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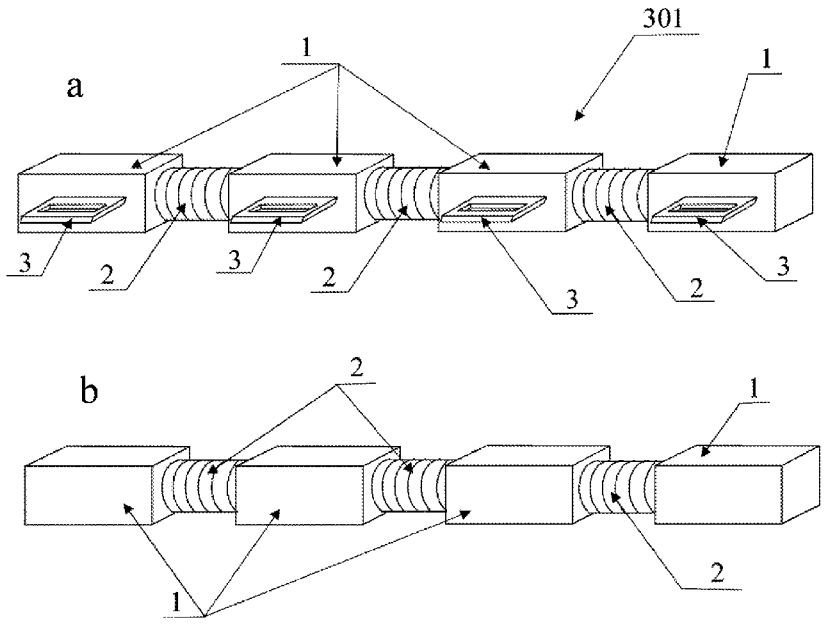

Fig. 11

(57) Abstract: The subject of the invention is a system of implants for stabilization of the spine and a method of stabilizing the spine. A system of implants for stabilization of the spine A comprises implants one or implants two or implants three differing in their structure, and it is characterized in that the implants one (100, 200, 300), the implants two (101, 201, 301) and the implants third (102, 202) comprise at least one movable module with adjustable degree of mobility. The method of stabilization of the spine is characterized by the use of implants having structural elements with an adjustable degree of mobility.

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WO 2020/008331 A1

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System of implants for stabilization of the spine

The invention relates to a system of implants for spinal stabilization.

In the prior art there are known systems for spinal stabilization and methods of spinal stabilization such as: introduced in the sixties and seventies of the last century, widely used screw stabilization for example, transpedicular one or attached to the lateral masses of the vertebrae in the cervical spine, and the method of interspinous stabilization using diverse implants for example, of the Coflex type.

In the case of transpedicular stabilization of the spine, the "rigid" variant is most commonly used and with transpedicular screws and rigid rods made of titanium alloys. A less common variant is so-called dynamic stabilization of the spine using transpedicular screws and elastic rods, most often made of Peek material (polyetheretherketone) or other elastic elements connecting the screws. Manufacturers of Peek rod systems include Medtronic (CD-Horizon Legacy Peak Rod System) and Depuy Synthes (Expedition and Viper Peek Rod System), Lfc (bDs). Numerous solutions that employ various structurally different dynamic elements to connect transpedicular screws are available on the market such as: Dynasys (from Zimmer company), Elaspine (from Spinelab company), Transition (from Globus company) - a rod, connecting element made of flexible polymer, K-rod (from Biomech) - Peek rod and metal tubes, Accuflex - rods with

circular cuts (from Globus company), DSS (Paradigm Spine) - spiral connecting element, Isobar TTL Dynamic Compression Rod (from Scient'x) - titanium rods with movable joints, Cosmic (from Ulrich) - titanium rods and screws with movable heads, Bioflex (from Bio-Spine) - connecting elements of the spring type, Annex (from Spine Wave) - titanium rods and swivel connectors, Aladyn Dynamic Plate (from Alphatec Spine) - plates with moving hinges. The Polish patent application P.405512 discloses a solution concerning a system of devices for interspinous stabilization of the spine. A feature of this system is the simultaneous use of interspinous implants and rails for multilevel stabilization of the spine (A) involving at least three spinous processes at two levels, so that at least two interspinous implants are placed between the spinous processes at least at two levels of the spine (A) and two rails attached by them, one rail on each side of the spinous processes. The invention also relates to a method for stabilization of the spine.

The disadvantage of the known systems for rigid transpedicular stabilization of the spine is mostly the fact that the complete stiffening of a stabilized spine section results in a significant change in biodynamics, including loads of the adjacent spine segments. As a result, a significant percentage of patients undergoing surgery (according to some studies, as many as over 50%) experience pain, overload and degenerative changes in the adjacent spine segments, sacroiliac and hip joints. These patients require further treatment, often subsequent surgery.

Systems for dynamic transpedicular spinal stabilization have numerous disadvantages. Systems with Peek rods are rarely used. In such solutions there is no possibility of correction of or adjustment to the curvature of the spine, because the Peek rod has a fixed curvature that cannot be changed. Moreover, there is no easy way to stiffen the selected spine level. Peek rods are usually available in sets

of different lengths adjusted only to two levels of the spine (including three vertebrae).

In the other systems of dynamic spinal stabilization, elastic elements of different construction, connecting transpedicular screws, are employed. As the distances between the screws may vary, it is difficult to select the lengths of the connecting elements to provide a complete and biomechanically suitable stabilization structure. In practice, each patient may require different lengths of connecting elements. Thus, when stabilizing even a single level of the spine (two vertebrae), the set of connecting elements should consist of a large number of these elements in different lengths. When stabilizing two or more levels of the spine, the complexity of the structural system increases significantly. Because of this, many of these systems are designed to stabilize only one level of the spine. The examples of such systems are DSS and Accuflex. The K-rod system of Biomech company enables multi-level dynamic stabilization of the spine, wherein the selected level of the spine can be completely immobilized using a rigid tube of the correspondingly fitted length, through which a flexible rod runs stabilizing the other selected spine levels. The Dynasys system has a flexible screw-connecting element that can be cut to the suitable length, as well as Peek rods.

In the literature a significant percentage of cracking of the stabilizing implants of the Accuflex system is reported (22% of all cases) as well as cases of loosening of the stabilizing construction for other systems used for dynamic stabilization of the spine.

Unfortunately, the foregoing disadvantages of the existing systems for dynamic stabilization of the spine, including their complexity, cause that they are very rarely used. Some of them have been withdrawn from use, e.g. Accuflex, Aladyn, Bioflex.

The present disclosure of the invention concerns a new system of spinal stabilization to be applied in different configurations in each region of the spine, including the paravertebral bone structures.

The proposed solution is primarily meant to be practical, free from disadvantages of the existing systems, as well as to introduce new advantages in the treatment of spinal disorders by means of stabilization.

According to the invention, a system of devices for spinal stabilization comprising implants first or implants second or implants third differing in their structure, that is characterized in that the implants first, the implants second and the implants third comprise at least one movable module with controllable degree of mobility.

