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(54) Title : ORTHOPEDIC IMPLANT IN THE FORM OF A PLATE TO BE FIXED BETWEEN TWO BONE PARTS

(54) Titre : IMPLANT ORTHOPEDIQUE SOUS FORME D'UNE PLAQUE DESTINEE A ETRE FIXEE ENTRE DEUX PARTIES D'OS

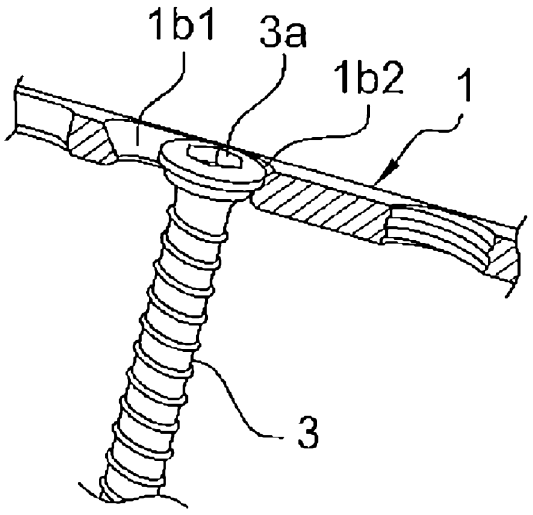

Fig. 5

(57) Abstract : The plate is fixed by screws (3) engaged in holes (1a) formed in the thickness of the plate which is designed in such a way as to ensure an adjustable compression effort, created by a screwing effect, which brings the two bone parts closer together. The design consists of at least one recess (1b) having a cross-section defining a plurality of separate areas (1b1), (1b2) and (1b3) that can co-operate with a screw (3) in order to generate a progressive translational movement of the screw (3) during the screwing action, corresponding to a movement of at least one of the bone parts, and causing the compression effort. Said plate (1) comprises a recess (1c) for the introduction of a spindle (4) on the side of one of the bone parts, and another recess (1d) for the introduction of a spindle (5) on the side of the other bone part, one of said recesses (1c) consisting of a circular hole having a diameter which essentially corresponds to that of the spindle (4), and the other recess (1d) consisting of an oblong hole.

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La fixation est effectuée au moyen de vis (3) engagées dans des trous (1a) formés dans l'épaisseur de ladite plaque qui présente des agencements aptes à assurer, sous un effet de vissage, un effort de compression réglable apte à rapprocher les deux parties d'os. Les agencements sont constitués par au moins un logement (1b) qui présente un profil en section délimitant plusieurs zones distinctes (1b1), (1b2) et (1b3) aptes à coopérer avec une vis (3), afin de générer un déplacement progressif en translation de la vis (3) au fur et à mesure d'un vissage correspondant à un déplacement de l'une des parties d'os au moins, engendrant l'effort de compression, ladite plaque (1) présentant un logement (1c) pour l'introduction d'une broche (4) du côté de l'une des parties d'os et un autre logement (1d) pour l'introduction d'une broche (5) du côté de l'autre partie d'os, l'un des logements (1c) est constitué par un trou circulaire dont le diamètre correspond sensiblement à celui de la broche (4), tandis que l'autre logement (1d) est constitué par une lumière oblongue.

ORTHOPEDIC IMPLANT IN THE FORM OF A PLATE ADAPTED TO BE FIXED BETWEEN TWO BONE PARTS

Cross reference to related applications

This is the Australian national phase of PCT application PCT/FR2009/051878, filed 2 October 2009, published 8 April 2010 as 2010/037984, and claiming the priority of French patent application 0856693 itself filed 2 October 2008, whose entire disclosures are herewith incorporated by reference.

Field

The invention relates to the technical field of orthopedic implants.

More particularly, the invention relates to a plate for arthrodesis or osteosynthesis adapted to be fixed between two bone parts.

Background

In a manner known to one having ordinary skill in the art, the type of plate used for arthrodesis or osteosynthesis generally has holes for anchor screws, allowing arthrodesis between two bones or an osteosynthesis between two bone fragments. This is, for example, the case for the bones of the hand or foot, without however excluding other applications, particularly in the field of the spine. Depending on the pathological case to be treated, these plates can have a generally rectilinear shape or have other geometric shapes.

