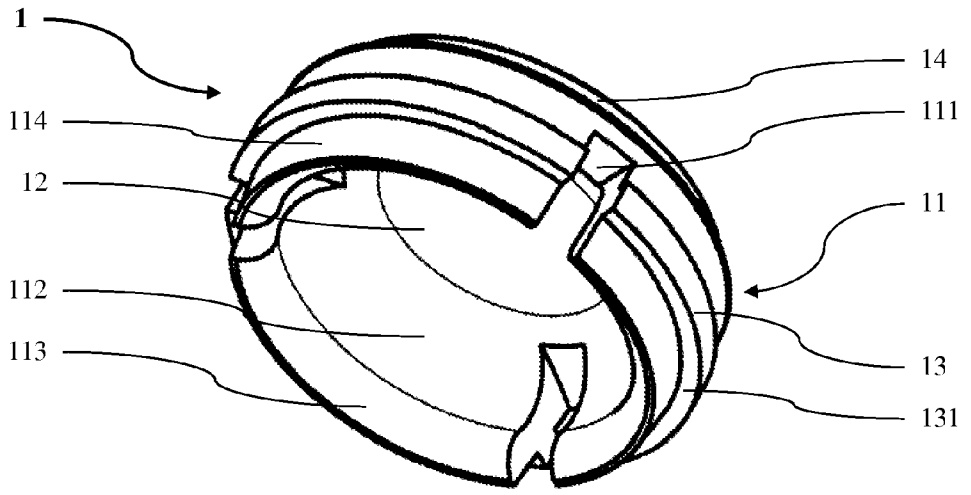


Fig. 1

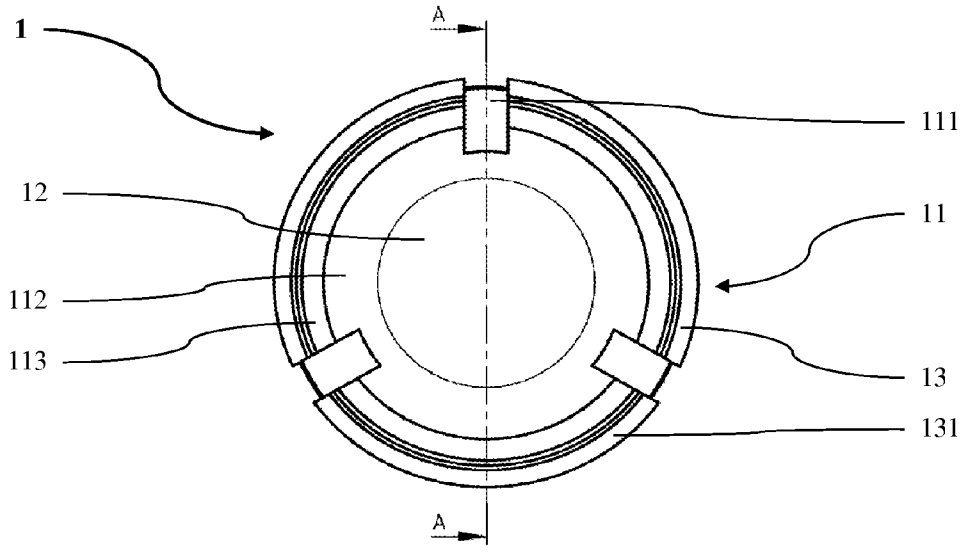


Fig. 2

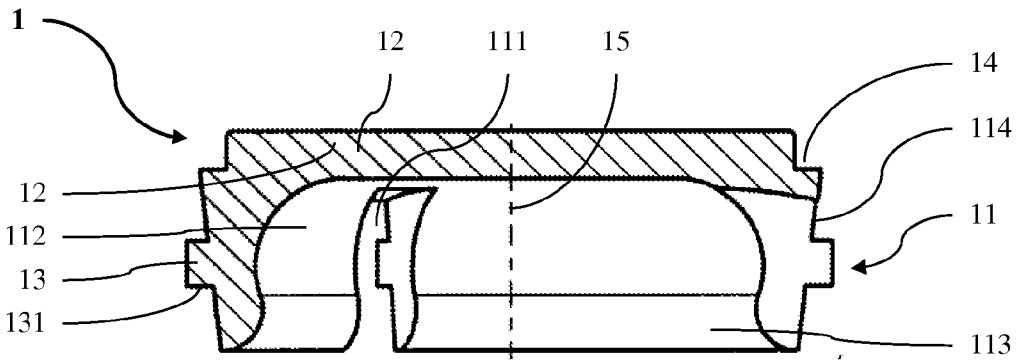


Fig. 3

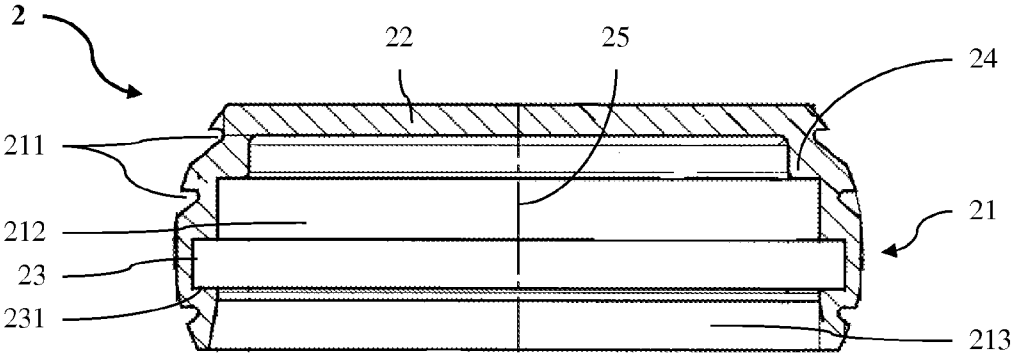


Fig. 4

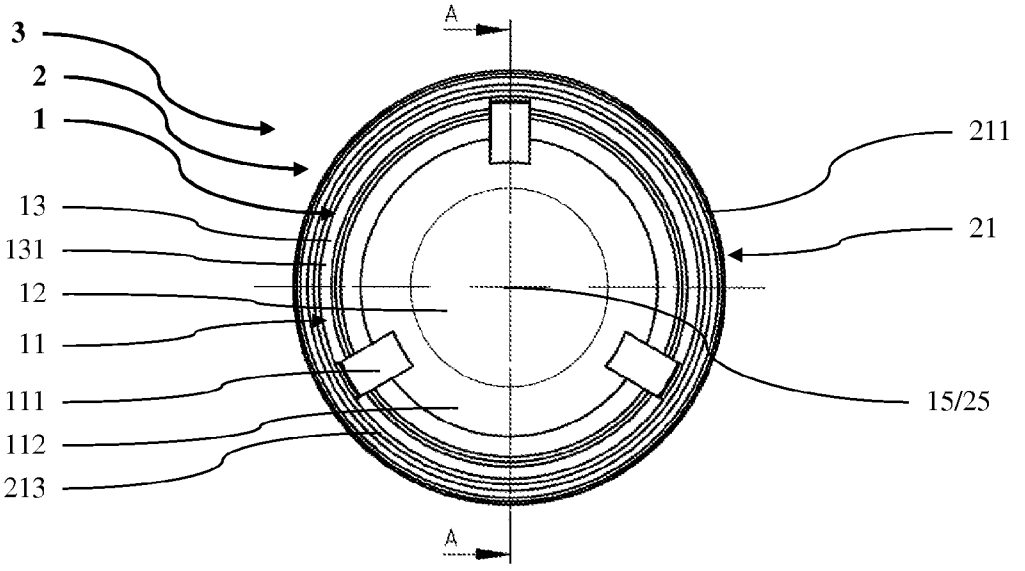