Preferably, the implants first, the implants second or the implants third contain at least two rigid modules and at least one movable module connected to two rigid modules, wherein the movable module has an controllable degree of movement.

Also preferably, the rigid module is a rigid catch for connecting the movable module to the spine and/or to the paravertebral anatomical structures and/or to another implant and/or intermediate element.

Also preferably, the rigid module comprises at least one grip.

Also preferably, the rigid module comprises two grips.

Furthermore preferably, an actuator regulating the mobility degree of the movable module is placed in at least one rigid module connected to a movable module.

Also preferably, an actuator adjusting the mobility degree of the movable module is placed in at least one movable module.

Also preferably, at least one rigid module and/or one movable module has biosensors.

Also preferably, an actuator controlling the mobility degree of the movable module is provided with its own source of energy and a microprocessor control unit.

Also preferably, the energy source of the actuator is rechargeable using internal and/or external wireless devices.

Preferably, actuators adjusting the mobility degree of the various movable modules are mutually coupled.

Preferably, the actuator regulating the mobility of the movable module is controlled by a remote control from outside the rigid and/or movable module by means of a wireless link.

Also preferably, the actuator is an electric micro-actuator.

Also preferably, the rigid module is provided with at least one grip cooperating with a screw and/or other element anchoring to the spine and/or paravertebral anatomical structures and/or for connection with another implant and/or other intermediate element.

Furthermore, preferably, the rigid modules in one implant assume diverse spatial forms.

Preferably, the movable modules in one implant assume diverse spatial forms.

Preferably, the grips of the rigid modules in one implant assume diverse spatial forms.

Preferably, the catches in one implant assume diverse spatial forms.

Preferably, the rigid module of the implant first, the implant second and/or the implant third is made of titanium, an alloy thereof, stainless steel and/or polymers, ultra-high molecular weight polyethylene (UHMWPE) or polyetheretherketone (Peek), ceramic materials or combinations of the foregoing materials.

Also preferably, the rigid module of the implant first, the implant second and/or the implant third or a part thereof is made of a porous material.

Also preferably, at least one rigid module and/or one movable module has surface modifications.

Also preferably, the surface of at least one rigid and/or movable module or a part thereof contains bioactive agents.

According to the invention, the method of spinal stabilization is characterized by the use of implants having structural elements with a controllable degree of mobility.

An advantage of the solution is elimination of the disadvantages of the above-mentioned methods of spinal stabilization, while maintaining their significant positive features, i.e. providing dynamic, movable stabilization of the spine. However, the most important advantage of the proposed solution is the capability of smooth regulation of the mobility of the movable module, including all degrees of freedom of movement for a given level of the spine. Thus, a surgeon can freely shape the degree of stiffness for individual stabilized spine levels and, if necessary, can also shape the degree of curvature of a specific spine segment. In addition, he/she can also have an influence on stretching or compression of the individual spine levels. To a certain extent, the patient, appropriately trained by competent personnel, can also have a possibility of making an adjustment. The adjustment of the degree of stabilization and/or effect

on particular spinal levels is performed using external devices, including wireless ones.

The subject-matter of the invention is shown in the embodiments in the drawing, in which:

Fig. 1 shows a perspective view of a basic arrangement of implant modules for stabilization of one level of the spine;

Fig. 2 shows the basic arrangement of the implant modules of Fig. 1 in a top view;

Fig. 3 illustrates a perspective view of an arrangement of implant modules for two-level stabilization of the spine;

Fig. 4 shows the arrangement of the implant modules of Fig. 3 in a top view;

Fig. 5 shows a perspective view of an arrangement of implant modules for three-level stabilization of the spine;

Fig. 6 illustrates the arrangement of the implant modules of Fig. 5 in a top view;

Fig. 7 shows a basic arrangement of implant modules for single-level stabilization of the spine with rigid modules with one grip, in a perspective view of one side (a) and of the other side (b);

Fig. 8 shows a top view of a basic arrangement of implant modules single-level of spinal stabilization with rigid modules with one grip;

Fig. 9 illustrates an arrangement of implant modules for two-level stabilization of the spine with rigid modules with one grip in a perspective view of one side (a) and the other side (b);

Fig. 10 shows a top view of an arrangement of implant modules for two-level stabilization of the spine with rigid modules with one grip;

Fig. 11 shows an arrangement of implant modules for three-level stabilization of the spine with rigid modules with one grip in a perspective view of one side (a) and the other side (b);

Fig. 12 shows a top view of an arrangement of implant modules for three-level stabilization of the spine with rigid modules with one grip;

Fig. 13 illustrates a side perspective view of a basic arrangement of implant modules for single-level stabilization of the spine with rigid modules without grips;

Fig. 14 shows a top view of a basic arrangement of implant modules of Fig. 13;

Fig. 15 shows a top view of an embodiment of the basic implant of Fig. 1 and Fig. 2 with rigid modules in the form of a rigid catch for attachment;

Fig. 16 illustrates a top view of an embodiment of the implant for two-level stabilization of the spine of Fig. 3 and Fig. 4, with outermost rigid modules in the form of a rigid catch for attachment;

Fig. 17 shows a side view of a module arrangement of the implant first for two-level stabilization of the spine with rigid modules with two grips, mounted on the spine;

Fig. 18 shows a top view of a basic module arrangement of the implant first for two-level stabilization of the spine with rigid modules with two grips, mounted on the spine;

Fig. 19 shows a side view of a module arrangement of the implant second for two-level spinal stabilization with rigid modules with single grips, mounted on the spine on the two sides of the vertebrae;

Fig. 20 shows a top view of a module arrangement of the implant second for two-level spinal stabilization with rigid modules with single grips, mounted on the spine on the two sides of the vertebrae;

Fig. 21 shows a top view of a module arrangement of the implant second for two-level spinal stabilization with rigid modules with single grips, mounted on the spine on the two sides of the vertebrae, as in Fig. 18, with coupled actuators of the rigid modules;

Fig. 22 illustrates a top view of a module arrangement of the implant third with rigid modules without grips for two-level stabilization of the spine, mounted on the spine on the two sides of the vertebrae, with coupled actuators of the rigid modules;

As shown in Fig. 1 and Fig. 2, a basic implant first (100) for spinal stabilization is made of rigid modules (1) and movable modules (2). In the embodiment of the invention shown in Fig. 1 and Fig. 2, the rigid modules are provided with two grips (3) arranged on the sides of the rigid module (1). As shown in Fig. 3, Fig. 4, Fig. 5, and Fig. 6, the implants first (100, 200, 300) may comprise rigid modules (1) and movable modules (2) placed between them in other configurations and numbers. The principle of the structure of the implant first (100, 200, 300) depicted in Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5, and Fig. 6 is such that a basic arrangement of rigid modules (1) and movable modules (2) of the implant first (100, 200, 300) designed for single-level stabilization of the spine consists of two rigid modules (1) and one movable module (2) connecting them in a 2+1 arrangement, as shown in Fig. 1 and Fig. 2.

