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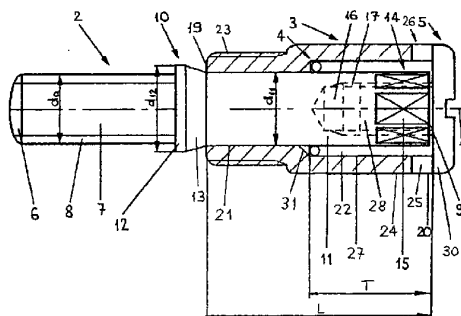
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(54) Title: ENDO-DISTRACTOR

(54) Bezeichnung: ENDO-DISTRAKTOR



(57) Abstract: The invention relates to a device for the distraction of bones or bone segments comprising: A) an anchoring screw (2) which has a threaded shank (7) that abuts on the screw tip (6), and a circular cylindrical and non-threaded screw shank (11) that abuts on the screw end (6), and; B) a distraction sleeve (3) which has a back end (20), a front end (19), a coaxially extending continuous boring (21), an outer thread (23) that abuts on the front end (19), and a coupling means (26) which is provided on the rear end (20) and which is provided for a screwing-in tool, whereby; C) the anchoring screw (2) comprises, between the threaded shank (7) and the screw shank (11), a collar (10) which radially projects from the screw shank (11) and which serves as an axial stop for the distraction sleeve (3) that is slid over the screw shank (11); D) the cross-section of the continuous boring (21) is enlarged along a boring section (22) which abuts on the rear end (20) and which extends to a depth (T), and; E) inside the boring section (22), a seal ring (4) is coaxially arranged between the lateral surface (27) and the screw shank (11).

(57) Zusammenfassung: Vorrichtung zur Distraction von Knochen oder Knochensegmenten mit A) einer Verankerungsschraube (2), welche einen an die Schraubenspitze (6) grenzenden Gewindenschaft (7) und einen an das Schraubenende (6) grenzenden kreiszylindrischen und gewindelosen Schraubenschaft (11) umfasst; und B) einer Distractionshülse (3), welche ein hinteres Ende (20), ein vorderes Ende (19), eine

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Zur Erklärung der Zweibuchstaben-Codes, und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

Veröffentlicht:

— mit internationalem Recherchenbericht

koaxial verlaufende Durchgangsbohrung (21), an das vordere Ende (19) angrenzend ein Aussengewinde (23), und am hinteren Ende (20) Kupplungsmittel (26) für ein Eindrehwerkzeug aufweist, wobei C) die Verankerungsschraube (2) zwischen Gewindenschaft (7) und Schraubenschaft (11) einen radial über den Schraubenschaft (11) vorstehenden Bund (10) umfasst, welcher als axialer Anschlag für die über den Schraubenschaft (11) geschobene Distraktionshülse (3) dient; D) die Durchgangsbohrung (21) auf einem an das hintere Ende (20) angrenzenden und bis zu einer Tiefe (T) reichenden Bohrungsabschnitt (22) im Querschnitt erweitert ist; und E) ein Dichtungsring (4) im Bohrungsabschnitt (22) koaxial zwischen Mantelfläche (27) und Schraubenschaft (11) angeordnet ist.

Endo-Distractor

The invention relates to an apparatus for the distraction of bones or bone segments.

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In modern surgical operative technique, external or also internal distractors are used to bring about a controlled displacement of bone fragments relative to one another. Endo-distractors are especially suitable for oral surgery, as they allow to minimise the disturbance of the patient during the distraction process which
10 may often take several weeks.

Distractors are also used with toothless jaws in cases of advanced atrophy of the mandible. Apart from the cosmetic aspect, mandibular atrophy may also create difficulties for the implantation of the set of artificial teeth. The absence of
15 the necessary bone substance may lead to a loosening of the implants or even to a fracture of the mandible. A pathological atrophy of the mandible is not only observed with old patients but may occur even with a 40-year-old patient, in which case the decision in favour of an operative intervention is greatly facilitated.

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In order to rebuild the mandible, an osteotomy of the mandible is realised in a horizontal direction. Subsequently, the osteotomy gap is continuously increased. This distraction of the osteotomy gap is carried out at a rate on the order of about $\frac{1}{2}$ mm per day. During the slowly advancing process of
25 distraction, osseous tissue is formed in the osteotomy gap. After completion of the distraction, the osteotomy gap has to be maintained at the right distance for a certain period of time.

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It is, therefore, an object of the invention to create an endo-distractor which
30 restricts the freedom of movement of the patient only marginally.

