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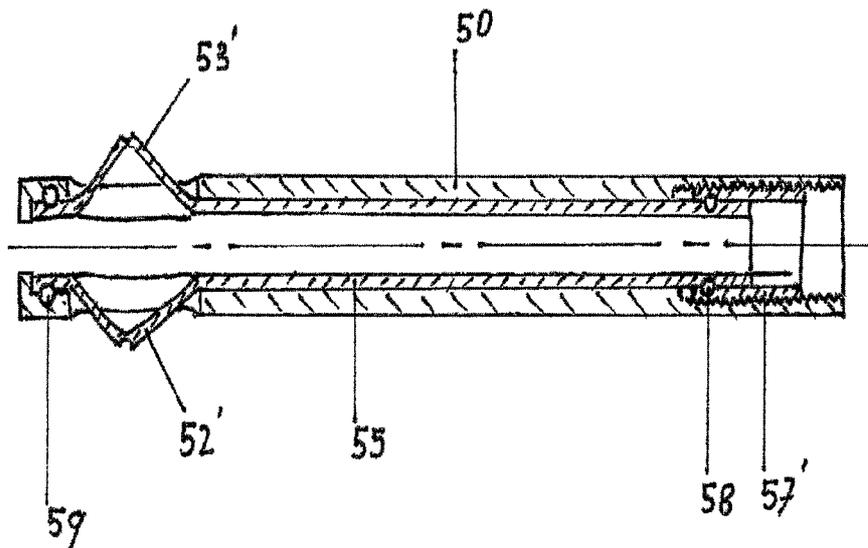
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(54) Title: MEDICAL DEVICE FOR TREATING BROKEN BONES OR FIXING STABILISING ELEMENTS TO BONE PARTS



(57) Abstract: A medical device for fixing bone parts or for fixing stabilizing elements to bone parts, comprising a rigid outer tube, which is provided with at least two opposed recesses on the side that is positioned in the bone, wherein a second inner tube is accommodated in said rigid outer tube, which inner tube is provided with at least two strips extending in the longitudinal direction of the inner tube on the side that is positioned in the bone, whilst means are provided for loading the inner tube in axial direction, in such a manner that a pressure force is exerted on said strips, which pressure force causes the strips to bend outwards through the aforesaid recesses.

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Medical device for treating broken bones or fixing stabilising elements to bone parts.

#### DESCRIPTION

The present invention relates to a medical device suitable for fixing bone parts, comprising

a rigid outer tube, which is provided with at least two opposed recesses near the first end that is positioned in the bone,

an inner tube that can be accommodated in the rigid outer tube, which inner tube is provided with at least two strips extending in the longitudinal direction of the inner tube on the side that is positioned in the bone, as well as

means for loading the inner tube in axial direction, in such a manner that a pressure force exerted on said strips causes the strips to bend outwards through the aforesaid recesses, which means for loading the inner tube in axial direction are made up of a screw that fits in another end of the outer tube that is positioned in the bone, which screw mates with screw thread present on the inner wall of the outer tube, wherein the first end of the outer tube that is positioned in the bone is made to exert a pressure force on the outwardly bending strips by suitably turning the screw.

Medical devices of the kind to which the present invention relates are used in positioning bone parts with respect to each other in case of a fracture or if two bones that are connected via one or more joints are to be immobilised. In all these cases the medical devices of the present kind are intended to take up and transmit a load in a direction substantially transversely to the longitudinal direction of the medical device .

Medical devices intended for fixing broken bone parts relative to each other are used in particular in the treatment of a broken femur head. An example of known medical devices of this kind is to be found in European patent EP 0 337 288 A 1. According to said document, one or more screws are screwed into the femur head, which screw is slidingly (in only one direction) accommodated in the plate that is fixed to the femur by means of screws. The screw and the plate are rigid, to such an extent that the device is capable of transmitting loads resulting from walking movements in a direction transversely to the longitudinal axis of the screw, wherein the screw can move at a fixed angle in the direction of the femur, as a result

of which the broken bones are firmly pressed together in the plane of fracture.

