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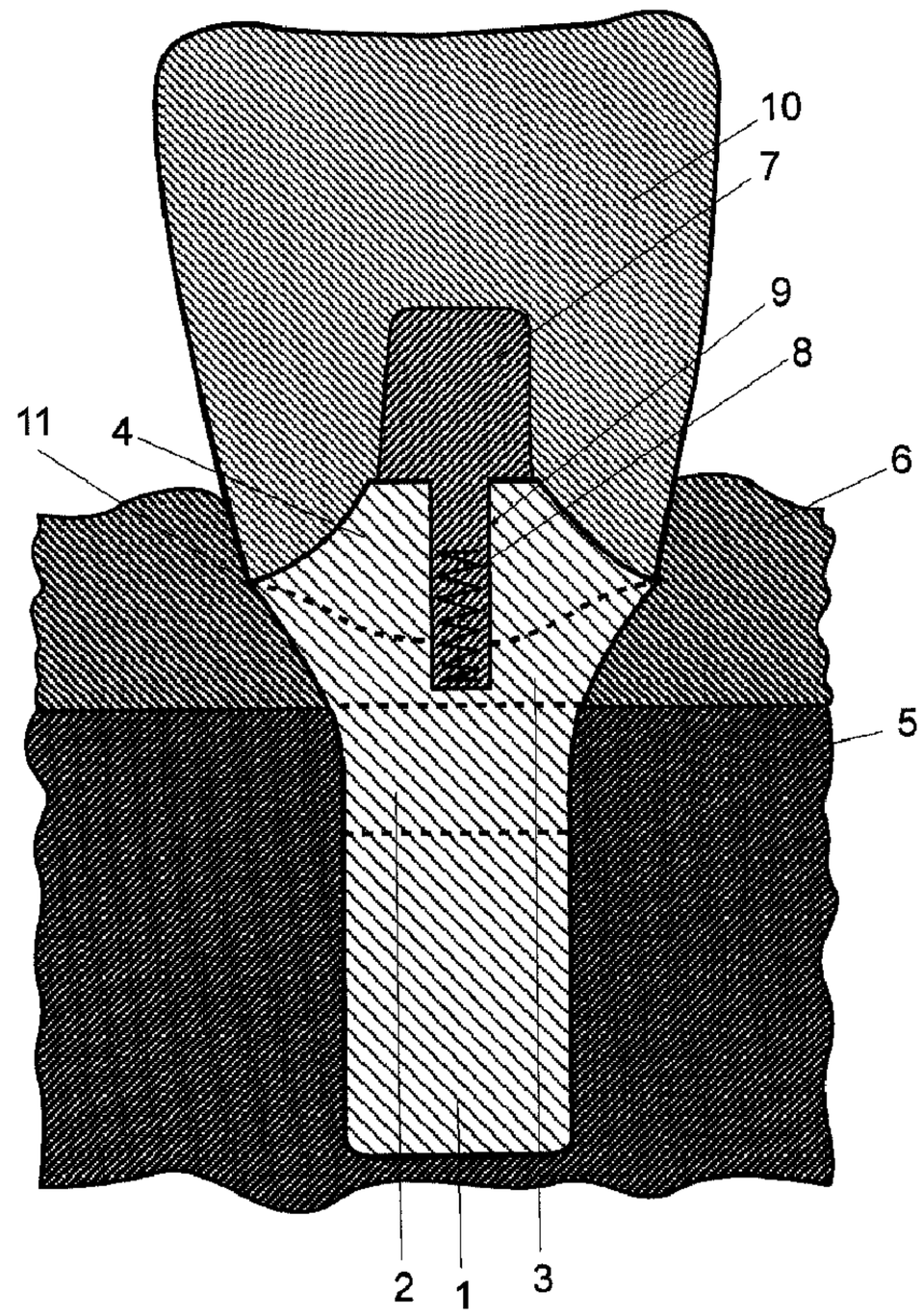

(57) Abrégé/Abstract:
The invention relates to a dental implant system comprising an implant and a superstructure (10; crown, bridge, etc). The implant is made as one piece and extends from the bone region to the height of the approximal gum papillae. The enossal (1, 2) and gingival

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(57) Abrégé(suite)/Abstract(continued):
regions (3) of the implant are formed corresponding to diagnostically derived patient data. As a result, the enossal region is adapted precisely to the shape of the ridge of the jaw, and completely fills the bone dehiscence arising from the implantation. The gingival region (3) correspondingly fills the cavity in the gingiva. The superstructure (10) is connected over the entire surface to the transgingival implant head (4), which both fill the remaining cavity of the gingiva, and is also connected to a prosthetic abutment pin (7) on the implant. The adapted surface structure thereof allows complete growing together in the enossal and gingival regions. Formation of gum pockets is completely prevented. No micromovements can occur in the implant system due to the construction thereof. Optimal force distribution is also ensured. The enossal region of the implant can also have a rotationally asymmetrical shape.

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(54) Title: DENTAL IMPLANT SYSTEM