Fig. 5

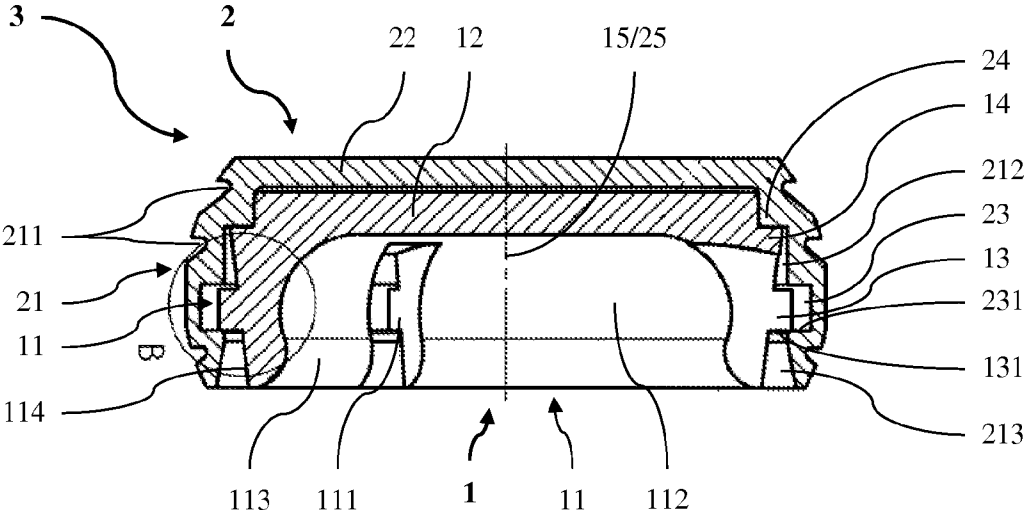

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Fig. 6

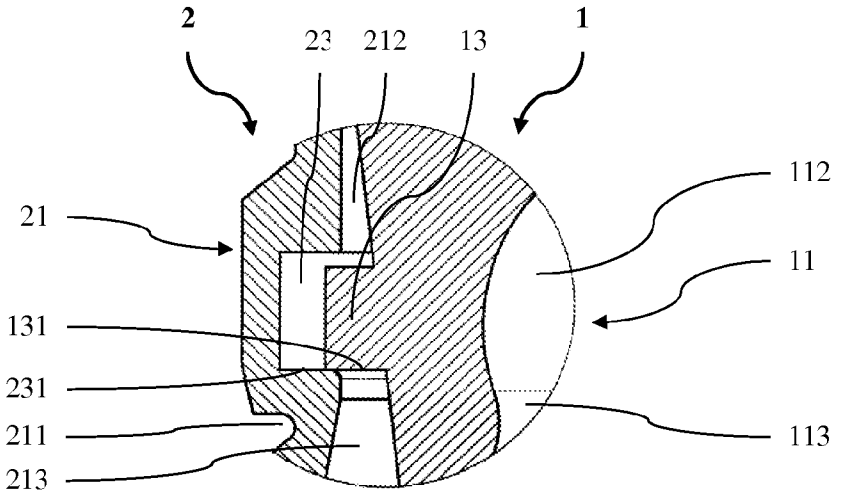
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Fig. 7