Broadly, the present invention provides a device for the distraction of bones or bone segments including: an anchoring screw which includes a longitudinal axis, a screw tip, a screw end with means for rotatably driving the anchoring screw, a threaded shank which adjoins the screw tip and has a screw thread, and a circular cylindrical and non-threaded screw shank adjoining the screw end; and a distraction sleeve axially displaceable on the screw shank which has a rear end, a front end, a continuous bore extending coaxially between the rear end and the front end, an external screw thread adjoining the front end, and coupling means formed in the rear end for receiving a screwing-in tool. The anchoring screw includes a collar arranged between the threaded shank and the screw shank which radially projects at least from the screw shank and which serves as an axial stop for the front end of the distraction sleeve that is slid over the screw shank. The continuous bore has a bore section with an enlarged cross-section which adjoins the rear end and extends to a depth (T), the bore section being provided with a lateral surface. A seal ring is coaxially arranged between the lateral surface and the screw shank.

In one embodiment, the inventive device for the distraction of bones or bone segments comprises an anchoring screw having a longitudinal axis, a threaded shank, a circular cylindrical screw shank, and a screw end provided with means for rotatably driving the anchoring screw, as well as a distraction sleeve axially displaceable along the screw shaft which is shaped in a hollow cylindrical form extending coaxially to the longitudinal axis and is provided with a rear end, a front end, a circular cylindrical, continuous bore, an external screw thread adjoining the front end, and a coupling means formed on the rear end for receiving a screwing-in tool. In addition, the anchoring screw comprises a collar located between the threaded shank and the screw shank and projecting radially at least over the screw shank so as to serve as an axial stop for the front end of the distraction sleeve that is slid over the screw shank. The continuous bore (hereinafter also called "continuous boring") comprises a bore section (or "boring section") with an enlarged cross-

section in which a seal ring is coaxially arranged between the lateral surface of the boring section and the screw shank. The external screw thread formed on the distraction sleeve is preferably realised as a left-hand thread.

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In the preferred embodiment of the device according to the invention, the collar is shaped in the form of a cone which leads to the screw shaft. Thus, the contact surface between said cone and the front end of the distraction sleeve is minimised, which has the advantageous result that in spite of the axial load existing between the anchoring screw and the distraction sleeve, the anchoring screw remains easily rotatable about the longitudinal axis. Instead of being conical, the transition segment may also be spherically convex.

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Depending on the type of seal used, the transition segment between the boring segment with enlarged cross-section and the continuous boring of the distraction sleeve may be shaped either in the form of a plan surface or of an inner cone leading to the continuous boring. Thus, a suitable axial contact surface for the seal ring may be obtained.

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The device according to the invention comprises in addition a cover screw which may be screwed into a bore formed on the screw end and provided with an internal screw thread. The cover screw forms the mechanical seal of the distractor in the oral cavity and, in addition, secures the anchoring screw in its position relative to the distraction sleeve.

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In a further embodiment of the device according to the invention, the screw thread is realised in the form of a self-tapping screw thread which may be provided with one or

several cutting grooves. The outside diameter of the screw thread may be in a range of between 2.2 mm and 3.5 mm, but is preferably 2.7 mm. The thread profile is asymmetrical, the flanks of the screw thread directed towards the screw tip preferably forming an angle of between 80 and 90 degrees relative to the longitudinal axis. The pressure load is thus transmitted in a substantially axial manner to the cancellous bone. The diameter of the screw shank may be in a range of between 1.8 mm and 2.5 mm, but is preferably 2.2 mm. The means for driving the anchoring screw must not radially project from the screw shank and may, for example, consist of surfaces evenly arranged in a polygonal pattern on the periphery of the screw shank so as to form preferably a square or a hexagon.

The external screw thread formed in the distraction sleeve may equally be advantageously provided with an asymmetrical thread profile, the flanks of the screw thread directed towards the rear end forming an angle of between 80 and 90 degrees relative to the longitudinal axis. Here again, a substantially axial transmission of the pressure load to the bone may be obtained.

Further advantageous embodiments of the invention will be characterised in the dependent claims.

The advantages achieved by the present invention consist essentially in the fact that due to the device according to the invention:

- the distraction force is applied in the centre of gravity of the distraction so that the distraction device is exclusively exposed to axial pressure and not to any

flexural strain. This makes it possible to create an endo-distraction device having small dimensions;

- the distraction occurring subsequently to the osteotomy may begin horizontally offset, representing at the same
5 time a horizontal displacement osteotomy, the offset being carried out in a controlled manner;
- the distraction following the osteotomy may be carried out in different directions, depending on the angle relative to the osteotomy plane selected for the bore
10 designed to receive the endo-distractor; It is thus possible to take corrective measures in cases of a defective relation of the crests of the maxilla and the mandible as a preparation for a prosthetic appliance to be placed subsequently;
- 15 - the distraction sleeve, together with its cover screw, may serve to stabilise a temporary prosthesis during the retention period of several months and may assume a function comparable to that of a dental implant;
- putting load on the endo-distractor and, as a
20 consequence, on the freshly distracted bone at an early stage provides a great deal of functional stimuli and thus leads to an accelerated bone formation in the distraction area;
- the screw thread of the distraction sleeve is
25 counterrotating and is thus secured against being screwed off in the course of the distraction;
- after the removal of the distraction sleeve, the left-hand thread of the latter leaves behind a left-hand thread formed in the bone. This thread, together with the right-
30 hand thread formed in the lower bone segment, simultaneously has the function of a pilot bore for the implant to be placed in the course of the same surgical intervention once the endo-distractor has been removed.

