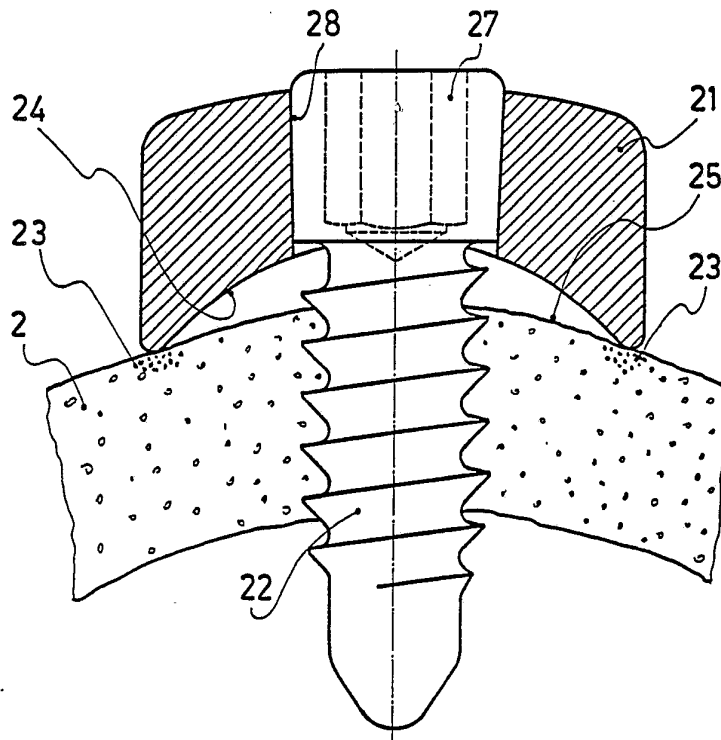




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<p>(21) International Application Number: PCT/EP87/00663 (22) International Filing Date: 3 November 1987 (03.11.87) (71) Applicant: SYNTHES AG [CH/CH]; Grabenstrasse 15, CH-7002 Chur (CH). (72) Inventors: PERREN, Stephan, M. ; Dischmastrasse 22, CH-7260 Davos Dorf (CH). STRAUMANN, Fritz ; Hauptstrasse 28, CH-4437 Waldenburg (CH). SUTTER, Franz ; Bennwilerstrasse 42, CH-4435 Niederdorf (CH). TEPIC, Slobodan ; Oberstrasse 20, CH-7270 Davos (CH). (74) Agent: LUSUARDI, Werther; Stockerstrasse 8, CH-8002 Zürich (CH). (81) Designated States: AT (European patent), BE (European patent), BR, CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).</p>		<p>Published <i>With international search report.</i></p>

(54) Title: IMPLANT FOR OSTEOSYNTHESIS



(57) Abstract

The implant for osteosynthesis according to the invention comprises a plate-like device (21) connectable with a bone (2) with at least two clearance holes (28) and screws (22) with a head (27) for fastening said device (21) rigidly to said bone (2), whereby the contact surface (23) of said device (21) to said bone (2) is reduced to the level necessary only for initially locking said screws (22) to said device (21) at the time of insertion. It allows operative treatment of bone fractures with minimal vascular damage to the treated bone.

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IMPLANT FOR OSTEOSYNTHESIS

Background of the Invention

This invention relates to an implant for osteosynthesis, comprising a device connectable with a bone with at least two clearance holes and screws with a head for fastening said device rigidly to said bone.

In conventional operative treatment of bone fractures a plate is applied to fractured bone bridging the fracture. The plate is fixed to the bone by means of a number of screws which are tightened in the bone producing compressive stresses between the plate and the bone. Transmission of functional load from the bone to the plate and back to the bone is achieved mostly by means of friction corresponding to the compressive stresses. Both the near and the far wall of the bone cortex are usually engaged by the screws. Bone cortex is supplied by blood from periosteal, or outer side, and from endosteal, or inner side. Compression between the plate and bone impedes the blood perfusion of the cortex region under the plate. This is believed to increase the chances of infection - a major complication of operative fracture treatment. Dead bone under the plate is in due course remodelled and revascularized. Porosity within the remodelling bone persists for a long time and reduces bone strength, particularly in fatigue. This requires keeping the plate on bone longer than needed for the fracture to heal.

The use of long screws running first through the near cortex, then through the medullary canal, and through the far cortex may further compromise blood supply of the fractured bone by cutting through larger blood vessels.

Summary of the Invention

The invention as claimed is intended to remedy these drawbacks. It solves the problem of how to design an implant for osteosynthesis that allows operative treatment of bone fractures with minimal vascular damage to the treated bone.

Further advantages offered by the invention are - besides the reduced damage to bone and in particular to the intramedullary vascular system - the possibility to use short screws which can be made self-tapping without compromises necessary with long self-tapping screws. Furthermore the plate design according to the invention allows for doubling the strength of the bone plate due to the reduced screw hole size. Variation of strength along the bone plate according to the invention is much smaller than in conventional plates. The same is true for stiffness. This facilitates plate adaptation to curved bone surfaces.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. For the better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which are illustrated and described preferred embodiments of the invention.

