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(54) **Intramedullary pin with self-locking end for metadiaphyseal fractures**

Intramedullar-Nagel mit selbstverriegelbarem Ende zur Behandlung von mediaphysialen Brüchen

Clou intramédullaire avec bout autoverrouillable pour le traitement des fractures

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(73) Proprietor: **Vicenzi, Guglielmo**
I-41034 Finale Emilia (Modena) (IT)

(72) Inventor: **Vicenzi, Guglielmo**
I-41034 Finale Emilia (Modena) (IT)

(74) Representative: **Modiano, Guido, Dr.-Ing. et al**
Modiano & Associati SpA
Via Meravigli, 16
20123 Milano (IT)

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Description

[0001] The present invention relates to an intramedullary pin for metadiaphyseal fractures of long bones.

[0002] It is known to intervene with intramedullary pins or the like to reduce metadiaphyseal fractures, i.e. fractures involving the intermediate part of long bones; the ends of said pins can or must be fixed with screws to both the intact cortices of the bone (i.e. the proximal cortex and the distal cortex), and fixing by means of screws to both of the cortices entails some disadvantages due, among other things, to the fact that additional surgical time is required and that it is often necessary to resort to radiological means for rather long times in order to determine the fixing position of the screws in the pin, with consequent exposure to the surgeon, to the assistants and to the operating-theater personnel of ionizing radiation even for prolonged periods of time.

[0003] Besides this, when the pin is to be removed at the end of the treatment, it is necessary to intervene not only in the region of the bone from which the pin is to be extracted but also distally, where the fixing screws must be removed.

[0004] DE-A-31 46 065 discloses an intra-medullary bone reinforcing member having a construction consisting of laminations. The side laminations are connected by pivots to cross arms. The cross arms connect to a housing which also holds the lower end of the central laminations. The reinforcer is inserted surgically into the medulla with the laminations all lying in the closed position. A screw mechanism at the proximal end in the housing is then turned which transmits motion down the length of the medulla to open out the two arms so that they fit snugly to the contours of the bone wall.

[0005] The technical aim of the present invention is to obviate the above disadvantages of known intramedullary pins, i.e. to provide a pin which does not require interventions from outside for distal pin-bone coupling, which allows an elastic osteosynthesis, which can be locked at one end with a screw (when desired or required) and rapidly self-locks at the other end, which can be installed very quickly requiring only an extremely short exposure to radiation, which does not require drilling nor preliminary preparation of the medullary canal and which can be even more easily removed when the fracture has been repaired.

[0006] Within the scope of this technical aim, an object of the present invention is to provide a pin which can be installed with a set of instruments which is extremely simple, is inexpensive and adapts to various dimensional situations of the bone in which it is installed, so that a very small number of sizes is sufficient to satisfy any requirement.

[0007] Another object of the present invention is to solve the above aim and object by means of a simple structure which is relatively easy to execute in practice, safe in use and effective in operation as well as relatively modest in cost.

[0008] This aim and these objects are achieved by the present intramedullary pin with self-locking end for metadiaphyseal fractures of long bones as defined in the appended claims.

[0009] Further particularities will become apparent and evident from the detailed description of a preferred but not exclusive embodiment of an intramedullary pin according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is a perspective side view of an open pin according to the invention;
figure 2 is a side view of the closed pin of figure 1 before it is inserted in the bone;
figure 3 is a schematic and sectional view of a pin inserted in the bone; and
figures 4 to 8 are views of provided retaining means of the stems.

[0010] With particular reference to the above figures, the reference numeral 1 indicates the intramedullary pin according to the invention for metadiaphyseal fractures of long bones, i.e. fractures which leave the ends practically intact.

[0011] The pin 1 is constituted by a proximal stub 2 which is provided with means 3 for fixing to the cortices; said means are advantageously constituted by a screw 4a the stem whereof can be screwed into an oblique hole 4 of the stub which can be threaded or not; at one end, the stub has an axial threaded hole 5 in which the stem 6 of a T-shaped grip handle 7, which facilitates the operations of inserting and extracting the pin, can be screwed.