These threaded bores therefore represent at the same time the pilot bores for receiving the dental implant to be subsequently inserted;

- the osseous left-hand thread of the hollow implant, after
5 the cutting of a right-hand thread for the dental implant, results in a reliable, new bone thread providing a good primary seat for the dental implant. The two counterrotating threads cross at different positions, depending on the difference in their respective thread
10 pitches; and
- for the reason mentioned above, all types of dental implant can be used, no matter what kind of screw thread they may have, and the surgeon is not limited to a particular type of implant to be used for the prosthetic
15 treatment.

With the aid of the device according to the invention, a distraction of the mandible may be realised using the following surgical technique:

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- The mandible is split horizontally using accesses that avoid excessive soft-tissue damage (osteotomy). Depending on the situation, two or several endo-distractors according to the invention are used. The anchoring screws of the
25 endo-distractors are passed through the cranial bone segment and the osteotomy gap and are then inserted into the caudal bone segment. The anchoring screws are screwed into the caudal bone segment until their threaded tips protrude from the opposite side thereof. The excessive
30 length corresponds to the amount of distraction to be obtained for the osteotomy gap. The distraction sleeves are inserted into the cranial bone segment and prevent the anchoring screws from moving in the cranial direction.

The actual distraction process takes place during several days or weeks and in most cases is carried out by the patient him-/herself. To this purpose, the patient turns
5 back the anchoring screw by about $\frac{1}{2}$ mm per day. As the distraction sleeve prevents the anchoring screw from being screwed out in the cranial direction, the cranial bone segment is lifted in the cranial direction by means of the distraction sleeve.

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The advantage of this surgical technique is that it may be realised with a relatively unsophisticated technical equipment as far as the implants are concerned and that the latter have a small volume.

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It allows in particular a vertical distraction of the alveolar processes of the maxilla and the mandible according to the Salzburg concept. It is of particular advantage if prior to the insertion of the implants the
20 alveolar process can be "rebuilt" to its initial height;
- the distance between the toothless alveolar processes of the maxilla and the mandible corresponds again to the height of natural teeth and the implant structures are low and therefore resistant;
25 - there are no recesses under the implants which are difficult to clean; and
- after completion of the distraction, the mandible has recovered its normal height and width and is capable of receiving long and stable implants, without running the
30 risk of a spontaneous fracture.

The endo-distraction implant according to the invention presents the following differences as compared to other known hollow implants:

- 5 1. The abutment (with axial and radial function) for the anchoring screw is integrated into a distraction sleeve inserted into the outer bone segment which does not need to have an internal screw thread and keeps the anchoring screw sealed tightly against bacteria and saliva by means of
10 O-rings during the entire distraction and retention period.
2. The anchoring screw is no longer guided by means of a metallic screw thread but is inserted directly in a threaded bore tapped into the osseous substance of the bone
15 segment situated on the opposite side of the osteotomy gap.
3. A secure guidance and directional stability of the distraction process is ensured by the threaded bore formed in the cortical bone.
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4. The distraction always occurs in the central part of the bone.
5. No part of the osteotomy line is covered on the outside
25 by metal, which is an ideal condition for callus formation.
6. The spare length of the anchoring screw corresponding to the extent of distraction required is always hidden deep in the soft tissues on the side opposite to the side on which
30 the device is readjusted and, for this reason, does not entail any negative effect on the patient.

7. The device according to the invention realised in the form of an endo-distraction implant may be used in two basic modes of application, each mode of application showing two different types which may be mutually combined:

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Mode of application a): As a distraction device in which the osteotomy fragment situated distally relative to the skin or the mucous membrane and provided with the bone thread for receiving the anchoring screw forms the stationary part, whereas the osteotomy fragment facing the skin or the mucous membrane and lodging the distraction sleeve forms the mobile part that is displaced relative to the stationary, principal fragment during the distraction treatment. This mode of application is used, for example, for distractions of the alveolar processes of the maxilla and the mandible extending over a large surface, for local distractions of the alveolar crest, distractions of the cheekbone, distractions of the mandibular neck, and for other osseous regions of the body, such as finger distractions.