Brief Description of the Drawings

In the drawings:

Fig. 1 is a schematic view of a fractured bone with a conventional bone plate.

Fig. 2 is a cross section of the plate according to Figure 1.

Fig. 3 is a transverse cross section of a bone plate according to the invention with short screws.

Fig. 4 is a longitudinal cross section of a bone plate according to Figure 3.

Fig. 5 is a cross section of a bone plate according to the invention with resorbable buds at the plate undersurface.

Fig. 6 is a cross section of a bone plate according to the invention with an expandable spherical insert.

Fig. 7 is a cross section of a bone plate according to the invention with an expandable conical insert.

Fig. 8 is a cross section of a bone plate according to the invention with removable clip-on springs.

Description of the Preferred Embodiments

Fig. 1 represents a conventional bone plate 1 for the treatment of bone fractures fixed to the bone 2 by means of a number of screws 4. Screws 4 are tightened in the bone 2 producing compressive stresses 5 between the plate 1 and the bone 2. As shown in Fig. 2 transmission of functional load from the bone 2 to the conventional plate 1 and back to the bone 2 is achieved mostly by means of friction corresponding to the compressive stresses 5. Both the near and the far wall of the bone cortex 2 are usually engaged by the screws 4. Bone cortex 2 is supplied by blood from periosteal, or outer side 6, and from endosteal, or inner side 7. Compression 5 between the conventional plate 1 and bone 2 impedes the blood perfusion of the cortex region 8 under the conventional plate 1. This is believed to increase the chances of infection - a major complication of operative

fracture treatment. Dead bone within region 8 is in due course remodelled and revascularized, whereby remodelling activity starts at periphery 9 of unperfused bone and proceeds towards the plate 1. Porosity within the remodelling bone persists for a long time and reduces bone strength, particularly in fatigue. This requires keeping the conventional plate 1 on bone longer than needed for the fracture to heal. Long screws 4 in running first through the near cortex 10, then through the medullary canal 11, and through the far cortex 12 may further compromise blood supply of the fractured bone by cutting through larger blood vessels.

In Figure 3 the plate 21 according to the invention is applied to the bone 2 by means of short screws 22. The plate undersurface is shaped so as to permit only point contact to the bone at very small areas 23. This may be achieved by arching the underside of the plate 24 at a curvature larger than that of the bone outer contour 25. In the longitudinal direction (Figure 4), the plate underside is also shaped with multiple arches 26 spanning the distance between the screws 22. This leaves the possibility of contact only at small areas 23. As shown in Figure 3 the screw 22 is provided with a conical head 27 which upon insertion locks safely in the conical hole 28 of the plate 21. The angle of the conus on the screw head 27 is smaller than friction angle. Preferred taper of the conus is between 1:5 and 1:20.

Using short screws 22 in place of conventional long ones is made possible by locking the screw 22 in the plate 21. This prevents tilting of the screw 22 within the cortex 2. Loads between the bone 2 and the plate 21 are transferred directly through the screws 22, which now act as pegs (under shear) rather than anchors (under tension). In addition to reducing damage to bone 2 and in particular to the intramedullary vascular system, short screws 22 can be made self-tapping without compromises necessary with long self-tapping screws.

The described undercutting of the plate 21 with arches 24 in transverse and arches 26 in longitudinal direction may be used to other advantages in addition to reducing the plate-bone contact to point-like areas 23. Conventional plate strength is lowest at the screw hole sections and so is the plate stiffness. Overall plate strength is limited by the weakest section. Keeping the outer dimensions similar to the normal plate, the plate design according to the invention allows for doubling the strength. This is mostly due to the reduced screw hole size. Variation of strength along the plate is much smaller than in conventional plates. The same is true for stiffness. This facilitates plate adaptation to curved bone surfaces.

Figure 5 shows another way to reduce the contact between the plate 21 and the bone 2 to point-like areas 23. Small buds 29 are added to the plate undersurface. These may be made from a

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material which is resorbable, or even dissoluble in body (e.g. polysaccharides), since they need to support the plate 21 only during screw insertion and locking into the plate 21.

Figure 6 shows a plate 21 according to the invention combined with a long screw 32 which may be locked into the plate 21 via the spherical insert 30 with substantial freedom of angular placement 31. The conical head 27 of the screw 32 expands the slotted sphere 30, locking itself and the sphere 30 in the plate 21. Taper on the conus is again smaller than friction angle, preferably between 1:5 and 1:20.

Figure 7 shows another embodiment of the invention where the locking of the screw 34 in the plate 21 is achieved by the conical insert 35 which expands the slotted screw head 33 thereby forming a rigid connection at the cylindrical interface 36.

Figure 8 shows a further embodiment of the invention where the minimal plate contact to the bone 2 is achieved through removable clip-on springs 27 providing bud-like extensions 38 on the undersurface of plate 21. Springs 37 may be removed following insertion and locking of screw 22 in the plate 21. Hooks 39 facilitate removal following screw tightening.