From this state of the art, the inventors have discerned that it would be desirable to provide a plate which, at least in certain embodiments, can improve, in a reliable and efficient manner, the compression in a precise direction between the bone parts held by the plate, or at least provide a useful alternative to known plates.

Definition

In the specification, including the claims, the term "comprising" shall be understood to have a broad meaning similar to the term "including" and will be understood to imply the inclusion of a

stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. This definition also applies to variations on the term "comprising" such as "comprise" and "comprises".

Summary

An orthopedic implant has been designed and developed in the form of a plate adapted to be fixed between two bone parts by screws engaged in holes extending through the entire thickness of the plate.

According to a first aspect of the present disclosure there is provided a bone plate adapted to span first and second bone parts comprising

first and second holes extending through the plate, the first and second holes adapted to receive first and second fixation members, wherein the first hole is for alignment with the first bone part and the second hole is for alignment with the second bone part;

a compression slot extending through the plate, the compression slot having an inclined surface adapted to interact with a portion of a third fixation member to cause displacement of the third fixation member when inserted into the compression slot; and

first and second pin holes for alignment with the first and second bone parts, respectively, the first pin hole being circular so that a first fixation pin is receivable in the first pin hole, the second pin hole being a slot that is elongated along a longitudinal axis of the bone plate so that a second fixation pin is translatable within the second pin hole along the longitudinal axis, the second pin hole being adapted to closely confront the second fixation pin, in a direction transverse to the longitudinal axis of the plate and along substantially its entire length, to control displacement of the second fixation pin according to a profile of the second pin hole.

In an embodiment the compression slot comprises at least one seat or recess having a cross-section defining several distinct regions adapted to cooperate with a third fixation member in the form of a screw in order to generate a progressive straight-line displacement of

the screw during the screwing action corresponding to a displacement of at least one of the bone parts, causing the compression force.

In an embodiment one of the regions is constituted of a hole having a diameter D1 adapted to receive the screw head, whereas another region is a hole having a diameter D2 less than the diameter D1, and having, over a determined height, a slope between 40° and 60°, the regions being connected by an intermediate region having a slope in the direction of the region constituted by the hole having the diameter D1. This can assist in obtaining compression that is controlled and adjustable.

The slope of the intermediate region may be between 15° and 30°.

Another problem that the present disclosure proposes to address is to provide a temporary fixation of the plate so as to facilitate the fixation of the plate by the operator by means of pins and in order, after the pins are set in place in one of the bone parts, to allow sliding under the plate at the time of screwing while ensuring a compression according to a precise direction.

Provision of the first, circular, pin hole for the insertion of a pin on the side of one of the bone parts, and the second pin hole, being a slot that is elongated along a longitudinal axis of the plate, for the insertion of a pin on the side of the other bone part, can assist in addressing this problem.

The diameter of the first pin hole may correspond substantially to that of the first fixation pin.

The second pin hole may be in the form of an oblong slot.

In an embodiment, to solve the problem to meet the particular anatomy, in the case of a plate for MTP arthrodesis, the axis of the elongated slot extends relative to the longitudinal axis of the plate at an angle between about 1° and 10°.

Generally, the plate may have smooth and/or threaded holes adapted to receive anchor screws to the bone parts.

Proceeding from this basic design of the plate and from the pathological case to be treated:

- either the different holes are aligned;
- or some of the holes are arranged according to the apex of a triangle or of a quadrilateral.

In one embodiment, the plate is longitudinally bent so as to adapt to the curvature of the bone parts.

