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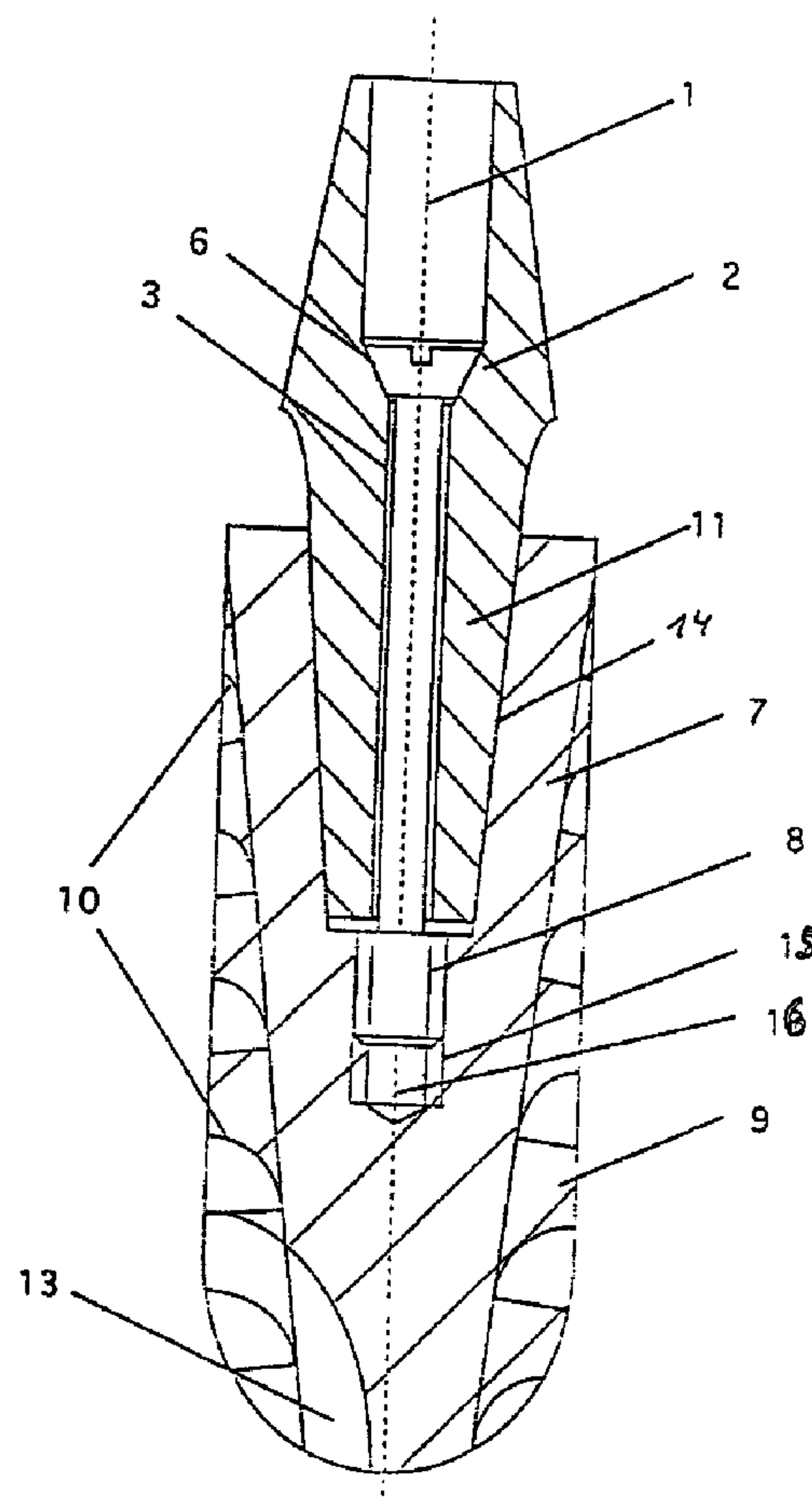
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(54) Title: TWO-PHASE TOOTH IMPLANT



(57) Abrégé/Abstract:

Mechanical joining of a two-phase tooth implant, consisting of two components which are joined by means of a conical pin (11) projecting into a conical sleeve (7), the cone pairing being realized within the self-locking region and the cone pin being penetrated



(57) **Abrégé(suite)/Abstract(continued):**

by a centrally aligned, tension screw reduced diameter which tensions the pair of cones against each other. The design permits the two implant components in a two-phase tooth implant to be steplessly positioned in the circumferential direction and to be joined in an anti-rotation, gap-free joint. The required degree of miniaturisation, with a sufficient component strength, is achieved through the use of a cone combination in the self-locking region and through a of the tension screw in the region of the cone joint. By these means, the mechanical, aesthetic and hygienic requirements for a two-phase tooth implant are better fulfilled than in the case of the known designs.