In the case of stabilization of each additional level of the spine A, the arrangement of rigid modules (1) and movable modules (2) of the implant first (100, 200, 300) is extended by two modules: one rigid module (1) and one movable module (2) for each additional level of spinal stabilization. Thus, when

stabilizing two levels of the spine, a 3+2 arrangement is used as depicted in Fig. 3 and Fig. 4. For three levels of the spine - a 4+3 arrangement as shown in Fig. 5 and Fig. 6 - and so on. It is worth noting that the number of movable modules (2) applied, is equal to the number of the stabilized levels of the spine, while the number of rigid modules (1) is greater by one. The curvature of the implants is adjusted accordingly to the curvature of the spine (A) due to the presence of the adjustable movable modules (2).

Fig. 7, Fig. 8, Fig. 9, Fig. 10, Fig. 11 and Fig. 12 show implants second as other embodiments of the invention. The main difference between the implants first (100, 200, 300) depicted in Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5, and Fig. 6 and the implants second (101, 201, 301) shown in Fig. 7, Fig. 8, Fig. 9, Fig. 10, Fig. 11, and Fig. 12 is that the rigid modules (1) in the implants first (100, 200, 300) have each two grips (3) placed individually on both sides of the rigid module (1), and the implants second (101, 201, 301) have one grip (3) each, placed only on one side of the rigid module (1). The grips (3) are used to connect with screws (4) running, for example, through the pedicles (c) of the vertebra and/or to the lateral masses or they are used to connect to other elements attaching to the spine A and/or to the paravertebral bone structures or to the intermediate elements. Hence, the grips (3) may have a different structure depending on the configuration of the implant in which they are present and/or of the attaching element of the implant and/or the intermediate element.

In Fig. 13 and Fig. 14 another embodiment of the invention is shown in which the implants third (102, 202) have rigid modules (1) without grips on their outer surfaces. They are placed directly in the heads of the screws (4), for example, transpedicular screws and/or screws inserted in the lateral masses and/or embedded in other elements attaching to the spine (A) and/or to the paravertebral bone structures.

The principle for building the module structure of the implants second (101, 201, 301) and the third (102, 202) in relation to the number of stabilized levels of the spine (A), is similar to that described above for the implants first (100, 200, 300).

As shown in the embodiments in Fig. 1 to Fig. 14 and Fig. 17 to Fig. 22 of the drawing, the rigid modules (1) are made in the shape of a cuboid. In other configurations and embodiments of the invention, they can assume different forms, including more complex ones, adapted to the specific anatomical structure of various sections of the spine (A), to its different surfaces, to the paravertebral bone structures, or they can assume only the form and function of grips, catches and/or elements connecting movable modules, when the actuator is placed in the movable module (2). Embodiments of implants with rigid modules in the form of catches (11) are shown in Fig. 15 and Fig. 16. In Fig. 15 an implant (100a) is depicted which is a variant of the structure of the implant first (100). It is composed of one movable module (2) and two catches (11), one at each end, for fixing the movable module to the spine (A) and/or to the paravertebral bone structures and/or with another implant and/or intermediate element. The implant (100a) is used for single-level regulated stabilization of the spine. In the case where the catches (11) take a form adapted to attaching to the spinous processes (a), then an interspinous implant with a controllable degree of mobility is obtained. In Fig. 16 an implant (200a) is depicted which is a variant of building of the implant first (200). It has two movable modules (2) and a single rigid module (1), connecting them, with a grip (3) on both sides, and a catch (11) at both ends of the implant (200a). The implant (200a), similar to the implant first (200), is used to stabilize two levels of the spine. Accordingly, it is possible to configure implants with grips (3) on both sides of the rigid modules (1) and with catches (11) on both ends for stabilization of more levels of the spine, thus creating a series of implant types (100a, 200a, 300a). In other embodiments, the

implant can have a catch (11) at one end only, thus providing a series of implant types with a catch (11) at one end - (100b, 200b, 300b). In a similar way, it is possible to build implant variants of the series (101, 201, 301) to obtain implants with one-sided grips (3) and one-sided catches at both ends of the implants – a series of types (101a, 201a, 301a), and implants with one-sided grips (3) and one-sided catch at only one end of the implant – a series of types (101b, 201b, 301b).

As shown in Fig. 1 to Fig. 16 of the drawing, movable modules (2) are located between rigid modules (1). These are movable elements. The degree of mobility of this module in all possible degrees of freedom of movement, its curvature in various planes is regulated on the principle of the actuator function, as described in the field of mechatronics. Movable modules (2) increase or decrease their length within a certain range, which enables proper positioning of implants on the surface of the spine (A), so that the movable modules (2) are located in the projection of the intervertebral spaces (d). Movable modules (2) can serve as actuators. Elements controlling the movable module (2) are located in at least one rigid module (1) and/or at least one movable module (2) depending on the configuration of the implant. In other configurations and embodiments of the invention, movable modules, similarly to rigid modules (2) can assume other forms, however, in this case the factor that determines their form of configuration can be primarily the function they are supposed to perform e.g. correcting improper curvature of the spine (A).

As shown in the embodiments of the spine stabilization in Fig. 17, Fig. 18, Fig. 19, Fig. 20, Fig. 21, and Fig. 22, a regulable system of stabilization of the spine (A) is based on the concept that within an area, for example, spatially limited by planes located laterally to the intervertebral joints (b) on the left and on the right side of the spine (A), and within the space obtained after the partial or complete removal of at least one spinous process (a), there is an arrangement of rigid modules (1) and movable modules (2) forming the implant, which are

placed so that the movable modules (1) are located in the projection of the intervertebral spaces (d), whereas the rigid modules (1) connect the movable modules (2) and, through grips (3), they provide attachment for screws (4) or they are inserted directly in the heads of the screws (4).

In Fig. 17 and Fig. 18 an embodiment of stabilization of the spine (A) in the lumbosacral region is shown. Here, stabilization involves two levels of the spine, and thus three vertebrae. After a surgical access has been performed, in the first phase of spinal stabilization, the space in which the implant first (200) from the type series (100, 200, 300) is to be placed, is appropriately prepared. This may require partial or complete removal of at least one spinous process (a). In the case of stabilizing one level of the spine (A), this may involve a maximum of two spinous processes (a), in the case of two spinal levels - three spinous processes (a) and so on. The implant first (200) is positioned on the posterior surface of the spine (A) within the area between the intervertebral joints (b), so that the central sections of the movable modules (2) are located in the projection of the intervertebral spaces (d). Next, the rigid modules (1) are attached to the spine (A), so that they are fixed to the screws (4) put through the pedicles using grips (3) located on both sides of the rigid modules (1).

In Fig. 19 and Fig. 20 another embodiment of stabilization of the spine A in the lumbosacral section is depicted, using an implant second (201) from the type series (101, 201, 301). Analogously, as described above, in the first phase, a surgical access is performed exposing posterior spinal structures, such as the spinous processes (a) and the intervertebral joints (b). After screwing the screws (4) through the pedicles (c) into the vertebral bodies, two implants second (201) are placed, one on each side of the spine, so that they are located from the medial side of the intervertebral joints (b). The method of positioning of the movable modules complies with the principle described earlier. As shown in Fig. 19 and

Fig. 20, these implants are fastened by means of grips (3) located on one side of the rigid modules (1) to the screwed in screws (4) .