According to a further aspect of the present disclosure there is provided a bone plate adapted to span first and second bone parts comprising:

first and second holes extending through the plate, the first and second holes adapted to receive first and second fixation members, wherein the first hole is for alignment with the first bone part and the second hole is for alignment with the second bone part;

a compression slot extending through the plate, the compression slot having an inclined surface adapted to interact with a portion of a third fixation member to cause displacement of the third fixation member when inserted into the compression slot; and

first and second pin holes for alignment with the first and second bone parts, respectively, the first pin hole being circular so that a first fixation pin is receivable in the first pin hole, the second pin hole being a slot that is elongated along a longitudinal axis of the bone plate so that a second fixation pin is translatable within the second pin hole along the longitudinal axis, the second pin hole being adapted to closely confront the second fixation pin, in a direction transverse to the longitudinal axis of the plate and along substantially its entire length, to control displacement of the second fixation pin according to a profile of the second pin hole, wherein a long axis of the second pin hole extends relative to the longitudinal axis of the plate at an angle.

Brief Description of the Drawings

Embodiments in accordance with the present disclosure will be described hereinafter in more detail, by way of example only, with reference to the attached drawings, in which:

FIG. 1 is a perspective view of an embodiment of a plate according to the present disclosure;

FIG. 2 is a partial, large-scale, perspective view showing the compression seat;

FIG. 3 is a longitudinal cross-section corresponding to FIG. 2;

FIGS. 4, 5, and 6 are partial, cross-sectional, schematic, perspective views showing the compression obtained as the screw is pressed into the compression seat;

FIG. 7 is a perspective view of another embodiment of the plate, particularly for MTP arthrodesis;

FIGS. 8, 9, and 10 are perspective views of embodiments of plates of other shapes, given by way of illustration;

FIG. 11 shows an embodiment of a plate longitudinally shaped to fit to the curvature of the bone;

FIGS. 12 to 18 are perspective views showing the installation and fixation of the plate on two bone parts for compressing same together, the bone parts being schematically shown as parallepipedal blocks; and

FIG. 19 is a partial view of the plate showing, schematically, two end positions of the initial drilling to obtain maximum compression (position 1) or no compression (position 0).

Description of Embodiments

The osteosynthesis and/or arthrodesis plate is indicated generally by reference numeral 1. In a known manner, this plate 1 has smooth and/or threaded holes 1a for anchor screws 2 screwed into bone parts O1 and O2, as described below.

According to a characteristic of an embodiment of a plate in accordance with the present disclosure, the plate 1 has at least one compression seat or formation 1b.

As shown, in particular in FIGS. 2 and 3, this seat 1b has several distinct regions 1b1, 1b2, and 1b3 that allow the desired compression to be set, particularly as a function of the bone quality and as a function of the start position of a screw 3 in the seat.

More particularly, the seat 1b is formed by three distinct regions having the following characteristics:

The region 1b1 is a hole having a diameter D1, adapted to receive the head 3a of the screw 3.

The region 1b2 is a hole having a diameter D2 less than the diameter D1 and having, over a determined height, comprised between about 1 and 2 mm, a slope of the order of 40° to 60° relative to a base plane of the plate.

The regions 1b1 and 1b2 are connected by an intermediate transition region 1b3 having a descending slope, that is angled downward in the direction of the region 1b1. This slope is between about 15° and 30°.

Considering these characteristics, compressing together the two bone parts O1 and O2 is carried out as follows, with reference, in particular, to the FIGS. 4, 5, 6, 15, and 16.

A pilot hole is first made in one of the bone parts being considered according to the region 1b2 or 1b1 as a function of the compression one wants to obtain.

The screw 3 is inserted into the hole until its head 3a contacts the plate 1 (FIGS. 4 and 5).

Since the hole of the region 1b2 has a diameter smaller than that of the screw head 3, this head immediately slides so as to be offset from the axis of the region 1b1, causing a first, rapid compression.

With continued screwing action, the screw head 3a slides along the slope of the intermediate region 1b3 causing a second compression until it reaches a stable position fitting in the hole 1b1 whose diameter is the same as that of the screw head 3a. Naturally, it is possible to stop at any intermediate position in order to precisely adjust the compression.

It should be noted also that the extent of compression generated is of the order of 0 to 3 mm and can be controlled as a function of the position of the initial passage. Therefore, it is possible to obtain maximum compression at a seat in position 1 and no compression at a seat in a position 0 (FIG. 19).