Abstract:

Mechanical joining of a two-phase tooth implant, consisting of two components which are joined by means of a conical pin (11) projecting into a conical sleeve (7), the cone pairing being realized within the self-locking region and the cone pin being penetrated by a centrally aligned, tension screw reduced diameter which tensions the pair of cones against each other. The design permits the two implant components in a two-phase tooth implant to be steplessly positioned in the circumferential direction and to be joined in an anti-rotation, gap-free joint. The required degree of miniaturisation, with a sufficient component strength, is achieved through the use of a cone combination in the self-locking region and through a of the tension screw in the region of the cone joint. By these means, the mechanical, aesthetic and hygienic requirements for a two-phase tooth implant are better fulfilled than in the case of the known designs.

Two-phase tooth implant

Description:

5 The invention concerns a two-phase tooth implant with a first implant component, having a central seating opening, which is inserted into the jawbone, and a second implant component which carries the dental structure and includes a conical seating element for the dental prosthesis and a
10 part which fits into the seating opening of the first implant component.

Intra-ossal tooth implants are used for anchoring individual teeth or dental prostheses. A distinction is
15 made between single-phase and two-phase systems, preference being given to two-phase systems which, concealed under the gum in a first phase, are able to osseointegrate safely without stress and only equipped with the part carrying the artificial tooth or dental prosthesis in the second, or
20 actual load-application phase. The part anchored in the jawbone has an appropriate screw profile or other macroscopic surface structures so that a firm primary anchorage is achieved. Metal and ceramic materials are known to be suitable.

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Great importance pertains to the mechanical joining of the two implant components, the part anchored in the jawbone and the part which is coupled to it and passes through the gum, projecting into the mouth cavity. General

requirements for such a joining element are the absorption and transfer of high masticatory forces with minimum dimensions and a joint between the two implant components which is free from play and as impervious to bacteria as possible. Such a joint, based on a cone, is known from WO 85/02337.

Anatomical, biomechanical and aesthetic requirements can necessitate the use of a mechanical joint having an angle between the part anchored in the bone and the part carrying the dental structure which projects into the mouth cavity. The angle enclosed between the two implant components increases the demands on such a joining element with respect to their twisting towards each other and their positional accuracy. These requirements would not be met by a joint effected by a simple threaded screw fitting as described, for example, in DE 24 54 414 A1 and DE 24 13 833. Positive joints, such as true-fitting hexagonal or octagonal geometries, are primarily selected to fulfil this function. Such positive joints are described, for example, in DE 40 28 855 A1, EP 0 438 048 A1, DE 41 27 839 A1, EP 0 504 119 A1, EP 0 323 421 A2 and WO 94/06367.

In DE 40 28 855 A1 there is proposed a distance sleeve with a positive-fit interlocking-face denticulation which provides for a torsion-free joint between the two implant components, there being described four possible positions in this structure and this denticulation being located inside the part inserted in the jawbone. Provided that the

rotational forces caused by masticatory stresses are introduced via this sleeve and not via the implant stud screwed into it which are not rotation-proof, this joint forms an anti-rotation device such as that required, for example, for a single artificial denture. For design and production reasons, this arrangement does not provide a gap-free joint. In DE 40 28 857 relating to the same implant, an anti-torsion device, to be effected by means of a deformed intermediate ring, is proposed as an alternative to the positive geometric fit. The force applied in assembling a screwed joint causes the two faces of the intermediate ring to be compressed as the parts which are to be joined together are raised or lowered. This rotation lock is subject to the masticatory forces, in that the effect of the torsion lock can decrease due to further deformation of the intermediate ring under the substantial masticatory stresses. Due to the limited geometric positive fit of the possible deformation and the inherent softness of the ring, this concept offers a substantially lesser locking effect against loosening of the joined components due to turning than the geometric positive fit. This joint also, like the concept described in DE 40 28 855, cannot be made gap-free.