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Mode of application b): As a distraction device in which the osteotomy fragment situated distally relative to the skin or the mucous membrane and provided with the bone thread for receiving the anchoring screw forms the mobile part, whereas the osteotomy fragment facing the skin or the mucous membrane and lodging the distraction sleeve forms the stationary part which pushes away the mobile bone part with the bone thread during the distraction treatment. This mode of application is used, for example, for chin augmentation distractions, augmentation distractions of the border of the mandible, bone transport in cases of deficiencies in the ramus of the mandible in combination

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with a functionally dynamic bridging plate, and for other osseous parts of the body.

c) Type 1: Utilisation of the inventive device embodied as
5 an endo-distraction implant in which the distraction sleeve including a stop for the anchoring screw is an implant screwed into the bone and thus rigidly connected to the osteotomy segment. This implant type is used, for example, for distractions of the alveolar processes of the maxilla
10 and the mandible extending over a large surface and for local distractions of the alveolar processes.

d) Type 2: Utilisation of the inventive device embodied as an endo-distraction implant in which the abutment including
15 a stop for the anchoring screw is stabilised straight or at various different angles relative to the bone, as required, by means of small miniature plates using specially designed screws. This implant type is used, for example, for cheekbone distractions, for chin augmentation distractions,
20 augmentation distractions of the border of the mandible, distractions of the mandibular neck, and bone transport in cases of deficiencies in the ramus of the mandible in combination with a functionally dynamic bridging plate.

25 The endo-distraction implant according to the invention may be used for the following areas of application:

1. distraction of the alveolar processes of the mandible extending over a large surface;
- 30 2. distraction of the alveolar processes of the maxilla extending over a large surface;

3. local distraction of the alveolar crest;
4. cheekbone distraction;
- 5 5. chin augmentation distraction;
6. augmentation distraction of the border of the mandible;
7. distraction of the mandibular neck;
- 10 8. bone transport in cases of deficiencies in the ramus of the mandible in combination with a functionally dynamic bridging plate;
- 15 9. in other osseous parts of the body, such as finger distractions.

For the prosthetic structures the following implant systems are primarily envisageable:

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 - Ankylos implants
 - Bonefit implants
 - Frialit II implants
 - Brånemark implants

25 The distraction sleeve of the inventive device embodied as an endo-distractor has several functions:

1. Abutment for lifting the upper osteotomy segment;
- 30 2. Gingiva former in view of the implant to be subsequently inserted;

3. Protected access to the internal screw, permitting to turn said screw;

4. Sealing possibility by means of kneaded wax due to the countersinking of the internal screw. A difference in level of 0.5 mm between the upper edge of the distraction sleeve and the end of the anchoring screw seems to be sufficient in order to safely lodge the bead of kneaded wax; and

5. Sleeve for receiving O-rings ensuring a tight sealing of the bone against saliva and bacteria.

The cover screw seals the dead space of the distraction sleeve, it has a function similar to that of a gingiva former and offers some degree of support for a temporary prosthesis.

The implantation is preferably carried out according to the following method:

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- surgical instructions concerning the distraction of the anterior mandible;

- anaesthesia;

- preparations;

25 - surgical drawing;

- type of incision;

- measuring;

- planning of the horizontal osteotomy;

- horizontal osteotomy;

30 - drilling of bores for receiving the implant;

- tapping:

- 2 x tapping of a left-hand thread ($\varnothing$ 4.0 mm) in the upper segment:

Equally by means of the ratchet and with sufficient cooling, the threads for [...] until all the bone chips have been removed from the bone threads.

- screwing in of the implants:

5 screwing in of the left-hand threaded, hollow implants provided with O-ring seals:

Using an adequate crown spanner and the ratchet, the two distraction sleeves are screwed completely into the two threads formed in the upper segment. In doing so, attention must be paid that the two O-rings placed within the distraction sleeve will not get lost, as they ensure that saliva, food residues, and germs are prevented from reaching the bone.

- securing of the implant;

15 - osteoplasty;

- wound closure;

- early postoperative period;

- distraction period;

- retention period; and

20 - insertion of the dental implants.

Once the ossification has been completed satisfactorily, the dental implants may be inserted.

25 It is important to use the longest implants available, as only long implants are apt to reach also the caudal osteotomy fragment, i.e. to bridge the distraction gap, which is necessary in order to counteract the tendency towards shrinking of the newly formed bone substance. In order to remove the inventive endo-distraction implants, a simple section of the crest of the mandible is performed, directly laying open the implant region. Positional records relating to the insertion of the implants are helpful for