According to another characteristic, the plate 1 has at least one guide hole 1c for the insertion of a guide pin 4 for temporarily fixing the plate 1. Advantageously, the plate 1 has a guide hole 1c for the insertion of a pin 4 on the side of one of the bone parts O1 and another guide hole 1d for the insertion of another guide pin 5 on the side of the other bone part O2.

Considering the effect of the desired compression, such as previously mentioned, the guide hole 1c is a circular hole whose diameter corresponds substantially to that of the pin 4, whereas the other guide hole 1d is an elongated slot, located on the side of the compression seat 1b.

These provisions therefore enable the bone to slide relative to the plate 1 at the time of screwing, while ensuring compression in a precise direction generally along the axis of the plate. The pins 4 and 5 are of any known and appropriate type, and familiar to one having ordinary skill in the art.

The elongated slot 1d for temporary fixation is particularly well adapted in the case of an MTP arthrodesis plate in order to take into account the anatomy according to which the angle between the phalange P1 and the metatarsus 1 is on the order of 10°. Indeed, a plate according to the state of the art makes it difficult to ensure the compression while keeping the above-described angle. According to the present disclosure, the slot 1d only has to be angularly oriented relative to the median axis of the plate 1 according to an angle of about 5° (FIG. 7).

As shown in the figures of the drawings, the plate 1 can have different shapes, with the holes 1a aligned as in FIG. 1 or arranged, all or in part on the corners of a triangle or of a quadrilateral (FIGS. 8, 9, and 10). More particularly, in FIG. 8, the plate is adapted to be used in the case of a Lapidus arthrodesis, in FIG. 9, for a basal osteotomy of the first

metatarsus and for a 2/3 Lisfranc arthrodesis (FIG. 10). These arrangements of the screws, in a triangle or in a quadrilateral, improve the mounting stability.

It should be noted also that the plate 1, no matter its geometric shape, can be bent longitudinally so as to adapt to the curvature of the bone (FIG. 6) making it possible, as a consequence, for the screws 2 to form an angle relative to one another (FIG. 11).

With reference to FIGS. 12 to 18 that show the setting in place of the plate according to the present disclosure:

After the osteotomies have been carried out, the plate 1 is positioned between the two bone parts O1 and O2 (FIG. 12).

The surgeon stabilizes the plate 1 with the two temporary pins 4 and 5, one of which is engaged in the hole 1c and whereas the other is engaged in the slot 1d (FIG. 13).

At least one screw 2 is engaged through the hole 1a and screwed into the bone part O1 where the compression formation 1b is not positioned (FIG. 14).

The surgeon then screws the screw 3 in the compression formation 1b, choosing the extent of compression as previously indicated (FIG. 15).

Once the compression is achieved (FIG. 16), the surgeon can screw in one or more additional screws 2 (FIG. 17), then remove the guide pins 4 and 5 (FIG. 18).

The advantages are readily apparent from the description.

Modifications and improvements may be incorporated without departing from the scope and spirit of the invention as set out in the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A bone plate adapted to span first and second bone parts comprising:

first and second holes extending through the plate, the first and second holes adapted to receive first and second fixation members, wherein the first hole is for alignment with the first bone part and the second hole is for alignment with the second bone part;

a compression slot extending through the plate, the compression slot having an inclined surface adapted to interact with a portion of a third fixation member to cause displacement of the third fixation member when inserted into the compression slot; and

first and second pin holes for alignment with the first and second bone parts, respectively, the first pin hole being circular so that a first fixation pin is receivable in the first pin hole, the second pin hole being a slot that is elongated along a longitudinal axis of the bone plate so that a second fixation pin is translatable within the second pin hole along the longitudinal axis, the second pin hole being adapted to closely confront the second fixation pin, in a direction transverse to the longitudinal axis of the plate and along substantially its entire length, to control displacement of the second fixation pin according to a profile of the second pin hole.

2. The bone plate according to claim 1, wherein the first and second holes are locking holes.

3. The bone plate according to claim 2, wherein the first and second holes include threading for engaging with a threaded section of the first and second fixation members.

4. The bone plate according to any preceding claim, wherein the compression slot is arranged between the first and second holes.

5. The bone plate according to claim 4, wherein the compression slot and the first hole each has a central axis that in use, extends into the first but not the second bone part.

