US009168074B2

(12) **United States Patent**
**Prandi et al.**

(10) **Patent No.: US 9,168,074 B2**
(45) **Date of Patent: *Oct. 27, 2015**

(54) **RESORPTIVE INTRAMEDULLARY IMPLANT BETWEEN TWO BONES OR TWO BONE FRAGMENTS**

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( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 114 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/795,946**

(22) Filed: **Mar. 12, 2013**

(65) **Prior Publication Data**

US 2013/0190761 A1 Jul. 25, 2013

**Related U.S. Application Data**

(63) Continuation of application No. 12/918,105, filed as application No. PCT/FR2009/051658 on Sep. 2, 2009, now Pat. No. 8,414,583.

(30) **Foreign Application Priority Data**

Sep. 9, 2008 (FR) ..... 08 56035

(51) **Int. Cl.**
***A61B 17/72*** (2006.01)
***A61B 17/68*** (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ..... ***A61B 17/7233*** (2013.01); ***A61B 17/68*** (2013.01); ***A61F 2/4225*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC ..... A61B 17/7208; A61B 17/7266
USPC ..... 606/62–64
See application file for complete search history.

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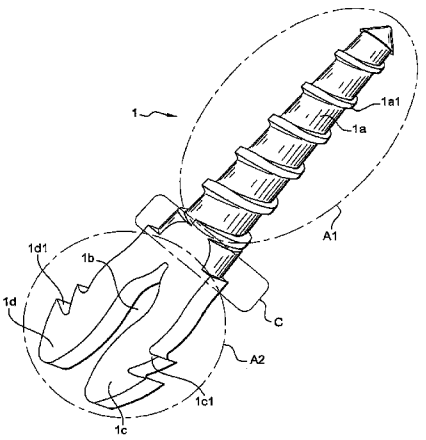
(57) **ABSTRACT**

The invention relates to an intramedullary implant for use between two bones or two bone fragments. The implant includes a single-piece body having a generally elongate shape and having, at each end, areas for anchoring to the bone portions in question, characterized in that one of said areas has a generally cylindrical shape while the other area has a flat cross-section.

**18 Claims, 4 Drawing Sheets**



(51) **Int. Cl.**

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| ***A61F 2/42*** | (2006.01) |
| *A61B 17/86* | (2006.01) |
| *A61F 2/30* | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***A61F2/4241*** (2013.01); *A61B 17/7208* (2013.01); *A61B 17/7225* (2013.01); *A61B 17/7266* (2013.01); *A61B 17/7283* (2013.01); *A61B 17/8605* (2013.01); *A61F 2002/30062* (2013.01); *A61F 2002/3085* (2013.01); *A61F 2002/30563* (2013.01); *A61F 2002/30622* (2013.01); *A61F 2002/30878* (2013.01); *A61F 2210/0004* (2013.01)