Another example of the known medical devices is to be found in US patent US 0,004,514 A1, for example, which employs a pin that is placed in the intramedullary cavity of the upper leg. A problem that occurs with these known devices is caused by the fact that the femur head can rotate freely about the screw axis with respect to the screw, in any case during insertion, which may lead to necrosis of the femur head. In addition, placement of the screw may cause damage to the bone in the femur head, to such an extent that it seriously impedes the healing process.

Medical devices that attempt to obviate this problem are known from US patent US 3,561,437, in which the pin is slidingly accommodated in one direction in the plate and the pin is driven rather than screwed into the bone. A problem that occurs with these known devices is caused by the fact that the pin can easily move out of the femur head.

To obviate this problem, constructions consisting of a pin that is slidingly accommodated in a plate have been conceived, in which constructions the pin is provided with elements that can expand in a direction transversely to the longitudinal direction of the pin. Examples of such constructions are shown in US 2,699,774, US 2,397,545 and US 4,204,531, for example. With all these constructions, the end of the pin that faces towards the femur head is provided with elements that are movable in the transverse direction of the pin, which parts elements are moved apart by suitable means once the pin has been placed. All these suitable means are fairly complicated and thus costly. A drawback of these known devices is that they are not hollow, so that they cannot be inserted over a guide wire.

Medical devices intended for use in situations in which two bones connected by a joint are to be immobilised are used in particular in fixing a vertebral segment. An example of known medical devices of this kind is to be found in US patent US 5,209,753, in which a screw is inserted into the pedicles of two or more vertebrae, which vertebrae are connected by means of plates or rods.

A problem that occurs with these known devices is caused by the fact that part of the bone in the pedicle may be damaged, to such an extent that a proper fixation is not obtained. In addition, very dangerous situations may arise upon turning a screw into the vertebra, because fibres of the dura may get entangled

when the screw breaks through the pedicle wall on the side of the spinal cord.

The object of the present invention is to provide a device that can be used for positioning bone parts or for connecting stabilising means to bone parts on either side of a joint so as to immobilise the intermediate joint, which device is sufficiently rigid for transmitting loads being exerted on the bone parts as a result of certain postures and movements of the body in a direction substantially transversely to the longitudinal axis of the device, without there being a risk of the medical device being driven out of the bone, and which can be inserted over a guide wire by simple surgery.

In order to accomplish the above object, the medical device according to the invention is configured as a rigid outer tube, which is provided with at least two opposed recesses on the side that is positioned in the bone, wherein a second inner tube is accommodated in said rigid outer tube, which inner tube is provided with at least two strips extending in the longitudinal direction of the inner tube on the side that is positioned in the bone, whilst means are present for loading the inner tube in axial direction, in such a manner that a pressure force is exerted on the aforesaid strips, which causes said strips to bend outwards through the aforesaid recesses.

In this way the device is capable of transmitting loads, such as transverse forces and bending moments, in a direction transversely to the longitudinal axis of the device, whilst the device is nevertheless secured against movement in the direction of its longitudinal axis. In this way the device is locked against being driven out of the bone part in question.

According to the invention, the means for loading the inner tube may be formed by a screw that fits in the outer tube, which screw mates with screw thread present on the inner wall of the outer tube, wherein the end piece, in this case made up of a shoulder, can exert a pressure force on the strips, causing said strips to bend outwards, by suitably turning the screw.

Another advantageous embodiment of the device according to the invention is characterised in that the inner tube is connected to the screw, which tube and which screw are hollow. The advantage of this is that the device as a whole can be inserted over a guide wire, which is especially important in the case of minimally invasive surgical procedures.

According to another embodiment, the means for loading the inner

tube are formed by a sleeve, which is provided with screw thread on its outer wall, which screw thread mates with screw thread on the inner wall of the outer tube. The sleeve is further connected to the inner tube, in such a manner that the sleeve can only rotate about the longitudinal axis of the inner tube with respect to the inner tube. By suitably rotating the sleeve, a pressure force will be exerted on the strips of the inner tube, so that the strips will bend outwards through the recesses in the outer tube.

According to the invention, the connection between the inner tube and the sleeve may be formed by an annular wire, which is accommodated in a recess jointly formed by a groove in the inner circumference of the sleeve and the outer circumference of the inner tube.