The anti-torsion joints proposed in WO 94/06367, EP 0 438 048 A1, DE 40 22 753 and DE 41 27 839 A1 are likewise based on interlocking positive-fit joints with the disadvantage that the rotational position is defined in steps and that this joint cannot be made gap-free. In the arrangement illustrated in EP 0 438 048 two positive-fit

joints are aligned in succession, and although it is possible to increase the fineness of the positional adjustment by this means, again in this case the rotational position of the part which is inserted into the bone and becomes firmly anchored there after the healing-in phase predetermines the final position of the support projecting into the mouth to which the dental prosthesis is applied.

A further problem with all positive-fit rotation locks is the necessity of producing these joints, even in series production, so that all parts fit with each other without play. Due to the pulsating stress caused by the masticatory load applied with large forces and at a high cyclic rate, there is a danger that a small amount of play present in the positive fit of the assembled structure will become larger as the functional period increases and that this in turn will result in disintegration of the entire dental structure. For this reason, EP 0 593 926 A1 describes an element which deforms under the initial stress resulting from assembly so as to compensate this play in a hexagonal structure. This elastically and/or plastically deforming element is again subject to the applied masticatory load, which again involves the risk of loosening of the joint.

25

Disadvantages of all positive-fit joints known hitherto are therefore the limited number of possible positions, the fact that a gap-free construction of these joining elements is attainable only at great expense and, likewise, the great difficulty in producing these structures free from

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play. The rotational position of the implant, however, must be determined as early as the surgical insertion stage with respect to the inclination of the seating stud due to the fact that, in the case of the joints described, such as 5 for example the octagonal joint, it is then only possible to effect positioning steps of 45° after the implant has become healed into the bone. In order for a gap-free joint to be achieved in all positive-fit centerings, all possible mutually contacting surface pairs must be made to fit 10 exactly, which requires an extremely precise production technology.

Joints which are free of both gaps and play and which are capable of transferring high axial forces and high flexural 15 forces can be produced by means of cone joints with a fixed thread, as described in WO 85/02337. However, due to the limited possible insertion force, resulting from the fixed thread, these are not suitable for transferring high forces in a circumferential direction, such as those which occur 20 in the case of application as a single tooth implant or in the case of an angle being included between the implant components.

The combination, proposed in WO 94/06396, of a positive-fit 25 and a non-positive cone joint by means of a joining sleeve does permit stepless adjustment of the rotational position, but this combination includes the risks, described above, of play and gaps in the joint. In addition, a joint made in this way will limit the attainment of the smallest 30 implant diameter that is possible, for a given masticatory

load, due to the size of the structure required,
necessitating a limited implant indication.

An object of the present invention, therefore, was to
5 develop a two-phase, gap-free tooth implant capable of
stepless positioning, with a first implant component,
having a central seating opening, which is inserted into
the jawbone and a second implant component which carries
the dental structure and includes a conical seating element
10 for the dental prosthesis and a part which fits into the
seating opening of the first implant component. This
joint, which is continuous in the circumferential direction
of the implant element, must be capable of coping with the
high mechanical stresses due to the forces of mastication
15 in spite of its very small dimensions and must remain
permanently free from gaps with, in particular, the
rotational forces occurring in the case of an angle being
included between the axes of the two implant components
being reliably absorbed and transferred.

20

This object is achieved, according to the invention, in
that the seating opening in the first implant component is
conical and the part of the second implant component which
fits into it is a matching cone, the second implant
25 component having a central bore passing through it within
which is located the cylindrical shaft of a tension screw
being of reduced diameter in the central part which has a
widened end with an outer fastening thread which fits into
the inner thread of a blind bore passing within the
30 extension of the seating opening.

To adress the differend_known it is preferable that the axes of the two conical parts of the second implant component are in alignment with each other or
5 alternatively,that_these axes can also include an angle.

It is furthermore advantageous if the central bore of the second implant component is widened within the end directed towards the mouth cavity so that the head of the tension
10 screw is seated within it.

It has proved advantageous if the angle of the conical seating opening of the first implant component and the angle of the part of the second implant component fitting
15 within it are selected so as to produce a self-locking cone joint. The angles are therefore normally of identical sizes.

It is also advantageous if the widened end of the tension
20 screw is irreversibly connected to the shaft and by this means the tension screw ist captured within the second implant component.