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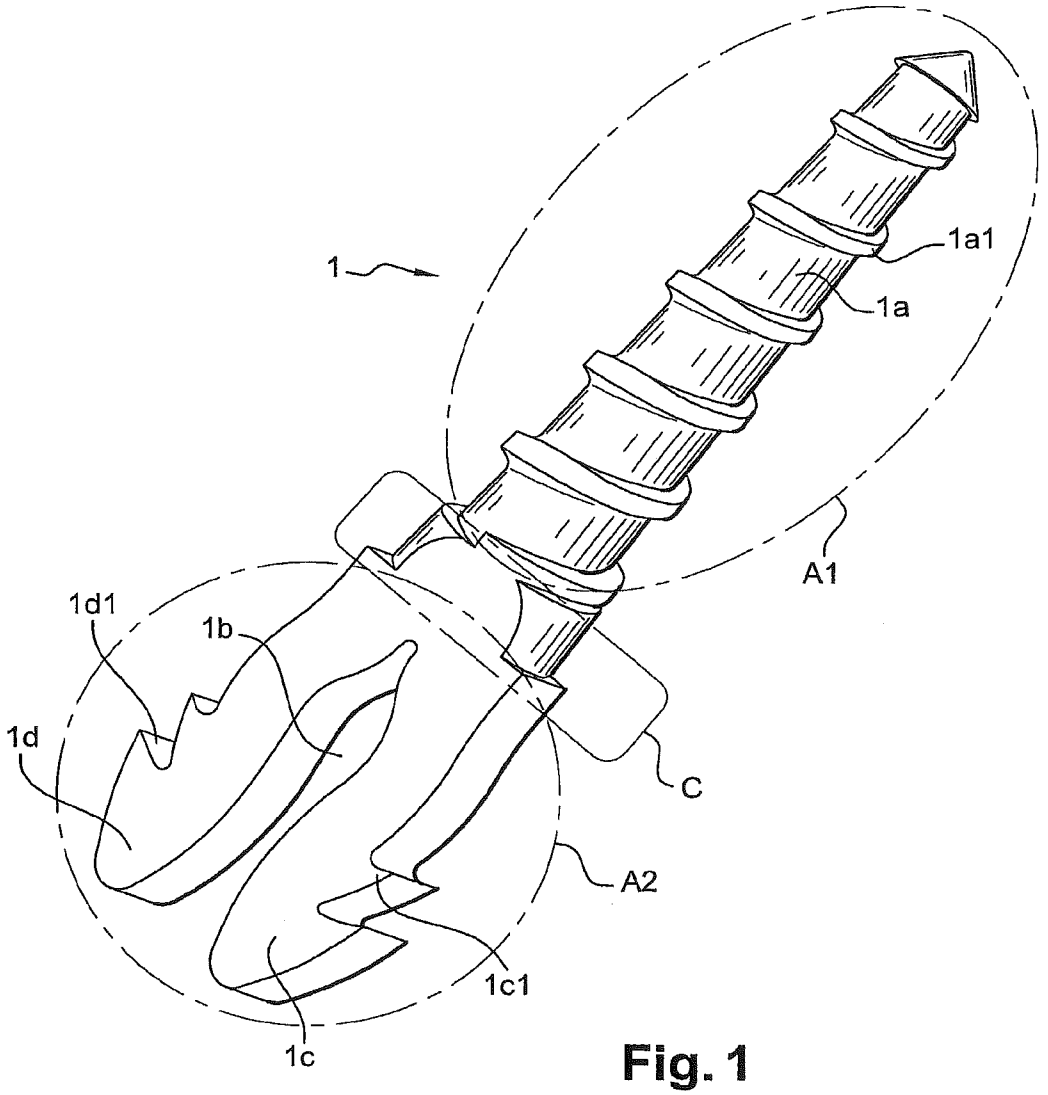