In an advantageous embodiment, the connection between the outer tube and the inner tube may be formed by an annular wire, which is accommodated in a recess jointly formed by a groove in the inner circumference of the outer tube and the outer circumference of the inner tube. In this way the outer tube can be secured in axial direction with respect to the inner tube (i.e. the longitudinal direction of the two tubes), and the inner tube can transmit an axial pressure force to the outer tube, which force is necessary in order to cause the aforesaid strips to bend outwards under plastic deformation.

In this way a simple, inexpensive, strong yet small-sized connection between the inner tube and the sleeve comprising hardly any moving parts is realised, wherein the sleeve can only rotate about the common longitudinal axis with respect to the inner tube.

According to another embodiment, the strips comprise a weakened portion at the location of their centre, seen in the longitudinal direction of the strips. This ensures that the bending of the strips will take place symmetrically relative to their centre. According to the invention, said weakened portion may be formed by an indentation or by one or more holes.

In another advantageous embodiment, the outer wall of the outer tube comprises at least one or more upright sections, which prevent rotation of the broken bone part with respect to the other part of the bone. The medical device according to the invention can be used in particular for treating broken hipbones according to any one or more of the preceding claims, and is characterised in that the side that is not positioned in the bone is slidably accommodated in a receiving

device, which receiving device is connected at an angle to a plate that can be fixed to a part of the broken hipbone, and in that the side that is positioned in the bone is fixed in the other part of the broken hipbone.

In this way the medical device can take up loads substantially transversely to the longitudinal axis of the device and transmit them to the plate, whilst the device that is positioned in the broken part of the hipbone can slide along the longitudinal axis of the medical device towards the other part, as a result of which the two parts are pressed firmly together, which is very conducive to the healing process. In another advantageous embodiment, the side of the medical device that is not positioned in the bone is slidingly accommodated in an opening of a pin which is placed in the intramedullary cavity of the upper leg.

The medical device according to the invention can furthermore be used in particular for immobilising two bones connected by one or more joints, in particular vertebrae, according to any one or more of the preceding claims, and is characterised in that the pin is connected to stabilising elements on the side that is not positioned in the bone, whilst the part that is positioned in the bone is inserted into the pedicle of the vertebra.

In addition to a medical device as described above, the present invention also relates to a pin which is in particular suitable for use in the above-described device. According to the invention, said pin is characterised in that it is provided with one or more or expandable elements in the form of one or more elongated strips extending in the longitudinal direction of the pin, whilst furthermore means are provided for exerting a pressure force on said strips in the longitudinal direction thereof, causing said strips to bend outwards under plastic deformation in a direction transversely to the longitudinal direction of the pin. The pin according to the invention may furthermore comprise all the features that have been described above upon use thereof in the medical device according to the present invention.

The present invention further relates to a hollow tube provided with two or more strips, which is suitable for use in a medical device or pin as described above.

Furthermore it is advantageous if the outer circumference of the pin according to the invention corresponds to the shape of a hole in the plate, wherein the outer circumference is so configured that the pin can only move in one direction with respect to the plate.

The invention will now be explained in more detail with reference to the appended drawing, which schematically shows by way of example a medical device with a few embodiments of pins according to the invention that can be used therein.

Figure 1 is a schematic view, not to scale, of a medical device of the kind to which the present invention relates, which shows the device in a situation of use on a broken femur, in which the medical device is slidingly accommodated in a plate.

Figure 2 is a schematic view, not to scale, of a medical device of the kind to which the present invention relates, which shows the device in a situation of use on a broken femur, in which the medical device is slidingly accommodated in a pin that is placed in the intramedullary cavity of the upper leg.

Figure 3 is a schematic view, not to scale, of a medical device of the kind to which the present invention relates, which shows the device in a situation of use for stabilising a joint between two vertebrae, in which the medical device is positioned in the pedicles of the vertebrae located adjacent to the joint and in which a stabilising element is connected to the two medical devices that are positioned one above another.

Figures 4 and 5 are a schematic, axial cross-sectional view and a schematic sectional view along the line VI-VI, respectively, of an outer, hollow element according to the invention that can be used in the medical device.

Figures 6 and 7 are a schematic, axial cross-sectional view and a schematic sectional view along the line VIII-VIII, respectively, of an inner tube that can be accommodated in the inner, hollow element.

