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(54) **Title:** BONE LENGTHENING DEVICE

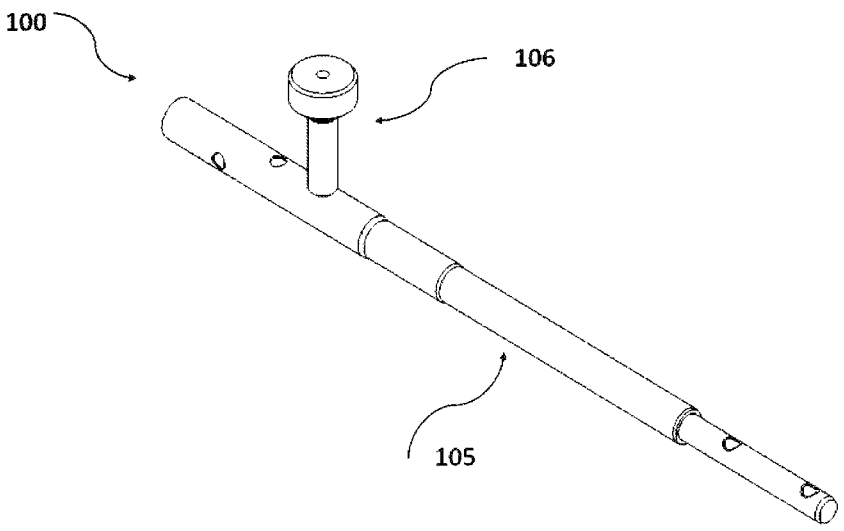


Fig. 1A

(57) **Abstract:** The present disclosure of the invention discloses an elongation device for long bones. The device comprises two parts. An intramedullary nail comprises an extension rod and a tubular sleeve, which may insert axially inside a long bone and a loading portion. The loading portion that may partially emerge from a small wound, couples with the intramedullary nail. The intramedullary nail and the loading portion may be configured through a pair of engaged bevel gears that the rotation of the loading portion rotates a drive bevel gear and subsequently rotates a driven bevel gear. At last, the extension rod may slide axially inside the tubular sleeve, consequently, the length of the device increase.

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BONE LENGTHENING DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority from Iranian Patent Application Ser. No. 140150140003007497, filed on January 11, 2023, is incorporated herein by reference.

TECHNICAL FIELD

[0002] This disclosure relates to elongation devices for elongating long bones such as the Femur, Tibia, and Humerus bones. More preferably, it relates to elongation devices that have manual control over the elongation device mechanically.

BACKGROUND

[0003] One of the common injuries resulting from accidents is a long bone fracture, which may have long-term side effects that may last a lifetime. The limb-length discrepancy is one of these lifetime side effects that may be the result of a comminuted fracture. In some cases, the long-term side effects of the limb-length discrepancy may be repaired by bone-lengthening surgery.

[0004] Another disorder that may affect the daily life of a patient is dwarfism disorder which results in shorter growth in the skeleton than normal growth. In some cases, bone-lengthening surgery may be a means for enhancing the life quality of the patient.

[0005] Bone-lengthening surgery has been used in clinics for several years. This treatment has two main phases. In the first phase, the bone is cut into two portions by osteotomy surgery and the bone lengthening devices are placed inside the body of the patient. Then, the recovery step begins. The recovery has two steps, lengthening and consolidation. During the lengthening, the distance

between the bone portions increases gradually within 3 to 6 months. Then consolidation starts, during which the bone with the final length will recover for 1 to 3 years.

[0006] Various devices have been developed for this treatment that can be classified into three main groups. The external fixator, Lengthening Over Nails (LON), and the devices that are completely placed inside the bone.

[0007] The external fixators only install outside the patient's body, through several screws. This method can be very annoying, painful, and may cause skin conditions or even secondary infections. These side effects may intensify by increasing the number of screws. In addition, the fixators remain attached to the body during all two phases, thus, the patient cannot move or walk easily during the treatment.

[0008] Despite the external fixators, LONs have two main parts, an internal part that is inserted into the bone and a set of external fixators. In this method, the set of external fixators is removed after the first step of the recovery. In comparison with using the external fixator, the merit of this method is removing the external fixators after the lengthening step, but it should be noted that the side effects of the external fixators remain for a short period. However, even with this method the patient is not allowed to move independently.

[0009] The third group of devices has the least side effects among all because they are completely inserted inside the body. The lengthening of these devices occurs using an electromagnetic motor inside the nail, which is inside the bone. The electromagnetic motor operates by a trigger and the lengthening eventuates. Although these devices minimize the pain and infection probability in comparison with the first two methods, their uncertainty, lack of reverse lengthening ability, and lack of resistance to the patient's weight load are the main problems that may cause difficulties for the patient.

SUMMARY

[00010] The following summary is not intended to include all features and aspects of the present disclosure, nor does it imply that the disclosure must include all features and aspects discussed in this summary.