Fig. 1

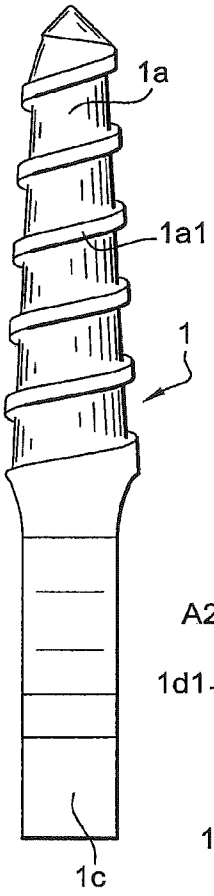


Fig. 3

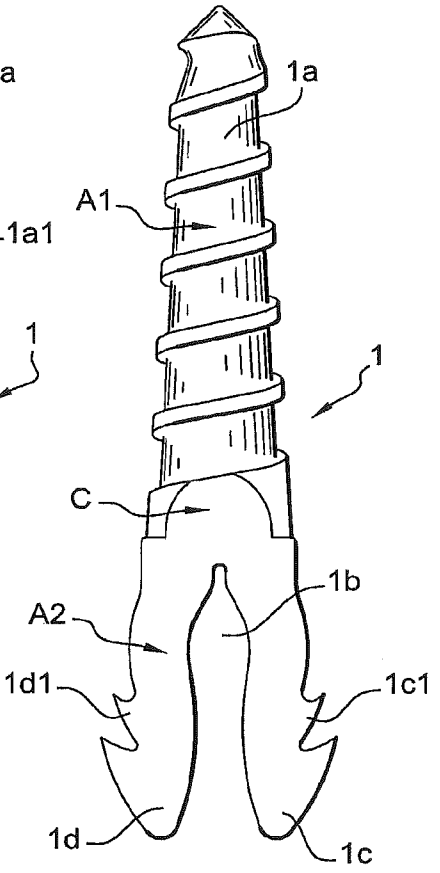


Fig. 2

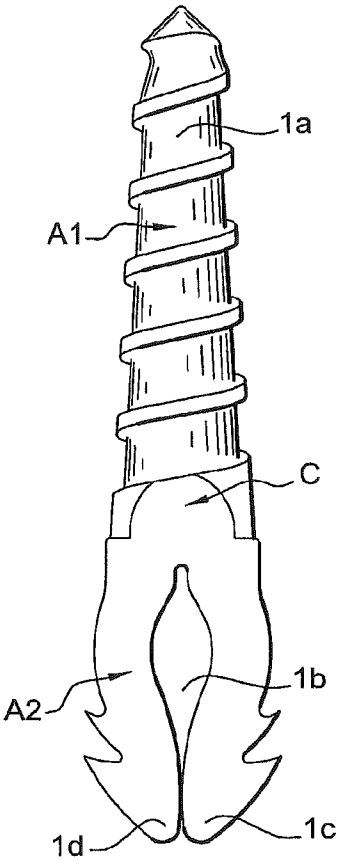


Fig. 4

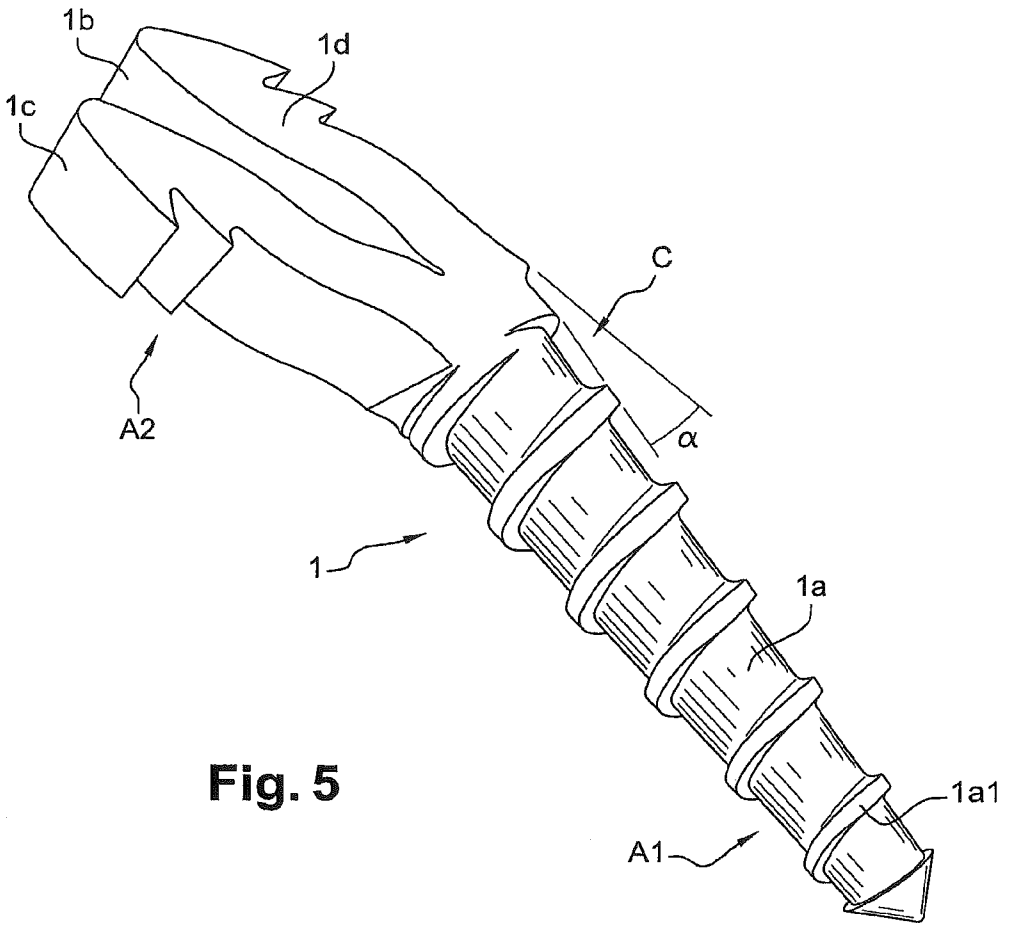


Fig. 5

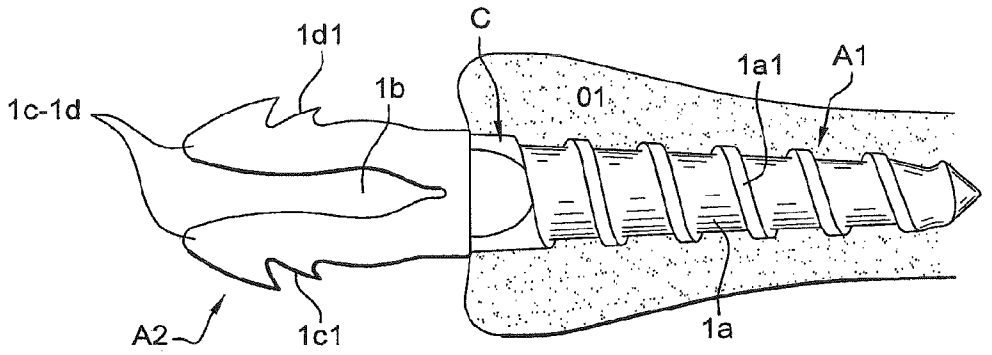


Fig. 6

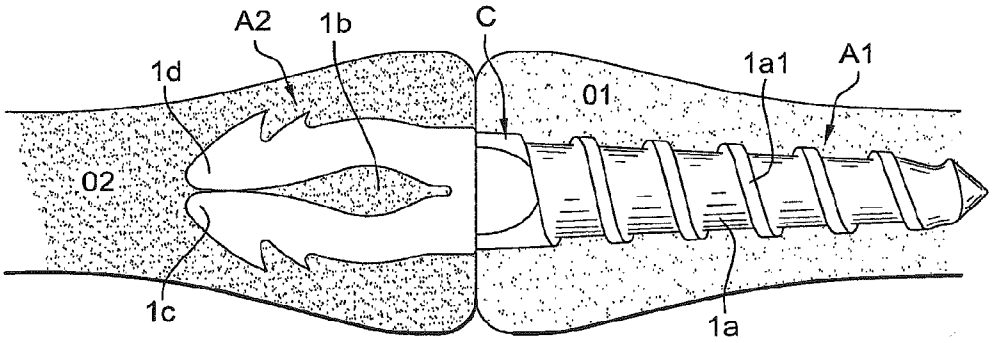


Fig. 7

# RESORPTIVE INTRAMEDULLARY IMPLANT BETWEEN TWO BONES OR TWO BONE FRAGMENTS

The invention relates to the technical field of orthopedic implants, particularly for arthrodesis and osteosynthesis.

More particularly, the invention relates to an intramedullary implant for arthrodesis between two bone parts or osteosynthesis between two bone fragments, particularly in the case of the hand or foot.

Different solutions have been proposed to achieve these functions.

For example, a solution comes from the teaching of patent application FR 2,884,406, of which the applicant of the present application is also the applicant. This patent describes an intramedullary osteosynthesis device made up of an elongated body whose ends constitute anchor zones cooperating with the bone parts to be immobilized. The anchor zones are shaped and made of a material selected to enable insertion into the bone parts, then to ensure an anchor in the bone parts by preventing any rotational movement by resisting traction and maintaining a compression force.

Another solution also comes from patent application FR 07.02003, also from the same applicant. This document describes an implant in the form of two anchor zones connected by a central zone and whose general shape is substantially inscribed in a very elongated rectangle while being substantially X-shaped, so as to form two legs in the anchor zones that are adapted to move apart by elastic or shape-memory effect.

From this design, different criteria have been established to make the implant easy to place and efficient in order to create a primary and secondary stability for the osteosynthesis or arthrodesis site.

However, these solutions are not adapted for the case of an implant made of resorptive material.

From this state of the art, the object that the invention proposes to attain is further improving the anchoring and the stability of the implant as well as its adaptation to the morphology of the implantation site when the implant is made of resorptive material.

To solve such a problem, a resorptive intramedullary implant between two bones or two bone fragments has been designed and developed; it is made up, in a known manner, of a single-piece body having a general elongated shape with, at each end, zones for anchoring to the bone parts being considered. According to the invention, one of the zones has a cylindrical shape, whereas the other zone is flat.