[0012] At the other end, the stub has at least two (five in the particular illustrated case) elastically deformable curved stems 8 (advantageously made of biocompatible steel such as for example AISI 316L) rigidly associated therewith; said stems can have a circular cross section and rounded ends 9; advantageously, one of the stems, for example the central one, is slightly longer than the others so as to define, when the stems are gathered in a bundle, a pointed assembly free end 1a which is easier to orientate and insert in bone cavities.

[0013] In order to improve load distribution and avoid fractures of the femoral lateral cortex, the stub 2 advantageously has a slightly developed curved shape, for example curved by 6-8 degrees for the femur, 20-25 degrees for the tibia, 25-30 degrees for the humerus: the base of the stub 2 is conveniently slightly frustum-shaped and converges toward the couplings of the stems.

[0014] Means 10 for the temporary binding retention of the bundled stems are provided and for example comprise a metallic wire 11; a manual grip ring 12 is rigidly associated with said wire at one end and a bent portion 13, which is engaged on said wire and defines a loop 14, is rigidly associated with said wire at the other end;

proximate to the ends, the stems 8 advantageously have respective grooves 15 in which the loop 14 can be accommodated while the wire runs between the curved stems 8 (see figures 4 and 5); advantageously, the wire is passed through the axial hole 5 which is extended downward and conveniently has a lateral notch in the threaded region so as to indeed allow the passage of the wire.

[0015] In another provided and preferred embodiment (see figure 6) the temporary retention binding means 10 are obtained as follows: the ends 16 of the stems 8 are folded at 90 degrees toward the center, are traversed by small holes 17 and have appropriate lengths so that the holes align at the central axis of the stem bundle; the lower end of the metallic wire 11 is passed through the holes 17; in this embodiment, the upward traction of the wire 11, which allows the release of the stems, is extremely easy.

[0016] In another provided embodiment (figure 7), the temporary binding retention means 10 are constituted by an ogival cap 18 which is forced around the free ends of the bundled stems; the cap 18 is made of bio-absorbable material, and in order to release the tip of the stems the wire 11, of appropriate rigidity, is pushed downward; after a short time the cap is reabsorbed by the tissues.

[0017] Figure 8 illustrates temporary binding retention means 10 constituted by a metallic wire 19 which is inserted in the grooves 15 of the stems, embraces the bundled stems and has its ends 20 mutually braided; the wire 19 is surmounted by a cable 21 which passes between two stems and is intended to be pulled so as to release the braided ends of the wire 20: the wire 20 remains coupled to one of the stems since it is passed through a hole of said stem or is tied onto the end thereof.

[0018] The temporary binding retention means 10 can also be constituted for example by bio-absorbable threads intended to be left in place after releasing the tips of the stems.

[0019] The operation of the pin according to the invention, for example for a femur prosthesis, is as follows:

a cylindrical channel F is provided in the proximal metaphysis A, extends downward through all of the metaphysis up to the medullary canal and is oriented along the axis of the bone: the pin according to the invention is inserted through said canal with the stems bundled, being aided in doing so by means of the handle 7 screwed to the proximal part of the stub: by using a radiographic examination means, the pin is caused to traverse the medullary canal until the end of the pin penetrates inside the medullary canal distally with respect to the fracture; the wire 11 is pulled, or pushed, by means of the manual grip ring 12 and releases the stems and allows them to open (for the embodiments shown in figures 6 and 7, the wire 11 slips out of the holes 17 or pushes the cap 18 away); as the insertion of the pin continues, the stems 8, by divaricating, press the bone of the metadiaphysis B from the inside and anchor thereto.

[0020] The proximal stub can then be anchored to the cortices at A by means of a screw.

[0021] Attention is called to the fact that the fixing of the pin in the distal region of the fracture occurs without having to intervene from the outside on this region: torsional movements of the distal fragment are furthermore prevented, since the various stems arrange themselves on different planes.