finding the location of the lateral implants at a safe distance from the mental nerve. First, the outer implants are inserted in the usual manner. Drilled bone chips occurring during the insertion of these implants are
5 carefully harvested using the bone aspirator and temporarily stored in a cell nutrient solution. Subsequently, the distraction sleeves are screwed out clockwise (left-hand thread) using the crown spanner and the ratchet, after which the anchoring screws are screwed
10 out anti-clockwise (right-hand thread) by means of their specific spanner. The following step consists in the bone preparation for the two mesial implants, great care being taken to temporarily store every bone fragment which can be harvested in a cell nutrient solution. In case of
15 dehiscences occurring in the region between the inserted implants and the bone, these are carefully curetted and filled up with bone chips and bone meal. A semi-permeable membrane placed over the implant prevents bone resorption and the ingrowth of connective tissue. After the
20 mobilisation of the mucous membranes, these are closed in two layers using slowly resorbable sutures. The sutures are removed two weeks after the implantation. A temporary prosthetic appliance can be made one week after the insertion of the implants at the earliest. Attention must
25 be paid to ensure that the centric occlusion is absolutely correct and that the prostheses are repeatedly padded in short intervals.

The principal advantage of the device according to the
30 invention consists in the fact that the oral vestibule does not need to undergo a second surgical intervention which would otherwise be necessary to remove parts of the implant. In addition, the initially drilled bores can be

used for the insertion of the final dental implant, which may be carried out under local anaesthesia in a simple manner easily acceptable for the patient.

5 Further advantages are as follows:

- The part of the endo-distraction implant to be worked on is always located at the same height relative to the surface of the skin or the mucous membrane, so that the
10 temporary prostheses can be made at an early stage;

- The number of implant parts may be reduced from at least three to no more than two;

15 - The distraction may be started in a controlled manner even with an offset relative to the osteotomy plane;

- By using different bore angles, the distraction may take place at various angles of inclination, depending on the
20 specific requirements;

- The implant may be completely removed in a very easy manner by simply screwing out the distraction sleeve and the anchoring screw;

25 - Once the implant has been removed, the final dental implant may immediately be inserted using any of the commercially available implant systems, so that no further surgical intervention will be necessary.

30 - The distraction system, which is reduced to an absolute minimum, is easy to use and requires only a very few instruments for its handling;

- Though suitable for a wide range of applications, the distraction system is always identical as to its setup, so that one can easily become skilled at the manipulation of the system, which is universally applicable, using always the same functional elements.

- During the insertion process, no parts undergo mechanical deformation, so that any damage of an implant, which might otherwise occur during adaptation works even before the implant is used, can be ruled out right from the beginning; and

- if in the course of a surgical intervention the application of a distraction device has failed, said distraction device may simply be inserted on another location, as the device is completely undamaged and shows no traces of prior use.

If two distraction devices according to the invention are required in order to prevent twisting and to obtain a better distribution of the distraction forces, the following two possibilities for doing so may be envisaged:

a) The two endo-distraction implants are inserted parallel to each other at a wide distance: The daily distraction by an equal amount on both sides is achieved by turning on both devices in an exactly identical manner by means of a spanner (a mark on the spanner is necessary).

b) Two devices are inserted at a narrow distance to each other and are manipulated by means of an attachment which simultaneously rotates the two threaded rods by an

identical angle of rotation in the same direction of rotation, thus causing a parallel distraction. An attachment of this type works with three serially interlocked gears the middle one of which being in
5 engagement, by its axis, with the spanner, whereas the two outer gears drive the threaded rods by means of their axes.

In addition, the following further advantages may be achieved by means of the device according to the invention:

10 - The left-hand thread of the hollow implant provides additional security while the right-hand thread of the threaded rod is used during the distraction. Should the hollow implant have become slightly loosened within the bone thread of the upper osteotomy segment, said implant is
15 tightened again by the torque of the threaded rod as said threaded rod is screwed out;

- A substantial improvement consists in the simplified setup of the device, as the three component parts of former
20 devices have been reduced to an absolute minimum of two component parts;

- Furthermore, one and the same device may be used as an all-purpose device for the most diverse areas of
25 application;

- No necessity of further surgery for the removal of the device, as this intervention coincides with the insertion of the dental implants and, in addition, provides the bores
30 required for the dental implants;

- Tight sealing of the bone against saliva and bacteria on the distraction site;

- No unnaturally shaped parts are required, neither in the oral cavity nor outside in the area of the face, so that no disfigurement occurs and the patient feels no embarrassment
5 in pursuing such activities as eating, speaking, or mouth hygiene;

- The endo-distractor according to the invention has the external shape of a single-tooth implant and is capable of
10 providing support even during the retention period, similar to a tooth or a dental implant; and

- The endo-distractor according to the invention is small but efficient as to the distraction length it allows, it
15 acts in the centre of the bone in the structurally most favourable region, and the component parts are exclusively exposed to axial, compressive and tensile stress (absence of any lateral shear forces and flexural stresses that are typical of many other known devices), which ensures the
20 greatest possible protection against fractures due to material fatigue.

In the following, the invention and improvements of the invention will be illustrated in greater detail with
25 reference to the partially diagrammatic representations of several embodiments.