(54) Bezeichnung: ZAHNIMPLANTATSYSTEM

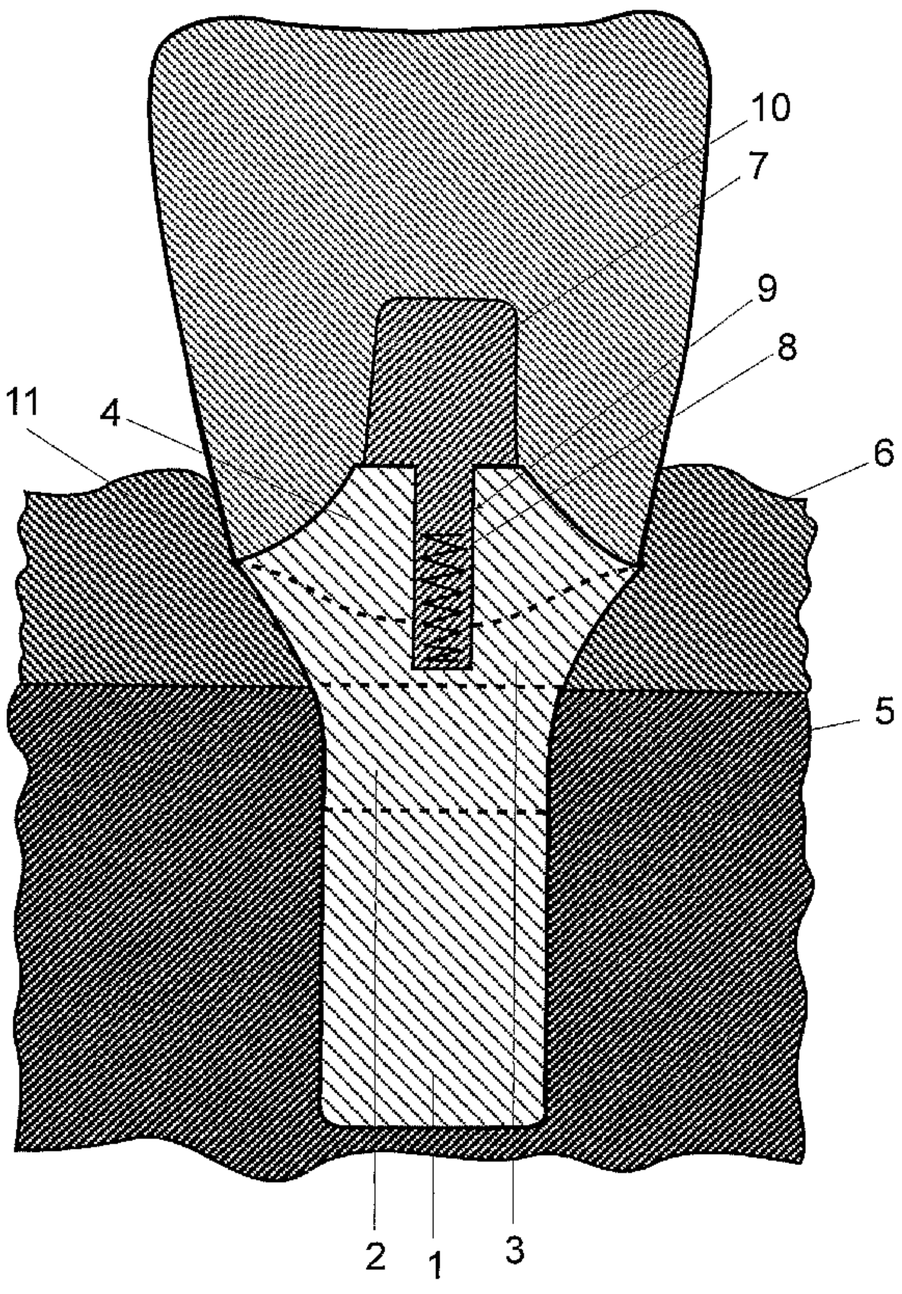

Fig. 1

(57) Abstract: The invention relates to a dental implant system comprising an implant and a superstructure (10; crown, bridge, etc). The implant is made as one piece and extends from the bone region to the height of the approximal gum papillae. The enossal (1, 2) and gingival regions (3) of the implant are formed corresponding to diagnostically derived patient data. As a result, the enossal region is adapted precisely to the shape of the ridge of the jaw, and completely fills the bone dehiscence arising from the implantation. The gingival region (3) correspondingly fills the cavity in the gingiva. The superstructure (10) is connected over the entire surface to the transgingival implant head (4), which both fill the remaining cavity of the gingiva, and is also connected to a prosthetic abutment pin (7) on the implant. The adapted surface structure thereof allows complete growing together in the enossal and gingival regions. Formation of gum pockets is completely prevented. No micromovements can occur in the implant system due to the construction thereof. Optimal force distribution is also ensured. The enossal region of the implant can also have a rotationally asymmetrical shape.

(57) Zusammenfassung: Die Erfindung betrifft ein aus einem Implantat und einer Suprastruktur (10; Krone, Brücke etc.) bestehendes Zahnimplantatsystem. Das Implantat ist aus einem Stück gefertigt und reicht vom Knochenbereich bis zur Höhe der approximalen Zahnfleischpapillen. Der enossale (1, 2) und der gingivale Bereich (3) des Implantats sind entsprechend diagnostisch ermittelter Patientendaten geformt. Infolgedessen ist der enossale Bereich

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genau an die Kammform des Kiefers angepasst und füllt durch die Implantation entstehende Knochendehiszenzen vollständig aus. Der gingivale Bereich (3) füllt entsprechend die Kavität in der Gingiva aus. Die Suprastruktur (10) ist ganzflächig mit dem transgingivalen Implantatkopf (4), die beide die übrige Kavität der Gingiva ausfüllen, verbunden und zusätzlich mit einem prothetischen Aufbaustift (7) am Implantat befestigt. Durch dessen angepasste Oberflächenstruktur wird ein vollständiges Verwachsen im enossalen und auch im gingivalen Bereich ermöglicht. Das Entstehen von Zahnfleischtaschen wird vollständig verhindert. Im Implantatsystem können konstruktionsbedingt keine Mikrobewegungen auftreten. Zudem ist eine optimale Kräfteverteilung gewährleistet. Der enossale Bereich des Implantats kann auch nichtrotationssymmetrisch ausgeformt sein.

Dental Implant System

The invention refers to a dental implant system comprising an implant and a superstructure.

Around 700,000 artificial tooth replacements are implanted each year in Germany. Usually, this replacement involves three components: An artificial root (root implant), a connecting piece, the so-called abutment, and a superstructure such as a crown or bridge.

To be able to implant the artificial tooth replacement, it is first necessary to remove all remains of the defective tooth, for example its roots. Subsequently, a hole is drilled into the jaw bone and possibly provided with a thread, prior to the root implant being driven or screwed into this hole. The implant thus usually takes the form of a cylinder or taper. After implantation into the jaw, the implant must be left to heal for three to six months; it must be allowed to fuse with the jaw bone. During this period, the implant must not be subjected to mechanical loads. After healing, the usual practice is to screw or bond the abutment to the implant, and subsequently to mount the superstructure on the abutment. The abutment incorporates a so-called abutment pin, which serves for the mechanical fixing of the superstructure on the abutment.

This method, however, entails several disadvantages. Inherent to the design, there is a gap susceptible to bacteriological colonisation between the implant and the abutment. Periodontal pockets along the abutment in the direction of the bone represent open portals of entry for bacteria. The acid waste products excreted by the bacteria hinder the fusing of the gingiva with the implant/abutment in the region of the gap. The jaw bone always regresses in accordance with the biological width; frequent additional consequences are gingivitis and further losses of bone substance, and subsequently further gingival loss. As a result, bacterial pockets may form, which, as they are not accessible to the patient himself, call for expensive and for the patient annoying dental recall measures to clean the affected pocket and regularly also lead to loss of the implant. A further disadvantage arising from the cleaning of the pocket is that the gingiva, as a re-

sult, is not able to fuse with the abutment in the region above the gap between the abutment and the implant. Furthermore, the temporarily unavoidable restricted accessibility of the periodontal pockets hinders proper oral hygiene in this region, with the consequence that the implant is considered very unpleasant by the patient. During this time, the inflammation and destruction of healthy tissue progresses further.

A further disadvantage is that the screw joints between root implant and abutment are subjected to high mechanical loads. The result is regularly micro-movements between the implant and the abutment and in the long run breaking of the screw with subsequent high costs. If the screw joint is fixed with cement or adhesive, moreover, protruding material may lead to irritation of the gingiva.

The root implants generally take the form of prefabricated, rotationally symmetrical standard implants in various graduated sizes. Due to the CE regulations concerning the sterilisation of medical products, the dentist performing the implantation is not permitted to individually adapt the prefabricated implant during the treatment. As a result of the given size graduation, therefore, compromises must often be accepted with regard to the size of the implant used. A further disadvantage is the fact that the implant cannot be matched to the bone dehiscences arising when drilling the implant bed in the ridge-form jaw bone. As a result, such implants display a significantly reduced bone contact area and consequently poorer anchoring than would be possible with individual adaptation. Furthermore, the anatomical soft-tissue demands of the gingiva are not taken into account. Aesthetics and hygiene are thus greatly impaired. The uncompensated bone dehiscences are regularly the cause for the formation of undesirable periodontal pockets. Finally, high storage costs arise, as the prefabricated standard implants must be kept in many sizes and forms.

The fixing of the superstructure to the abutment by way of an abutment pin leads to unfavourable force distributions and lever ratios, resulting in turn in an increased risk of breakage. In the case of screwed abutment pins, furthermore, the occurrence of destructive micro-movements has been proven.

Over the past years, considerable advances have been achieved in dental implantology; numerous developments are aimed at overcoming the above-mentioned problems.

In DE 196 47 489 A1, it is proposed to apply a directly plated, plastically formable metal layer to the abutment at the point of contact to the enossal implant body. This is intended to avoid the formation of a gap susceptible to bacteriological colonisation between abutment and implant. In a similar manner, DE 196 47 490A1 suggests the inclusion of a gold disc between the implant and the implant mount. It is true that both solutions achieve a minimisation of the gap, but it can be expected that the contact between titanium, gold and the gingiva and saliva will trigger irritating chemical reactions. Bacteriological colonisation, furthermore, is not to be excluded.

WO2004/058096 A1 describes an abutment which is provided with an axial through-hole. It is proposed to fasten the abutment to the implant by way of a screw, with this screw joint being fixed additionally with cement. The through-hole serves to enable excess cement to be pressed out during the cementing, so that it collects on the flat head of the implant. The cement can then be removed simply from the head. This is able to prevent gingivitis due to cement extruding at other places.

DE 10 2005 027 402 A1 discloses a method to produce an individualised replacement tooth, which can be mounted into a healed implant by way of a connecting stub. To reduce the outlay for the production of the dentures, it is proposed to produce the replacement tooth in one piece. It is possible to dispense with a separate abutment. It is not to be disputed that a simplification is achieved – the problem of a gap susceptible to bacteriological colonisation, however, remains.

EP 0 967 931 B1 presents a dental implant which comprises a tapered shaft section and a divergent head section, wherein both sections are formed integrally or produced as a compound part. The dental implant system covers furthermore an abutment match-

ing the dental implant and serving to support a denture or crown. The abutment is screwed into the tapered shaft section of the implant by way of a screw.

While it is true that the one-piece or integral design of the shaft and head sections avoids a microgap in the enossal region, the formation of a gap susceptible to bacteriological colonisation between the shaft/head section and the abutment in the gingival region, however, is inevitable.