Claims

1. An implant for osteosynthesis, comprising a device (21) connectable with a bone (2) with at least two clearance holes (28) and screws (22) with a head (27) for fastening said device (21) rigidly to said bone (2), characterized in that the contact surface (23) of said device (21) to said bone (2) is reduced to the level necessary only for initially locking said screws (22) to said device (21) at the time of insertion.
2. Implant according to claim 1, characterized in that the contact surface of the underside (24) of said device (21) to said bone (2) is reduced to point-like areas (23).
3. Implant according to claim 1 or 2, characterized in that the contact surface of the underside (24) of said device (21) to said bone (2) is less than 5%, preferably less than 2% of the full undersurface area (24) of said device (21).
4. Implant according to one of the claims 1 to 3, characterized in that the contact surface of the underside (24) of said device (21) to said bone (2) consists of contact buds (29) made of a material which is resorbable or dissoluble in body fluids, preferably in the form of resorbable or dissoluble buds (29) applied on the normal unstructured bone contact surface of said device (21).

5. Implant according to one of the claims 1 to 4, characterized in that additional clip-on springs (37) are provided for mounting on said device (21) which form bud-like extensions (38) on the undersurface (24) of said device (21).

6. Implant according to one of the claims 1 to 5, characterized in that said clearance holes (28) have the shape of a cone for receiving a correspondingly shaped screw head (27), with a cone angle being smaller than the resulting friction angle, preferably in the range of 1:5 to 1:20.

7. Implant according to one of the claims 1 to 6, characterized in that at least one of said clearance holes (28) is designed as self compressing hole.

8. Implant according to one of the claims 1 to 7, characterized in that only one of said clearance holes (28) is designed as self compressing hole.

9. Implant according to one of the claims 1 to 8, characterized in that said screw heads (27) are expandable by means of a third body (35) insertable into said head (27).

10. Implant according to one of the claims 1 to 9, characterized in that a third body (30) is provided fitting in said clearance hole (28) which is expandable by the conical screw head (27) having a cone angle being smaller than the resulting friction angle, preferably in the range of 1:5 to 1:20.

11. Implant according to one of the claims 1 to 10, characterized in that said screws (22) have a reduced length for engagement only with one cortex of said bone (2).

12. Implant according to one of the claims 1 to 11, characterized in that said device (21) is of plate-like form.

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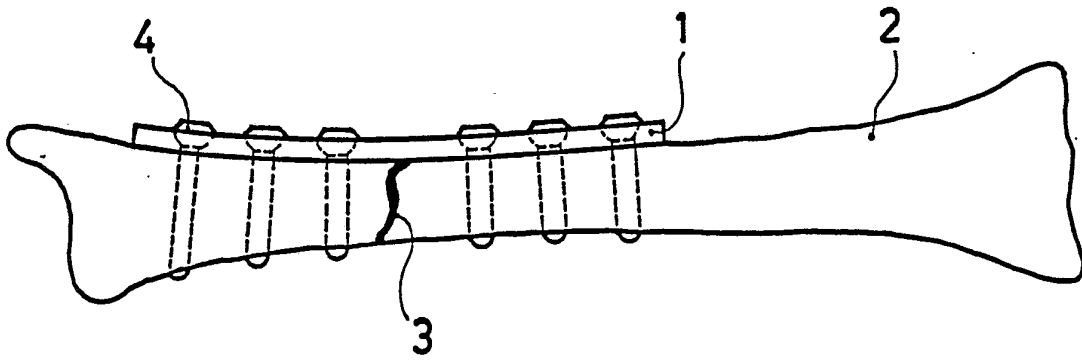