[00011] The present disclosure objects to resolving the problems of the prior types of elongation devices for elongating a bone by disclosing an elongation device. The elongation device comprises an intramedullary nail and a loading portion. The intramedullary nail comprises a tubular sleeve, an extension rod, and a transmission rod. The extension rod slides axially inside the tubular sleeve and each of the extension rod and the tubular sleeve may be coupled with one portion of a bone that is separated by osteotomy. An upper end of the tubular sleeve may be fastened to an upper portion of the bone through a fastening mean. A bottom end of the extension rod may be fastened to a bottom portion of the bone through a fastening mean. The tubular sleeve might fasten to the upper portion of the bone through the plurality of fastening means and the extension rod might fasten to the bottom portion of the bone through the plurality of fastening means, the arrangement of the plurality of fastening means may include one of parallel arrangement, skew arrangement, and lattice arrangement. A bottom end of the tubular sleeve is configured to the extension rod. According to this disclosure, an upper end of the transmission rod can be inside the tubular sleeve and engaged with it, while a bottom end of the transmission rod can be inside the extension rod and engaged with it in a way that at least a part of the transmission rod can be threaded. The threaded part of the transmission rod may be coupled with the extension rod, also the transmission rod may be coupled with a driven bevel gear. Finally, the extension rod can slide axially inside the tubular sleeve by rotation of the transmission rod.

[00012] The loading portion comprises an outer sleeve and a rotary nail that the rotary nail may be covered by the outer sleeve. In addition, the proximal end of the rotary nail may be coupled with a drive bevel gear and the distal end of the rotary nail may be coupled with a T-shaped handle. In an embodiment, the driven bevel gear and the drive bevel gear may be coupled. The outer sleeve may be coupled with the tubular sleeve from the proximal end.

[00013] In this disclosure, the upper end of the transmission rod can be coupled with the tubular sleeve through a first set of a plurality of balls and the transmission rod can be axially aligned inside the tubular sleeve through a second set of a plurality of balls. The rotation module of the driven bevel gear and the drive bevel gear may be between 0.2 and 1 mm.

[00014] In an embodiment, the outer diameter of the tubular sleeve may be analogous to the bone diameter in that the outer diameter of the tubular sleeve reduces gradually from the upper end of the tubular sleeve to the bottom end of the tubular sleeve. This means, the upper end of the tubular sleeve with the maximum outer diameter may be fastened to the upper portion of the bone and the bottom end of the tubular sleeve may have the minimum outer diameter. The outer diameter of the upper end of the tubular sleeve may be between 10 and 20 mm. The outer diameter of the bottom end of the tubular sleeve may be between 9 and 14 mm.

[00015] According to this disclosure, the transmission rod and the driven bevel gear may be integrated inseparably with each other and the rotary nail, the drive bevel gear, and the T-shaped handle may be integrated inseparably with each other.

[00016] In an embodiment, the proximal end of the outer sleeve can be mounted on the tubular sleeve, in a way that the interface of the proximal end of the outer sleeve and the tubular sleeve can be sealed.

BRIEF DESCRIPTION OF THE DRAWINGS

[00017] The novel features which are believed to be characteristic of the present disclosure, as to its structure, organization, use, and method of operation, together with further objectives and advantages thereof, will be better understood from the following drawings in which a presently preferred embodiment of the present disclosure will now be illustrated by way of examples. It is expressly understood, however, that the drawings are for illustration and description only and are not intended as a definition of the limits of the present disclosure. Embodiments of the present disclosure will now be described by way of example in association with the accompanying drawings in which:

[00018] The disclosure will now be described by reference to the preferred embodiments.

[00019] **Fig. 1A** shows a general up-right perspective view of an elongation device for elongating a bone according to the embodiments of the disclosure.

[00020] **Fig. 1B** shows an up-right perspective view of an elongation device for elongating a bone according to the embodiments of the disclosure.

[00021] **Fig. 1C** shows a side view of the closed and enlarged states of an elongation device according to the embodiments of the disclosure.

[00022] **Fig. 2** shows a perspective cross-sectioned view of an elongation device according to the embodiments of the disclosure.

DETAILED DESCRIPTION

[00023] The novel features which are believed to be characteristic of the present disclosure, as to its structure, organization, use and method of operation, together with further objectives and advantages thereof, will be better understood from the following discussion.

[00024] Aspects of the disclosure are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings in which references indicate similar elements. It should be noted that references to "an" and "one" embodiment in this disclosure are not necessarily to the same embodiment, and such references mean at least one. In the following description, numerous specific details are set forth to provide a thorough description of the disclosure. However, it will be apparent to one skilled in the art that the disclosure may be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid obscuring the disclosure.

[00025] The device disclosed in this disclosure is completely inserted into the body except for a sealed handle that will be out of the body. The infection probability through the handle spot is minimized because of the sealing procedure that completely separates the body fluids from outside the body. This device operates mechanically, which means it does not cause uncertainty and is fully controllable. The mechanical operation of this device not only allows the operator to reverse the lengthening direction (decrease the length of the device) in case of any incident, but also it provides an opportunity to use a single device for double lengthening with one surgery. The further benefit of this device relates to its analogous structure to the long bone that allows the patient to walk and live normally only a few weeks after the surgery.

[00026] The present disclosure of the invention discloses a telescopic elongation device for long bones that its intramedullary nail places inside a long bone. The length of the long bone extends by enhancing the length of the elongation device. All parts of this elongation device are placed inside the body of the patient except for a T-shaped handle that emerges from a small wound. The T-shaped handle allows the patient to extend the length of the elongation device using only human hand strength. This one wound significantly lessens the probability of secondary infections.