EP 0 891 163 B1 describes a dental support structure comprising an implant and an abutment. The upper edge of the abutment and accordingly the lower edge of the crown fixed to the abutment are matched to the corresponding exit profile and the dimensions of the tooth to be replaced at the point of emergence from the gingiva.

As the boundary between the abutment and the crown is matched to the profile of the gingiva, this achieves aesthetic and functional advantages over rotationally symmetrical solutions. The boundary between the abutment and the crown, however, lies exactly at the height of the gingival margin or above the same. As the gingiva usually recedes over the course of time, it is unavoidable that the metallic abutment will protrude above the gingival margin and become visible after a certain time.

Alternatively to the above-described dental prosthesis method, the general state of the art uses a rotationally symmetrical implant wherein the enossal parts of the implant, the abutment and, if applicable, the abutment pin are produced as one piece or at least jointed seamlessly (see DE 10 2005 001 185 A1).

Such implants thus avoid a gap in the boundary region between jaw bone and gingiva from the beginning and the gingiva is able to fuse with the implant without problems, as micro-movements are avoided. Even so, these implants have not been able to assert themselves for several essential reasons. One reason is the fact that the abutment pin, as required by the design, protrudes into the mouth. This leads inevitably to mechanical loads on the implant during the period of healing and consequently frequently to failure

of the implantation. A further reason is the fact that, due to the rotational symmetry of the implant, the latter remains visible at the transition from crown to gingiva, which is not acceptable from an aesthetic point of view, particularly when using titanium. It is especially disadvantageous that the vestibular/buccal and palatinal/lingual bone dehiscences caused by the drilling into the ridge-form jaw bone are not taken into account by the form of the implant.

The purpose of the invention is to overcome the disadvantages in the prior state of the art. It is to present in particular an aesthetically appealing dental implant system which remains invisible at the gingival margin, permits good fusing with the gingiva in the gingival region and guarantees a mechanically stable and long-lasting connection between a dental abutment and the jaw bone.

In accordance with the invention, this task is solved by the characteristic features described herein.

The starting point is a dental implant system comprising an implant and a superstructure mounted thereupon. The implant comprises a lower enossal section with a typically honeycomb- or thread-like surface structure, an upper enossal section with roughened surface which widens towards the top, a transgingival section with smooth walls and a transgingival implant head. All these sections are joined to each other seamlessly and without gaps.

The lower enossal section is usually formed to be rotationally symmetrically cylindrical/tapered, combined rotationally symmetrically cylindrical/tapered, rotationally symmetrically stepwise cylindrical/tapered or combined rotationally symmetrically stepwise cylindrical/tapered. It is preferably provided with a honeycomb structure with tips at the corner points, which is known for its good fusing into the jaw bone.

According to the invention, the upper enossal section displays a shortening in each of the vestibular/buccal and palatinal/lingual directions. Accordingly, the upper enossal

section is designed to be higher at the side points at which it lies against the jaw ridge. In this way, the implant is matched precisely to the patient-specific jaw ridge form, and the bone dehiscences arising from drilling of the implant bed are thus taken into account fully by the implant. The widening of the upper enossal section towards the top achieves a greater bone contact area for implantation and consequently a better hold for the implant in the jaw bone.

The smooth transgingival section is shaped according to the cavity in the patient's gingiva. As a result of this anatomical shaping, the form of the transgingival section in any longitudinal or cross-section plane differs from each correspondingly previous or subsequent longitudinal or cross-section plane.

The transgingival section is limited to the top by an individually formed transgingival implant head whose shape is differentiated three-dimensionally in its height, width and depth, i.e. the implant head represents the “lid section” of the implant. Its form in any longitudinal or cross-section plane similarly differs from each correspondingly previous or subsequent longitudinal or cross-section plane. The encircling edge formed in this way by the transgingival section and the transgingival implant head here corresponds to the preparation boundary and is formed such that, following implantation, it runs slightly, typically 1 mm, below the gingival margin.

The transgingival implant head displays a flat portion at its centre. This is surrounded by a portion which drops off more steeply and connects the flat portion with the transgingival section of the implant. The plateau formed by the flat portion of the implant head is hereby arranged such that its height lies precisely at the height of the upper gingival boundary in the approximal direction.

Due to the matching of the upper enossal section to the patient-specific jaw ridge form, the steeper portion of the implant head is longer and steeper in the vestibular/buccal direction and in the palatinal/lingual direction than in the other directions.

A superstructure is glued or cemented onto the whole area of the implant head by way of its underside, which is matched to the form of the implant head. This joint takes up the majority of the forces acting between the implant and the superstructure. To prevent lateral shifting and to achieve further mechanical stabilisation, an abutment pin is additionally screwed into the transgingival section of the implant approximately at the centre of the preparation area and on its other side joined with the superstructure. The basal surface of the abutment pin lies on the flat portion of the transgingival implant head and acts as a force-compensating tilt-prevention feature and as a feature to take up and distribute forces.

The implant is advantageously produced from a single blank. Suitable materials proven for medical applications are here titanium and zirconium dioxide, as well as all materials suitable for dental implantation.

The dental implant system in accordance with the invention displays several advantages compared to the systems normally used.

One essential advantage of the implant system is the fact that it dispenses with an abutment, which means that there is from the beginning no gap susceptible to bacteriological colonisation in the boundary region between jaw bone and gingiva. As the preparation boundary lies just below the gingival margin, it is accessible for the patient and can be cleaned conveniently by the patient. The necessity of pocket cleaning by the dentist is eliminated. Already during the period of fusing of the enossal section into the jaw bone, furthermore, the implant is at the same time able to fuse with the gingiva in the transgingival region. This is particularly advantageous where the gingiva is still “fresh and bloody” from the implantation procedure. As there is no necessity to clean pockets, it is later also not necessary to detach gingival substance which has already fused to the implant. As a result, expensive and for the patient annoying recall measures are avoided and moreover, as no periodontal pockets are formed as would otherwise be the case, the implant is not perceived as a foreign body by the patient, because

the corresponding oral hygiene measures can be performed simply and above all reliably.

The elimination of the screw joint between implant and abutment excludes the micro-movements between implant and abutment which are otherwise inherent to the design and frequently the cause not only for the breaking of the screw, but also for regression of the surrounding portions of the jaw bone and subsequently furthermore for regression of the gingiva which lies over the jaw bone and is supported and stabilised by that bone.

The individual size and form of the lower enossal section, which is matched to the anatomy of the patient, achieves the largest possible bone contact area. The upwardly widening form and the precise matching of the upper enossal section to the ridge form of the jaw bone, and the resulting full adaptation to the bone dehiscences arising from the drilling of the implant bed, similarly ensures a large area of contact in the upper portion of the jaw bone. Thanks to their structured and rough surfaces, the enossal sections of the implant are able to fuse quickly and reliably with the jaw bone.

The only joint of the dental implant system has been chosen such that, on the one hand, it can be cleaned by the patient himself, and on the other hand, mechanical stresses due to mechanical contact, e.g. with other teeth, are nevertheless for the most part avoided during the healing phase.

Contrary to dental implant systems used to date, in which the mechanical joint between implant and superstructure is achieved predominantly by way of an abutment/abutment pin, the system referred to by the invention uses a large-area, adhesively bonded joint formed by glue or cement between implant head and superstructure to take up the mechanical loads. The prosthetic pin used has a supporting function, prevents lateral shifting during mounting of the superstructure and, through the basal contact on the flat portion of the transgingival implant head, acts as an element to take up forces in the case of laterally incident forces.

In accordance with the invention, it is also proposed to shape the lower and upper enossal sections of the dental implant system such that they are rotationally asymmetrical, wherein the geometry corresponds to the superimposition of at least two rotationally symmetrical bodies, whose axes of symmetry are vertically parallel to each other or else tilted relative to each other such that they intersect at least in the upper enossal section. The geometric bodies also overlap each other at least in the upper enossal section, so that integral, rotationally asymmetrical cross-section areas are formed there. The lower enossal section can be formed like the root of a tooth or else display similarly integral cross-section areas.

Through the rotationally asymmetrical form of the enossal section, the inserted implant and the jaw bone form an abutment which is able to withstand relatively high torsional and tilting loads. At the same time, this design permits unambiguous positioning and fixing of the implant in the jaw bone.

For the parts of the upper and lower enossal sections which display integral cross-section areas, geometries which correspond to the superimposition of cylindrical geometric bodies and conical tips are to be preferred. The cylinders may possess identical or different radii. The axes of symmetry of the bodies are arranged such that they intersect at least in the upper enossal section. The angle of tilting of the axes of symmetry to each other usually amounts to between 1° and 45°.