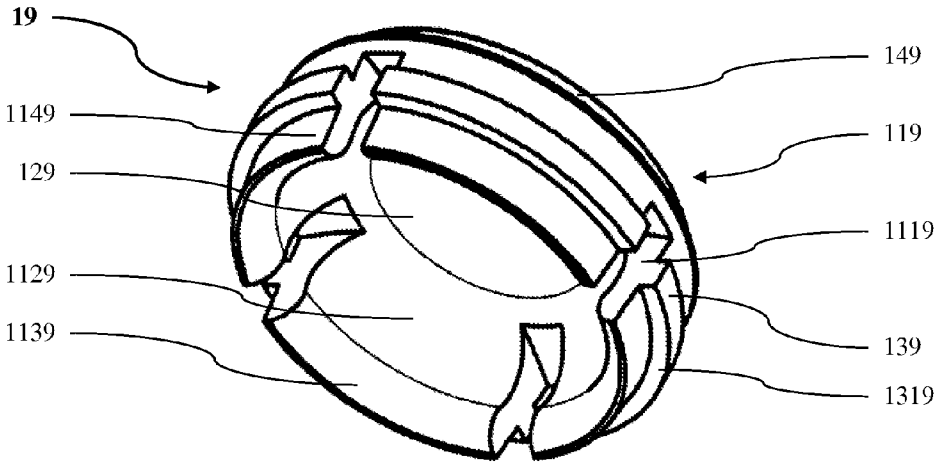

Fig. 8

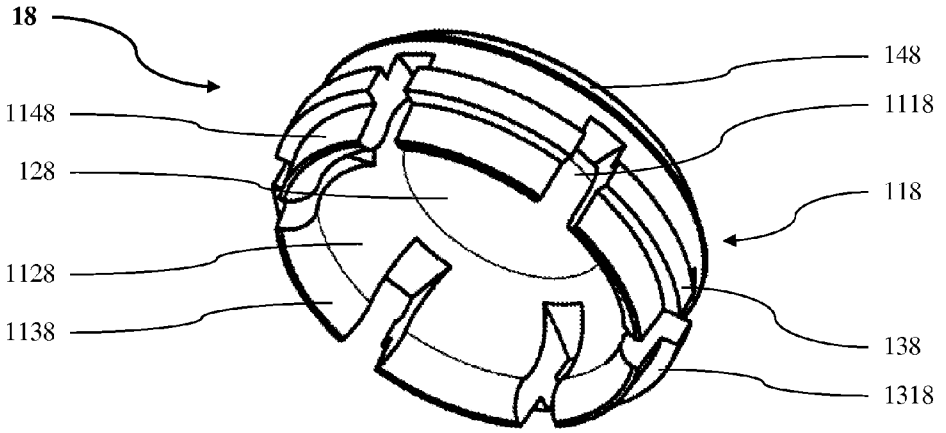

Fig. 9

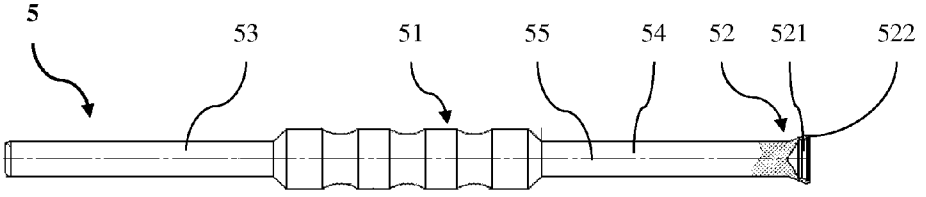

Fig. 10

CONNECTION OF A PROSTHESIS STRUCTURE WITH AN IMPLANT STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from European application EP 10 16 8364.7, filed Jul. 2, 2010, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The invention relates to a connection device as well to a corresponding retention insert, a corresponding method and a corresponding demounting tool. Connection devices of this kind, which comprise a holding shell and a retention insert, wherein the holding shell has an end side and a substantially ring-shaped holding rim projecting therefrom and the retention insert has an end side and a substantially ring-shaped retention rim projecting therefrom, and wherein the holding rim and the end side of the holding shell form a retainer in which the retention insert can be arranged such that an outer surface of the retention rim of the retention insert is located adjacent to an inner surface of the holding rim of the holding shell, can be used for connecting a dental prosthesis structure with a dental implant structure or with a capped tooth.

BACKGROUND OF THE INVENTION

[0003] In dentistry, damaged or diseased teeth are nowadays regularly replaced with artificial dentures. Such dentures can be configured in various ways for a single tooth, a plurality of teeth together or as full dentures. Such a denture often comprises an implant structure and a prosthesis structure. The prosthesis structure can comprise a synthetic prosthesis material as carrier material and one or more tooth crowns attached thereto. The implant structure can be formed as one part or also comprise more parts, wherein two-part structures typically comprise a dental implant and a connector or abutment, respectively. Moreover, the implant structure can also comprise a web which is connected across several dental implants with the jaw bone. The dental implant or the entire implant structure is engrafted as an artificial root of the tooth at a target place in a jaw bone of a patient. To this end, the jaw bone is partially treated in advance in that, for example, bone substance is built (osseosynthesis) or replaced with artificial tissue and/or in that a drill hole is provided at the target place in the jaw bone. Then, the dental implant or the implant structure is generally screwed into the jaw bone, for example via a screw thread, as an enossal dental implant or it is just put into it. Within typically three to six months, the dental implant or the implant structure and the surrounding jaw bone unite to form a tight and strong carrier unit. This process is referred to as osseointegration. Dental implants or implant structures are typically made of titanium or also of ceramic materials. If it is possible, alternatively to dental implants, also capped teeth are connected with prosthesis structures, wherein to this end a cap is attached to the tooth or a remainder of a tooth. In the following, capped teeth are not mentioned separately to simplify matters, but they can also be used as an alternative to the mentioned implant structures.

[0004] Nowadays a plurality of different connection mechanisms are used for mounting the prosthesis structure to the engrafted implant structure. For a comfortable releasable connection, in particular snap-engagement structures are used, wherein the implant structure comprises a female or male part and the prosthesis structure comprises a corresponding male or female part. For example, WO 2010/025034 A1, also published as US Patent application no: 2010/0055645, wherein both publications are incorporated herein by reference in their entirety, describes a snap-engagement system as such a connection mechanism. Thereby, the implant structure is formed, e.g., as one part and comprises a head having a flat end and an adjoining portion being bulged outwardly. Moreover, a holder being open in the direction of the flat end is provided in the center of the head. The prosthesis structure comprises a retention part made of a synthetic material and a cap made of titanium. The retention part is substantially cup-shaped, wherein the inner side of its rim is formed in accordance with the bulged portion of the head of the implant structure. The retention part moreover comprises a central post corresponding to the holder of the head. The cap, in turn, is also substantially cup-shaped, wherein the inner side of its rim is formed in accordance with the outer side of the rim of the retention part. For connecting the prosthesis structure with the implant structure, normally first the retention part is pressed into the cap, wherein the rim of the retention part is deformed inwardly and expands again when the retention part is arranged in the cap. Then, the cap together with the retention part is pressed onto the head of the implant structure, wherein both the rim and the post of the retention part are deformed and expand as much as possible when the prosthesis structure is arranged on the head of the implant structure.

[0005] A problem nowadays often occurring in artificial dentures is the fact that the position of the dental implant or the implant structure depends on various factors, for example the condition of the jaw bone, the progress of a possible osseointegration and in particular also an exact insertion. Accordingly, nowadays it is regularly not possible to place implant structures exactly at a desired target place and in a desired target position and connect them with the prosthesis structure. This problem is of additional relevance in prosthesis structures which, for example, are intended for replacing a plurality of teeth and which are connected with the jaw bone of the patient via a plurality of implant structures that are parallelized as much as possible.

[0006] In order to nevertheless allow a reliable connection of the prosthesis structure with the implant structure, the mentioned connection mechanisms are partly configured so as to allow to a certain extent a compensation for diverging implanted implant structures. For example, the retention parts of the described snap-engagement systems are typically relatively soft and elastic so that it is to a certain extent possible to compensate for axial divergences of implant structures implanted in a disparallel manner. Sometimes also sets of analogous retention parts made of materials having different hardnesses are marketed so that during fitting the prosthesis structure it is possible to select appropriate retention parts depending on the degree of disparallelism of the implant structures. For such a selection and adaptation of the retention parts during fitting of the prosthesis structure, however, it is often necessary to test different hardnesses of retention parts, which can be difficult and laborious. Moreover, when being mounted in and dismounted from the corresponding caps, the retention parts are also squeezed and damaged due to the mentioned deformation, which can lead to a high consumption of retention parts. Moreover, during everyday use of the

prosthesis structure and as a consequence of the mentioned compensation function, the retention bodies are strained so much by deformation as well as a non-uniform mounting and dismounting of the prosthesis structure that they have to be renewed regularly, which can be laborious and expensive. Finally, dirt particles can collect in the hollow spaces formed by the deformation of the retention parts, which is mostly not desired.

[0007] Therefore, there is a need for a connection device for connecting a prosthesis structure with an implant structure or a capped tooth as well as a corresponding retention insert, via which a prosthesis structure can be mounted and dismounted relatively easily and efficiently in the mouth of a patient, which can be adapted relatively easily to the specific conditions, and in which retention inserts can be renewed relatively easily and gently.

SUMMARY OF THE INVENTION

[0008] In certain embodiments, the invention addresses this and other needs via a connection device, a retention insert, a method and a demounting tool. Certain advantageous embodiments of the invention are described hereinbelow.