Moreover, the elongation device allows the patient to enhance a certain length in multiple times, smaller, and more precise steps.

[00027] In this application, the phrases "limb lengthening device", "telescopic elongation device", "elongation device for long bones", "elongation device", and "device" are stands for "elongation device for elongating a bone" and may be used interchangeably, also "bone" stands for the "long bone" phrase. In addition, the thicker ends of the bone are named the "upper side of the bone" and the thinner middle of that is named the "bottom side of the bone". Subsequently, the thicker side of the device is named "up" of the device and the thinner side of the device is named the "bottom" of that.

[00028] In the figures, the main elements are disclosed in more detail. The disclosed details are not intended to limit the shown implementations but are to accord the widest possible scope consistent with the principles and features disclosed herein.

[00029] **Fig. 1A** illustrates a general up-right perspective view of an elongation device for elongating a bone **100** according to exemplary and non-limiting implementation of the present disclosure. According to this figure, the device **100** may comprise an intramedullary nail **105** and a loading portion **106**. The intramedullary nail **105** inserts axially inside the bone, in which the bone is separated laterally into two portions through an osteotomy surgery, and detachably connects to the portions of the bone. Afterward, the loading portion **106**, partially emerging from a small wound, couples with the intramedullary nail **105**.

[00030] **Fig. 1B** demonstrates the intramedullary nail **105** that may comprise a tubular sleeve **101**, an extension rod **102**, and a transmission rod **207** (which further is illustrated in **Fig. 2**), in which the extension rod **102** may slide axially inside the tubular sleeve **101** (**Fig. 1C**). The upper side of the tubular sleeve **101** may fasten to the upper side of the bone by an upper fastening mean **103**.

The bottom side of the extension rod **102** may fasten to the bottom side of the bone by a bottom fastening mean **104**. In a preferred embodiment, the tubular sleeve **101** and the extension rod **102** are fastened to the bone by a plurality of fastening means. In an embodiment, the plurality of fastening means may be a plurality of screws. In another embodiment, the plurality of fastening means may be a plurality of pins. In an exemplary embodiment, each of the tubular sleeve **101** and the extension rod **102** may be fastened to the bone by a couple of fastening means. In one aspect, the plurality of upper fastening means **103** may have a parallel arrangement; in another aspect, the plurality of upper fastening means **103** may have a skew arrangement (**Fig. 1B**); in the third aspect, the plurality of upper fastening means **103** may have a lattice arrangement; each of the mentioned arrangements for upper fastening means **103** may include one or more fastening means. For instance, one embodiment may have a couple of upper fastening means **103** and another embodiment may have a triple upper fastening means **103**. In other aspects, the plurality of bottom fastening means **104** may have a parallel arrangement (**Fig. 1B**); in another aspect, the plurality of bottom fastening means **104** may have a skew arrangement; in the third aspect, the plurality of bottom fastening means **104** may have a lattice arrangement; each of the mentioned arrangements for bottom fastening means **104** may include one or more fastening means. For instance, one embodiment may have a couple of bottom fastening means **104** and another embodiment may have a triple bottom fastening means **104**. In some embodiments, the arrangement of the plurality of upper fastening means **103** and the plurality of bottom fastening means **104** may be personalized concerning the patient's anatomy.

[00031] **Fig. 1C** illustrates the length of the device **100** elongates by sliding the extension rod **102** outwardly along the tubular sleeve **101**; this lengthening **110** may be in the range of 0.02 to 10 cm. In a preferred embodiment, the device **100** lengthening's **110** may be between 0.1 to 10 cm. In an

embodiment, the device **100** lengthening's **110** may be between 5 to 7 cm. In another embodiment, it may be between 0.5 to 5 cm.

[00032] Moreover, the outer diameter of the tubular sleeve **101** (shown in **Fig. 1C**) varies in accordance with the bone anatomy, the outer diameter of the tubular sleeve **101** at the upper side of the device **111** is the maximum and at the bottom side of the device **112** is the minimum. By the same token, the outer diameter of the tubular sleeve **101** reduces gradually from the upper end of the tubular sleeve **101** to the bottom end of the tubular sleeve **101**. In one aspect, the maximum outer diameter **111** of the upper end of the tubular sleeve **101** is between 10 and 20 mm, and the minimum outer diameter **112** of the bottom end of the tubular sleeve **101** is between 9 and 14 mm. In the next embodiment, the outer diameter of the tubular sleeve **101** may be personalized concerning the patient's anatomy.

[00033] **Fig. 2** shows the internal parts of the device **100**. The extension rod **102** slides axially inside the tubular sleeve **101** through the transmission rod **207**. The transmission rod **207** could be inside the tubular sleeve **101** at its upper end **221** and inside the extension rod **102** at its bottom end **220**. The transmission rod **207** could be engaged with the tubular sleeve **101** at its upper end **221.** The transmission rod **207** could be engaged with the extension rod **102** at its bottom end **220**. The transmission rod **207** may be threaded **208**, at least in a part, in which the threaded **208** part of the transmission rod **207** may be coupled with the extension rod **102**. Rotating the transmission rod **207** slides the extension rod **102** along the tubular sleeve **101** axially.