FIGURE 1

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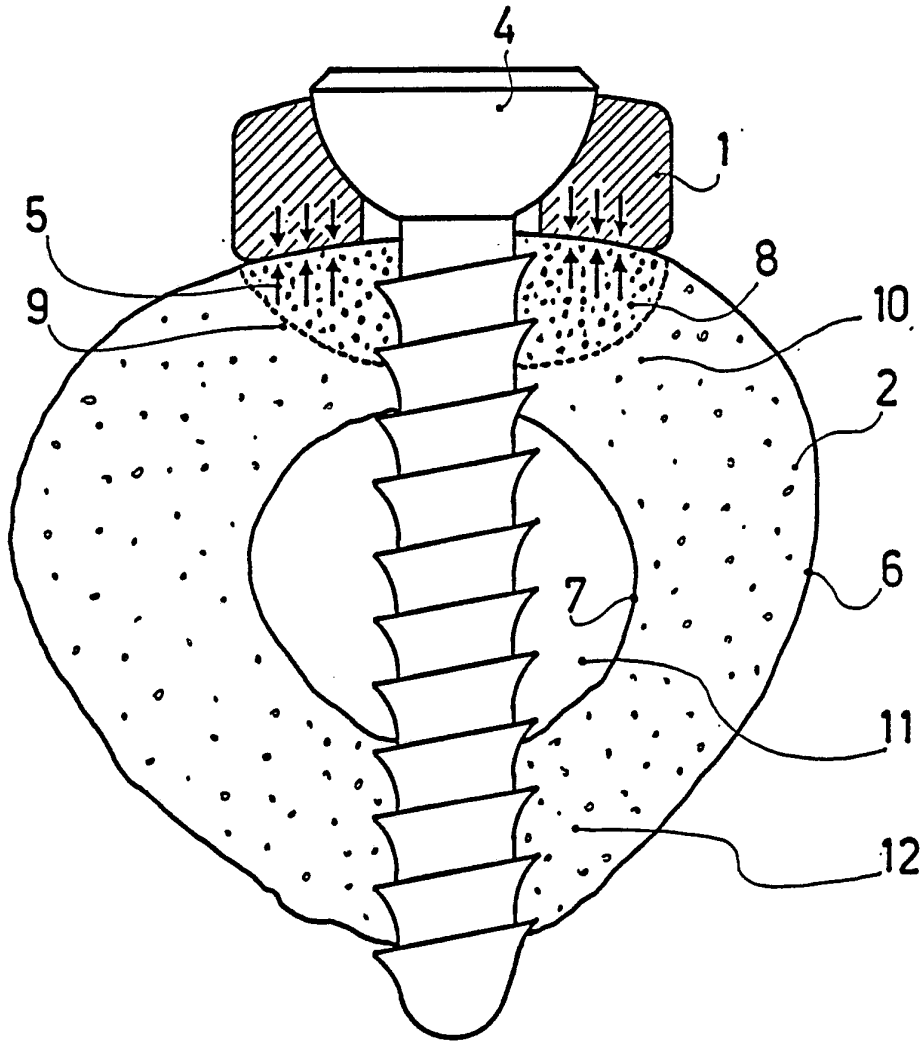


FIGURE 2

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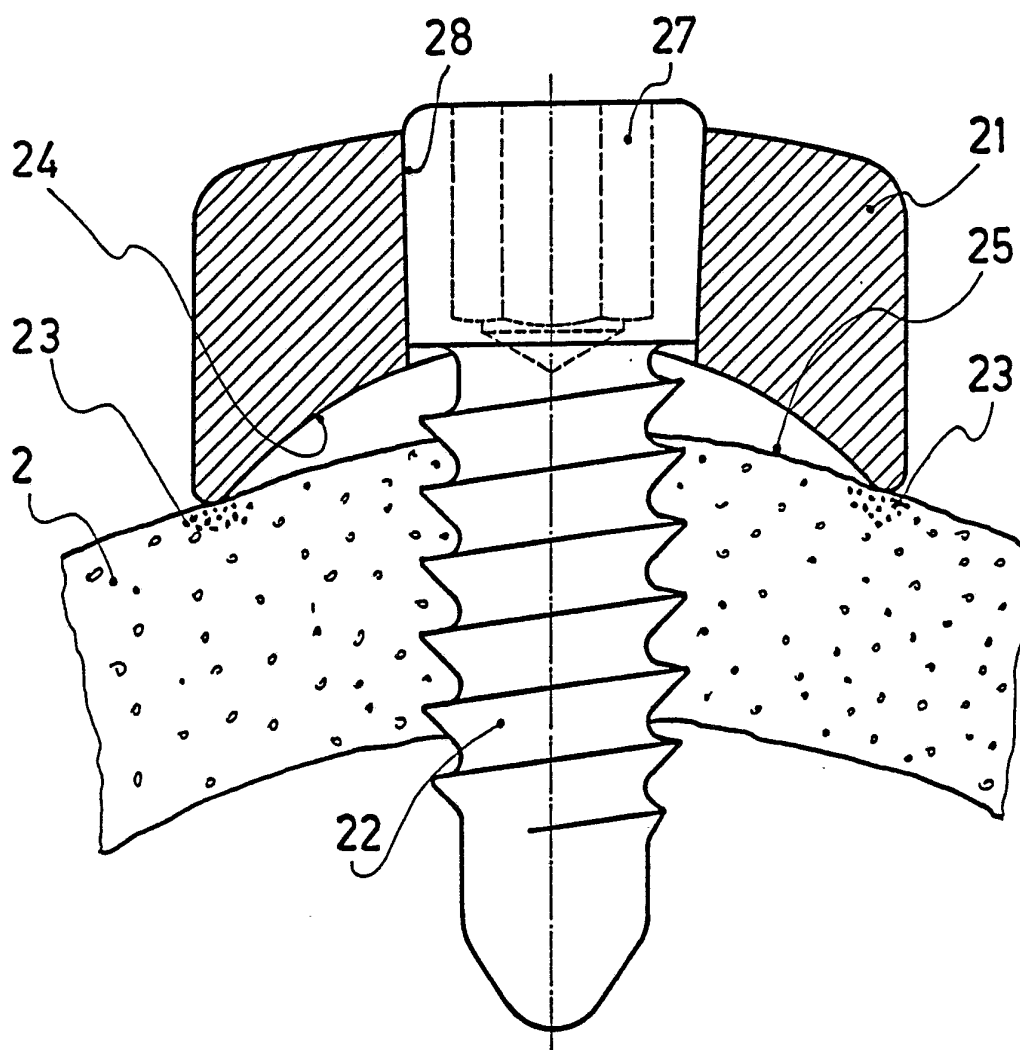


FIGURE 3.