[0022] The coupling which is furthermore provided between the two ends of the fracture, instead of being rigid, is slightly elastic, and this allows the more rapid forming of the bone callus which restores the continuity of the fractured bone.

[0023] When the fracture has consolidated, it is possible to extract the pin by first screwing the stem 6 of the handle 7 at 5 and by then simply pulling; the stems will slip out.

[0024] It should be noted that a small number of sizes of the invention are sufficient to be able to intervene on any type of patient and fracture and that no preliminary drilling or medullary canal preparation operations are required.

[0025] In the case of the femur, in order to adapt the pin to the natural procurvature of the bone in which it is inserted, the bundled stems are given a slight procurvature: this can be obtained either by providing right and left pins or by providing an appropriate curving device to be used shortly before the prosthesis is installed.

[0026] It has thus been observed that the invention achieves the proposed aim and objects.

[0027] The invention thus conceived is susceptible to numerous modifications and variations, all of which are within the scope of the inventive concept.

[0028] All the details may furthermore be replaced with other technically equivalent elements.

[0029] In practice, the materials employed, as well as the shapes and dimensions, may be any according to the requirements without thereby abandoning the scope of the protection of the following claims.

[0030] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Intramedullary pin (1) with a self-locking end for accomodation in a metadiaphyseal-fractured long bone, the pin comprising a proximal stub (2) for fix-

ing to a proximal cortex of the bone by fixing means (3), at least two curved and elastically deformable stems (8) with proximal ends rigidly associated axially to said stub, said stems (8) being able to extend inside the medullary canal of the bone and being elastically expandable such that the distal ends (9) of the stems can be anchored to the bone of the metadiaphysis (B) to produce an integral coupling between the pin and the bone.

2. Intramedullary pin as claimed in claim 1 **characterised in that** said means (3) for fixing the proximal stub (2) comprise a threaded oblique hole (4) in the stub (2) in which the stem of a screw (4a) adapted to pass through the bone cortices can be screwed.

3. Intramedullary pin as claimed in claim 1 or claim 2 **characterised in that** the stub (2) has a slightly curved axis.

4. Intramedullary pin as claimed in any preceding claim **characterised in that** said stems (8) have rounded distal ends (9) and that one of the stems is slightly longer than the other.

5. Intramedullary pin as claimed in any preceding claim **characterised in that** said stems (8) have a slight procurvature for improved binding of fractured femur bones.

6. Intramedullary pin as claimed in any preceding claim **characterised in that** the pin comprises at least three stems.

7. Intramedullary pin as claimed in any preceding claim **characterised in that** once the fracture has consolidated the pin may be removed from the bone by pulling on the stub (2).

8. Intramedullary pin as claimed in claim 7 **characterised in that** a handle (7) may be attached to the stub (2).

Patentansprüche

1. Intramedullärer Stift (1) mit einem selbstverriegelnden Ende zur Aufnahme in einem metadiaphysealgebrochenen langen Knochen, wobei der Stift einen proximalen Stumpf (2) aufweist zur Befestigung an einem proximalen Kortex des Knochens mittels Befestigungsmitteln (3), zumindest zwei gekrümmte und elastisch verformbare Stäbe (8), deren proximale Enden fest axial mit dem Stumpf verbunden sind, wobei sich die Stäbe (8) in dem medullären Kanal des Knochens erstrecken können und elastisch ausweitbar sind, so dass die distalen Enden (9) der Stäbe an dem Knochen der Metadiaphysis (B) verankert werden können, um eine integrale Kopplung zwischen dem Stift und dem Knochen herzustellen.

2. Intramedullärer Stift nach Anspruch 1, **dadurch gekennzeichnet, dass** die Mittel (3) zum Befestigen des proximalen Stumpfes (2) eine schräge Schraubenöffnung (4) in dem Stumpf (2) aufweisen, in welche der Schaft einer Schraube (4a) hineingeschraubt werden kann, die durch die Knochenkortizes hindurchtreten kann.

3. Intramedullärer Stift nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** der Stumpf (2) eine leicht gekrümmte Achse hat.