[00034] According to **Fig. 2**, the transmission rod **207** may couple with the tubular sleeve **101** through a first set of a plurality of balls **201**. The first set of the plurality of balls **201** provides the easy rotation of the transmission rod **207** inside the intramedullary nail **105**, in a way that the tensions and strains inside the intramedullary nail **105** do not limit the rotation of the transmission

rod **207**. Subsequently, friction reduction through the first set of the plurality of balls **201** allows the user to rotate the T-shaped handle **206** with a bare hand, which leads to the rotation of the transmission rod **207** and slide on the extension rod **102**. In an embodiment, the first set of the plurality of balls **201** may be a thrust bearing.

[00035] According to **Fig. 2**, the transmission rod **207** may be axially aligned inside the tubular sleeve **101** through a second set of a plurality of balls **202**. The second set of the plurality of balls **202** prevents direct contact between the transmission rod **207** and tubular sleeve **101** and decreases friction between them by keeping the transmission rod **207** in the axial direction. In an embodiment, the second set of the plurality of balls **202** may be a radial bearing.

[00036] Referring back to **Fig. 2**, a portion of the transmission rod **207** may be coupled with a driven bevel gear **210**, which transmits the rotation force to the transmission rod **207**. In one aspect, the transmission rod **207** and the driven bevel gear **210** may be integrated inseparably. In an exemplary embodiment, the driven bevel gear **210** may be placed closer to the upper end of the tubular sleeve **101** than the bottom of the extension rod **102**. In the next embodiment, the driven bevel gear **210** may also be placed about the middle of the tubular sleeve **101**.

[00037] Referring to **Fig. 2**, the loading portion **106** comprises an outer sleeve **204** and a rotary nail **203**. The rotary nail **203** may couple with a drive bevel gear **205** at the proximal end and may couple with a T-shaped handle **206** at the distal end. In a preferred embodiment, the rotary nail **203**, the drive bevel gear **205**, and the T-shaped handle **206** may be integrated inseparably.

[00038] According to **Fig. 2,** the driven bevel gear **210** and the drive bevel gear **205** may be coupled, in a way that the rotation of the T-shaped handle **206** rotates the rotary nail **203** and the drive bevel gear **205**. Consequently, the drive bevel gear **205** rotates the driven bevel gear **210** and the transmission rod **207**. Finally, the rotation of the transmission rod **207** slides the extension rod

102 axially. The extension rod **102** may slide between 0.02 and 10 cm in an embodiment. In an exemplary embodiment, it may slide between 1 to 10 cm. The driven bevel gear **210** and the drive bevel gear **205** may be engaged to configure between 0.2- and 1-mm elongation per each round, which means one round rotation of the rotary nail **203** slides the extension rod **102** between 0.2 and 1 mm. In an embodiment, the driven bevel gear **210** and the drive bevel gear **205** rotation module may be between 0.5 and 0.6 mm.

[00039] The rotary nail **203**, demonstrated in **Fig. 2**, may be covered by the outer sleeve **204**. The outer sleeve **204** may couple with the tubular sleeve **101** at the proximal end. In one aspect, the outer sleeve **204** may mount on the tubular sleeve **101**. Furthermore, the interface of the outer sleeve **204** and the tubular sleeve **101** may be sealed.

Exemplary embodiment 1:

[00040] In one embodiment of the disclosure, the tubular sleeve may connect to the bone through three skew screws.

Exemplary embodiment 2:

[00041] In one embodiment of the disclosure, the tubular sleeve may connect to the bone through three parallel screws.

Exemplary embodiment 3:

[00042] In one embodiment of the disclosure, the tubular sleeve may connect to the bone through a plurality of lattice screws.

Exemplary embodiment 4:

[00043] In one embodiment of the disclosure, the device lengthening may be between 5 and 8.5 cm.

Exemplary embodiment 5:

[00044] In one embodiment of the disclosure, the maximum outer diameter of the tubular sleeve may be 14 mm and the minimum outer diameter of the tubular sleeve may be 12 mm.

Exemplary embodiment 6:

[00045] In one embodiment of the disclosure, the maximum outer diameter of the tubular sleeve may be 14 mm and the minimum outer diameter of the tubular sleeve may be 10 mm.

Exemplary embodiment 7:

[00046] In one embodiment of the disclosure, the maximum outer diameter of the tubular sleeve may be 15 mm and the minimum outer diameter of the tubular sleeve may be 11 mm.

Exemplary embodiment 8:

[00047] In one embodiment of the disclosure, the maximum outer diameter of the tubular sleeve may be 14 mm and the minimum outer diameter of the tubular sleeve may be 10.5 mm.

What is claimed is:

1. An elongation device for elongating a bone comprising:

An intramedullary nail comprises a tubular sleeve, an extension rod, and a transmission rod;

wherein the extension rod slides axially inside the tubular sleeve;

wherein each of the extension rod and the tubular sleeve are coupled with one portion of the bone that is separated by osteotomy;

wherein an upper end of the tubular sleeve is fastened to an upper portion of the bone through a fastening mean;

wherein a bottom end of the tubular sleeve is configured to the extension rod;

wherein a bottom end of the extension rod is fastened to a bottom portion of the bone through a fastening mean;

wherein an upper end of the transmission rod is engaged with the tubular sleeve and a bottom end of the transmission rod is engaged with the extension rod;

wherein at least a part of the transmission rod is threaded;

wherein the threaded part of the transmission rod is coupled with the extension rod;

wherein the transmission rod is coupled with a driven bevel gear; and

wherein the extension rod slides axially inside the tubular sleeve by rotation of the transmission rod;

A loading portion comprises an outer sleeve; and a rotary nail;

wherein the rotary nail is covered by the outer sleeve;

wherein a proximal end of the rotary nail is coupled with a drive bevel gear; and

wherein a distal end of the rotary nail is coupled with a T-shaped handle;

wherein the driven bevel gear and the drive bevel gear are coupled; and

wherein the outer sleeve is coupled with the tubular sleeve from a proximal end.