[0009] The invention can, in one embodiment, be described as follows: A connection device for connecting a prosthesis structure with an implant structure or a capped tooth comprises a holding shell and a retention insert. The retention insert comprises an end side and a substantially ring-shaped retention rim projecting therefrom and the holding shell comprises an end side and a substantially ring-shaped holding rim projecting therefrom. The holding rim and the end side of the holding shell may form a retainer in which the retention insert can be arranged such that an outer surface of the retention rim of the retention insert is located adjacent to an inner surface of the holding rim of the holding shell. The outer surface of the retention rim of the retention insert may be arranged, at least partly, in a manner spaced from and adjacent to the inner surface of the holding rim of the holding shell when the retention insert is arranged in the retainer of the holding shell and when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert. In this connection, the term "radial forces" refers to forces acting radially with respect to the holding rim and/or the retention rim such that the holding rim is pressed in the direction of the retention rim and/or in particular the retention rim is pressed in the direction of the holding rim. Depending on the initial situation, implant structures and capped teeth can be used alternatively with respect to each other. In the following, capped teeth are not mentioned explicitly. However, they are comprised as an alternative when implant structures are mentioned. In particular, in the following the term "implant structure" in this connection also comprises capped teeth.

[0010] The connection device can be provided in particular as a female part of a snap-engagement connection. Connection devices of this kind can have a total width between about 9 mm and about 3 mm or between about 7 mm and about 4 mm or between about 6 mm and about 5 mm and in particular of about 5.5 mm. Moreover, they can have a height between about 1 mm and about 3 mm or between about 1.5 mm and about 2.5 mm and in particular of about 2 mm. The outer surface of the retention rim and the inner surface of the holding rim can have any suitable shape, for example a substantially planar shape or substantially curved shape. The prosthesis structure can in particular be a prosthesis for a plurality of teeth. By using the connection device, the holding shell can be firmly connected with the prosthesis structure, for example it can be cast into a synthetic prosthesis material. For allowing an appropriate connection with the prosthesis structure, the holding shell can also comprise suitable means such as one or more notches on its outer surface. The implant structure can consist of one or more parts, wherein it can comprise, e.g., a screw-shaped implant body and a connector or abutment arranged thereon. The abutment can have a head with a male part of a snap-engagement connection. The holding shell and the retention insert can be substantially cup-shaped and in particular suitable for being connected with a male part of the implant structure. The end sides of the holding shell and the retention insert can be substantially disk-shaped and have an opening or be completely closed. The holding rim can project substantially at a right angle from the circumference of the end side of the holding shell.

[0011] In that the adjacent outer surface of the retention rim and inner surface of the holding rim are at least partly not contacting each other but are spaced from each other when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert, it can, i.a., be achieved that the retention insert is connected relatively loosely with the holding shell when the connection device has not yet been placed on the implant structure. Advantageously, this loose connection is just sufficient for holding the retention insert in the holding shell to thus allow a comfortable handling. This loose connection can allow the retention insert to be relatively easily removed from and inserted in the holding shell without having to be substantially deformed or strained in any other way. Thus, it is possible to insert and remove the retention insert gently, which can improve the flexibility and lifetime of the connection device.

[0012] When the connection device is then connected with the implant structure as intended, for example such that a male head is inserted or snapped in the retention body, radial forces can act from the head on the retention rim of the retention body. These forces can press the retention rim in the direction of the holding rim of the holding shell so that the retention rim is moved in the direction of the holding rim. As a result, it can be moved in a resilient manner in the direction of the holding rim without being considerably squeezed or similarly deformed. Thus, the retention body can be firmly connected with the holding shell when the prosthesis structure is connected via the connection device with the implant structure. At the same time, a spring force can act from the moved retention rim on the head so that the connection device is clamped on the head. Moreover, the retention rim of the retention body can return resiliently into its original position after the prosthesis structure has been removed from the implant structure so that the retention body is relatively little strained and can have a relatively long lifetime. Finally, the retention rim can also be moved in a non-uniform manner along the circumference in the direction of the holding rim so that an inaccurate position of the implant structure and in particular disparallelism can be compensated for without the retention body being substantially squeezed or similarly deformed.

[0013] Preferably, in the connection device the outer surface of the retention rim of the retention insert is at least partly arranged so as to be spaced from and adjacent to the inner surface of the holding rim of the holding shell in that the outer surface of the retention rim of the retention insert is more strongly inclined in the direction of a central axis of the

connection device than the inner surface of the holding rim of the holding shell. In this connection, the "central axis" corresponds to the central axis or longitudinal axis or rotational axis of the holding shell or retention insert which extends substantially perpendicular with respect to the respective end side, wherein it extends in particular perpendicularly through the center of the respective end side in case this end side is, e.g., substantially disk-shaped. In this connection, the term "inclined in the direction of the central axis of the connection device" relates to an inclination of the outer surface of the retention rim or the inner surface of the holding rim relative to the corresponding end side. This inclination can correlate with an angle between the outer surface of the retention rim or the inner surface of the holding rim and the corresponding end side, wherein in this case the angle between the outer surface of the retention rim and the corresponding end side is, in accordance with the invention, smaller than the angle between the inner surface of the holding rim and the corresponding end side. The mentioned stronger inclination of the outer surface of the retention rim as compared to the inclination of the inner surface of the holding rim can lead to a space being formed between the outer surface of the retention rim and the inner surface of the holding rim, wherein said space can increase in size starting from the corresponding end side. In accordance with the invention, the adjacent outer surface of the retention rim and inner surface of the holding rim thus at least partly do not contact each other but are spaced from each other when the retention insert is arranged in the retainer of the holding shell and when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert.

[0014] The retention rim of the retention insert of the connection device advantageously comprises recesses which start on an end of the retention rim facing away from the end side of the retention insert and extend in the direction of the end side of the retention insert. The retention rim can also have lamellae and recesses alternating in the circumferential direction. Such recesses can serve for determining the deformability or resiliency and thus the degree of hardness of the retention insert for a given material. In particular, analogous retention inserts can be provided with a different number of recesses, wherein the hardness of the retention inserts increases as the number of recesses decreases. The different degrees of hardness of retention inserts of the same kind can be indicated easily by differently colored retention inserts.

[0015] Preferably, the recesses in the retention rim of the retention insert of the connection device extend over at least about 50% of the width of the retention rim of the retention insert, preferably over at least about 70% of the width of the retention rim of the retention inert and in particular over at least about 80% of the width of the retention rim of the retention insert. Such recesses can allow an appropriate elastic movability of the lamellae arranged between the retainers. The retention rim of the retention insert preferably comprises three, four, five, six or more recesses. Such a number of recesses allows a regular arrangement in the circumferential direction and entails that the retention insert can be manufactured relatively easily.

[0016] Advantageously, the retention rim of the retention insert of the connection device comprises a projection projecting radially from the outer surface of the retention rim of the retention insert and the holding rim of the holding shell comprises a corresponding groove extending radially from the inner surface of the holding rim of the holding shell. The projection and the groove can extend in particular along substantially the entire circumference of the retention rim or the holding rim. Via such a projection and such a corresponding groove it can be achieved relatively easily that the retention insert is firmly connected with the holding shell when the retention insert is arranged in the retainer of the holding shell and a radial force is acting on the holding rim of the holding shell and/or on the retention rim of the retention insert.