Figures 8 and 9 are schematic, axial cross-sectional views of the medical device assembled from the parts shown in figures 6 and 7 and the assembled medical device in its situation of use, respectively.

Figure 10 is a schematic, axial cross-sectional view of another advantageous embodiment of the medical device.

Figure 11 is a three-dimensional view of an advantageous embodiment of the medical device.

In figure 1, numeral 1 indicates a femur with a femur head 2, whilst numeral 3 indicates a fracture between the femur head and the femur. A plate 4 is fixed to the femur 1 by means of screws 5. The plate 4 is provided with a receiving

part 6 including an angle therewith, in which a pin 7 provided with expanded lateral elements 8 is slidingly accommodated.

Figure 2 shows another construction, in which the pin 7 is slidingly accommodated in a cavity 9 of a pin 10 that is positioned in the intramedullary cavity 11 of the femur.

Figure 3 shows a construction comprising two pins, which pins are positioned in pedicles 12 of two vertebrae 13 disposed one above another. A stabilising element 15 is placed between the two pins on the side 14 not positioned in the bone, which element functions to restrict movement of the intervertebral disc 16 between the vertebrae.

The construction and the operation of the medical device will now be discussed in more detail with reference to the following figures. In figures 1, 2 and 3 the expanded elements 8 ensure that a reliable connection that will not come loose is obtained between the medical device and the surrounding bone.

In figures 4-10 an advantageous embodiment of the pin according to the invention is shown.

Figure 4 is an axial cross-sectional view of an outer tube 50, which is provided with screw thread 51 on one side and with recesses 52 and 53 and a shoulder 54 on the other side. Figure 5 is a sectional view along the line VI-VI of an advantageous embodiment of the outer tube.

Figure 6 shows an inner tube 55 which is provided with strips, two strips 52' and 53' in this case, on one side, which strips are dimensioned to fit in the recesses 52 and 53 of the outer tube 50 as discussed above. Said strips 52' and 53' are connected by an end piece 56, although said end piece may also be left out under certain circumstances. On the other side a screw 57 is shown, which screw can mate with the screw thread 51. The strips 52' and 53' are already slightly bent in this embodiment, which slightly facilitates the subsequent deformation thereof. Figure 7 is a sectional view along the line VIII-VIII of an advantageous embodiment of the outer tube.

Figure 8 schematically shows how the tube 55 can be accommodated in the tube 50 and be sealed by the screw 57. Tightening the screw 57 will result in the inner tube 55 being forced to the left, seen in the drawing, with the end piece 56 thereof abutting against the shoulder 54, as a result of which a pressure force will be exerted on strips 52' and 53', causing them to bend outwards

under plastic deformation to the shape shown in figure 9. If, for whatever reason, the pin needs to be removed after some time, this can be done by carefully dislodging the pin and retracting it, with the strips partially or entirely deforming back to their original shape. It is possible in this context to connect the screw 57 to the tube 55 in such a manner that the tube 55 is carried along with the screw when the screw is turned back, which will be accompanied, of course, by deformation of the strips 52" and 53' in reverse direction.

In all the preceding examples pins provided with two expandably deformable strips have been shown, but it will be apparent to those skilled in the art that said number may be increased as required.

Figure 10 shows an embodiment in which the connection between the inner wall of the outer tube 50 and the outer wall of the inner tube 55 is formed by an annular wire 59, which functions to fix the two parts in axial direction with respect to each other. A second ring 58 is provided between the outer wall of the inner tube and the hollow sleeve 57' for the purpose of fixing the inner tube and the sleeve in axial direction with respect to each other, the two parts can freely rotate about their common longitudinal axis relative to each other, however. This construction makes it possible to turn the sleeve in or out as desired by means of the mating screw thread 51', as a result of which the strips 52' and 53' will be plastically deformed in inward or outward direction, respectively.

Figure 11 is a three-dimensional view of an advantageous embodiment of the medical device, which is provided with two wings 60 on the side that is positioned in the bone.

It will be apparent from the foregoing that the invention provides a medical device, and a pin in particular suitable for use therein, for the treatment of broken bones which is remarkable for its simplicity, the absence of mechanical pivot points, its reliability, its ease of use and its relatively low manufacturing costs. Although two embodiments have been discussed in the foregoing, it will furthermore be apparent that many variants are conceivable within the scope of the present invention.