2. The elongation device of claim 1, wherein the upper end of the transmission rod is coupled with the tubular sleeve through a first set of a plurality of balls.
3. The elongation device of claim 1, wherein the transmission rod is axially aligned inside the tubular sleeve through a second set of a plurality of balls.
4. The elongation device of claim 1, wherein the driven bevel gear and the drive bevel gear are engaged to configure between 0.2- and 1-mm elongation per each round of the rotary nail.
5. The elongation device of claim 1, wherein the outer diameter of the tubular sleeve is analogous to the bone diameter.
6. The elongation device of claim 5, wherein the upper end of the tubular sleeve is fastened to the upper portion of the bone; wherein the upper end of the tubular sleeve has the maximum outer diameter.
7. The elongation device of claim 6, wherein the maximum outer diameter of the upper end of the tubular sleeve is between 10 and 20 mm.
8. The elongation device of claim 5, wherein the bottom end of the tubular sleeve has the minimum outer diameter.

9. The elongation device of claim 8, wherein the minimum outer diameter of the bottom end of the tubular sleeve is between 9 and 14 mm.
10. The elongation device of claim 5, wherein the outer diameter of the tubular sleeve reduces gradually.
11. The elongation device of claim 1, wherein the device elongating length is between 0.1 and 10 cm.
12. The elongation device of claim 1, wherein the transmission rod and the driven bevel gear are integrated inseparably with each other.
13. The elongation device of claim 1, wherein the rotary nail, the drive bevel gear, and the T-shaped handle are integrated inseparably with each other.
14. The elongation device of claim 1, wherein the proximal end of the outer sleeve is mounted on the tubular sleeve.
15. The elongation device of claim 14, wherein the interface of the proximal end of the outer sleeve and the tubular sleeve is sealed.
16. The elongation device of claim 1, wherein the tubular sleeve fastens to the upper portion of the bone through the plurality of fastening means.
17. The elongation device of claim 1, wherein the extension rod fastens to the bottom portion of the bone through the plurality of fastening means.
18. The elongation device of claims 16 and 17, wherein the arrangement of the plurality of fastening means includes one of a parallel arrangement, a skew arrangement, or a lattice arrangement.
19. An elongation method for elongating a bone according to the elongation device of each of the claims 1 to 18 comprising:

coupling each of an extension rod and a tubular sleeve with one portion of the bone that is separated by osteotomy;

exceeding the distance between the portions of the bone by sliding the extension rod axially inside the tubular sleeve; and

wherein sliding is proportional to rotating a rotary nail.

20. An elongation method of claim 19, wherein one round rotating of the rotary nail slides the extension rod between 0.2 and 1 mm.

AMENDED CLAIMS
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[Claim 1] (amended) An elongation device for elongating a bone comprising:
An intramedullary nail comprises a tubular sleeve, an extension rod, and a transmission rod;
wherein the extension rod slides axially inside the tubular sleeve;
wherein each of the extension rod and the tubular sleeve are coupled with one portion of the bone that is separated by osteotomy;
wherein an upper end of the tubular sleeve is fastened to an upper portion of the a bone through a fastening mean;
wherein a bottom end of the tubular sleeve is configured to the extension rod;
wherein a bottom end of the extension rod is fastened to a bottom portion of the a bone through a fastening mean;
wherein an upper end of the transmission rod is engaged with the tubular sleeve and a bottom end of the transmission rod is engaged with the extension rod;
wherein at least a part of the transmission rod is threaded;
wherein the threaded part of the transmission rod is coupled with the extension rod;
wherein the transmission rod is coupled with a driven bevel gear; and
wherein the extension rod slides axially inside the tubular sleeve by rotation of the transmission rod;
wherein the upper end of the transmission rod is coupled with the tubular sleeve through a first set of a plurality of balls;
A loading portion comprises an outer sleeve; and a rotary nail;
wherein the rotary nail is covered by the outer sleeve;
wherein a proximal end of the rotary nail is coupled with a drive bevel gear; and
wherein a distal end of the rotary nail is coupled with a T-shaped handle;
wherein the driven bevel gear and the drive bevel gear are coupled; and
wherein the outer sleeve is coupled with the tubular sleeve from a proximal end.

[Claim 2] (cancelled) The elongation device of claim 1, wherein the upper end of the transmission rod is coupled with the tubular sleeve through a first set of a plurality of balls.

[Claim 3] The elongation device of claim 1, wherein the transmission rod is

axially aligned inside the tubular sleeve through a second set of a plurality of balls.

[Claim 4] The elongation device of claim 1, wherein the driven bevel gear and the drive bevel gear are engaged to configure between 0.2- and 1-mm elongation per each round of the rotary nail.