6. The bone plate according to any preceding claim, wherein a long axis of the second pin hole extends relative to the longitudinal axis of the plate at an angle within a range of about 1° to about 10°.

7. The bone plate according to any preceding claim, wherein the bone plate includes a plurality of holes that are arranged according to the corners of a triangle or of a quadrilateral.

8. The bone plate according to any preceding claim, wherein the compression slot is defined by distinct regions, a first region having a hole with a first diameter, a second region having a hole with a second diameter less than the first diameter and including a first sloped section, and a third region interposed between the first and second regions and having a second sloped section.

9. The bone plate according to claim 8, wherein the first and second sloped sections are angled towards the first region.

10. The bone plate according to either of claims 8 or 9, wherein the first sloped section is sloped within a range of about 40° to about 60° relative to a base plane of the plate, and the second sloped section is sloped within a range of about 15° to about 30°.

11. The bone plate according to any preceding claim, wherein a bottom surface of the bone plate is curved so as to adapt to a curvature of the first and second bone parts.

12. The bone plate according to claim 11, wherein the curvature of the bone plate is configured to arrange the first and second fixation members at an angle relative to one another once inserted into the first and second holes.

13. The bone plate according to any preceding claim, wherein a long axis of the second pin hole does not intersect with the first pin hole.

14. The bone plate according to any preceding claim, wherein the second pin hole is offset from the first pin hole in a direction extending transverse to the longitudinal axis of the plate.

15. The bone plate according to any preceding claim, wherein a long axis of the compression slot is substantially aligned with a long axis of the second pin hole.

16. A bone plate adapted to span first and second bone parts comprising:

first and second holes extending through the plate, the first and second holes adapted to receive first and second fixation members, wherein the first hole is for alignment with the first bone part and the second hole is for alignment with the second bone part;

a compression slot extending through the plate, the compression slot having an inclined surface adapted to interact with a portion of a third fixation member to cause displacement of the third fixation member when inserted into the compression slot; and

first and second pin holes for alignment with the first and second bone parts, respectively, the first pin hole being circular so that a first fixation pin is receivable in the first pin hole, the second pin hole being a slot that is elongated along a longitudinal axis of the bone plate so that a second fixation pin is translatable within the second pin hole along the longitudinal axis, the second pin hole being adapted to closely confront the second fixation pin, in a direction transverse to the longitudinal axis of the plate and along substantially its entire length, to control displacement of the second fixation pin according to a profile of the second pin hole, wherein a long axis of the second pin hole extends relative to the longitudinal axis of the plate at an angle.

17. The bone plate according to claim 16, wherein the first and second holes are locking holes.

18. The bone plate according to either of claims 16 or 17, wherein the first and second holes include threading for engaging with a threaded section of the first and second fixation members.

19. The bone plate according to any of claims 16 to 18, wherein the compression slot is arranged between the first and second holes.

20. The bone plate according to claim 19, wherein the compression slot and the first hole each has a central axis that for extending into the first but not the second bone part.

21. The bone plate according to any of claims 16 to 20, wherein the bone plate includes a plurality of holes that are arranged according to the corners of a triangle or of a quadrilateral.

22. The bone plate according to any of claims 16 to 21, wherein the compression slot is defined by distinct regions, a first region having a hole with a first diameter, a second region having a hole with a second diameter less than the first diameter and including a first sloped section, and a third region interposed between the first and second regions and having a second sloped section.

23. The bone plate according to claim 22, wherein the first and second sloped sections are angled towards the first region, the first sloped section is sloped within a range of about 40° to about 60° relative to a base plane of the plate, and the second sloped section is sloped within a range of about 15° to about 30°.

24. The bone plate according to any of claims 16 to 23, wherein a bottom surface of the bone plate is curved so as to adapt to a curvature of the first and second bone parts, the curvature of the bone plate arranging the first and second fixation members at an angle relative to one another once inserted into the first and second holes.

25. The bone plate according to any of claims 16 to 24, wherein the second pin hole is offset from the first pin hole in a direction extending transverse to the longitudinal axis of the plate.