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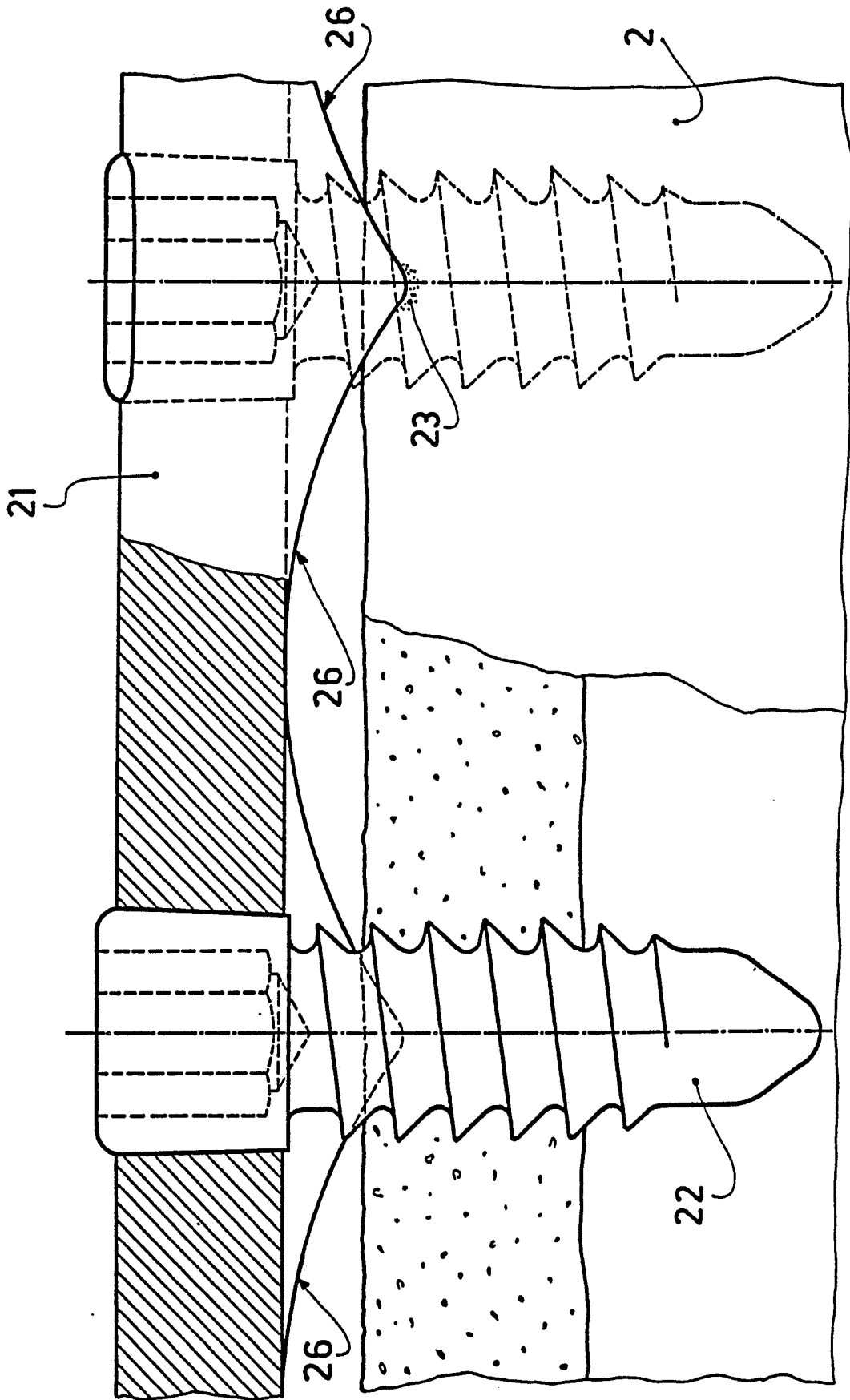