[Claim 5] The elongation device of claim 1, wherein the outer diameter of the tubular sleeve is analogous to the bone diameter.

[Claim 6] The elongation device of claim 5 4, wherein the upper end of the tubular sleeve is fastened to the upper portion of the bone; wherein the upper end of the tubular sleeve has the maximum outer diameter.

[Claim 7] The elongation device of claim 6 5, wherein the maximum outer diameter of the upper end of the tubular sleeve is between 10 and 20 mm.

[Claim 8] The elongation device of claim 5 4, wherein the bottom end of the tubular sleeve has the minimum outer diameter.

[Claim 9] The elongation device of claim 8 7, wherein the minimum outer diameter of the bottom end of the tubular sleeve is between 9 and 14 mm.

[Claim 10] The elongation device of claim 5 4, wherein the outer diameter of the tubular sleeve reduces gradually.

[Claim 11] The elongation device of claim 1, wherein the device elongating length is between 0.1 and 10 cm.

[Claim 12] The elongation device of claim 1, wherein the transmission rod and the driven bevel gear are integrated inseparably with each other.

[Claim 13] The elongation device of claim 1, wherein the rotary nail, the drive bevel gear, and the T-shaped handle are integrated inseparably with each other.

[Claim 14] The elongation device of claim 1, wherein the proximal end of the outer sleeve is mounted on the tubular sleeve.

[Claim 15] The elongation device of claim 14 13, wherein the interface of the proximal end of the outer sleeve and the tubular sleeve is sealed.

[Claim 16] The elongation device of claim 1, wherein the tubular sleeve fastens to the upper portion of the bone through the plurality of fastening means.

[Claim 17] The elongation device of claim 1, wherein the extension rod fastens to the bottom portion of the bone through the plurality of fastening means.

[Claim 18] The elongation device of claims 16 15 and 17 16, wherein the arrangement of the plurality of fastening means includes one of a parallel arrangement, a skew arrangement, or a lattice arrangement.

[Claim 19] (cancelled) An elongation method for elongating a bone according to the elongation device of each of the claims 1 to 18 comprising:
coupling each of an extension rod and a tubular sleeve with one portion of the bone that is separated by osteotomy;
exceeding the distance between the portions of the bone by sliding the extension rod axially inside the tubular sleeve; and
wherein sliding is proportional to rotating a rotary nail.

[Claim 20] (cancelled) An elongation method of claim 19, wherein one round rotating of the rotary nail slides the extension rod between 0.2 and 1 mm.