In Fig. 21 an embodiment of spinal stabilization is shown using an implant second (201) and the element connecting the complementary implant modules (5) on both sides of the spine (A). The element linking the modules (5) serves for coordinated control of both implants, and can assume various forms: it can combine different types of modules and it can be present in varying numbers depending on the implant configuration.

In Fig. 22 an embodiment of spinal stabilization is depicted using implants third (202) from the series of types (102, 202, 302). The method of performing stabilization using this type of device is similar to that described for the implants second (201). The difference is that the implants third from the type series (102, 202, 302), in this embodiment the implants third (202), are attached directly to the heads of the screws (4) put through the pedicles. As shown in Fig. 22, as in the case of the implants second (101, 201, 301), connecting elements of the modules (5) of both implants may be used.

Claims

1. A system of implants for stabilization of the spine comprising implants first or implants second or implants third differing in their structure, **wherein** the implants first (100, 200, 300), the implants second (101, 201, 301) and the implants third (102, 202) comprise at least one movable module with controllable degree of mobility.

2. The system of implants of claim 1, **wherein** the implants first (100, 200, 300), the implants second (101, 201, 301) and the implants third (102, 202) comprise at least two rigid modules (1), and at least one movable module (2), connected to two rigid modules (1), wherein the movable module (2) has a controllable degree of mobility.

3. The system of implants of claim 1, **wherein** the rigid module (1) is a rigid catch (11) for attaching the movable module (2) to the spine and/or to the paravertebral anatomical structures and/or to another implant and/or an intermediate element.

4. The system of implants of claim 1, **wherein** the rigid module (1) comprises at least one grip (3).

5. The system of implants of claim 4, **wherein** the rigid module (1) comprises two grips (3).

6. The system of implants of claim 1, **wherein** in at least one rigid module (1) connected to the movable module (2) an actuator to adjust the mobility degree of the movable module (2) is arranged.

7. The system of implants of claim 1, **wherein** in at least one movable module (2), an actuator to adjust the mobility degree of the movable module (2) is arranged.

8. The system of implants of claim 1, **wherein** at least one rigid module and/or one movable module has sensors.

9. The system of implants of claim 6 or 7, **wherein** the actuator adjusting the mobility level of the movable module (2) is provided with its own energy source and a microprocessor control system.

10. The system of implants of claim 9, **wherein** the source of energy of the actuator is rechargeable using internal and/or external wireless devices.

11. The system of implants of claim 6 or 7, **wherein** actuators adjusting the mobility degree of various movable modules (2) are mutually coupled.

12. The system of implants of claim 6 or 7, **wherein** the actuator regulating the mobility of the movable module (2) is controlled from the outside of the rigid module (1) and/or the movable module (2) via a wireless link.

13. The system of implants of claim 6 or 7, **wherein** the actuator is an electric micro-actuator.

14. The system of implants of claim 1, **wherein** the rigid module (1) is provided with at least one grip (3) that cooperates with a screw (4) or other element anchoring to the spine and/or paravertebral anatomical structures and/or is used to attach with the intermediate element and/or with another implant.

15. The system of implants of claim 1, **wherein** rigid modules (1) in a single implant assume diverse spatial forms.

16. The system of implants of claim 1, **wherein** the movable modules (2) in a single implant assume diverse spatial forms.

17. The system of implants of claim 4 or 5 or 14, **wherein** the grip (3) assumes diverse spatial forms.

18. The system of implants of claim 3, **wherein** the catch (11) assumes diverse spatial forms.

19. The system of implants of claim 1, **wherein** the rigid module (1) of the implant first (100, 200, 300), the implant second (101, 201, 301) and the implant third (102, 202) is made of titanium, an alloy thereof, stainless steel and/or polymers, ultra-high molecular weight polyethylene (UHMWPE) or polyetheretherketone (Peek), ceramic materials or a combination of the aforementioned materials.

20. The system of implants of claim 1, **wherein** the rigid module (1) of the implant first (100, 200, 300), the implant second (101, 201, 301) and the implant third (102, 202) or a part thereof is made of a porous material.

21. The system of implants of claim 1, **wherein** at least one rigid module (1) and/or one movable module (2) has surface modifications.

22. The system of implants of claim 1, **wherein** surface of at least one rigid and/or movable module or part thereof contains bioactive agents.

23. A method of stabilization of the spine, **characterized in that** implants having structural elements with a controllable degree of mobility are used.