**CLAIMS**

1. A medical device suitable for fixing bone parts, comprising  
a rigid outer tube, which is provided with at least two opposed recesses near the first end positioned in the bone,  
an inner tube that can be accommodated in the rigid outer tube, which inner tube is provided with at least two strips extending in the longitudinal direction of the inner tube on the side that is positioned in the bone, as well as  
means for loading the inner tube in axial direction, in such a manner that a pressure force exerted on said strips causes the strips to bend outwards through the aforesaid recesses, which means for loading the inner tube in axial direction are made up of a screw that fits in another end of the outer tube that is positioned in the bone, which screw mates with a screw thread present on the inner wall of the outer tube, wherein the first end of the outer tube that is positioned in the bone is arranged to exert a pressure force on the outwardly bending strips by suitably turning the screw, **characterised in that** the connection between the outer tube and the inner tube is formed by an annular wire, which is accommodated in corresponding grooves formed in the inner wall of the outer tube and the outer wall of the inner tube.
2. A medical device according to claim 1, **characterised in that** the inner tube is connected to the screw, which screw is hollow.
3. A medical device according to either one or both of the preceding claims, **characterised in that** the connection between the screw and the inner tube is formed by an annular wire, which is accommodated in corresponding grooves in the outer wall of the inner tube and the inner circumference of the screw.
4. A medical device according to any one or more of the preceding claims, **characterised in that** said strips comprise a weakened portion at the location of their centre, seen in the longitudinal direction of the strips.
5. A medical device according to claim 4, **characterised in that** said weakened portion is formed by a cut, an indentation or one or more holes.
6. A medical device according to any one or more of the preceding claims, **characterised in that** the outer tube is provided with one or more upright sections.

7. A medical device according to any one or more of the preceding claims, **characterised in that** the other end positioned outside the bone is slidingly accommodated in a receiving device, which receiving device is connected at an angle to a plate that can be fixed to a part of the broken hipbone, and in that the side that is positioned in the bone is fixed in the other part of the broken hipbone.

8. A medical device according to claim 7, **characterised in that** the side that is not positioned in the bone is slidingly accommodated in an opening of a pin which is placed in the intramedullary cavity of the upper leg.

9. A medical device for immobilising two bones connected by one or more joints, in particular vertebrae, according to any one or more of the preceding claims, **characterised in that** the other end not positioned in the bone can be connected to stabilising elements, and wherein the first end that is positioned in the bone can be inserted into the pedicle of the vertebra.

10. A pin in particular but not exclusively suitable for use in a medical device according to any one or more of the preceding claims, **characterised in that** the pin comprises one or more of the features defined in the preceding claims.