[0017] As a result, the projection of the retention rim of the retention insert is preferably arrangeable in the groove of the holding rim of the holding shell in such a manner that the retention insert is releasably held in the holding shell when the retention insert is arranged in the retainer of the holding shell and when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert. In particular, the projection can thus be arranged only partly in the groove when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert so that the retention insert is held firmly enough in the holding shell for being held therein but is nevertheless held loosely enough in the holding shell for being easily removable from the holding shell.

[0018] Preferably, the projection of the retention rim of the retention insert comprises a substantially planar projection supporting surface and the groove of the holding rim of the holding shell comprises a substantially planar groove supporting surface, wherein a part of the projection supporting surface contacts a part of the groove supporting surface when the retention insert is arranged in the retainer of the holding shell and when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert, and wherein the groove supporting surface is rounded towards its end facing the retention insert and/or the projection supporting surface is rounded towards its end facing the holding shell. In particular, the groove supporting surface can be rounded away from the projection supporting surface and the projection supporting surface can be rounded away from the groove supporting surface. The projection supporting surface of the projection of the retention insert can in particular be configured so as to face substantially away from the end side of the retention insert and the groove supporting surface of the groove of the holding shell can be configured so as to face substantially towards the end side of the holding shell. By means of such a rounded groove supporting surface and/or projection supporting surface, an appropriate supporting but nevertheless easily releasable connection between retention insert and holding shell can be realized.

[0019] Advantageously, the projection of the retention rim of the retention insert can be arranged in the groove of the holding rim of the holding shell such that the retention insert is permanently connected with the holding shell when the retention insert is arranged in the retainer of the holding shell and when a radial force is acting on the retention rim of the retention insert in the direction of the holding rim of the holding shell and/or on the holding rim of the holding shell in the direction of the retention rim of the retention insert. For example, when a force is acting on the holding rim in the direction of the retention rim and/or in particular a force is acting on the retention rim in the direction of the holding rim, the holding rim and the retention rim can be moved relative to each other such that the projection is further or completely arranged in the groove and the retention insert is thus permanently or firmly connected with the holding shell. The radial

force can be applied to the retention rim or maintained by a male part of the head of the implant structure.

[0020] The retention rim of the retention insert of the connection device preferably comprises an inner surface opposite to the outer surface, wherein the inner surface is rounded towards the end facing away from the end side of the retention insert. By means of such a rounded shape of the retention rim it is possible that, on the one hand, the connection device is centered when being placed on the male part of the snap-engagement connection or the head of the implant structure and, on the other hand, during this placement a force is continuously applied to the retention rim in the direction of the holding rim. This force is maintained even after the placement is completed so that the retention rim is pressed and moved in the direction of the holding rim and thus a permanent or firm connection between retention insert and holding shell is possible.

[0021] Preferably, the retention insert and/or the holding shell is/are made of a biocompatible polymeric material, in particular a polyetheretherketone. Other possible biocompatible materials are polyamides such as polyhexamethylene adipic acid amide. Connection devices of this kind can be manufactured easily. Moreover, it is possible to manufacture in particular also the holding shells of a light-colored, preferably gingiva-colored material so that the connection device is preferably not readily visible in the mouth of a patient. Moreover, such connection devices can also be used in holistic medicine in which there are specific requirements as to the materials to be used and in particular the use of titanium is not admitted. Alternatively, however, the holding shell can also be made of titanium.

[0022] A further aspect of the invention relates to a retention insert of a connection device for connecting a prosthesis structure with an implant structure as described above.

[0023] Preferably, the retention insert comprises an end side and a substantially ring-shaped retention rim projecting therefrom and is adapted to be arranged in a retainer in the holding shell formed by a holding rim and an end side of the holding shell such that an outer surface of the retention rim of the retention insert is adjacent to an inner surface of the holding rim of the holding shell. The retention insert may be configured such that the outer surface of the retention rim of the retention insert is at least partly spaced from and adjacent to the inner surface of the holding rim of the holding shell when the retention insert is arranged in the retainer of the holding shell and when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert. Advantageously, the retention insert is configured such that the outer surface of the retention rim of the retention insert is at least partly spaced from and adjacent to the inner surface of the holding rim of the holding shell in that the outer surface of the retention rim of the retention insert is more strongly inclined in the direction of a central axis of the connection device than the inner surface of the holding rim of the holding shell.

[0024] The retention rim preferably comprises recesses starting on an end facing away from the end side and extending in the direction of the end side. The recesses in the retention rim thus advantageously extend over at least about 50% of the width of the retention rim, preferably over at least about 70% of the width of the retention rim and in particular over at least about 80% of the width of the retention rim. The retention rim preferably comprises three, four or six recesses.

[0025] The retention rim advantageously comprises a projection projecting radially from the outer surface of the retention rim, wherein the projection is configured so as to correspond to a groove extending from the inner surface of the holding rim of the holding shell. The projection of the retention rim can preferably be arranged such in the groove of the holding rim of the holding shell that the retention insert is releasably held in the holding shell when the retention insert is arranged in the retainer of the holding shell and when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert. The projection of the retention rim of the retention insert preferably comprises a substantially planar projection supporting surface, wherein a part of the projection supporting surface contacts a part of a substantially planar groove supporting surface of the groove of the holding rim of the holding shell when the retention insert is arranged in the retainer of the holding shell and when essentially no radial forces are acting on the holding rim of the holding shell and on the retention rim of the retention insert, and wherein the projection supporting surface is rounded towards its end facing the holding shell. The projection of the retention rim is advantageously configured such that it can be arranged in the groove of the holding rim of the holding shell in such a manner that the retention insert is permanently connected with the holding shell when the retention insert is arranged in the retainer of the holding shell and when a radial force is acting on the retention rim of the retention insert in the direction of the holding rim of the holding shell and/or on the holding rim of the holding shell in the direction of the retention rim of the retention insert.

[0026] The retention rim preferably comprises an inner surface opposite to the outer surface, wherein the inner surface is rounded towards the end facing away from the end side of the retention insert. Preferably, the retention insert is made of a biocompatible polymeric material, in particular of a polyetheretherketone.

[0027] Another aspect of the invention relates to a method for connecting a prosthesis structure with an implant structure via a connection device as described above, wherein the holding shell of the connection device is firmly mounted to the prosthesis structure and wherein the implant structure comprises a head being configured for a snap-engagement connection. As discussed above with respect to the connection device, the term "implant structure" in this respect also comprises capped teeth. The method comprises: inserting the retention insert of the connection device axially into the holding shell of the connection device until the retention insert is arranged in the holding shell; arranging the prosthesis structure at the implant structure so that the head of the implant structure contacts the retention insert of the connection device; and pressing the prosthesis structure on the implant structure so that the retention insert is pressed axially on the head of the implant structure, wherein a radial force is acting on the retention rim of the retention insert so that the retention rim is moved at least partly in the direction of the holding rim of the holding shell. By means of such a method, the prosthesis structure can be relatively easily, comfortably and reliably placed or snapped on the implant structure in a releasable manner. At the same time, the retention inserts are relatively little strained and can be replaced relatively easily.