4. Intramedullärer Stift nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Stäbe (8) abgerundete distale Enden (9) haben und dass einer der Stäbe geringfügig länger ist als der andere.

5. Intramedullärer Stift nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Stäbe (8) eine leichte Krümmung aufweisen für eine verbesserte Bindung von gebrochenen Oberschenkelknochen.

6. Intramedullärer Stift nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Stift zumindest drei Stäbe aufweist.

7. Intramedullärer Stift nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Stift durch Ziehen an dem Stumpf (2) aus dem Knochen entfernt werden kann, sobald der Bruch geheilt ist.

8. Intramedullärer Stift nach Anspruch 7, **dadurch gekennzeichnet, dass** ein Griff (7) an dem Stumpen (2) anbringbar ist.

Revendications

1. Broche intra-médullaire (1) ayant une extrémité à auto-verrouillage pour être reçue dans un os long fracturé de façon diaphysaire, la broche comprenant une embase proximale (2) à fixer à un cortex proximal de l'os par des moyens de fixation (3), au moins deux tiges élastiquement déformables et courbées (8) ayant des extrémités proximales rigidement associées axialement à ladite embase, lesdites tiges (8) étant capables de s'étendre à l'intérieur du canal médullaire de l'os et pouvant être élastiquement étirables de telle sorte que les extrémités distales (9) des tiges peuvent être ancrées à l'os de la métadiaphyse (B) pour produire un accou-

plement intégral entre la broche et l'os.

2. Broche intra-médullaire selon la revendication 1, **caractérisée en ce que** lesdits moyens (3) pour fixer l'embase proximale (2) comprennent un trou oblique taraudé (4) dans l'embase (2) dans lequel la tige d'une vis (4a), adaptée pour traverser les cortex osseux, peut être vissée.

3. Broche intra-médullaire selon la revendication 1 ou la revendication 2, **caractérisée en ce que** l'embase (2) présente un axe légèrement courbé.

4. Broche intra-médullaire selon une quelconque revendication précédente, **caractérisée en ce que** lesdites tiges (8) ont des extrémités distales arrondies (9) et **en ce que** l'une des tiges est légèrement plus longue que l'autre.

5. Broche intra-médullaire selon une quelconque revendication précédente, **caractérisée en ce que** lesdites tiges (8) ont une légère courbure pour améliorer la liaison des os du fémur fracturé.

6. Broche intra-médullaire selon une quelconque revendication précédente, **caractérisée en ce que** la broche comprend au moins trois tiges.

7. Broche intra-médullaire selon une quelconque revendication précédente, **caractérisée en ce que**, une fois que la fracture est consolidée, la broche peut être retirée de l'os en tirant sur l'embase (2).

8. Broche intra-médullaire selon la revendication 7, **caractérisée en ce qu'**une poignée (7) peut être fixée à l'embase (2).