26. A bone plate substantially as described in the Detailed Description of Embodiments section with reference to any one or more of the accompanying drawings.

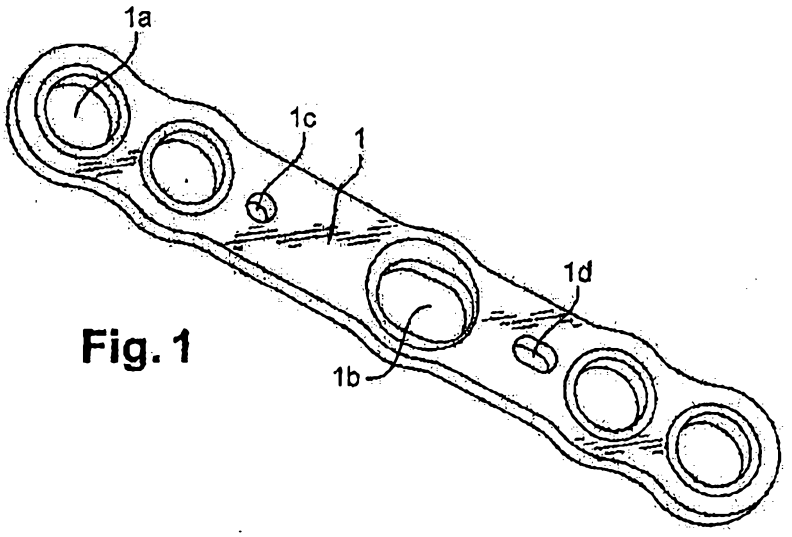

Fig. 1

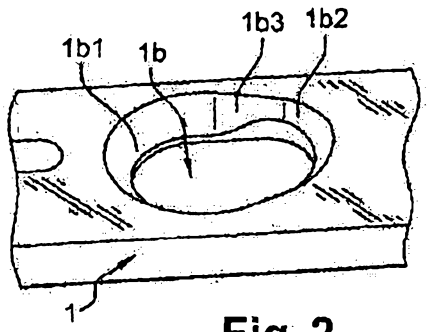

Fig. 2

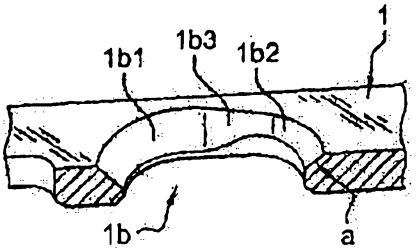

Fig. 3

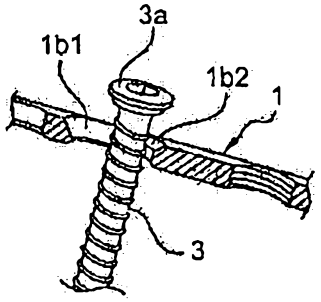

Fig. 4