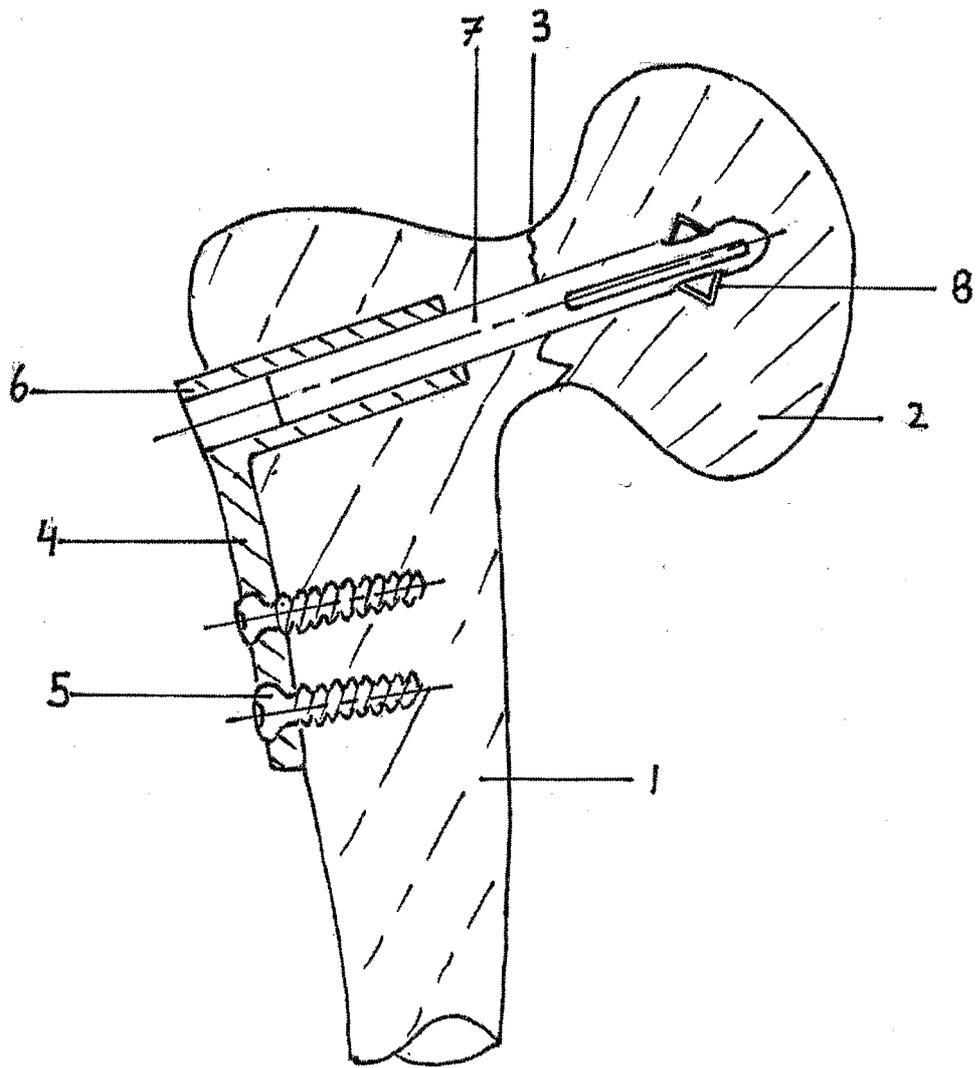


Fig. 1

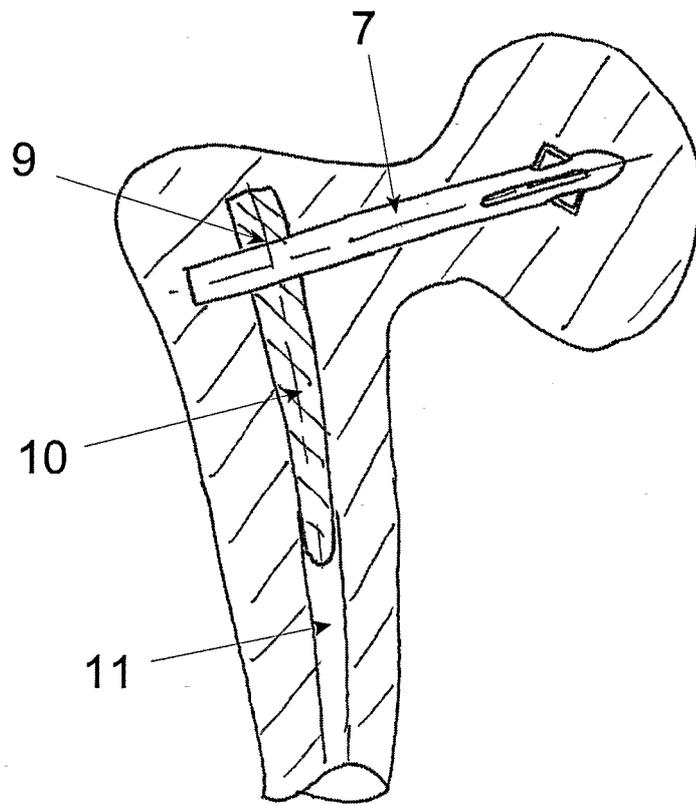


Fig. 2

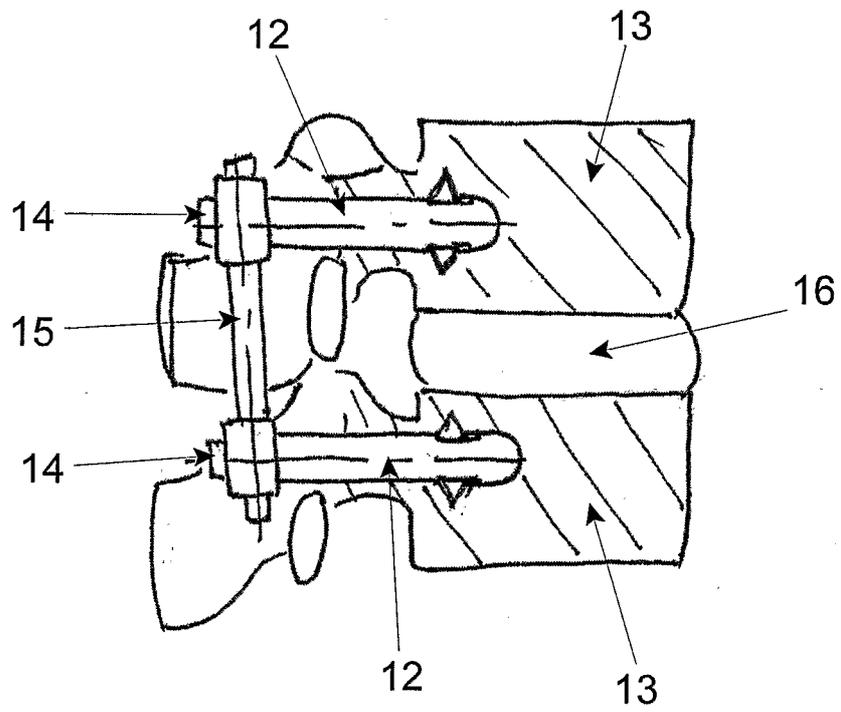


Fig. 3

Fig. 5

VI-VI

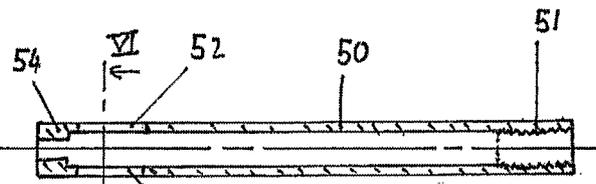


Fig. 4

VIII-VIII

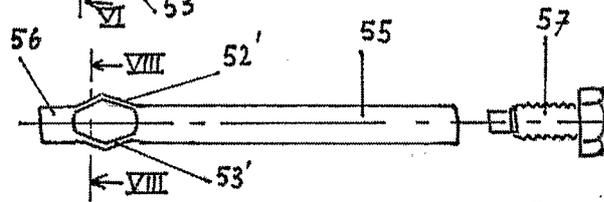


Fig. 6

Fig. 7

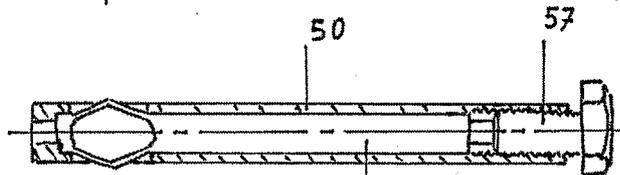


Fig. 8

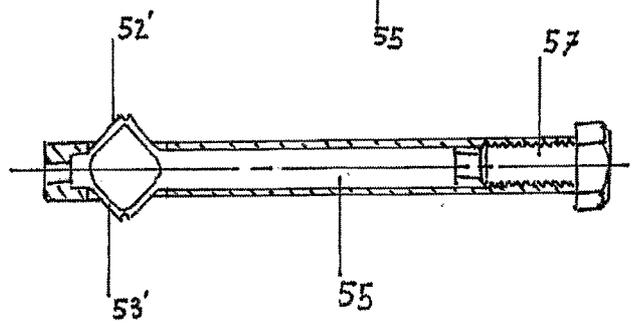


Fig. 9

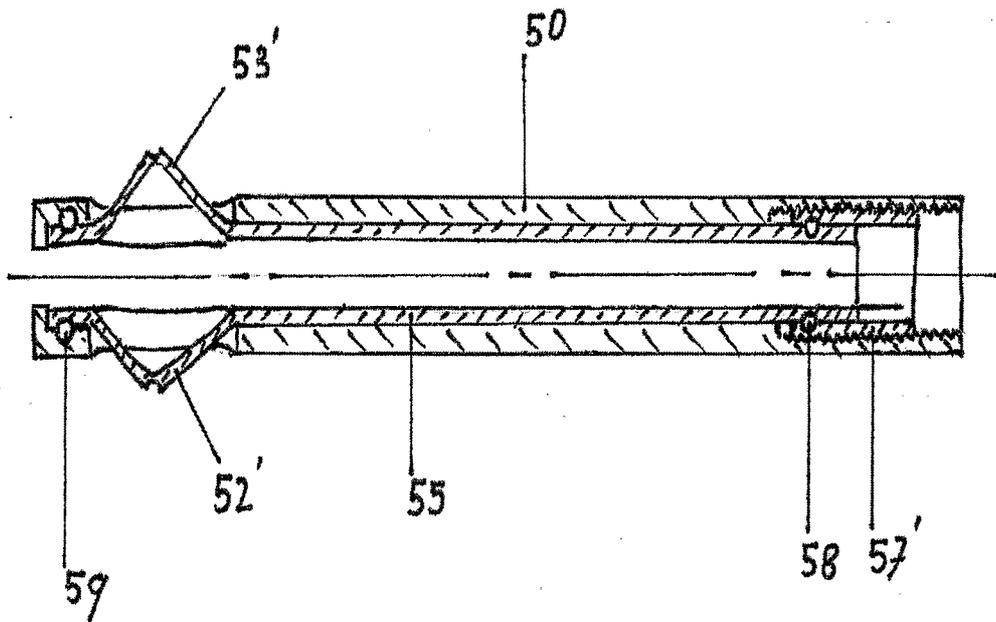


Fig. 10

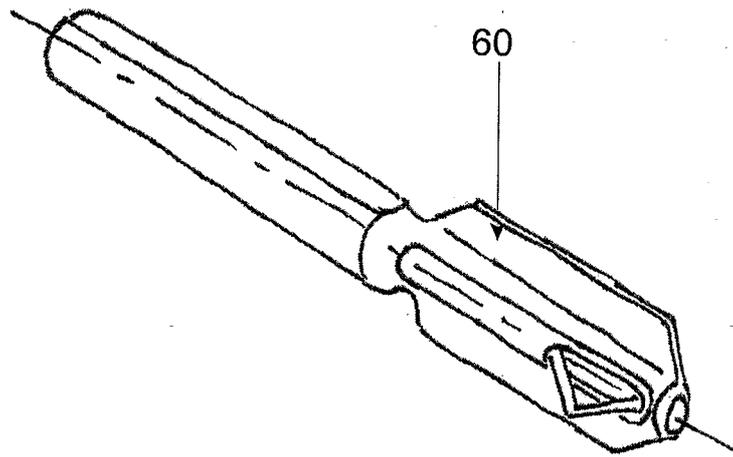


Fig. 11

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/NL2006/000523

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. A61B17/84      A61B17/74      A61B17/78      A61B17/70  
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According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**  