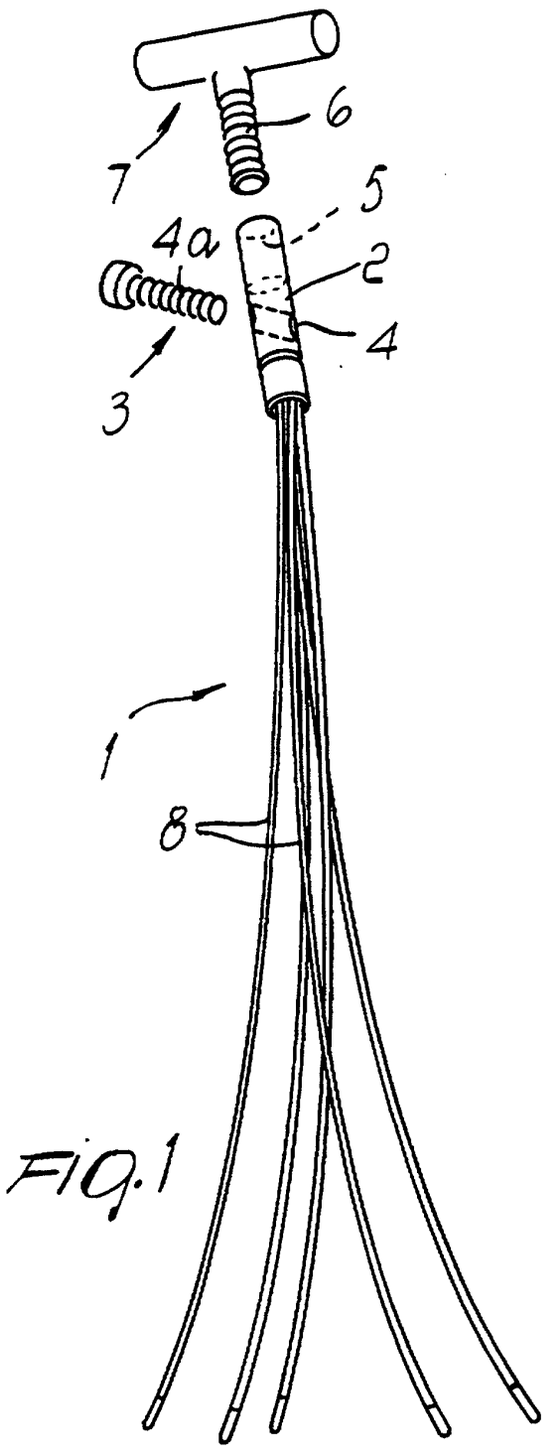

FIG. 1

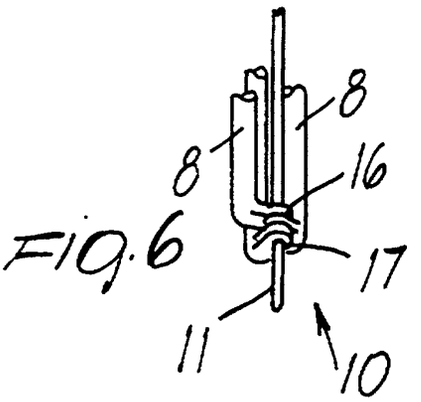

FIG. 6

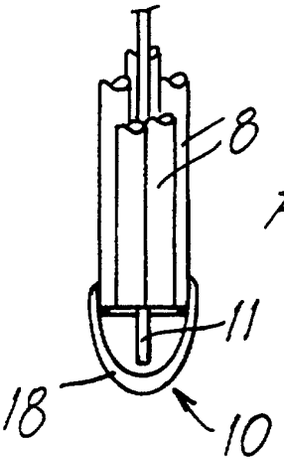

FIG. 7

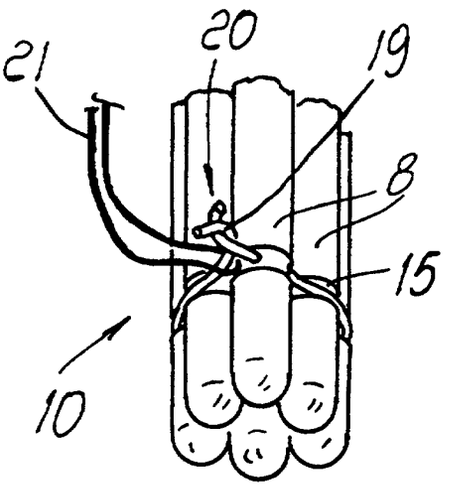

FIG. 8