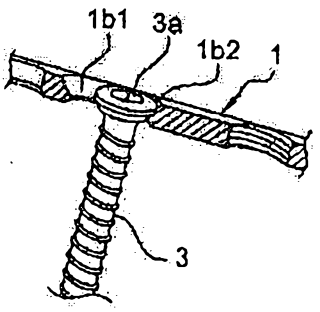

Fig. 5

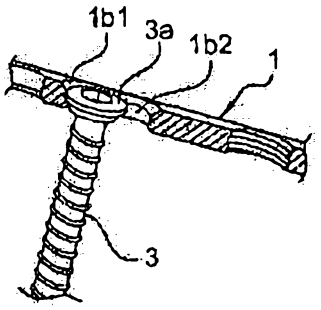

Fig. 6

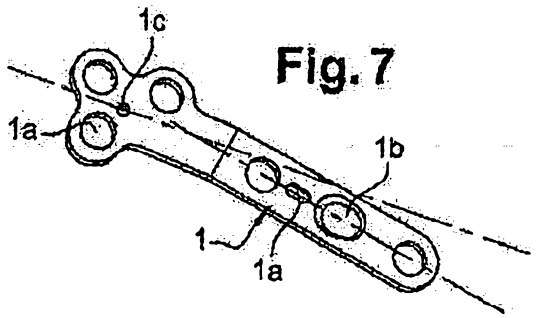

Fig. 7

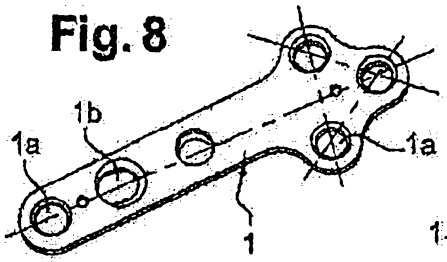

Fig. 8

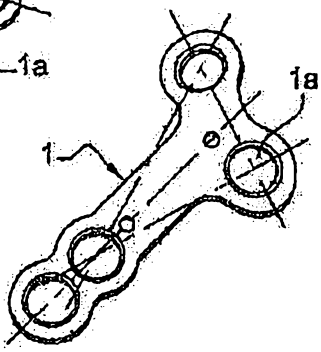

Fig. 9

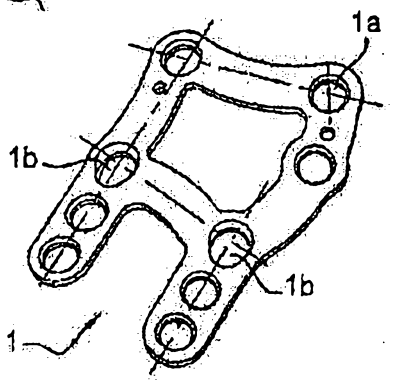

Fig. 10

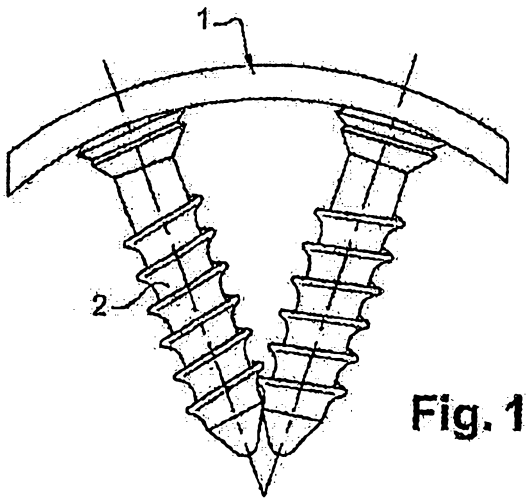

Fig. 11

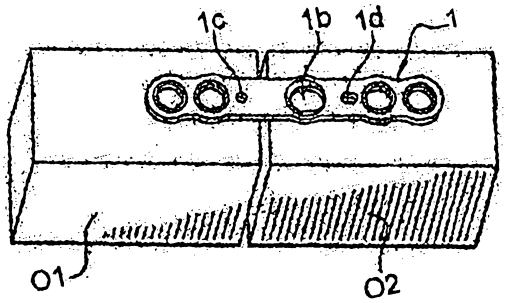