[0028] A further different aspect of the invention relates to a demounting tool for demounting a retention insert from a holding shell of a connection device as described above. The

demounting tool comprises a sleeve-shaped head which can be arranged between an outer surface of a retention rim of the retention insert and an inner surface of a holding rim of the holding shell when the retention insert is arranged in a retainer of the holding shell. An inner side of the head is conical so that the retention rim of the retention insert is moved in the direction of a central axis of the connection device when the head of the demounting tool is arranged between the outer surface of the retention rim of the retention insert and the inner surface of the holding rim of the holding shell. By means of such a demounting tool, the retention rim can be moved inwardly or in the direction of the central axis in such a resilient manner that the retention insert is no longer held in the holding shell and thus can be removed from the retention shell without difficulty. In particular, a projection of the retention insert can be moved essentially completely out of a groove of the holding shell so that the retention insert is no longer connected with the holding shell. Preferably, a distal end of the head of the demounting tool has a tapered shape. Such a tapered shape of the head allows the head to be centered and inserted easily between the retention rim and the holding rim.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] In the following, the connection device according to the invention, the retention insert according to the invention, the demounting tool according to the invention and the method according to the invention are described in more detail with reference to the attached drawings and on the basis of embodiments, wherein

[0030] FIG. **1** shows a perspective view of a first embodiment of a retention insert according to the invention of a first embodiment of a connection device according to the invention;

[0031] FIG. **2** shows a bottom view of the retention insert of FIG. **1**;

[0032] FIG. **3** shows a cross-sectional view along the line A-A of the retention insert of FIG. **2**;

[0033] FIG. **4** shows a cross-sectional view of an embodiment of a holding shell of the first embodiment of a connection device;

[0034] FIG. **5** shows a bottom view of the first embodiment of a connection device, wherein the retention insert of FIG. **1** is arranged as intended in the holding shell of FIG. **4**;

[0035] FIG. **6** shows a cross-sectional view along the line A-A of the connection device of FIG. **5**;

[0036] FIG. **7** shows a cross-sectional view of the detail B of the connection device of FIG. **6**;

[0037] FIG. **8** shows a perspective view of a second embodiment of a retention insert according to the invention of a second embodiment of a connection device according to the invention;

[0038] FIG. **9** shows a perspective view of a third embodiment of a retention insert according to the invention of a third embodiment of a connection device according to the invention; and

[0039] FIG. **10** shows a partial sectional side view of an embodiment of a demounting tool according to the invention.

VARIOUS AND PREFERRED EMBODIMENTS OF THE INVENTION

[0040] In the following description, specific expressions are used for practical reasons and are not to be understood as being restrictive. The terms "right", "left", "bottom" and "top" refer to directions in the drawing to which reference is made. The terms "inwardly" and "outwardly" refer to directions towards or away from the geometrical center of the connection device and named parts thereof. The terminology comprises the terms explicitly mentioned above, derivations thereof and terms having a similar meaning.

[0041] FIG. **1** shows a first embodiment of a retention insert **1** according to the invention. The substantially cup-shaped retention insert **1** comprises a substantially disk-shaped closed end side **12** and a substantially ring-shaped retention rim **11** projecting at the circumference thereof at an angle. The retention rim **11** comprises an outer surface **114**, three recesses **111** uniformly spaced from each other in the circumferential direction, and lamella portions **112** arranged therebetween. The recesses **111** start from an end of the retention rim **11** facing away from the end side **12** and extend in the direction of the end side **12** over more than 80% of the retention rim **11**. The lamella portions **112** comprise an inner surface describing an inner surface of the retention rim **11** opposite to the outer surface **114**. The inner surfaces of the lamella portions **112** are rounded outwardly towards the open end of the retention insert **1**, i.e. towards the end of the retention insert **1** facing away from the end side **12**, and thus comprise a correspondingly curved portion **113**.

[0042] A step **14** extending along the entire circumference is formed at the peripheral upper rim of the end side **12**. Approximately in the center of the retention rim **11** there is provided a bar-shaped projection **13** projecting radially from the outer surface **114** of the retention rim **11** and extending along the entire circumference of the lamella portions **112** of the retention rim **11**. The projection **13** comprises a planar radial outer side, a planar upper side being at a right angle thereto and facing the end side **12**, and a planar bottom side being at a right angle thereto, facing away from the end side **12** and describing a projection supporting surface **131**. The retention insert **1** is completely made of polyetheretherketone, wherein alternatively also a different biocompatible polymeric or non-polymeric material can be used.

[0043] For the entire further description, the following is true: If a Figure comprises reference signs for the sake of clarity of the drawing and if these reference signs are not mentioned in the directly corresponding text of the description, reference is made to the explanation thereof in previous descriptions of the Figures. Moreover, if reference signs are mentioned in the text of the description directly relating to a Figure and if these reference signs are not contained in the corresponding Figure, reference is made to the previous Figures.

[0044] FIG. **2** shows the retention insert **1** from a bottom or from an open side. It is evident therein that the projection **13** projects from the rest of the retention inset **1** radially outwardly so that in the view of FIG. **2** the projection supporting surface **131** of the projection is completely visible. It is also evident that the three recesses **111** are uniformly distributed across the circumference at an angle of about 120° relative to one another. Furthermore, in combination with FIG. **1** it is evident that the lamella portions **112** of the retention rim **11** start from the substantially disk-shaped end side **12**. Its inner surfaces each have an upper portion which is curved inwardly with a positive radius of curvature and which transitions into the portion **113** which is curved outwardly with a negative radius of curvature.

[0045] FIG. **3** shows a cross-sectional view of the retention insert **1**. The step **14** comprises two surfaces being arranged at a right angle relative to one another, wherein one of these surfaces is directed outwardly and the other one towards the top. The outer surface **114** of the retention rim **11** is angled relative to the end side **12** such that it is inclined inwardly in the direction of a central axis **15** of the retention insert **1**. The outer surface **114** and the end side **12** enclose an acute angle between 82° and 85°, or between 83° and 84°, preferably of about 83.3°.

[0046] FIG. **4** shows an embodiment of a substantially cup-shaped holding shell **2** comprising a substantially disk-shaped closed end side **22** and a substantially ring-shaped holding rim **21** projecting therefrom in an angled manner at the circumference. The holding rim **21** comprises an inner surface **212** and three notches **211** formed at an outer side that is bulged outwardly, said notches being arranged at different heights and extending along the entire circumference of the holding rim **21**. The inner surface **212** of the holding rim **21** is at a right angle with respect to the end side **22**, wherein it transitions towards the bottom open end of the holding shell **2** into an outwardly inclined portion **213**. At the transition between end side **22** and holding rim **21** there is provided a step **24** having a planar inner side facing a central axis **25** and a planar bottom side being at a right angle thereto and facing the bottom open end of the holding shell **2**. From the inner surface **212** of the holding rim **21**, a groove **23** is formed in the holding rim **21**, said groove comprising an inner surface, a bottom surface being at a right angle thereto and facing away from the end side **22**, and a groove supporting surface **231** also being at a right angle thereto and facing the end side **22**. The holding shell **2** is completely made of polyether ether ketone, wherein alternatively also a different biocompatible polymeric or non-polymeric material can be used, for example titanium.