For parts of the lower enossal section formed like the root of a tooth, geometries which correspond to the superimposition of conical geometric bodies arranged parallel to each other are to be preferred.

The method to produce the dental implant system and to introduce the same into the jaw or mouth of the patient comprises the following steps:

First, the form of the jaw and the form of the gingiva of the patient to be treated are recorded by way of CT (computer tomography), DVT (volume tomography) or alternatively by way of an OPG.

On a blank from which the whole implant is to be produced, the enossal section is first shaped on the basis of the determined anatomical diagnostic data with the aid of CAD/CAM technology. This section is formed to be rotationally symmetrically cylindrical/tapered, combined rotationally symmetrically cylindrical/tapered, rotationally symmetrically stepwise cylindrical/tapered or combined rotationally symmetrically stepwise cylindrical/tapered. To permit good fusing into the bone, the enossal section is provided with a structured surface. The preferred choice is here a proven honeycomb structure with tips at its corner points.

Subsequently, a further enossal section is formed by way of CAD/CAM adjoining the enossal section shaped on the basis of the determined anatomical diagnostic data. For individual adaptation to the jaw ridge form, a greater shortening is here incorporated in the vestibular/buccal direction and a lesser shortening in the palatinal/lingual direction. In this way, the bone dehiscences arising from the drilling of the implant bed are later taken into account fully by the form of the implant.

Thereafter, a transgingival section is produced by manual working or possibly by way of CAD/CAM on the basis of the determined anatomical diagnostic data. The individual shaping results in each longitudinal plane and each cross-section plane of the transgingival section always possessing a form which differs from each correspondingly previous or subsequent longitudinal or cross-section plane.

Subsequently, the transgingival implant head representing the upward limitation of the transgingival section is produced by manual working or possibly by way of CAD/CAM. The implant head is shaped according to the diagnostic survey data pertaining to the form and edge contour of the cavity in the gingiva such that edge formed by the preparation area and the transgingival section runs below the gingival margin after implanta-

tion. A flat portion is formed approximately in the centre of the implant head, surrounded by a portion which drops off more steeply. The steeper portion connects the flat portion and transgingival section. Furthermore, a threaded hole is drilled into the flat portion of the implant head to accept an abutment pin.

Next, the transgingival section and the transgingival implant head are smoothed. The smoothing is done preferably by manual mechanical polishing or by CAD/CAM. Thereafter, the surface of the whole enossal section of the implant is roughened by way of suitable techniques.

The next step is to gradually approach and determine the diameter of the implant bed to be drilled. To this end, the implant bed is first drilled into the jaw bone step by step using corresponding drills, beginning with a diameter approx. 1 mm smaller and progressing to a diameter 0.5 mm smaller than the lower enossal section of the implant. Subsequently, the hardness and quality of the bone is determined from the drill hole and by way of further test procedures. As the bone quality and hardness may alter dramatically during enlarging of the drilled hole, the diameter of the drilled hole is increased gradually in steps of 0.1 mm. After each drilling, the bone quality is determined once more and the diameter of the drilled hole checked with the aid of suitable measuring instruments and methods. The drilled hole is enlarged further step by step until the bone quality and the size of the drilled hole are matched optimally to each other.

Then, the implant is inserted by driving the enossal section into the drilled hole.

Subsequently, the implant heals and fuses into the jaw over a period of 3 to 6 months.

In a further step, a suitable abutment pin is selected or produced. If the implant displays no angulation, then it is possible to use a straight, prefabricated abutment pin with a thread on one side to permit it to be screwed into the transgingival implant head and a peg for fixing to the superstructure on the opposite side. In case of angulation, a sleeve of mould plastic is shaped individually, either subtractively by way of mechanical attrition

or additively by applying wax. The resulting model is subsequently cast in metal according to the lost-mould principle, a screw being inserted through the sleeve in the longitudinal direction and the resulting pin being screwed to the transgingival implant head by way of this screw. Alternatively, the abutment pin may also be produced wholly by way of CAD/CAM.

Furthermore, a superstructure matched individually to the diagnostic data of the patient is produced, e.g. a crown or bridge. When doing so, the underside of the superstructure, which serves as the contact surface to the implant, can be formed on the basis of the already available geometric data of the preparation boundary when shaping the edge, and by way of the inverted data of the surface of the implant head when shaping the topology of the underside surface.

Once the implant has healed and fused into the jaw, the abutment pin is screwed into the threaded hole in the implant head.

Subsequently, the underside of the superstructure which has been formed according to the shape of the implant head is glued or cemented with the whole area of the implant head. As part of the same step, the abutment pin is joined mechanically with the superstructure.

In the following, the invention is explained in more detail by way of four embodiments; schematic representations are first shown for:

Fig. 1: A dental implant with crown (section; view from vestibular side)
Fig. 2: A dental implant (section; view from approximal side)
Fig. 3: A dental implant in a top view

Fig. 1 shows the cross-section, viewed in the palatinal direction, of a one-piece dental implant made of titanium with a crown 10 fixed to said implant. For better illustration,

Fig. 2 shows the cross-section of an implant with prosthetic abutment pin 7, but viewed in the direction of the jaw bone.

The implant comprises a lower enossal section 1, an upper enossal section 2, a transgingival section 3 and a transgingival implant head 4. To produce the implant, section 1 and section 2 are formed by way of CAD/CAM, and section 3 and the transgingival implant head 4 by way of CAD/CAM or by manual working of a blank.

The lower enossal section 1 which sits deep within the jaw bone displays a honeycomb structure on its surface, with tips in each of the corners of the honeycomb. This proven structure permits optimum fusing of the implant into the bone.

Adjoining the lower enossal section 1 is the upper enossal section 2, which is shaped such that its upper edge aligns exactly with the top edge of ridge-form jaw bone 5. To achieve this, the upper enossal section 2 is usually formed to be significantly shorter on the vestibular side and a little shorter on the palatinal side than at all other points. There are cases, however, in which the palatinal side must be formed to be shorter than the vestibular side to achieve precise adaptation to the jaw ridge form. Bone dehiscences arising from the drilling of the implant bed are taken into account fully and anatomically by way of this special form. To achieve furthermore a wide contact area and a better force distribution in the bone 5, the upper enossal section 2 widens towards the top (funnel form). Thanks to the roughened surface, the section 2 is also able to fuse with the jaw bone 5.

The section 2 is followed by the smoothly polished transgingival section 3. This section is formed such that it reaches to approx. 1 mm below the gingival margin on all sides, corresponding approximately to the depth to which also a healthy tooth is not fused with the gingiva but instead merely in loose contact. The smoothly polished titanium surface here permits good and irritation-free fusing of the gingiva 6.

The end of the transgingival section 3, which at the same time represents the preparation boundary 11, marks the transition to the transgingival implant head 4. The implant head 4 comprises a flat, practically level inner portion 12 and a surrounding steeper portion 13; the portions 12/13 (not shown here) may also be combined without a transition, for example in a crowned form. The steeper portion 13 connects the flat portion 12 with the transgingival section 3. Due to the matching of the implant to the ridge form of the jaw bone 5, the portion 13 is mostly significantly longer and steeper in the vestibular/buccal direction and a little longer and steeper in the palatinal/lingual direction than in the other directions.

As can be seen in Fig. 3, there is a threaded hole in the flat portion 12 of the implant for the fixing of the prosthetic abutment pin. Furthermore, a recess 14 is provided in the portion 12 in the form of a partial circular segment to prevent rotation of the crown; to this end, a corresponding mating element is formed on the underside of the crown 10. As can be seen in Fig. 2, an individually produced prosthetic abutment pin 7 is used. This pin also engages in the recess 14 and is this also secured against rotation. If a straight, standardised abutment pin 7 is used, then this pin does not engage in the recess 14 and instead its peg part is merely bevelled. When the pin is later cemented into the crown 10, which is in turn fixed to the implant and secured against rotation by way of the recess 14 and the actual form of the implant head 4 up to the preparation boundary 11, the pin is joined with the crown 10 and thus secured against rotation.

The underside of the crown 10 which serves as the transition to the implant is matched precisely to the form of the implant head 4 down to the preparation boundary 11. It is here an advantage that the already available geometric data of the preparation boundary 11 can be used for the shaping of the edge of the underside, and similarly the inverted geometric data of the implant head 4 can be used to shape the surface of the underside.