In the drawings:

30 Fig. 1 shows a longitudinal section of the preferred embodiment of the device according to the present invention;

Fig. 2 is a sectional view of a mandible at the beginning of the distraction process, including a device according to the invention inserted therein;

- 5 Fig. 3 is a sectional view of a mandible during the distraction process, including a device according to the invention inserted therein; and

- Fig. 4 is a sectional view of a mandible during the
10 distraction process, including two devices according to the invention inserted therein.

- Fig. 1 shows a preferred embodiment of the device according to the invention. Said device comprises an anchoring screw
15 2 having a longitudinal axis 1 as well as a distraction sleeve 3 extending coaxially to the longitudinal axis 1, a seal ring 4, and a cover screw 5. The anchoring screw 2 includes a threaded shank 7 which adjoins a rounded screw tip 6 and has a screw thread 8 that extends over
20 approximately half of the anchoring screw 2 and is provided with an outside diameter d_a . Said threaded shank 7 is adjoined respectively by a collar 10 and a circular cylindrical screw shank 11 with a diameter d_{11} which are axially arranged in the mentioned order in the direction of
25 the screw end 9. The screw thread 8 is asymmetrically shaped, forming an angle of 87 degrees between the flanks of the screw thread directed towards the screw tip 6 and the longitudinal axis 1. Facing the threaded shank 7, the collar 10 has a circular cylindrical section 12 with a
30 diameter d_{12} , said diameter d_{12} being superior to the outside diameter d_a and superior to the diameter d_{11} of the screw shank 11. Facing the screw shank 11, the collar 10 comprises a cone 13 which leads in a conically tapered

manner from the section 12 to the screw shank 11. Arranged on the screw shank 11 in the area of the screw end 9, the means 14 for driving the anchoring screw 2 are realised in the form of a hexagon consisting of six surfaces 15 regularly arranged about the periphery of the screw shank 11. The screw end 9 is provided with a bore 16 extending coaxially to the longitudinal axis 1 and provided with an internal screw thread 17.

- 10 The distraction sleeve 3 is shaped in the form of a hollow cylinder extending coaxially to the longitudinal axis 1 and has a front end 19, a rear end 20, and a length L extending parallel to the longitudinal axis 1. The distraction sleeve 3 comprises an external screw thread 23 beginning on the front end 19 and extending over half of the length L, whereas the sleeve segment 24 that adjoins the rear end 20 has an enlarged diameter and is provided with four slots 25 arranged on the rear end 20 and extending orthogonally relative to one another so as to serve as a coupling means 26 for receiving a screwing-in tool. The continuous boring 21 extending coaxially to the longitudinal axis 1 is of circular cylindrical shape and has a diameter that permits the distraction sleeve 3 to be axially displaced along the screw shank 11. Beginning from the rear end 20, the continuous boring 21 has a boring section 22 with an enlarged cross-section which penetrates to a depth T, the boring section 22 conically leading to the continuous boring 21 with half a cone angle of 60 degrees and the depth T being dimensioned in such a way that the boring section 22 does not extend over the entire sleeve segment 24. The distraction sleeve 3 may be slid over the screw shank 11 from the screw end 9 until its front end 19 abuts on the cone 13, the distraction sleeve 3 remaining freely

rotatable on the screw shank 11 about the longitudinal axis 1 and the rear end 20 projecting over the screw end 9.

Between the lateral surface 27 of the boring section 22 and
5 the screw shank 11, a seal ring 4 is arranged which ensures a tight sealing between the oral cavity and the mandible.

In addition, the device comprises a cover screw 5 the threaded portion 28 of which may be screwed into the
10 internal screw thread 17 formed in the screw end 9 until the screw head 30 abuts on the rear end 20 of the distraction sleeve 3.

Figs. 2 and 3 illustrate a distraction process through the
15 example of a mandible 33 having undergone osteotomy and presenting the osteotomy gap 32. The drawings show in particular a distraction process according to the mode of application a) in which the alveolar process is displaced in the cranial direction. As described above, the anchoring
20 screws 2 of the endo-distractors are passed through the cranial bone segment 34 and through the osteotomy gap 32 and are then inserted into the caudal bone segment 35. The anchoring screws 2 are screwed into the caudal bone segment 35 until their threaded tips 6 protrude from the opposite
25 side thereof. The excessive length corresponds to the amount of distraction to be obtained for the osteotomy gap. The distraction sleeves 3 are inserted into the cranial bone segment 34 and prevent the anchoring screws 2 from moving in the cranial direction. As the anchoring screw 2
30 is screwed backwards, the cranial bone segment 34 is lifted in the cranial direction by the action of the distraction sleeve 3, while the caudal bone segment 35 remains stationary.

Fig. 4 equally illustrates the distraction process according to the mode of application b) through the example of a mandible 33 that has undergone osteotomy. In this
5 example the distraction results in a displacement of the chin in the caudal direction.