FIGURE 4

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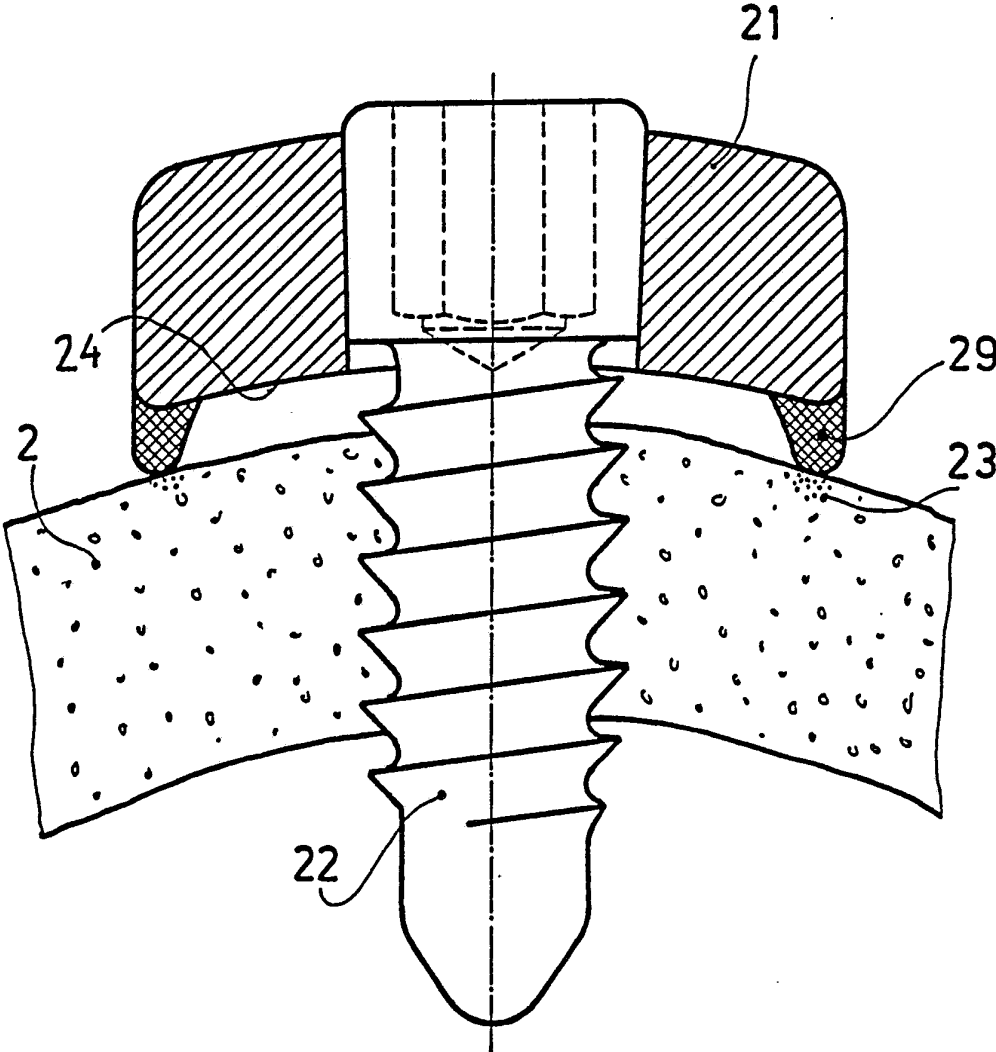


FIGURE 5

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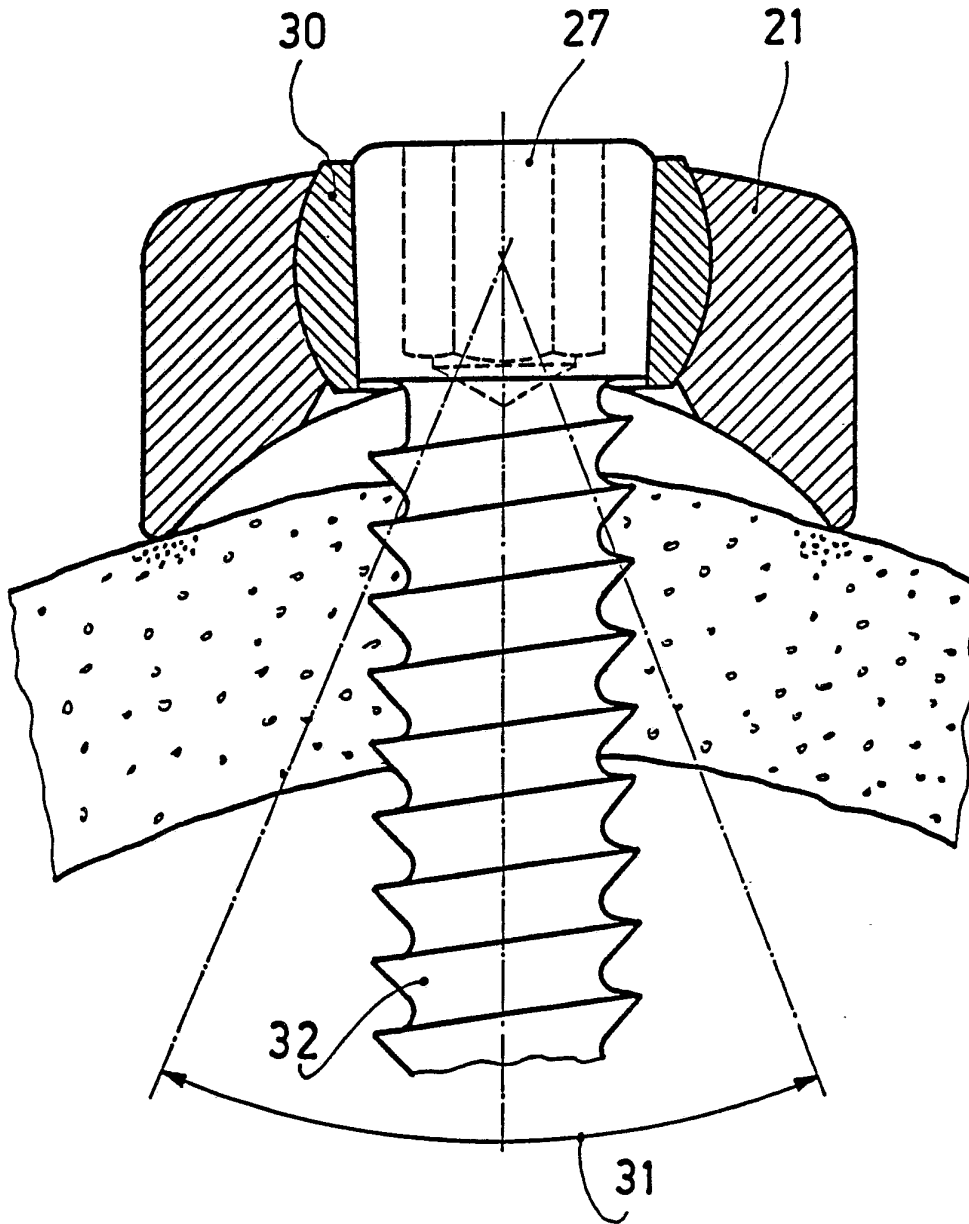