Matched in this way, the underside of the crown 10 is bonded with the transgingival implant head 4 over its full area and without gaps using cement or glue. Given the good

accessibility of the preparation boundary 11, it is not a complicated matter to remove any material extruded during the gluing or cementing. In addition, the smooth part of the prosthetic abutment pin 7 is cemented into the crown. The abutment pin 7 is screwed into the implant head 4 with its other side, which is formed as a screw. In this arrangement, the full-area bonding between the crown 10 and the implant takes up a large proportion of the forces arising during chewing. The connection via the prosthetic peg 7 and the area contact on the flat portion 12 of the implant head 4 serves to prevent lateral shifting and assists the taking-up and distribution of shearing forces.

Embodiments of the invention with regard to the enossal section are shown in Figs. 4 to 7, namely the arrangement of the holes drilled in the jaw ridge to create the form of the implant bed and in the end to determine the geometry of the enossal section of the dental implant system. The individual illustrations show:

Fig. 4: The arrangement of two holes drilled offset to each other and the resulting implant bed (in the shape of a figure 8) as a top view;

Fig. 5: The arrangement of three holes drilled in a line with a defined spacing and tilted towards each other (not visible from the illustration) as a top view;

Fig. 6: The arrangement of three holes drilled in the form of an equilateral triangle with a defined spacing and tilted towards each other (not visible from the illustration) as a top view;

Fig. 7: The arrangement of three holes drilled in a line with a defined spacing and tilted towards each other as a side view.

Figs. 4 to 6 each show in their upper drawings the positions of the individual holes 17-19 to be drilled for the implant bed and in their lower drawings the form of the implant bed 20 arising from the overlapping of the drilled holes. The drilled holes are cylindrical and each possess the same diameter.

Fig. 4 depicts two holes, Fig. 5 three holes in a line and Fig. 6 three holes in the form of an equilateral triangle (drilled holes 17-19), these holes having been drilled with a de-

fined spacing and tilted towards each other. In the case of the three drilled holes 17-19 arranged in a line, the resulting implant bed 20 enables the implant to withstand relatively higher torsional loads, whereas the implant bed formed with the three drilled holes 17-19 arranged in the form of an equilateral triangle is less sensitive to tilting moments.

From Fig. 7, it can be seen that, on the one hand, the tips of the drilled holes 17-19 meet at the lowermost point of the implant bed 20, and on the other hand, the drilled holes 17-19 overlap each other over the whole length of the implant bed. This achieves the conical form of the implant bed 20, and thus of the lower enossal section, with a full area to each cross-section.

List of references:

1	Lower enossal section
2	Upper enossal section
3	Transgingival section
4	Transgingival implant head
5	Jaw bone
6	Gingiva
7	Prosthetic abutment pin
8	Thread
9	Threaded hole
10	Crown
11	Preparation boundary/edge
12	Flat head portion
13	Steeper head portion
14	Recess
15	Vestibular/buccal shortening
16	Palatinal/lingual shortening
17-19	Drilled hole
20	Implant bed

Patent claims

1. A dental implant system comprising an implant and a superstructure mounted thereupon, wherein the implant comprises a lower enossal section (1) with a honeycomb-like surface structure, an upper enossal section (2) with roughened surface which widens towards the top, a transgingival section (3) with smooth walls and a transgingival implant head (4) and all these sections are joined to each other without gaps, characterised in that

- the enossal section of the implant displays a rotationally asymmetrical geometry which corresponds to the superimposition of n, where n is at least two, rotationally symmetrical geometric bodies, each in the form of a cylinder with a conical tip, whose axes of symmetry run parallel to each other or tilted relative to each other such that the axes of symmetry intersect at the lower end of the lower enossal section and the axis of symmetry of each geometric body overlaps with each other geometric body,

- and the upper enossal section (2) displays a shortening in the vestibular/buccal direction (15) and a shortening in the palatinal/lingual direction (16), each beginning at the upper end of the upper enossal section (2) and ending at the lower end of the transgingival section (3), whereby the upper enossal section (2) is exactly defined and ends with the bone dehiscences arising from the drilling of the implant bed,

- and the transgingival section (3) is rotationally asymmetrical over its whole course, such that each longitudinal plane and each cross-section plane displays a form which differs from each previous or subsequent longitudinal or cross-section plane and the transgingival section (3) is limited to the top by a transgingival implant head (4) whose shape is differentiated three-dimensionally in its height, width and depth, wherein an encircling edge (11) is defined by way of the transition between implant head (4) and transgingival section (3), whereby the transgingival section (3) is exactly defined and the edge (11) ends at most 1 mm below the upper margin of the gingival cavity arising from drilling of the implant bed.

2. A dental implant system according to Claim 1, characterised in that the implant, comprising the lower enossal section (1), the upper enossal section (2), the transgingival section (3) and the transgingival implant head (4), is designed in one piece.

3. A dental implant system according to Claims 1 or 2, characterised in that the geometry of the upper and lower enossal sections of the implant corresponds to the superimposition of geometric bodies which possess the form of a cylinder with a conical tip, wherein the axes of symmetry of the cylinders run parallel to each other and are spaced to each other in the form of a polygon with n sides.

4. A dental implant system according to any one of Claims 1 to 3, characterised in that the implant is made of titanium.

5. A dental implant system according to any one of Claims 1 to 3, characterised in that the implant is made of zirconium dioxide.

6. A dental implant system according to any one of Claims 1 to 5, characterised in that the implant head (4) displays a flat portion (12) approximately at its centre, bordered by a surrounding portion which drops off (13), whereby the flat portion (12) and the transgingival section (3) are connected to each other.

7. A dental implant system according to any one of Claims 1 to 6, characterised in that the transgingival implant head (4) displays a recess (14) which serves to prevent rotation of the superstructure (10).

8. A dental implant system according to Claim 7, characterised in that the recess (14) possesses the form of a circular segment.

9. A dental implant system according to Claim 7 or 8, characterised in that a prosthetic abutment pin (7) engages in the recess (14).

10. A dental implant system according to any one of Claims 1 to 9, characterised in that the flat portion (12) of the implant head (4) ends at most 1 mm above the edge (11).