Advantageously, the implant is made of a resorptive material whose mechanical properties are determined to last the time necessary for the consolidation, so that the implant is resorbed after six months. For example, the implant is composed of lactic acid polymer or copolymer (PLA, PGA, etc.).

Considering the specific mechanical characteristics of resorptive materials, and to solve the given problem of improving anchoring and stability, the cylindrical cross-section is threaded and tapers in the direction of its free end.

To solve the given problem of enabling a deformation by elasticity, thus causing an expansion adapted to the geometry of the site and to the properties of the material, the flat cross-section zone has, substantially in its median portion, an opening adapted to enable elastic deformation of the zone. The opening defines at least two anchor arms.

It therefore appears that the combination of a cylindrical and threaded anchor zone and a flat-sectioned anchor zone is particularly advantageous with respect to the problem to be solved.



To solve the given problem of withstanding the shear and flexion forces that may occur in the area of the bone site, between the two anchor zones, the body has a central transition zone adapted to withstand the shear and flexion forces occurring in the area of the bone site and adapted to serve as an abutment.

From this basic design of the implant, the anchor zones are either coaxial or angularly offset by between about 1° and 30° and, advantageously, by 10°. The bend between the anchor zones is located so as to substantially correspond to an arthrodesis line of the bones being considered.

The invention is explained in more detail hereinafter with reference to the attached drawings, in which:

FIG. **1** is a perspective view of the implant;

FIG. **2** is a front view of the implant before insertion into the bone part in question;

FIG. **3** is a side view corresponding to FIG. **2**;

FIG. **4** is a view like FIG. **2** showing the position of the anchor arms of the flat section after insertion;

FIG. **5** is a perspective view of another advantageous embodiment of the implant;

FIGS. **6** and **7** show the installation of the implant into two bone parts.

The implant according to the invention has a one-piece body **1** of elongated shape and having a first proximal zone A**1** and a second distal zone A**2**. The entire implant body is made of a resorptive material whose mechanical properties are determined for the implant to be resorbed in no less than about 6 months. In one embodiment, the implant is composed of lactic acid polymer or copolymer (PLA, PGA, etc.).

As will be described later in the description, the zones A**1** and A**2** have anchor formations for the respective bone parts. Taking into account the specific characteristics of the resorptive material and to attain the given object of anchoring and stability, the zone A**1** has a cylindrical section, whereas the other zone A**2** is flat.

The zone A**1** has a generally cylindrical outer surface **1***a* with a limited taper toward its free end. The surface **1***a* has a helical rib forming a screw thread **1***a***1**.

The zone A**2** is flat and has, substantially in its center, an opening **1***b* adapted to enable elastic deformation of the zone A**2**. More particularly, the opening **1***b* defines at least two anchor arms **1***c* and **1***d*, each having at least one outwardly projecting tooth **1***c***1**, **1***d***1**.

Advantageously, between the two zones A**1** and A**2**, the body **1** has a central transition zone C adapted to withstand shear and flexion forces that can occur at the end of a bone. By way of non-limiting example, this median zone C can have a length of about 3.5 mm and a thickness of about 2 mm, for an overall implant length comprised between about 15 and 25 mm and a diameter of about 2 or 3 mm at the zone A**1**.

In the embodiment shown in FIG. **1**, the two zones A**1** and A**2** are coaxial.

To solve the problem of adaptation to the shape of the implantation site, the anchor zones A**1** and A**2** can be offset by an angle $\alpha$ adapted to the geometry of the bone site. This angle $\alpha$ is comprised between about 1° and 30° and, advantageously, on the order of 10° when the implant is for foot arthrodesis (FIG. **5**).

In this embodiment in which the two anchor zones are angularly offset, the bend is located so as to correspond substantially to the arthrodesis line of the bone parts being fused.

FIGS. **6** and **7** schematically show the positioning of the implant according to the invention between two bone parts O**1** and O**2**. After suitable holes have been made in the bone by a rasp-type tool, the operator screws the thread **1***a* into the bone part O**1** substantially up to the median zone C that serves as an

abutment preventing the implant from sinking too deeply into the bone (FIG. **6**). The operator then fits the second bone part O**2** back onto the anchor arms **1***d* and **1***c* of the zone A**2**, and the anchor arms then spread and tighten by elasticity (FIG. **7**).