Fig. 12

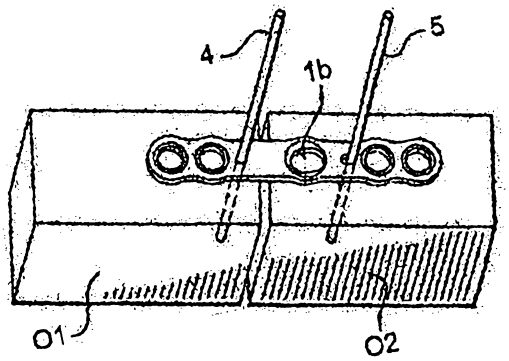

Fig. 13

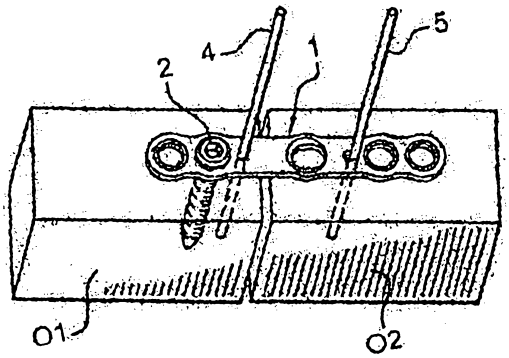

Fig. 14

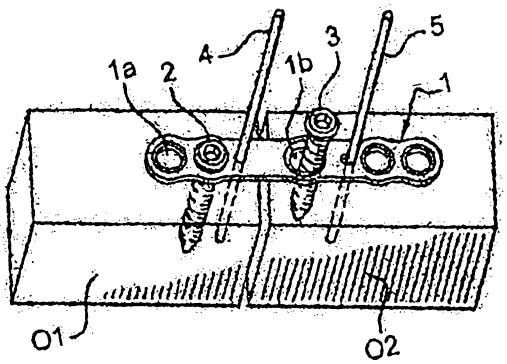

Fig. 15

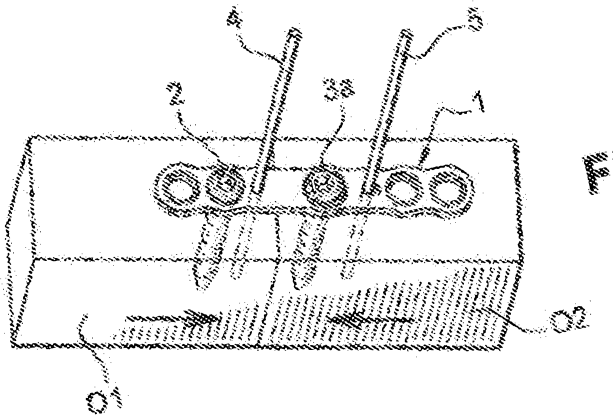

Fig. 16

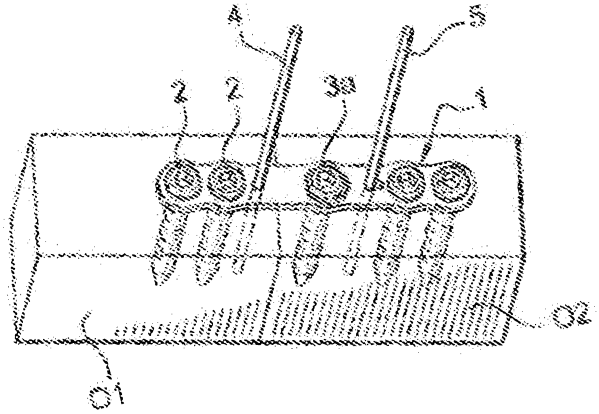

Fig. 17

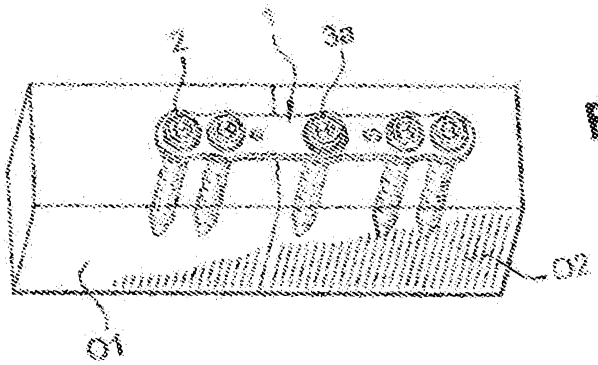

Fig. 18

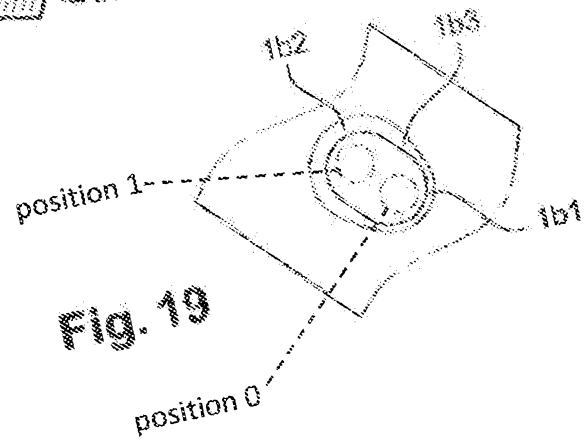

Fig. 19