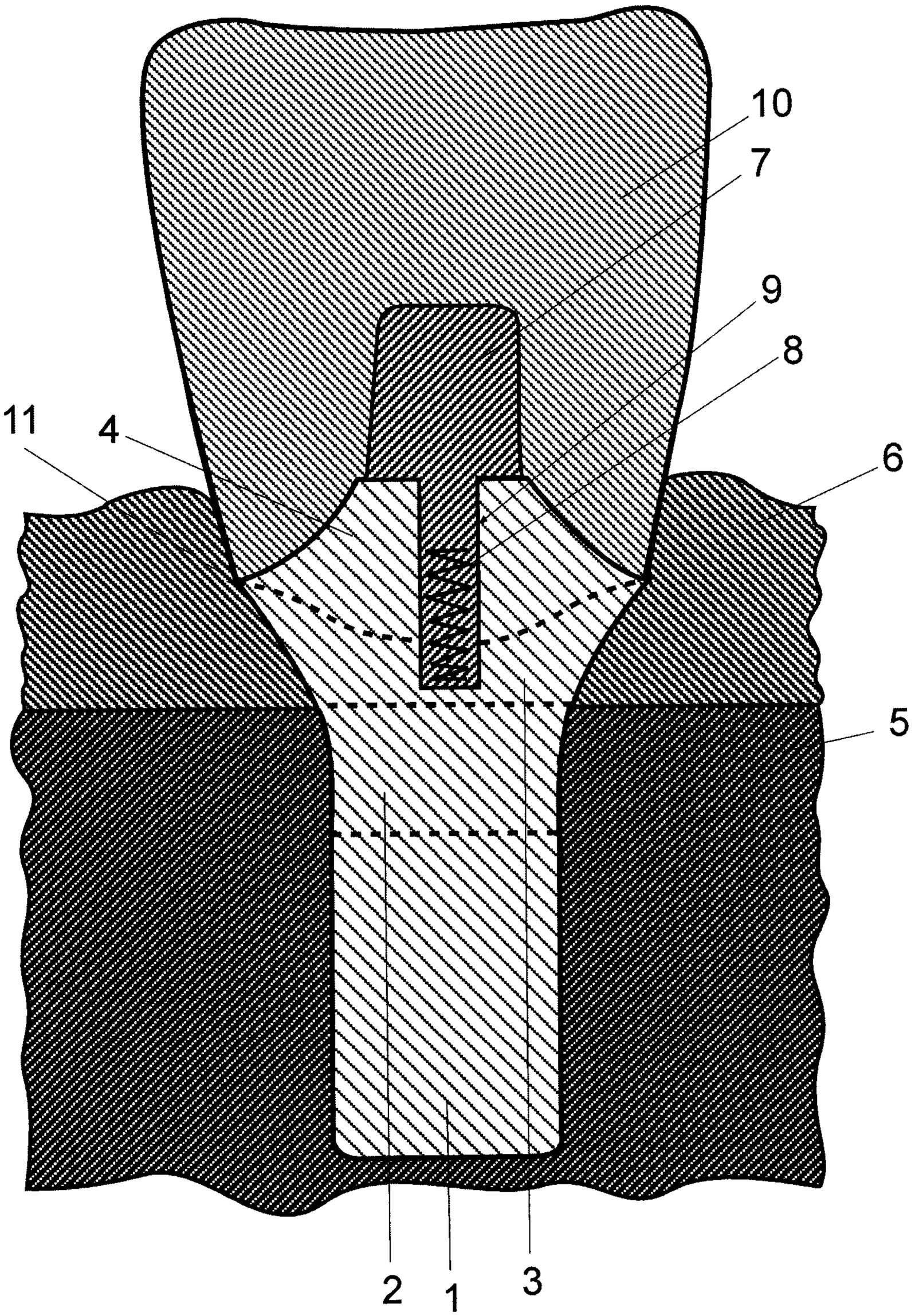


Fig. 1

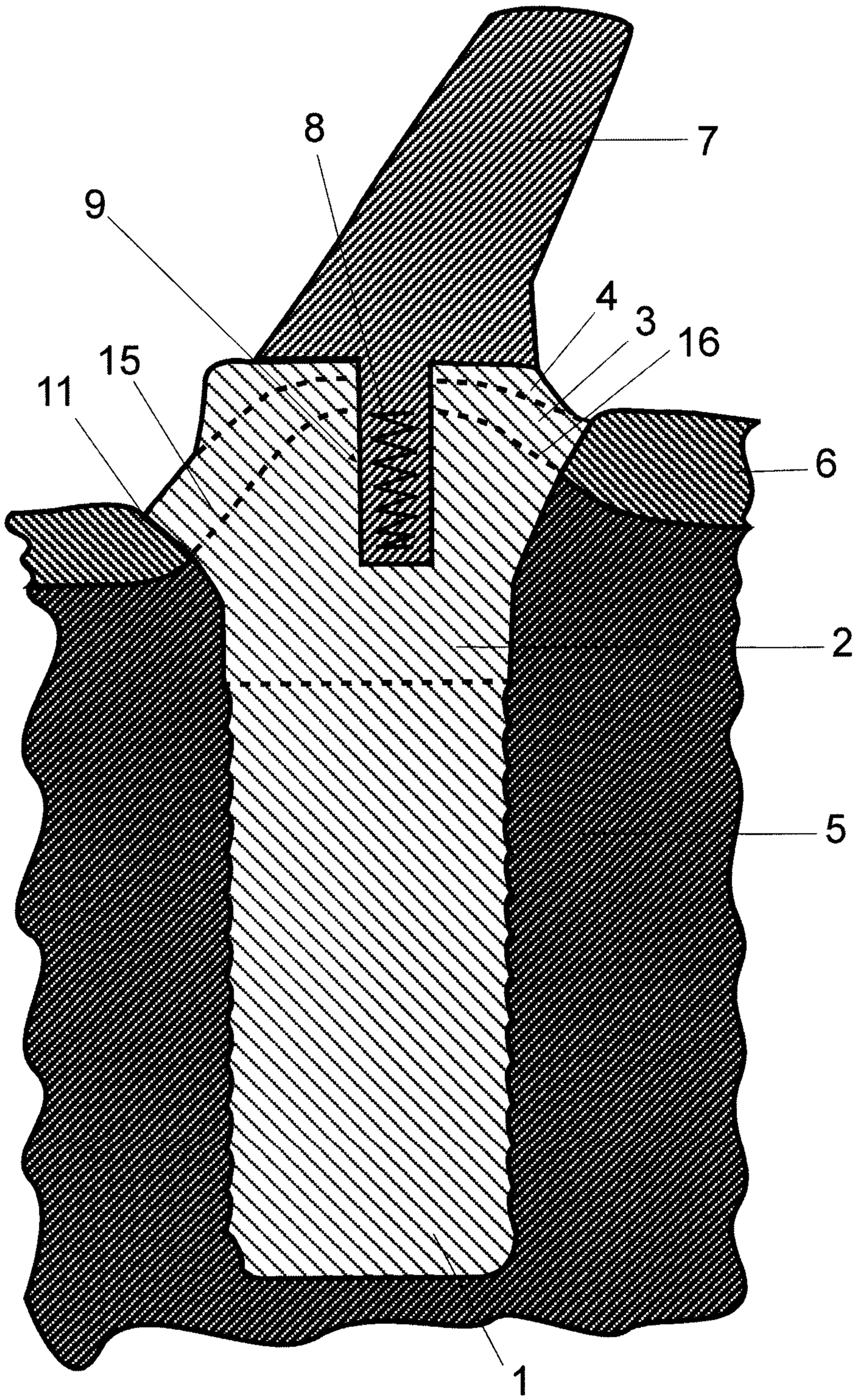


Fig. 2

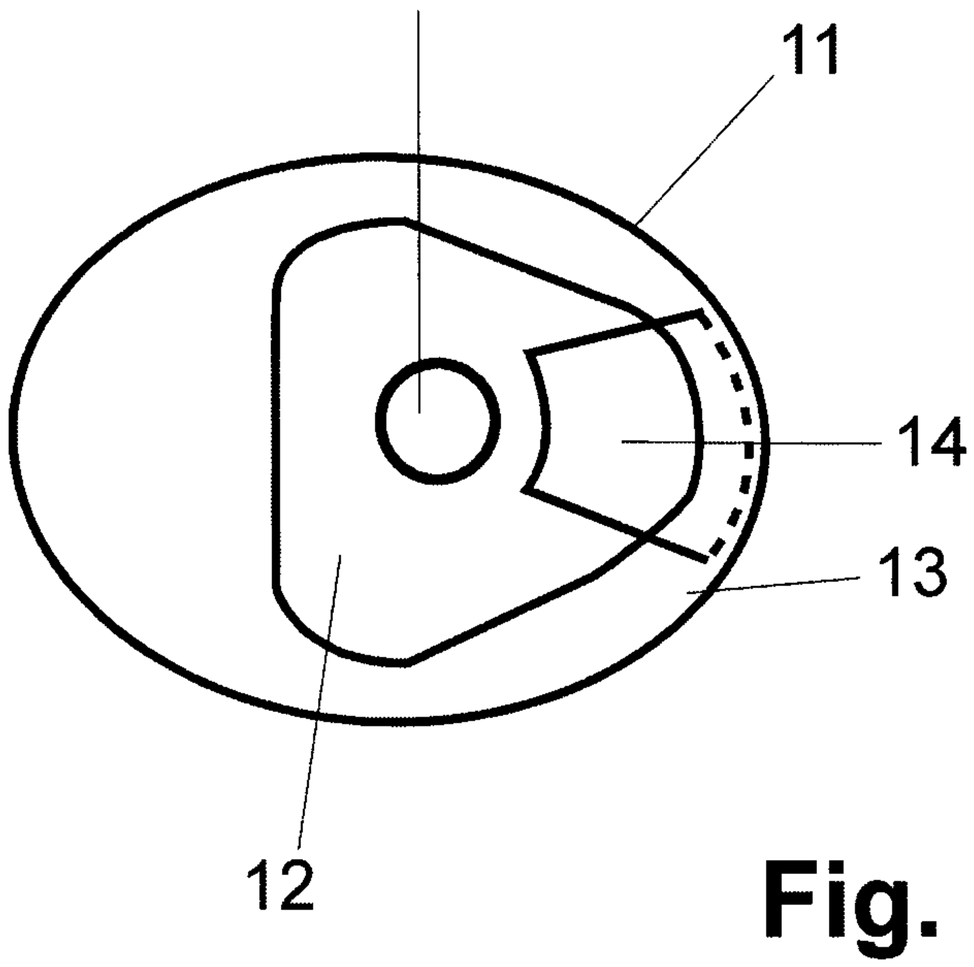


Fig. 3