Claims

1. A device for the distraction of bones or bone segments including:
an anchoring screw which includes a longitudinal axis, a screw tip, a
5 screw end with means for rotatably driving the anchoring screw, a threaded
shank which adjoins the screw tip and has a screw thread, and a circular
cylindrical and non-threaded screw shank adjoining the screw end; and
a distraction sleeve axially displaceable on the screw shank which has a
rear end, a front end, a continuous bore extending coaxially between the rear
10 end and the front end, an external screw thread adjoining the front end, and
coupling means formed in the rear end for receiving a screwing-in tool, wherein:
the anchoring screw includes a collar arranged between the threaded
shank and the screw shank which radially projects at least from the screw
shank and which serves as an axial stop for the front end of the distraction
15 sleeve that is slid over the screw shank;
the continuous bore has a bore section with an enlarged cross-section
which adjoins the rear end and extends to a depth (T), said bore section being
provided with a lateral surface; and
a seal ring is coaxially arranged between the lateral surface and the
20 screw shank.
2. A device as claimed in claim 1, wherein the collar includes a cone which
leads to the screw shank.
- 25 3. A device as claimed in claim 1, wherein the collar includes a spherically
convex, tapered portion which leads to the screw shank.
4. A device as claimed in any of the claims 1 to 3, wherein the bore section
has an inner cone which leads to the continuous bore.
- 30 5. A device as claimed in any of the claims 1 to 4, wherein it includes in
addition a cover screw and wherein the screw end is provided with a bore
having an internal screw thread into which said cover screw may be screwed.

6. A device as claimed in any of the claims 1 to 5, wherein the screw thread is self-tapping.

7. A device as claimed in any of the claims 1 to 6, wherein the screw thread
5 has an asymmetrical thread profile.

8. A device as claimed in claim 7, wherein the flanks of the screw thread directed towards the screw tip and the longitudinal axis form an angle of between 80 and 90 degrees.

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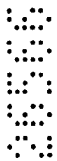
9. A device as claimed in any of the claims 1 to 8, wherein the external screw thread has an asymmetrical thread profile.

10. A device as claimed in claim 9, wherein the flanks of the screw thread
15 directed towards the rear end and the longitudinal axis form an angle of between 80 and 90 degrees.

11. A device as claimed in any of the claims 1 to 10, wherein the thread profile of the external screw thread displays flattened, threaded tips.

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12. A device as claimed in any of the claims 1 to 11, wherein the means for rotatably driving the anchoring screw do not radially protrude from the screw shank.

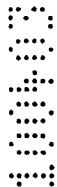


13. A device for the distraction of bone or bone segments substantially as
25 herein described with reference to any one of the embodiments shown in the accompanying drawings.

DATED : 9 April, 2003

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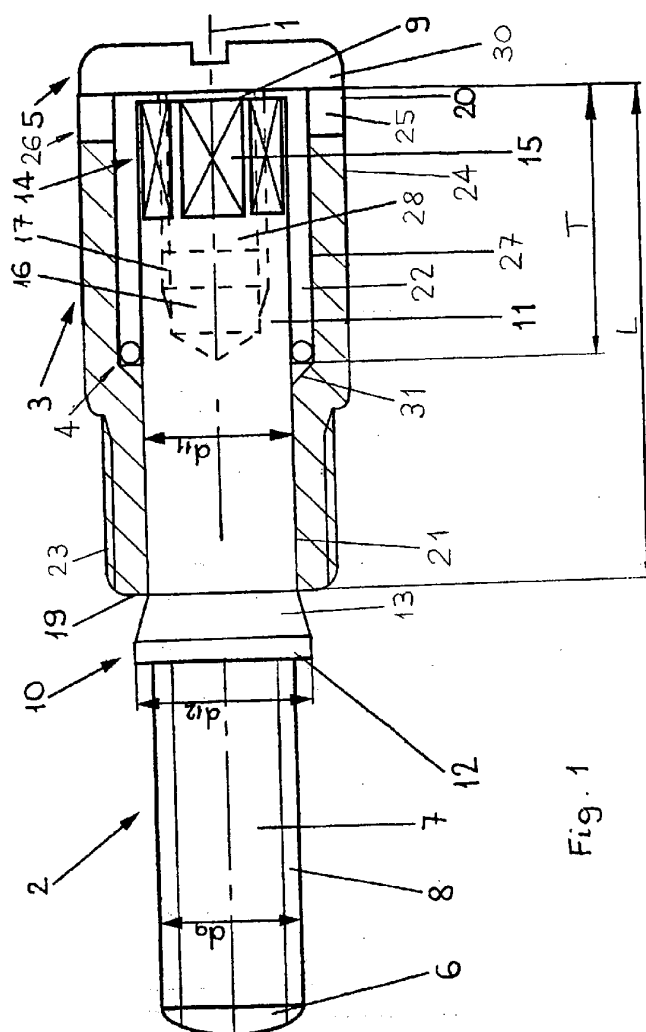
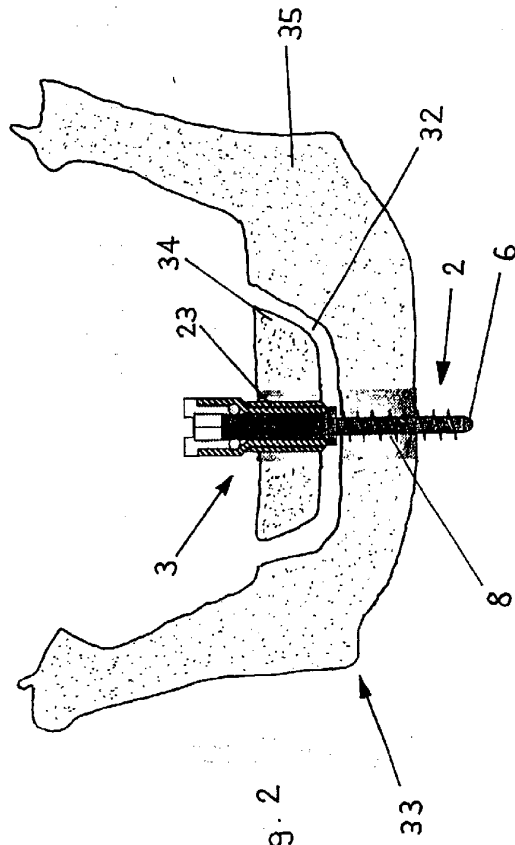