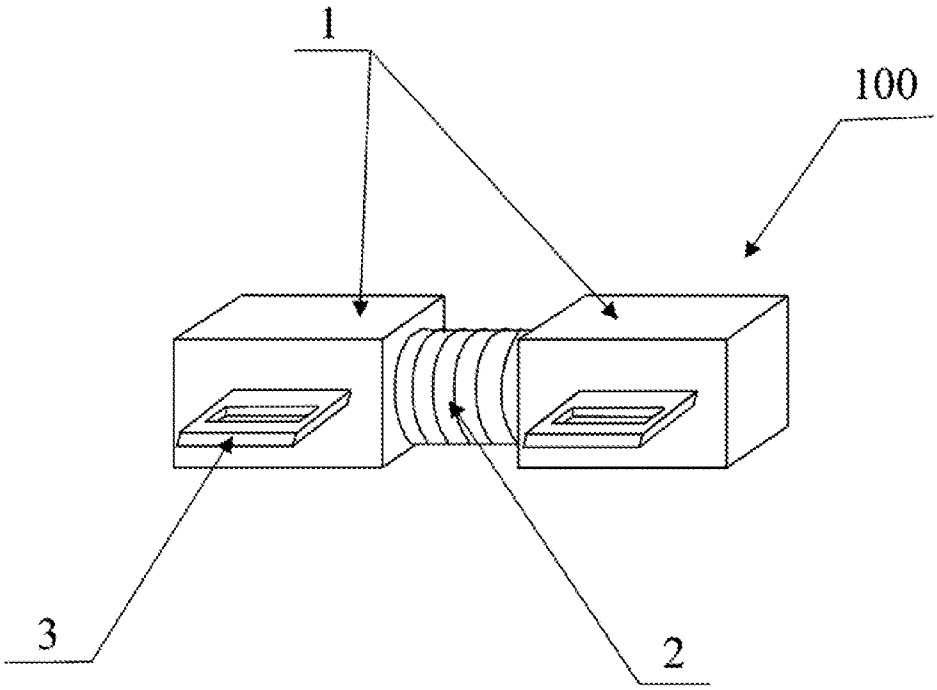

Fig. 1

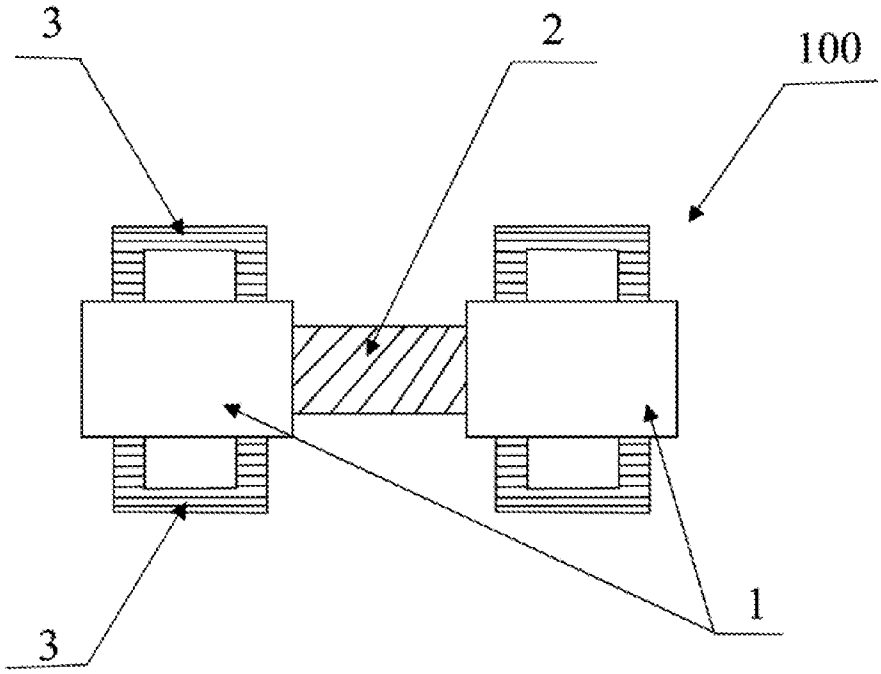

Fig. 2

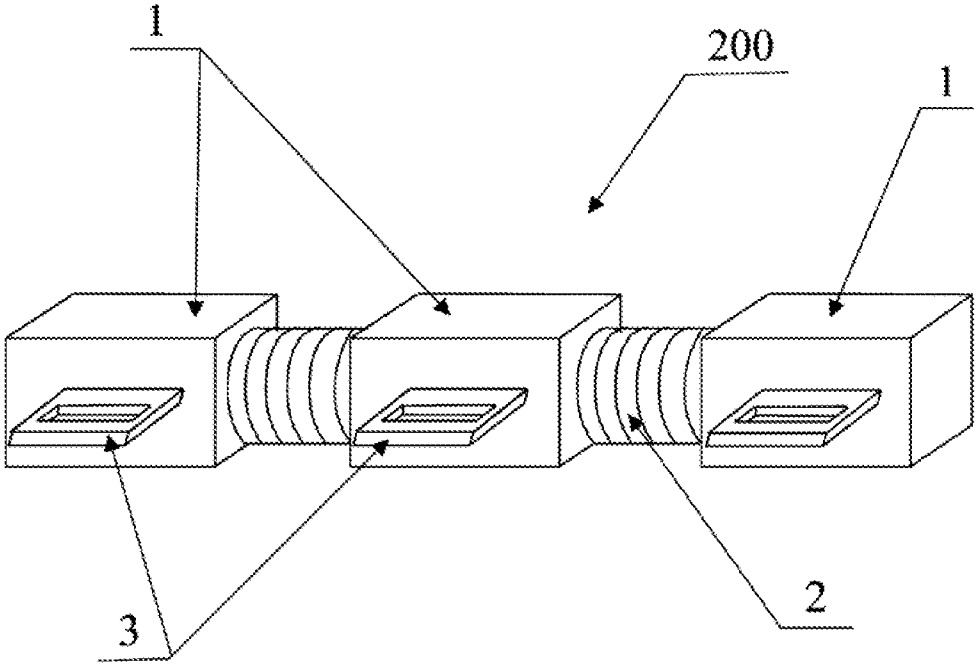

Fig. 3

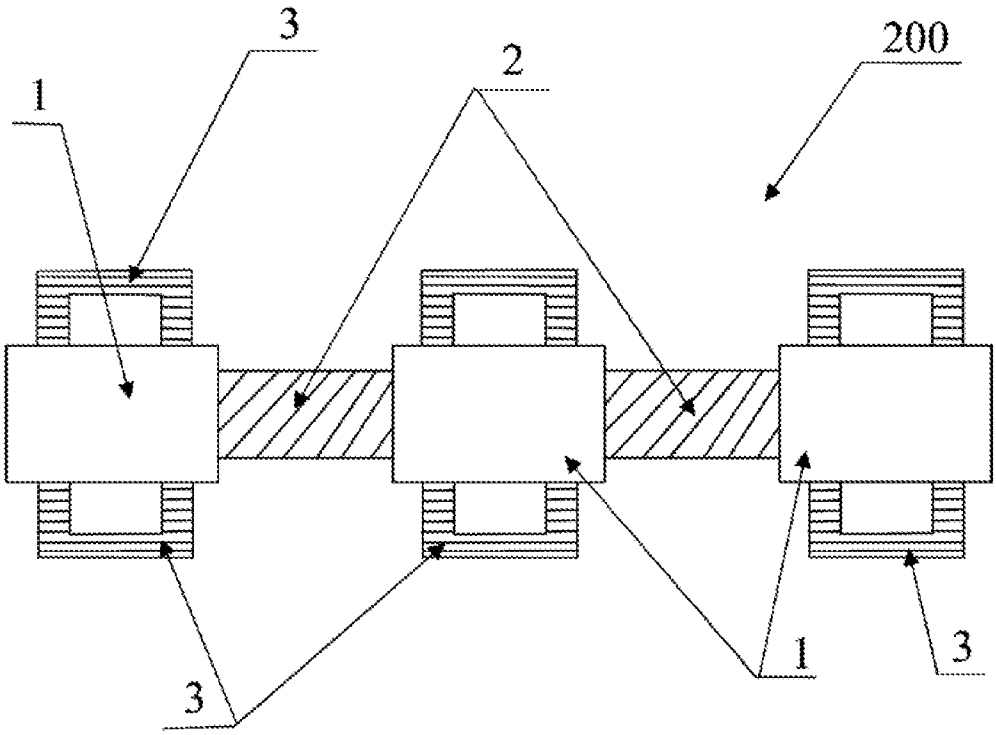