[0047] FIG. **5** and FIG. **6** show an embodiment of a connection device **3** according to the invention, which comprises the retention insert **1** and the holding shell **2**. The retention insert **1** is inserted, starting with its end side **12**, through the open side of the holding shell **2** so far into the holding shell **2** until the step **14** of the retention insert **1** contacts the step **24** of the holding shell **2**. During this insertion, the inclined portion **213** of the inner surface **212** of the holding rim **21** serves for centering and guiding the retention insert **1** relative to the holding shell **2**. The central axis **15** of the retention insert **1** and the central axis **25** of the holding shell **2** lie at the same place and together form a central axis of the connection device **3**.

[0048] By forming the inner surface **212** of the holding rim **21** of the holding shell **2** in a manner inclined at a right angle relative to the end side **22** of the holding shell **2** and the outer surface **112** of the retention rim **11** of the retention insert **1** in a manner inclined at an acute angle in the direction of the central axis **15**, **25**, a space which increases towards the bottom or in the direction of the open side of the connection device **1** is formed between the inner surface **212** of the holding rim **21** and the outer surface **112** of the retention rim **11**. This space allows the projection **13** of the retention insert **1** to lie only partly in the groove **23** of the holding shell **2**. Thus, the retention insert **1** is held releasably in the holding shell **2** and the connection device **1** forms a unit.

[0049] FIG. **7** shows a detail of the connection device **3**, in which in particular the arrangement of the groove **23** in the holding shell **2** and the projection **13** of the retention insert are shown in detail in a state in which essentially no radial forces are acting on the holding rim **21** of the holding shell **2** and on the retention rim **11** of the retention insert **1**. The groove supporting surface **231** of the groove **23** is curved downwardly in the direction of the central axis **15**, **25**. This curvature allows the projection **13** to be removable from the groove **23** smoothly and with relatively little force required. Thus, the retention insert **1** can be removed comfortably and easily from the holding shell **2**. FIG. **7** moreover shows that the groove **23** is higher than the projection **13**. Due to this shape, an outwardly swiveling movement of the retention rim **11** is not impaired by the groove **23** because during such a swiveling movement the projection **13** is not only moved outwardly but also slightly upwardly.

[0050] By applying the connection device **3**, the holding shell **2** is mounted firmly to a prosthesis structure. To this end, it can, e.g., be cast in a synthetic prosthesis material, wherein the notches **211** of the holding rim **21** contribute to a reliable firm connection between holding shell **2** and prosthesis structure. Furthermore, an implant structure having a head that is designed for a snap-engagement connection is engrafted in a jaw bone as intended. Before connecting the prosthesis structure with the implant structure, the retention insert **1** is moved axially into the holding shell **2** until the retention insert **1** is arranged or held in the holding shell **2**. The retention insert **1** is clamped by the step **14** and the projection supporting surface **131** between the step **24** of the holding shell and the groove supporting surface **231** so that the retention insert **1** is held in the holding shell **2** and thus the prosthesis structure.

[0051] The prosthesis structure is then arranged at the implant structure so that the head of the implant structure contacts the retention insert **1** of the connection device **3**. Then, the prosthesis structure is pressed on the implant structure so that the retention insert **1** is pressed axially on the head of the implant structure. The connection device **3** is centered by the outwardly curved portion **113** of the retention rim **11**. Moreover, a radial force increasing along this outwardly curved portion **113** is acting on the retention rim **11** so that the latter is moved in the direction of the holding rim **21**. In particular, the acute angle between the outer surface **114** of the retention rim **11** and the end side **12** of the retention insert **1** is obtunded by bending the lamella portions **112** of the retention rim **11** resiliently outwardly. By means of the outwardly moved retention rim **11**, the projection **13** is arranged such in the groove **23** that the retention insert **1** is permanently connected with the holding shell **2**.

[0052] When the prosthesis structure is placed on the implant structure, the head of the implant structure is snapped in the connection device **3**. The head is enclosed in the portion of the inner surface **112** of the retention rim **11** of the retention insert **1** which portion is curved inwardly with a positive radius of curvature, wherein it is held by the elastic or resilient forces of the retention rim **11** acting in the direction of the central axis and induced by the movement of the retention rim **11**. Accordingly, the head is held the stronger the greater these elastic forces are. And these elastic forces depend, i.a., on the material of which the retention insert **1** is made and on the number and size of the recesses **111** of the retention rim **11**.

[0053] FIG. **8** shows a second embodiment of a retention insert **19** according to the invention, which retention insert is designed substantially analogously to the retention insert **1** described above, except for the fact that it comprises a retention rim **119** having four recesses **1119**. In particular, the retention insert **19** comprises an end side **129** as well as the

retention rim **119** with an outer surface **1149**, the four recesses **1119** spaced uniformly with respect to each other in the circumferential direction, as well as lamella portions **1129** arranged therebetween. The recesses **1119** are angled about 90° relative to each other. They start from an end of the retention rim **119** facing away from the end side **129** and extend in the direction of the end side **129** over more than 80% of the retention rim **119**. The inner surfaces of the lamella portions **1129** have a curved portion **1139**. The retention insert **19** further comprises a step **149** and a projection **139** having a projection supporting surface **1319**. The retention insert **19** is completely made of polyether ether ketone. As the retention insert **19** has one recess **1119** more than the retention insert **1** described above, it is accordingly softer. For indicating this different hardness, the retention insert **19** can have a color different from that of retention insert **1**.

[0054] FIG. **9** shows a third embodiment of a retention insert **18** according to the invention, which retention insert is designed substantially analogously to the retention inserts **1** and **19** described above, except for the fact that it comprises a retention rim **118** having six recesses **1118**. In particular, the retention insert **18** comprises an end side **128** as well as the retention rim **118** with an outer surface **1148**, the six recesses **1118** spaced uniformly with respect to each other in the circumferential direction, as well as lamella portions **1128** arranged therebetween. The recesses **1118** are angled about 60° relative to each other. They start from an end of the retention rim **118** facing away from the end side **128** and extend in the direction of the end side **128** over more than 80% of the retention rim **118**. The inner surfaces of the lamella portions **1128** have a curved portion **1138**. The retention insert **18** further comprises a step **148** and a projection **138** having a projection supporting surface **1318**. The retention insert **18** is completely made of polyether ether ketone. As the retention insert **18** has more recesses **1118** than the retention inserts **1** and **19** described above, it is accordingly softer. For indicating this different hardness, the retention insert **18** can have a color different from that of retention inserts **1** and **19** described above.

[0055] FIG. **10** shows an embodiment of a demounting tool **5** according to the invention, which is substantially rotationally symmetric about a longitudinal axis **55**. The demounting tool **5** comprises a shank-shaped cylindrical first portion **53** and a shank-shaped cylindrical second portion **54**, which are connected with each other by a grip **51**. At an end facing away from the grip **51**, the second portion **54** transitions into a sleeve-shaped head **52**. The head **52** comprises a hollow space formed by an inner side **521**. The inner side **521** is conical so that the hollow space diminishes in the direction of the second portion **54**. The distal end **522** of the head **52**, which faces away from the second portion **54**, is tapering.