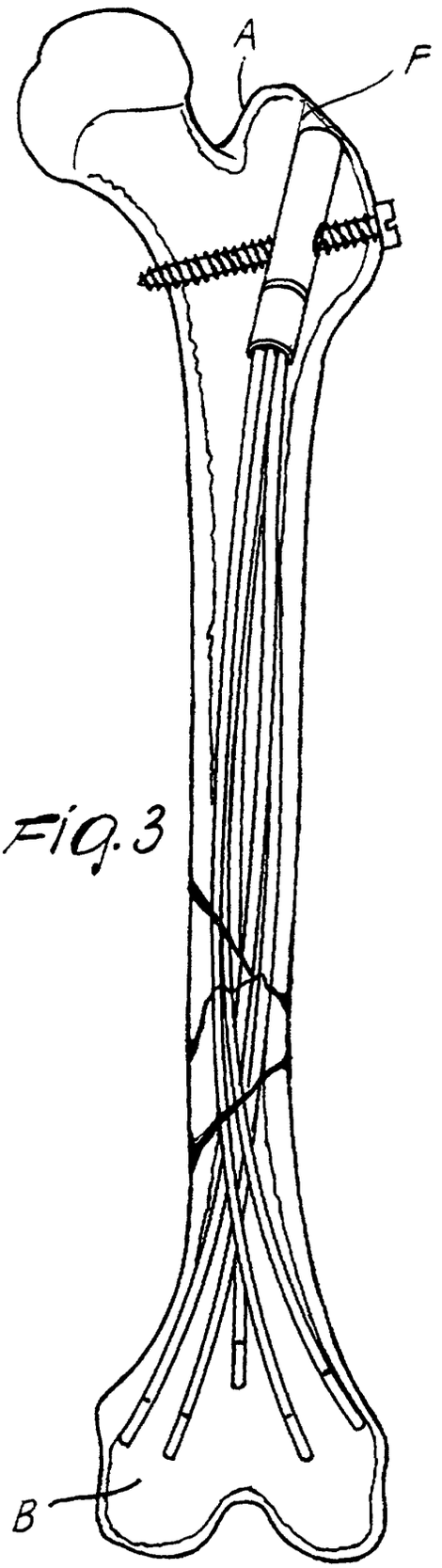

Fig. 3

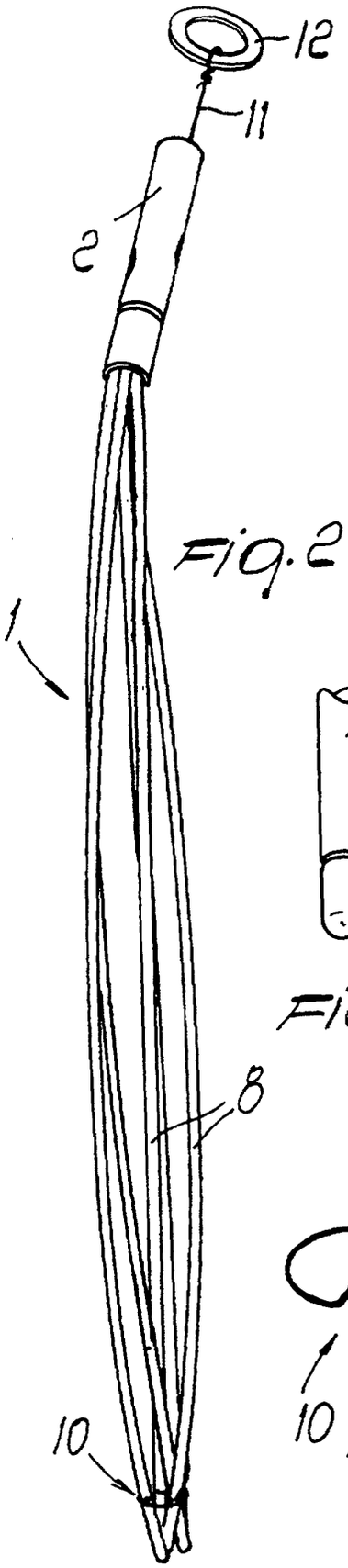

Fig. 2

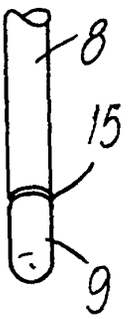

Fig. 4

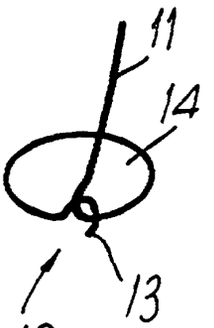

Fig. 5