Fig. 4

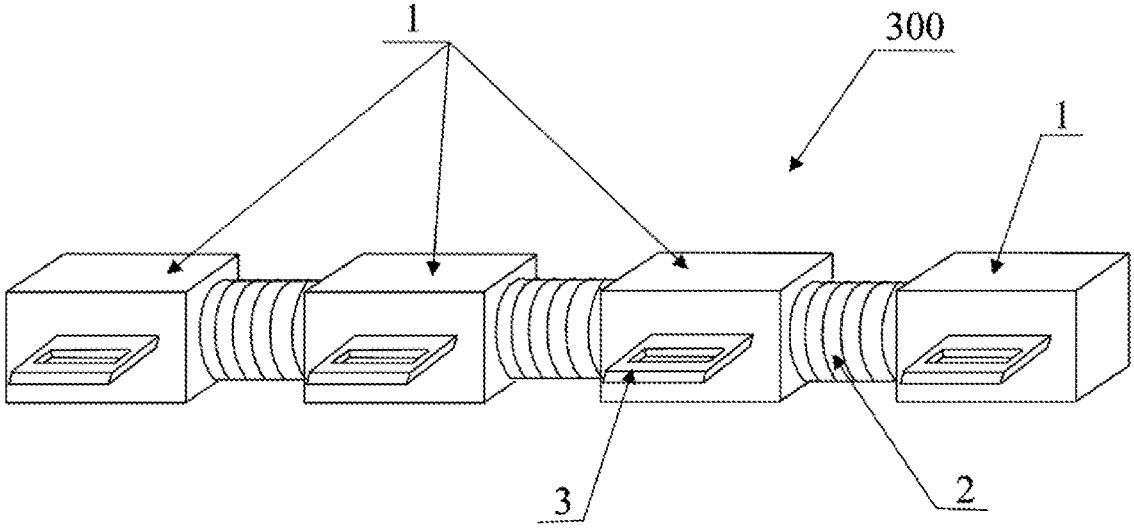

Fig. 5

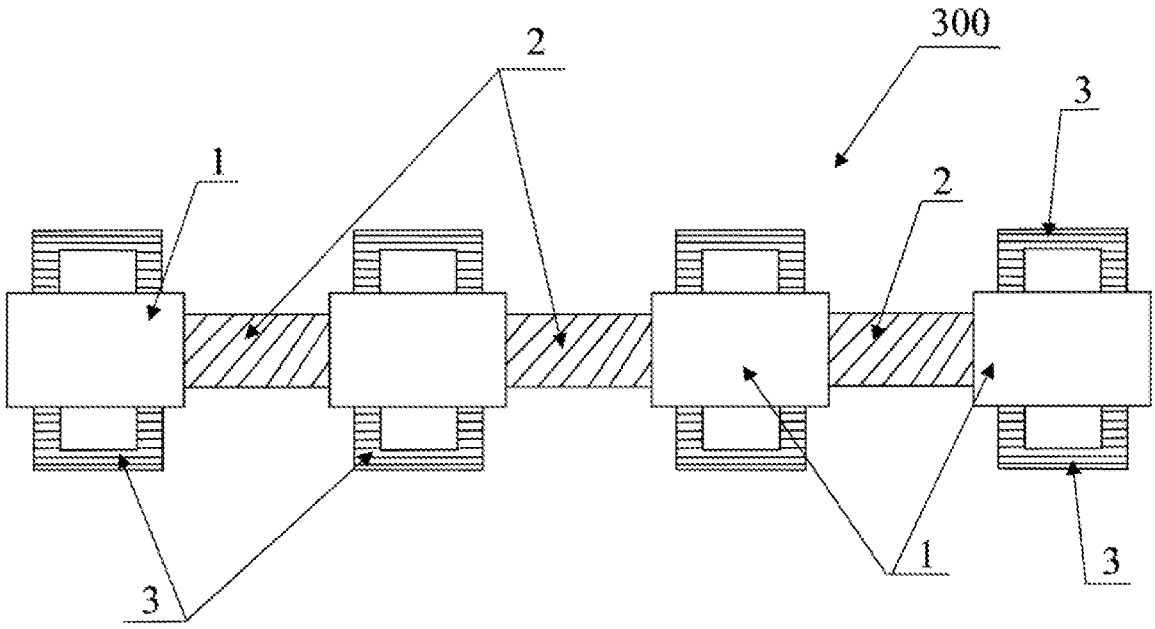

Fig. 6

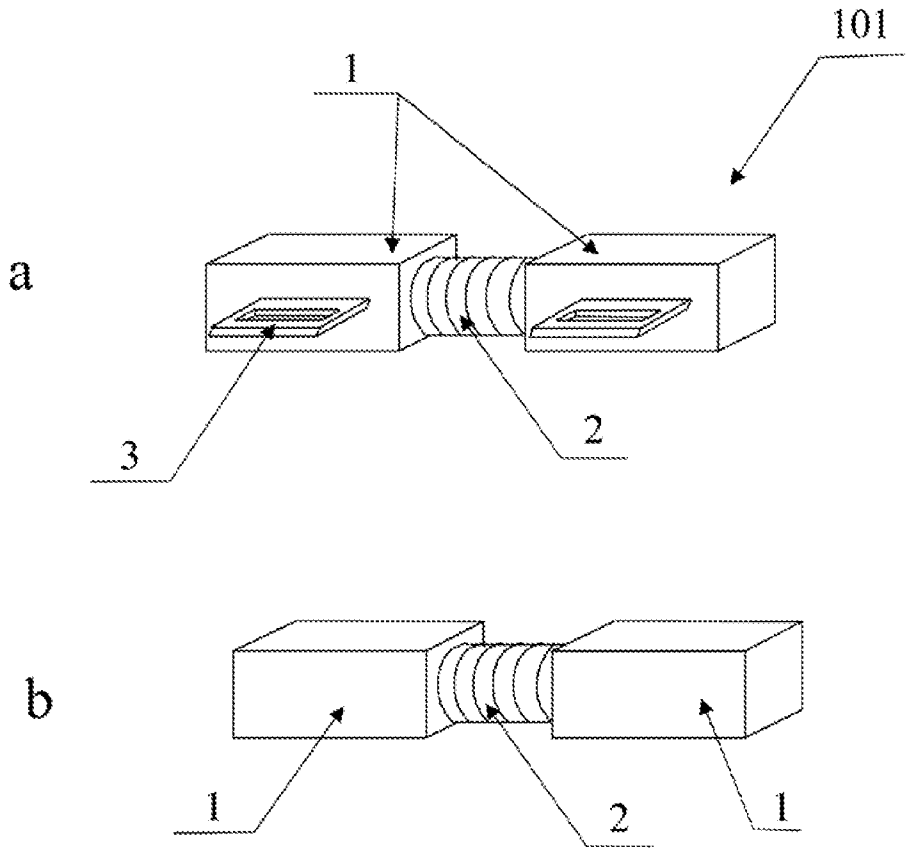

Fig. 7

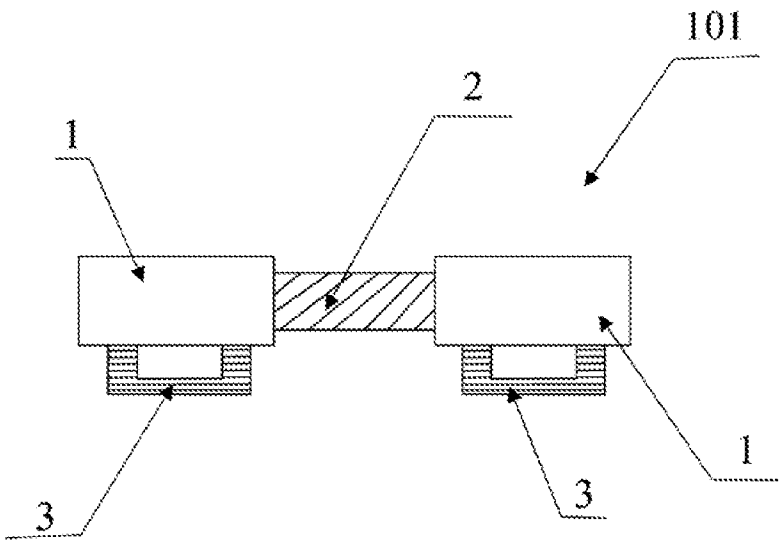