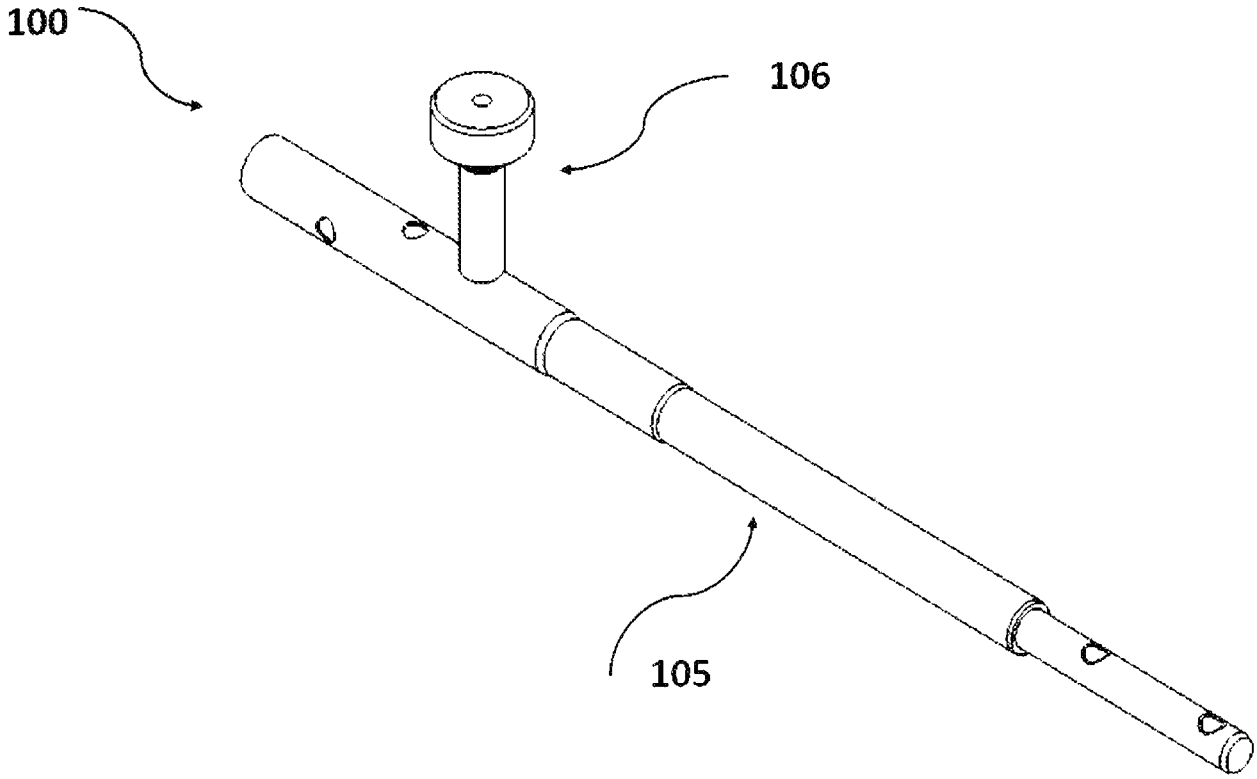


Fig. 1A

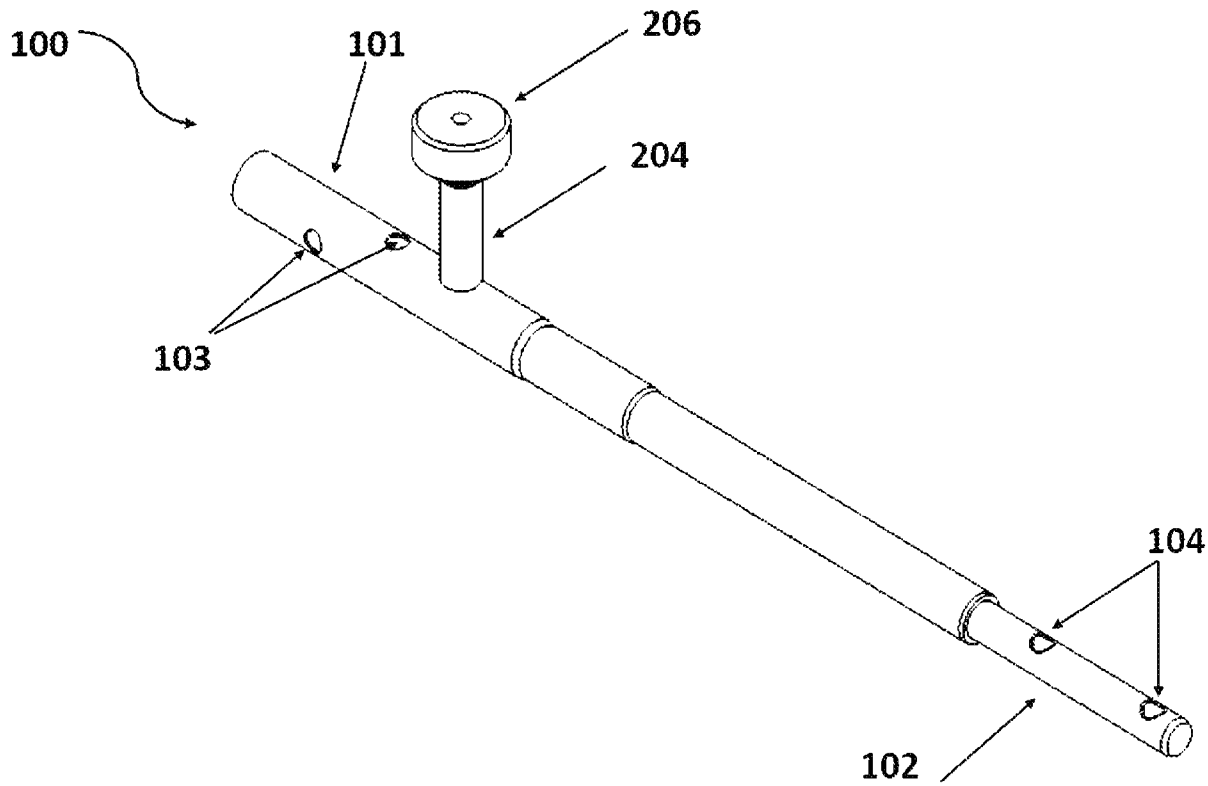


Fig. 1B

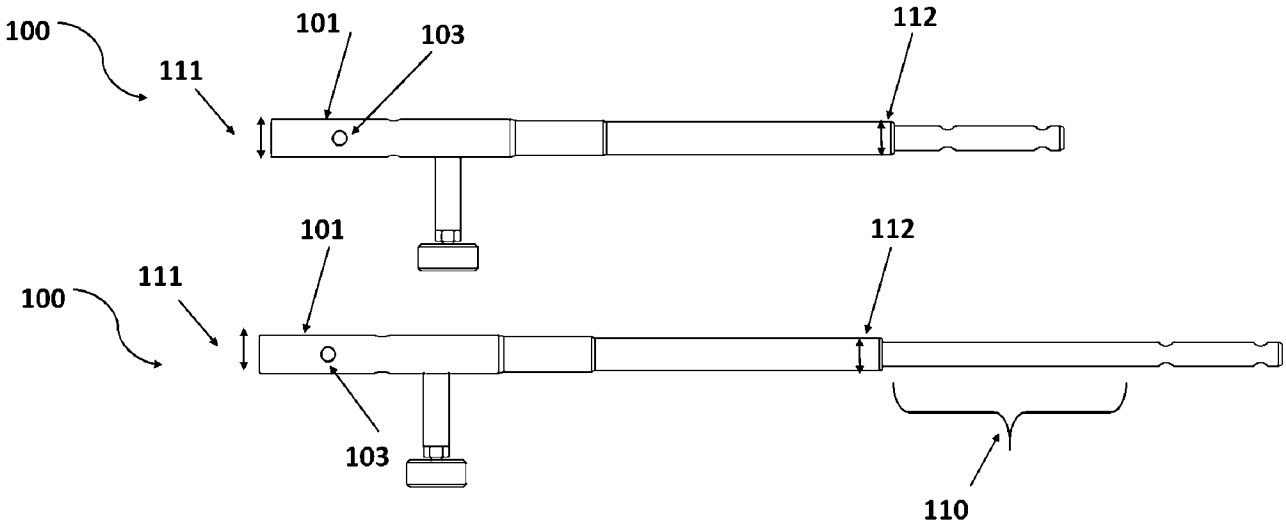


Fig.1C

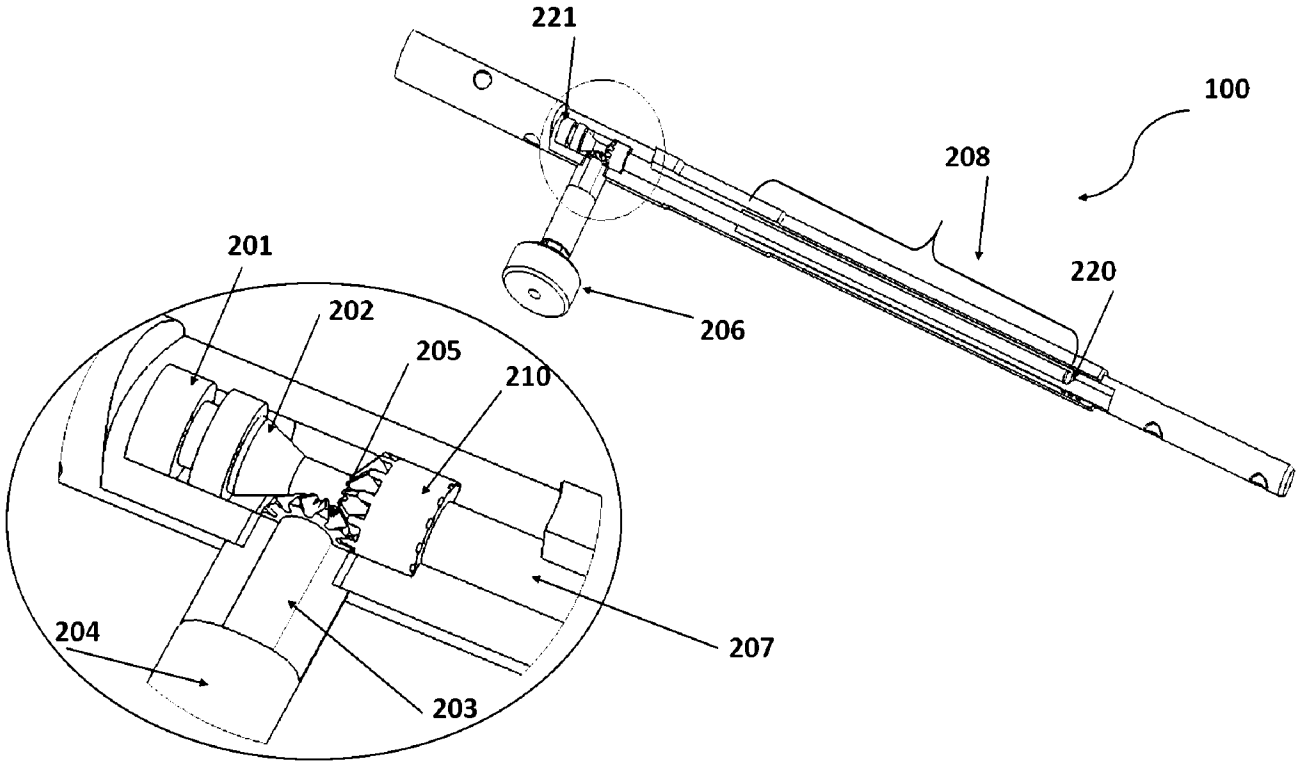


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2023/057133

A. CLASSIFICATION OF SUBJECT MATTER
A61B17/68 Version=2023.01

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 database consulted during the international search (name of database and, where practicable, search terms used)

DATABASES: Patseer, IPO Internal Database
KEYWORDS: Bone lengthening, intramedullary nail, handle, bevel gear

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO2022009219A1 (Rohan Milind Deshpande Ayush Sanjay Gaikwad), 13, January 2022 (13-01-2022) Abstract; Figures 1-19; Claims 1-19; Description Pages 12-20.	1-18
X	CN109276300A (Yancheng Risheng Yueheng Intelligent Technology Co ltd), 29, January 2019 (29-01-2019). Whole document	1-18

☐ 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
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"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)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15-09-2023	15-09-2023
Name and mailing address of the ISA/ Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Authorized officer Pradeep Dhakad Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2023/057133

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 19-20
because they relate to subject matter not required to be searched by this Authority, namely:
Claims 19-20 are application claims and disclose: An elongation method
for elongating a bone, i.e., a rehabilitation therapy which is a treatment method [methods for treatment of the human or animal body by surgery or therapy, as well as diagnostic methods], which isn't required to be searched by International Searching Authority

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

International application No.
PCT/IB2023/057133

Continuation of Claims found unsearchable(Box II)

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accordance with PCT Article 17(2)(a)(i) and [Rule 39.1(iv)].