 Minimum documentation searched (classification system followed by classification symbols)  
**A61B**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)  
**EPO-Internal**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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X	abstract; figures 1,4 paragraphs [0018], [0019] -----	<b>10</b>
A	FR 2 653 006 A (DORANGE ARNAUD) 19 April 1991 (1991-04-19)	<b>1-5</b>
X	abstract; figures 3-5 -----	<b>10</b>
A	US 2004/133204 A1 (DAVIES JOHN BRUCE CLAYFIELD) 8 July 2004 (2004-07-08)	<b>1,4,5</b>
	abstract; figures 1A,1A-2E,9 -----	
A	US 6 328 758 B1 (TORNIER ALAIN ET AL) 11 December 2001 (2001-12-11)	<b>1,4,5</b>
	abstract; figures 3,4a,4c -----	
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Further documents are listed in the continuation of Box C       See patent family annex

\* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier document but published on or after the international filing date	"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  1 February 2007	Date of mailing of the international search report  09/02/2007
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Name and mailing address of the ISA/ European Patent Office, P B 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel (+31-70) 340-2040, Tx 31 651 epo nl, Fax (+31-70) 340-3016	Authorized officer  <b>Macaire, Stephane</b>
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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/NL2006/000523

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 254 639 A (INDUSTRIAS QUIRURGICAS DE LEVANTE, s.L) 6 November 2002 (2002-11-06) abstract; figures 7,8 -----	9

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