For good primary stability and sucessfull longterm fixation
25 it is advantagous if the first implant component has an essentially cylindrical outer form with a spherically rounded end and a thread of specially adapted geometry for example with a_varying flank depth, the form of the thread flanks varying continuously upwards from the end embedded
30 in the bone towards the seating opening, the thread flank

which points upwards towards the seating opening being formed as a plane surface and the thread flank which points downwards, varying in form, having a curved, concave shape.

5 The cone joint designed according to the invention enables the implant components to be firmly joined together in a gap-free, rotationally stable joint due to the cone angle being matched to the friction ratios of the cone joint and to the central tension screw being aligned within the axis
10 of the cone, the rotational position of the two implant components being freely and steplessly selectable during assembly. In order to accommodate to the constricted space conditions and to meet the mechanical requirements of the joint, the tension screw is of reduced diameter in the
15 region of through passage of the cone absorbing the axial and bending forces and widened in the region of the thread absorbing the tensile forces. For the purpose of achieving a seal, it is preferable if the seating of the tension screw head is also conical in form, the frictional action
20 of the tension screw cone being significantly less than the frictional action of the joining cone. The fact that the thin tension screw lies close to the neutral axis of the cone joint which is subjected to bending load means that the load-bearing capacity of the cone joint is weakened
25 only by an insignificant amount. It is possible to achieve an optimum load capacity of the cone joint with respect to axial and bending forces and forces in the circumferential direction through matching of the angle of the joining cone, the shaft cross-section of the tension screw and the
30 cone angle under the screw head. The cone angle is

preferably selected so that the joint is located in the self-locking region and so that the forces occurring in application never exceed this self-locking region, with the
5 result that no additional operational forces are transferred to the tension screw. It is possible to achieve an increased sealing effect in the cone entry region or to influence the tension of the implant part anchored in the bone by the selection of small angle
10 variations between the outer and inner cones. If the angle of the outer cone is slightly larger than that of the inner cone, an increased sealing effect is achieved in the cone entry region, in the sense of a pinched edge. If the angle
15 of the outer cone is slightly smaller than that of the inner cone, tensions in the part embedded in the bone caused by the cone joint are displaced towards the centre of the component.

20 According to an aspect of the invention there is provided a two-phase tooth implant, which is free of gaps and capable of being steplessly positioned, the two-phase tooth implant comprising a first implant component, having a central seating opening, which is inserted into the jawbone, and a
25 second implant component which carries the dental structure and includes a conical seating element for the dental prosthesis and a part which fits into the seating opening of the first implant component, wherein the seating opening in the first implant component is conical and the part of
30 the second implant component which fits into it is a matching cone, the second implant component having a central bore passing through it within which is located the tapered cylindrical shaft of reduced diameter of a tension

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screw which has a widened end relative to the central bore,
with an outer fastening thread which fits into the inner
thread of a blind bore passing within the extension of the
seating opening wherein an angle of the conical seating
5 opening and an angle of the part of the second implant
component which fits within it are selected so as to
produce a self-locking cone joint.

10 Further details are contained in the following description
of the embodiment examples of the invention illustrated in
schematic form in the drawings.

15

Fig. 1: A cone joint designed according to the
invention, with a central tension
20 screw.

20

Fig. 2: A cone joint designed according to the
invention, with a central tension screw
25 with an angle included between the two
implant components.

25

Fig. 3: Detail of the tension screw with a reduced cross-section in the area of the joining cone.

5 The second implant component (11) according to Fig. 1 and 2, which acts as a joining element, is bored along its axis (1), the bore (3) being widened in the region of the end (2) projecting into the mouth cavity. The diameter of the widened bore (3) matches the head (5) of a central
10 tension screw (4). In the region of the central bore (12) the diameter is slightly larger than the shaft diameter of the central tension screw (4). The head (5) of this central tension screw (4) is located in the widened bore (3) of the end (2) projecting into the mouth cavity. The
15 cone angle of the head seating (6) is selected so as to render possible both a secure sealing of the screw head (5) on the seating and a sufficient pretensioning of the tension screw (4). The angles of the inner cone of the first implant component (7) anchored in the bone and of the
20 conical pin which is to be mechanically fixed within it are identical or matched to each other. This angle is constructed so as to produce a self-locking of the cone joint for the possible combinations of axial forces, bending forces and forces in the circumferential direction.

25 The tension screw (4) terminates in an increasing cross-section at its lower end (8) which has a fastening thread by means of which the tension screw (4) and, consequently, the joining cone, is tensed against the first implant component (7) anchored in the bone.