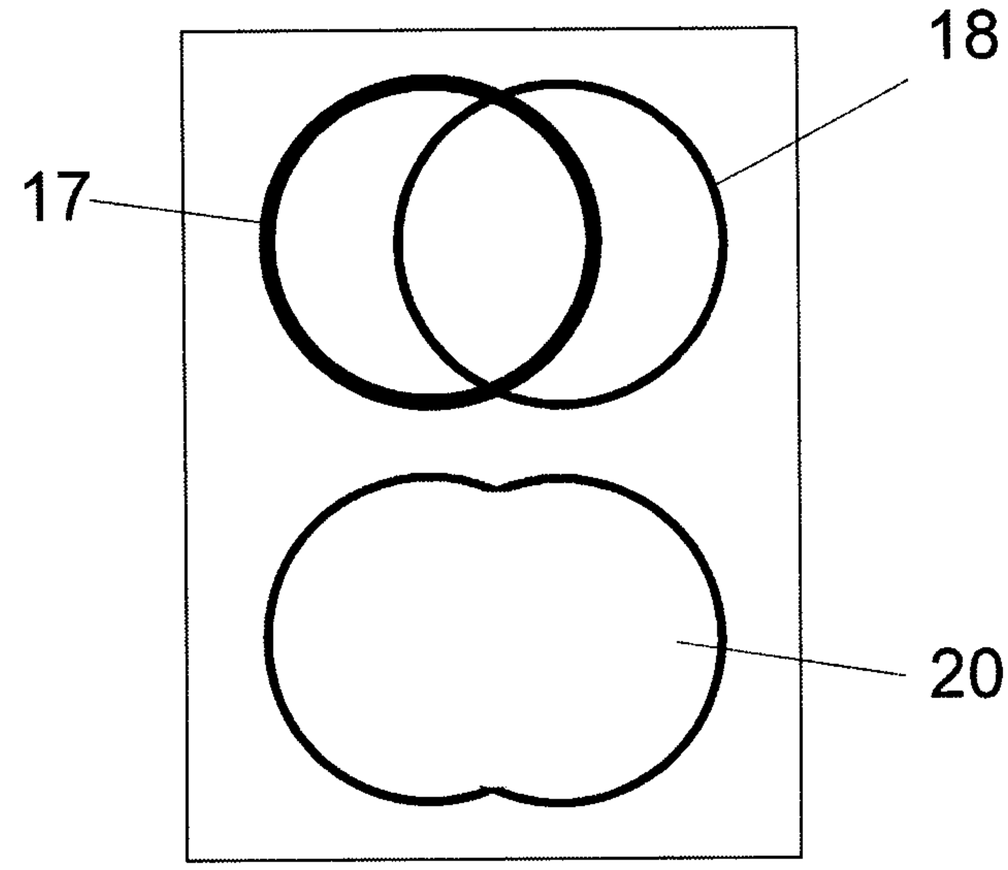


Fig. 4

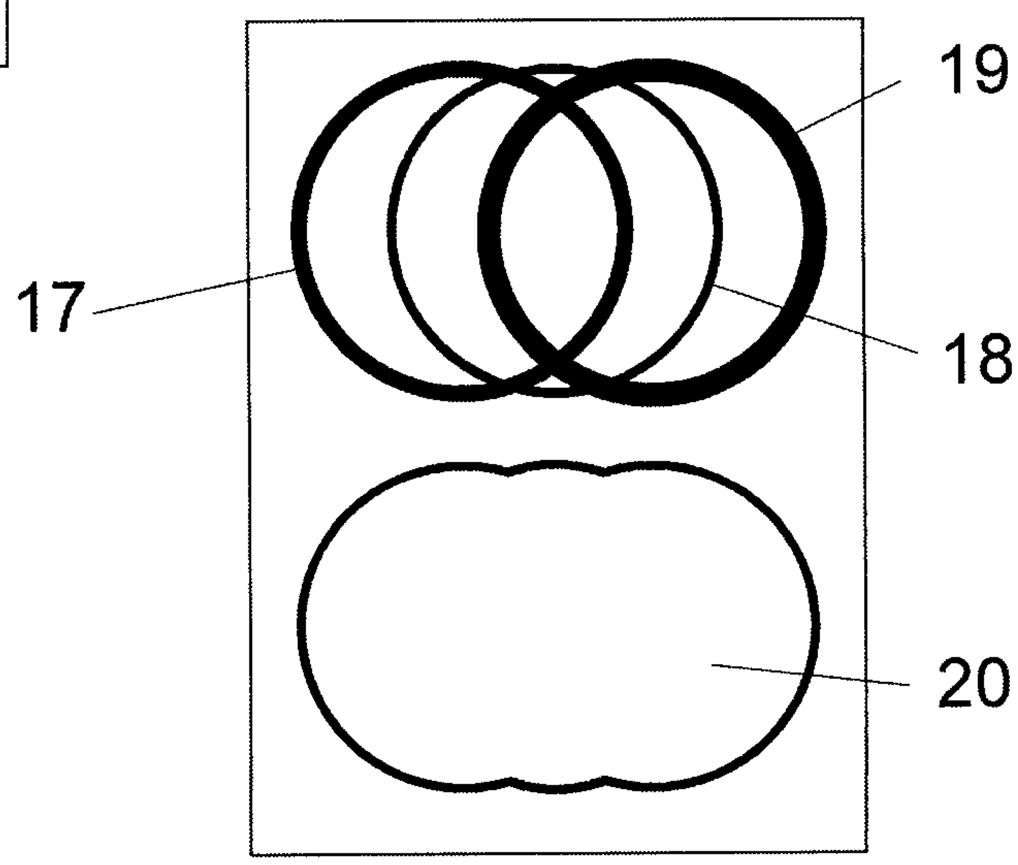


Fig. 5

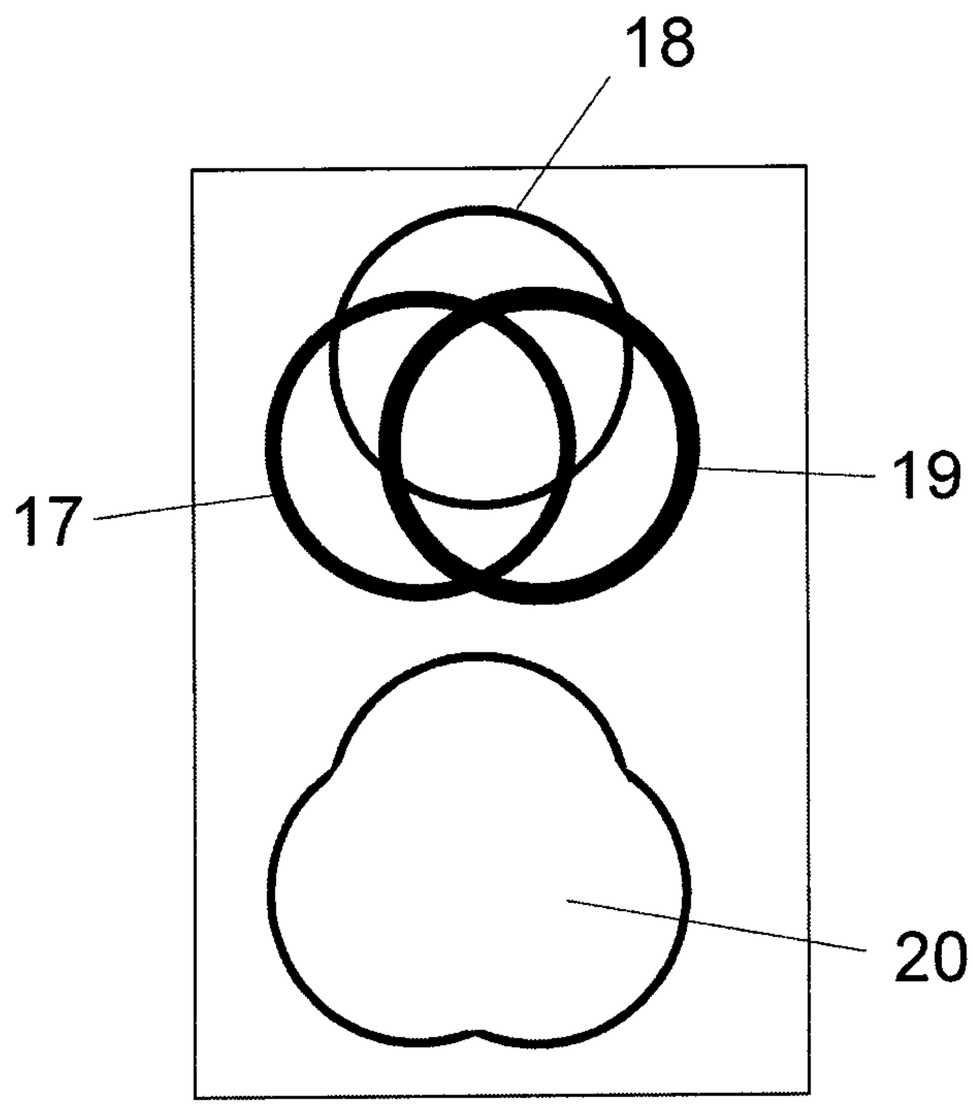