Fig. 8

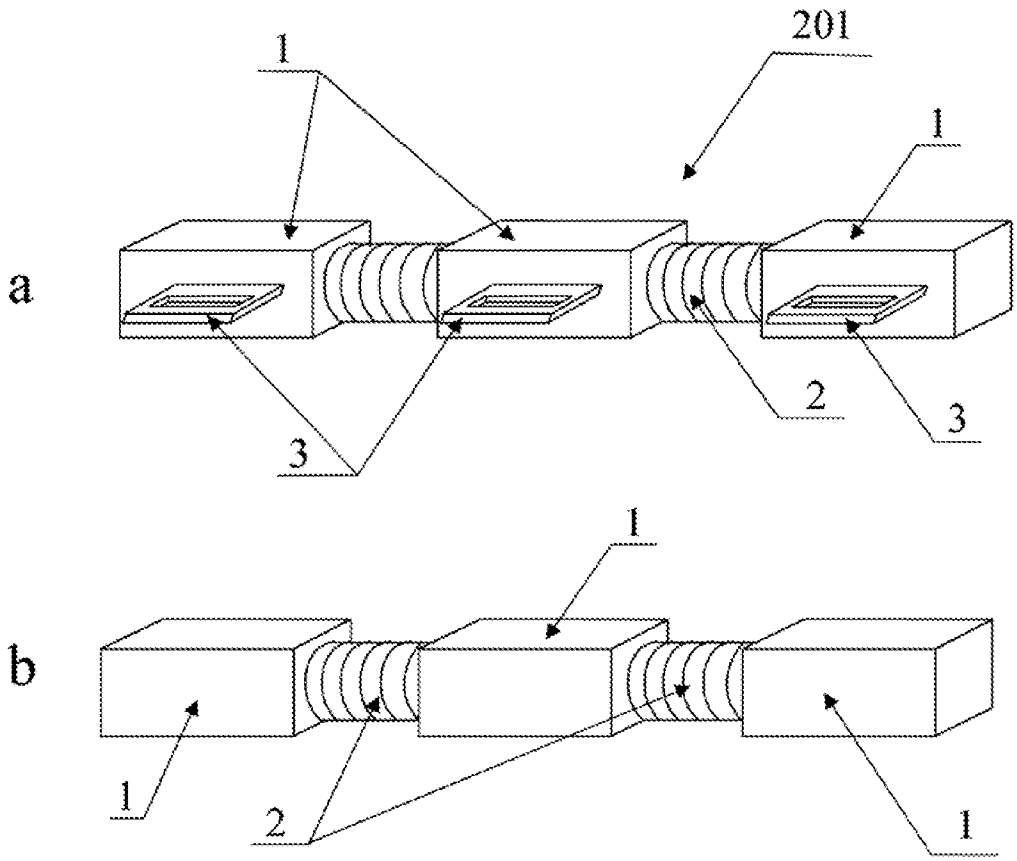

Fig. 9

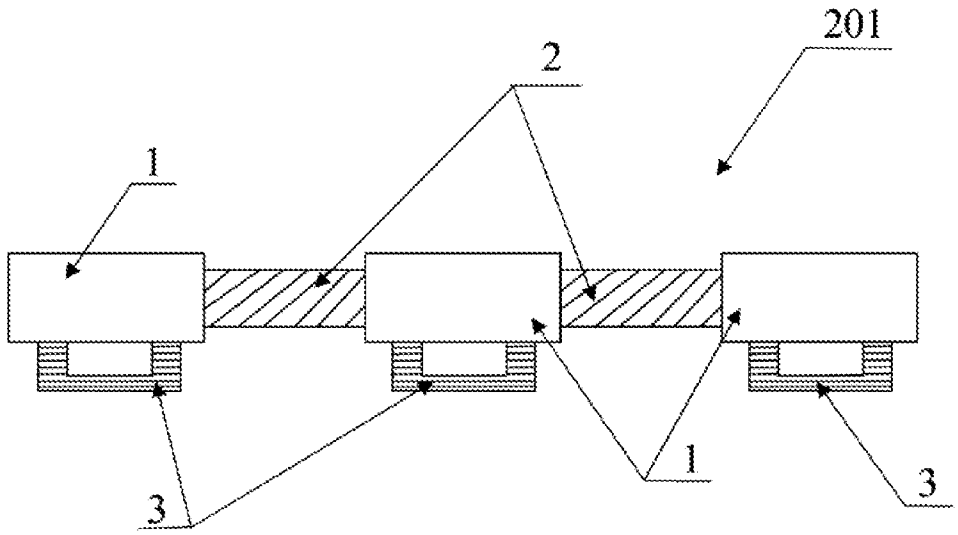

Fig. 10

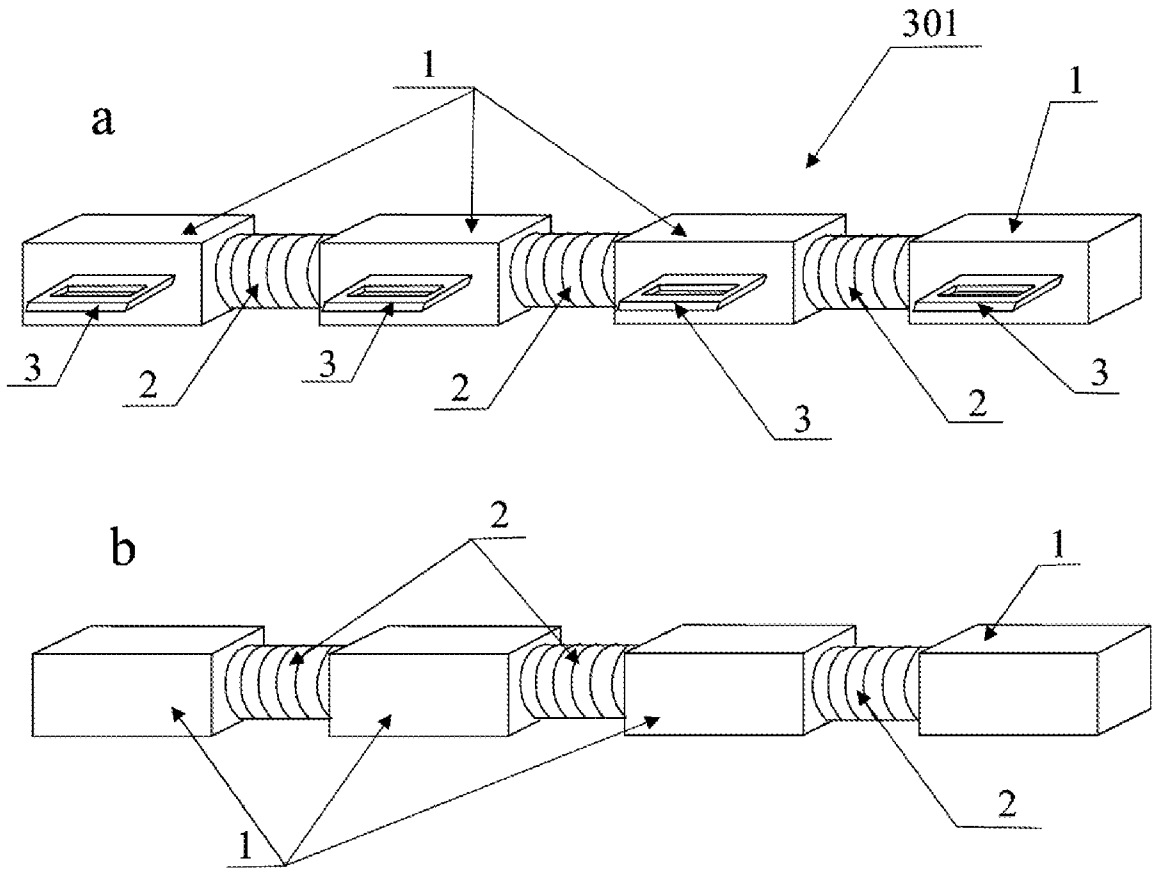

Fig. 11