The operative technique can be the following:

Drilling of the two holes with a conventional drill;

Preparation of the holes with a rasp for the flat side and a bone tap to form the inner screw thread on the cylindrical side;

Use of a screwdriver with a gripper end;

Screwing in the cylindrical side P**1** for a PIP arthrodesis of the foot;

Fitting of the bone back onto the flat side of the implant.

The advantages are readily apparent from the description; in particular, it is to be emphasized and understood that the combination of the two anchor zones A**1** and A**2** of cylindrical and flat shape, respectively, significantly enhances anchoring and stability of the implant adapted to the geometry of the bone site and the material properties, namely, a resorptive material.

The invention claimed is:

**1**. An intramedullary implant for use between first and second bone parts, the implant comprising:

a first threaded end for anchoring to the first bone part;

a second end extending from the first end for anchoring to the second bone part, the second end having a longitudinal axis, a body portion, and a plurality of teeth projecting from the body portion, wherein at least a first tooth of the plurality of teeth is spaced from a second tooth of the plurality of teeth in a direction along the longitudinal axis of the second end, the first and second teeth extending from the body portion in a same direction, and at least the first tooth extending from the body portion in a different direction than a direction a third tooth of the plurality of teeth extends from the body portion.

**2**. The intramedullary implant of claim **1**, wherein the first threaded end tapers in a direction away from the second end.

**3**. The intramedullary implant of claim **1**, wherein the second end has an opening in a median portion therein, the opening allowing for elastic deformation of the second end.

**4**. The intramedullary implant of claim **3**, wherein the opening defines at least two spreadable arms.

**5**. The intramedullary implant of claim **1**, further comprising a central transition zone between the first and second ends, the central transition zone defined at the second end by an abutment at an edge of the second end, the abutment being transverse to a longitudinal axis of the first end adapted to prevent overinsertion of the implant into the second bone part.

**6**. The intramedullary implant of claim **5**, wherein a face of the abutment defines a plane perpendicular to the longitudinal axis of the first end.

**7**. The intramedullary implant of claim **1**, wherein a longitudinal axis through the first end is offset from the longitudinal axis of the second end by an angle less than 30 degrees.

**8**. The intramedullary implant of claim **7**, wherein the offset is located at a position corresponding substantially to an arthrodesis line defined at the intersection of the first and second bone parts.

**9**. The intramedullary implant of claim **1**, wherein the implant is made of resorptive material.

**10**. The intramedullary implant of claim **1**, wherein the first and third teeth are positioned at the same axial location along the longitudinal axis of the second end.

**11**. The intramedullary implant of claim **1**, wherein the body portion has opposing flat surfaces parallel to the longitudinal axis.

**12**. The intramedullary implant of claim **1**, wherein a flat surface of the first tooth is coplanar with a flat surface of the second tooth.

**13**. The intramedullary implant of claim **1**, wherein a cross-section of the body portion is non-circular.

**14**. The intramedullary implant of claim **1**, wherein the first tooth, the second tooth, and the third tooth each include flat surfaces, the flat surfaces of the first tooth, the second tooth, and the third tooth defining planes parallel to each other.

**15**. An intramedullary implant for use between first and second bone parts, the implant comprising:

a first threaded end for anchoring to the first bone part;

a second end extending from the first end for anchoring to the second bone part and having a plurality of outwardly projecting teeth, at least a first tooth of the plurality of teeth spaced from a second tooth of the plurality of teeth in a direction along the longitudinal axis of the second end, and at least the first tooth extending in a different direction than a third tooth of the plurality of teeth, the second end having an opening in a median portion thereof.

**16**. The intramedullary implant of claim **15**, further comprising a central transition zone between the first and second ends, the central transition zone defined at the second end by an abutment at an edge of the second end, the abutment being transverse to a longitudinal axis of the first end adapted to prevent overinsertion of the implant into the second bone part.

**17**. The intramedullary implant of claim **15**, wherein the second end has a cross-section with opposing flat first and second surfaces when viewed in a direction perpendicular to a longitudinal axis thereof.

**18**. The intramedullary implant of claim **15**, wherein a flat surface of the first tooth is coplanar with a flat surface of the second tooth.

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