FIGURE 6

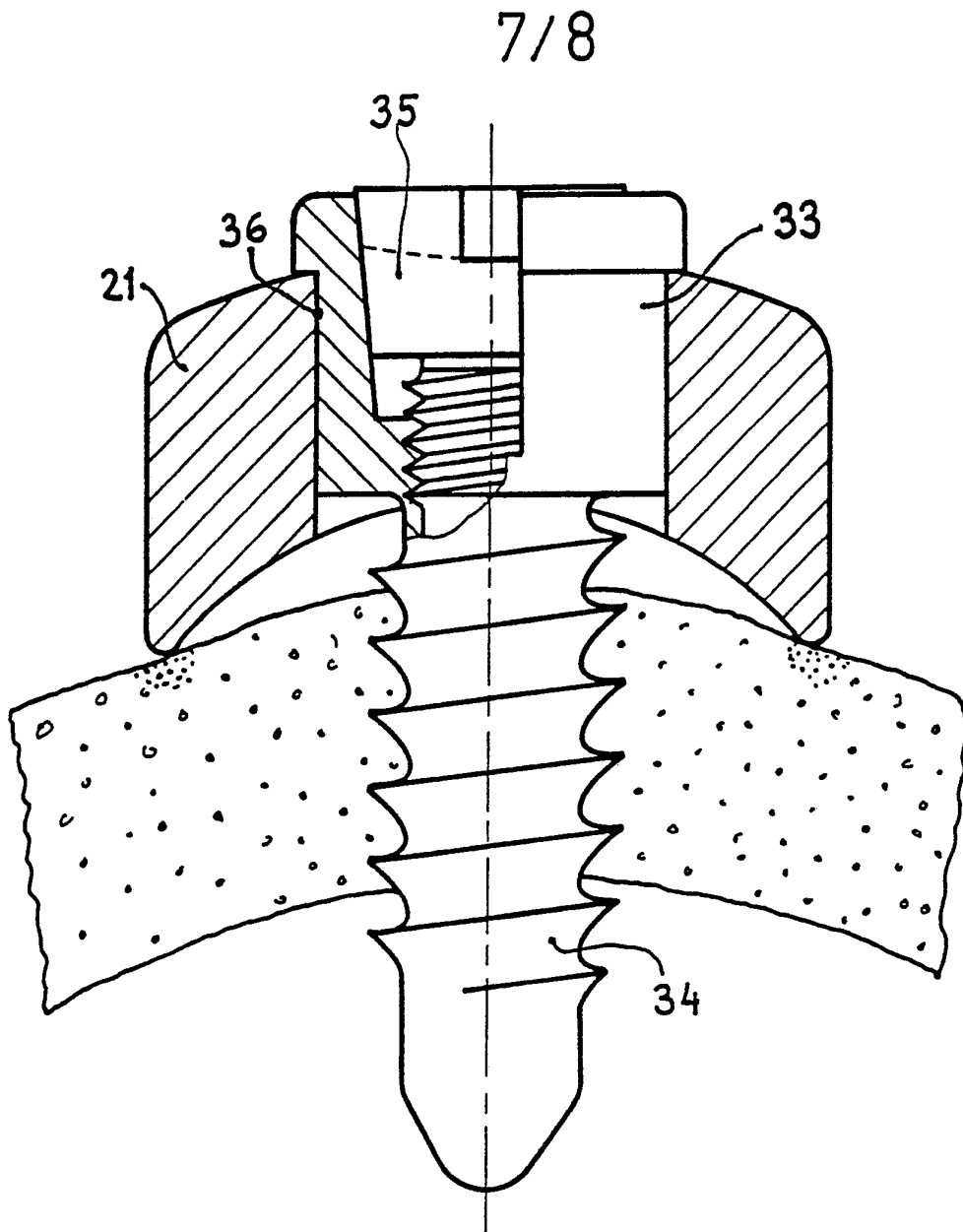


FIGURE 7

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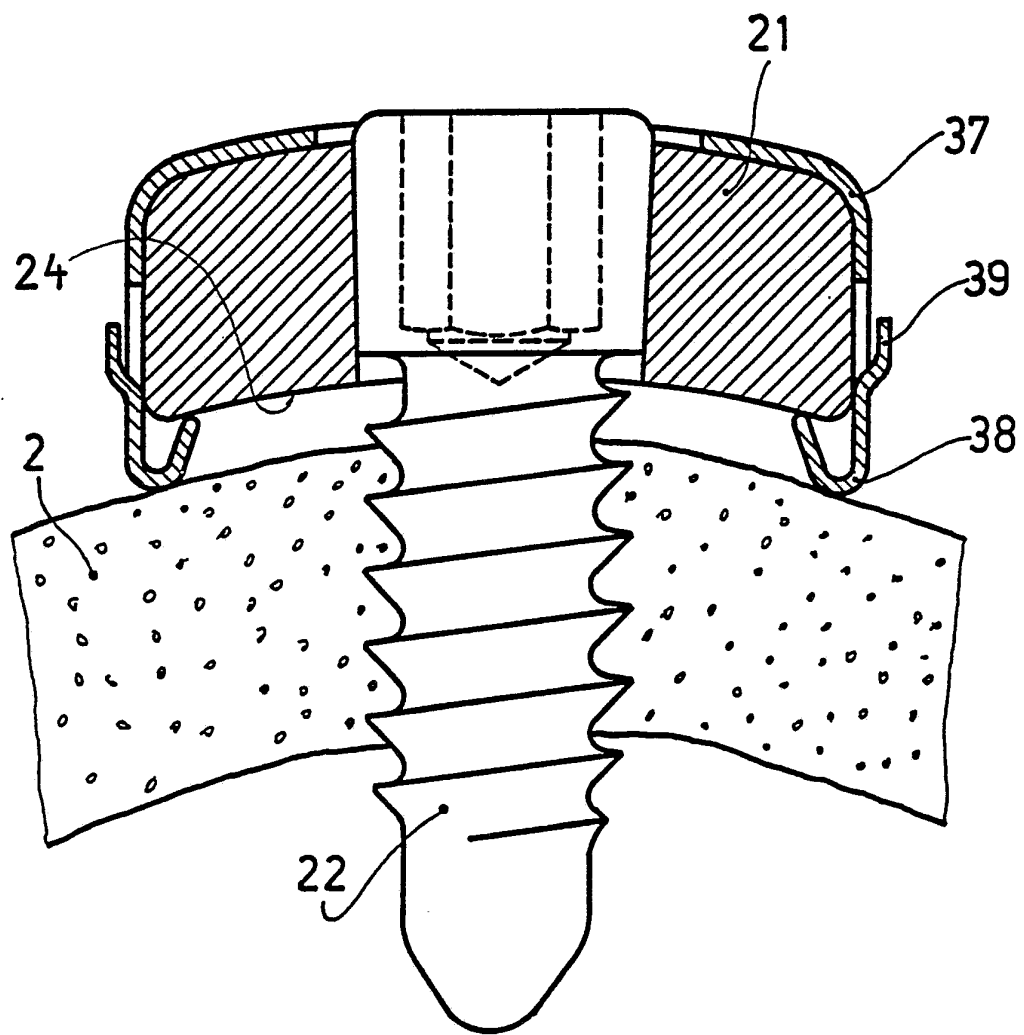
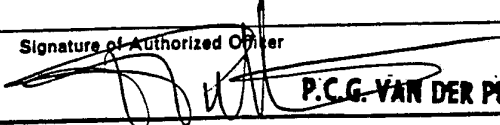


FIGURE 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 87/00663

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁴ : A 61 B 17/58		
II. FIELDS SEARCHED		
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	DE, C, 3442004 (H. OTTE et al.) 24 April 1986, see figures 1,3; column 2, line 60 - column 3, line 16; column 4, lines 16-35	1,12
Y	--	11
A	--	2,3,6
A	WO, A, 8700419 (3M) 29 January 1987, see claim 1	4
Y	DE, A, 2438669 (BEZOLD) 26 February 1976, see figure 3	11

<p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
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14th June 1988	08 JUL 1988	
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**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

EP 8700663
SA 19753

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 24/06/88. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-C- 3442004	24-04-86	None	
WO-A- 8700419	29-01-87	AU-A- 5956386 EP-A- 0229106 JP-T- 63500076	10-02-87 22-07-87 14-01-88
DE-A- 2438669	26-02-76	US-A- 4029091 CH-A- 597837	14-06-77 14-04-78