Fig. 1



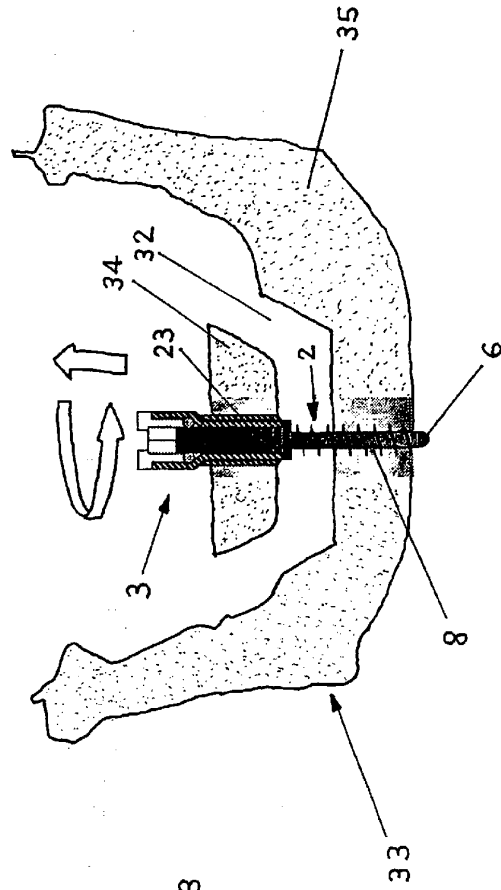


Fig. 3

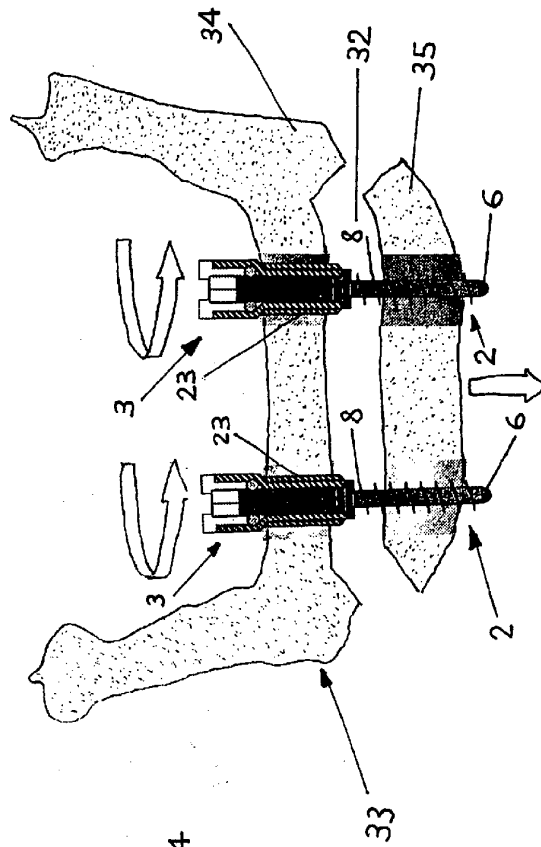


Fig. 4