Fig. 6

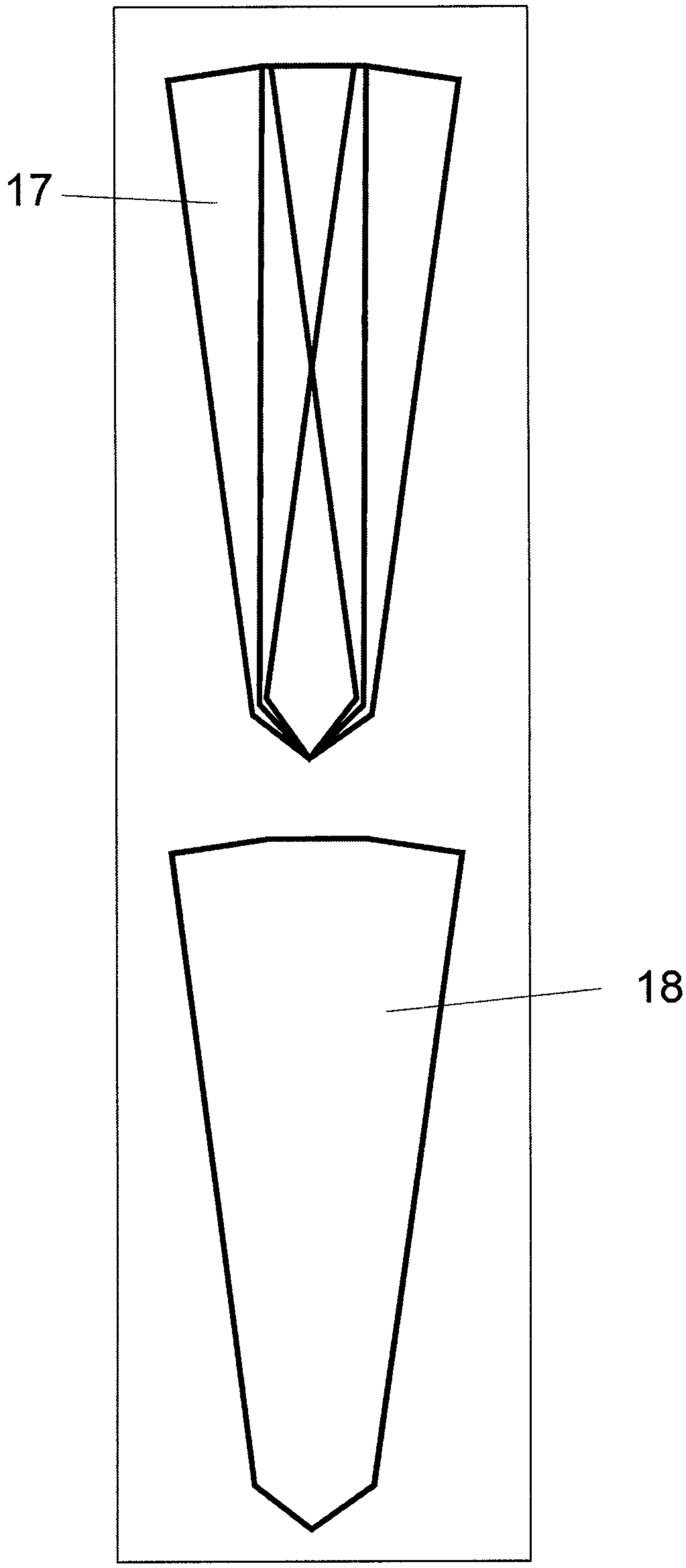
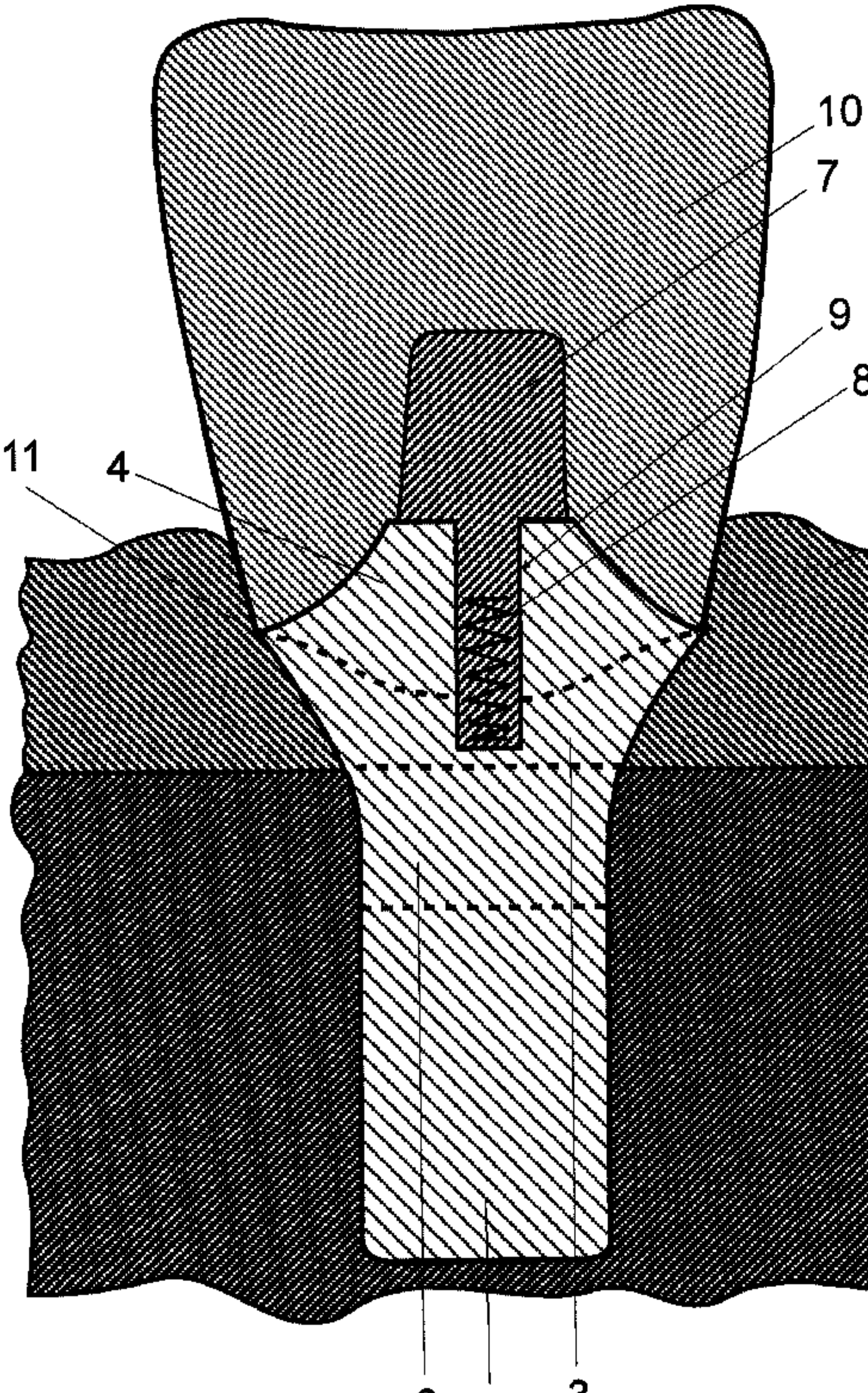


Fig. 7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