[0056] For removing a retention insert from a holding shell of a connection device according to the invention, the distal end **522** of the head **52** can be inserted between a retention rim of the retention insert and a holding rim of the holding shell. Due to the conical shape of the inner side **521** of the head **52**, the retention rim is moved more and more inwardly so that the retention insert is held less and less in the holding shell. When the head **52** is inserted in the connection device in the manner appropriate for demounting, the retention insert can thus be removed relatively easily from the holding shell.

[0057] Although the invention is illustrated and described in detail on the basis of the Figures and the corresponding description, this illustration and this detailed description are to be understood to be illustrative and exemplary and not as restricting the invention. It is self-evident that experts can make changes and adaptations without leaving the scope and the gist of the following claims. In particular, the invention also comprises embodiments with any combination of features which are mentioned or shown above or below in connection with different embodiments.

[0058] The invention also comprises individual features in the Figures, even if they are shown therein in connection with other features and/or if they are not mentioned above or below. The embodiments described in the Figures and the description and individual features thereof can also be excluded from the subject-matter of the invention.

[0059] Moreover, the term "comprise" and derivations thereof do not exclude other elements or steps. Furthermore, the indefinite article "a" and derivations thereof do not exclude a plurality. The functions of several of the features mentioned in the claims can be fulfilled by a unity. The terms "substantially", "about", "approximately" and the like in connection with a characteristic or a value in particular also define exactly this characteristic or exactly this value. All reference signs in the claims are not to be understood as restricting the scope of the claims.

1. A connection device for connecting a prosthesis structure with an implant structure or a capped tooth,

said connection device comprising a holding shell and a retention insert,

wherein said retention insert has an end side and a substantially ring-shaped retention rim projecting therefrom,

and said holding shell has an end side and a substantially ring-shaped holding rim projecting therefrom,

wherein said holding rim and said end side of said holding shell form a retainer in which said retention insert can be arranged such that an outer surface of said retention rim of said retention insert is adjacent to an inner surface of said holding rim of said holding shell,

wherein

said outer surface of said retention rim of said retention insert is, at least partly, spaced from and adjacent to said inner surface of said holding rim of said holding shell when said retention insert is arranged in the retainer of said holding shell, and

when essentially no radial forces are acting on said holding rim of said holding shell and on said retention rim of said retention insert.

2. The connection device according to claim **1**, wherein said outer surface of said retention rim of said retention insert is, at least partly, spaced from and adjacent to said inner surface of said holding rim of said holding shell in that said outer surface of said retention rim of said retention insert is more strongly inclined in the direction of a central axis of said connection device than said inner surface of said holding rim of said holding shell.

3. The connection device according to claim **1**, wherein said retention rim of said retention insert comprises recesses starting from an end of said retention rim facing away from said end side of said retention insert and extending in the direction of said end side of said retention insert.

4. The connection device according to claim **3**, wherein said recesses in said retention rim of said retention insert extend over at least about 50% of the width of said retention rim of said retention insert.

5. The connection device according to claim **3**, wherein said retention rim of said retention insert comprises three, four, five or six recesses.

6. The connection device according to claim **1**, wherein said retention rim of said retention insert has a projection projecting radially from said outer surface of said retention rim of said retention insert and said holding rim of said holding shell comprises a corresponding groove extending radially from said inner surface of said holding rim of said holding shell.

7. The connection device according to claim **6**, wherein said projection of said retention rim of said retention insert is arrangeable in said groove of said holding rim of said holding shell such that said retention insert is releasably held in said holding shell when said retention insert is arranged in the retainer of said holding shell and when essentially no radial forces are acting on said holding rim of said holding shell and on said retention rim of said retention insert.

8. The connection device according to claim **6**, wherein said projection of said retention rim of said retention insert comprises a substantially planar projection supporting surface and said groove of said holding rim of said holding shell comprises a substantially planar groove supporting surface, wherein a part of said projection supporting surface contacts a part of said groove supporting surface

when said retention insert is arranged in the retainer of said holding shell, and

when essentially no radial forces are acting on said holding rim of said holding shell and on said retention rim of said retention insert, and

wherein said groove supporting surface is rounded towards its end facing said retention insert and/or said projection supporting surface is rounded towards its end facing said holding shell.

9. The connection device according to claim **6**, wherein said projection of said retention rim of said retention insert can be arranged in said groove of said holding rim of said holding shell such that said retention insert is permanently connected with said holding shell when said retention insert is arranged in the retainer of said holding shell and when a radial force is acting on said retention rim of said retention insert in the direction of said holding rim of said holding shell and/or on said holding rim of said holding shell in the direction of said retention rim of said retention insert.

10. The connection device according to claim **1**, wherein said retention rim of said retention insert comprises an inner surface opposite to said outer surface, wherein said inner surface is rounded towards an end facing away from the end side of said retention insert.

11. The connection device according to claim **1**, wherein said retention insert and/or said holding shell is/are made of a biocompatible polymeric material, in particular of a polyetheretherketone.

12. A retention insert of a connection device for connecting a prosthesis structure with an implant structure according to claim **1**, wherein the retention insert has an end side and a substantially ring-shaped retention rim projecting therefrom, wherein said retention rim of said retention insert optionally comprises recesses starting from an end of said retention rim facing away from said end side of said retention insert and extending in the direction of said end side of said retention insert.

13. A method for connecting a prosthesis structure with an implant structure via a connection device according to claim **1**, wherein said holding shell of said connection device is firmly mounted to the prosthesis structure and wherein the implant structure comprises a head suitable for a snap-engagement connection, wherein

said retention insert of said connection device is moved axially into said holding shell of the connection device until said retention insert is arranged in said holding shell,

the prosthesis structure is arranged at the implant structure so that the head of the implant structure contacts said retention insert of said connection device, and

the prosthesis structure is pressed on the implant structure so that said retention insert is pressed axially on the head of the implant structure, wherein a radial force is acting on said retention rim of said retention insert so that said retention rim is moved at least partly in the direction of said holding rim of said holding shell.

14. A demounting tool for demounting a retention insert from a holding shell of a connection device according to claim **1**, the demounting tool comprising a sleeve-shaped head which can be arranged between an outer surface of a retention rim of said retention insert and an inner surface of a holding rim of said holding shell when said retention insert is arranged in a retainer of said holding shell, wherein an inner side of said head is conical so that said retention rim of said retention insert is moved in the direction of a central axis of said connection device when said head of said demounting tool is arranged between said outer surface of said retention rim of said retention insert and said inner surface of said holding rim of said holding shell.

15. The demounting tool according to claim **14**, wherein the distal end of said head is tapered.

16. The connection device according to claim **4**, wherein said recesses in said retention rim of said retention insert extend over at least about 70% of the width of said retention rim of said retention insert.

16. The connection device according to claim **4**, wherein said recesses in said retention rim of said retention insert extend over at least about 80% of the width of said retention rim of said retention insert.

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