The first implant component (7) is primarily anchored in the bone, being surrounded and held stable by the bone structure during the healing-in phase, by means of a special outer thread (9), the flank geometry (10) of which varies over the length of the implant. The special form of the outer thread is such that the masticatory forces are dispersed in correspondence with the normals to the surfaces of the thread flanks and directed into the depth of the bone mass in correspondence with the form of these flanks which varies over the length of the implant. This positive fit is supported by recesses (13) at the lower end and by a microstructure on the entire surface which comes into contact with the spongy bone mass.

The second implant component (11) has the form of two cylindrical truncated cones, one mounted on the other by their base, having axes which can be aligned to each other or enclose an angle, one of the two cones fitting into the seating opening (14) of the first implant component (7) anchored in the bone, while the other cone supports the dental prosthesis.

In order to allow for both the mechanical stresses, as a pretensioned element, and the requirements of miniaturisation, the tension screw (4) is of reduced diameter in the central region.

The central reduced diameter of the tension screw (4) is also necessary in order to achieve a sufficient flexural resistance of the cone and a sufficient bearing length of

the interconnected cone pair with the small diameter of the implant and the associated small available structural volume of the cone joint. At the same time, this provides for a sufficiently large seating of the screw head (5) and
5 a sufficiently large diameter of the fastening thread at the lower end (8) of the tension screw (4).

A possibility for production of the reduced central diameter is offered by joining the lower end (8) or, alternatively,
10 the screw head (5) to the tension screw (4) by welding. The tension screw (4) is joined to the joining cone so as to be incapable of loosening due to the fact that the bore diameter (3) is smaller than the screw head (5) and the thread. In the case of use of a titanium implant material,
15 this joint can be effected by means, for example, of laser welding. Alternatively, other material-closing joining methods, or a positive-fit joint, e.g. a thread, may be used.

20 For the purpose of producing the intended cohesive friction of the cone joint which is of particular importance for absorption of the operational forces acting in the circumferential direction in combinations which enclose an angle (12) between the two implant components, the central
25 tension screw (4) is pretensioned by a defined quantity by means of a torque wrench which is appropriately miniaturised for use within the mouth. The use of a torque wrench ensures that the two components are joined together in a reproducible, gap-free and therefore germproof joint.

By means of a standardised, equally dimensioned cone joint, it is possible for parts which are to be anchored in the jawbone and which are of widely differing geometry, e.g. having different diameters and lengths, to be freely
5 combined with parts which project into the mouth cavity, so that the individual conditions of the patient to be treated are accommodated to a high degree with a relatively small number of components.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A two-phase tooth implant, which is free of gaps and capable of being steplessly positioned, the two-phase tooth implant comprising a first implant component, having a central seating opening, the first implant component being inserted into the jawbone, and a second implant component which carries a dental structure and includes a conical seating element for a dental prosthesis and a part which fits into the seating opening of the first implant component, wherein the seating opening in the first implant component is conical and the part of the second implant component which fits into it is a matching cone, the second implant component having a central bore passing through it within which is located the tapered cylindrical shaft of reduced diameter of a tension screw which has a widened end relative to the central bore, with an outer fastening thread which fits into the inner thread of a blind bore passing within the extension of the seating opening wherein an angle of the conical seating opening and an angle of the part of the second implant component which fits within it are selected so as to produce a self-locking cone joint.
2. The tooth implant according to claim 1, wherein the axes of the two conical parts of the second implant component are aligned with each other.
3. The tooth implant according to claim 1, wherein the axes of the two conical parts of the second implant component enclose an angle.

4. The tooth implant according to any one of claims 1 to 3, wherein the central bore is widened within the end directed towards the mouth cavity so that the head of the tension screw is seated within it.

5. The tooth implant according to any one of claims 1 to 3, wherein the angles are different.

6. The tooth implant according to any one of claims 1 to 4, wherein the widened end of the tension screw is irreversibly connected to the tapered shaft.

7. The tooth implant according to any one of claims 1 to 4, wherein the first implant component which is to be anchored in the bone has a substantially cylindrical outer form with a spherically rounded end and a thread with a varying flank depth, the form of the thread flanks varying continuously upwards from the end embedded in the bone towards the seating opening.

8. The tooth implant according to claim 7, wherein the thread flank which points upwards toward the seating opening is formed as a plane surface and the thread flank which points downwards, varying in form, has a curved, concave shape.