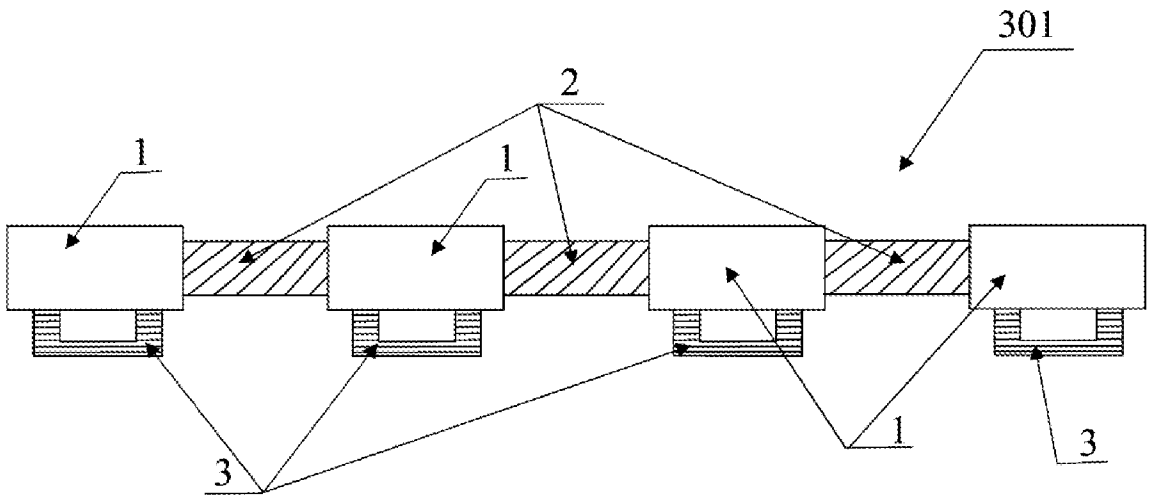

Fig. 12

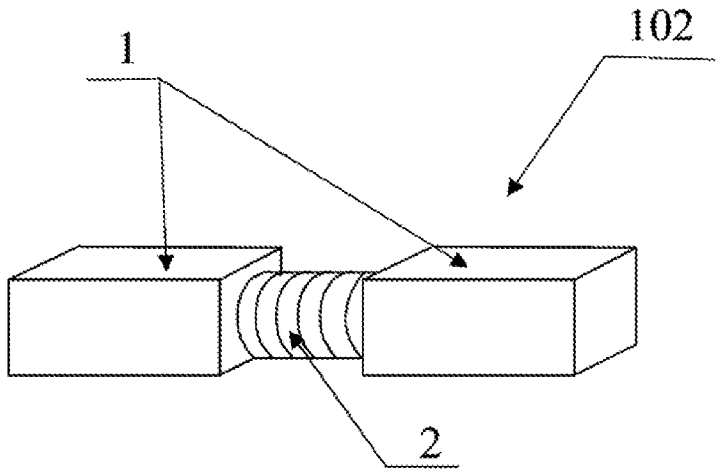

Fig. 13

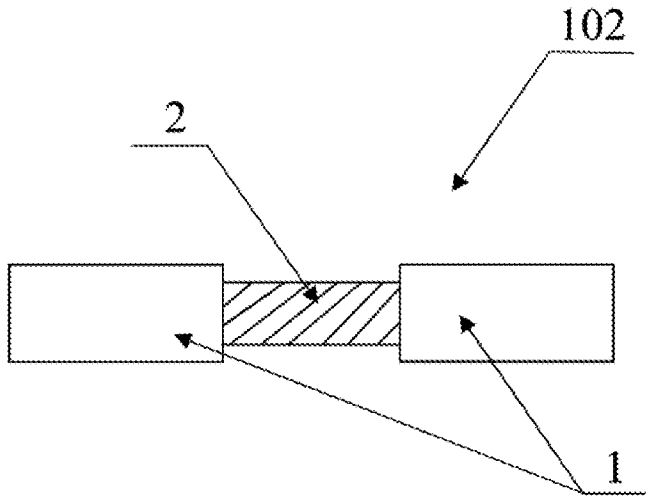

Fig. 14

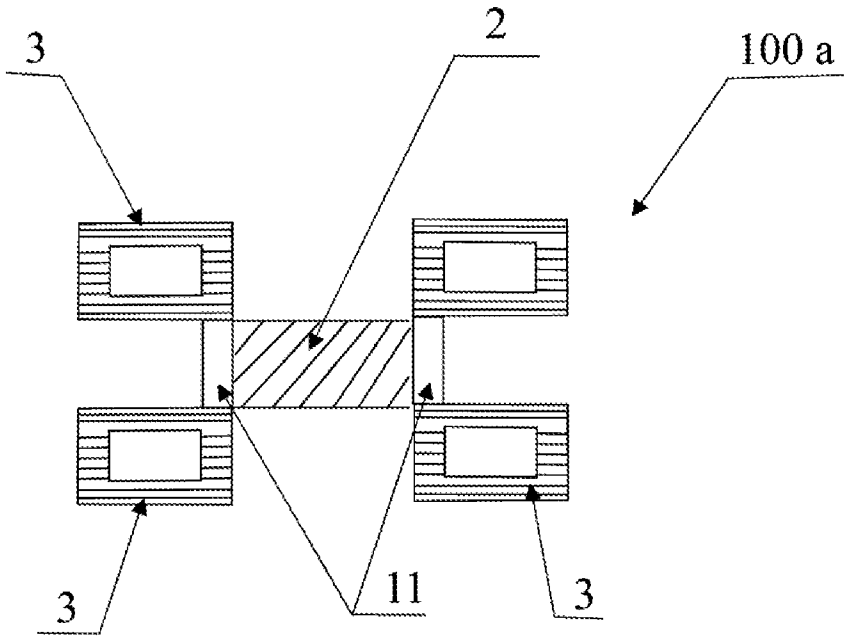

Fig. 15

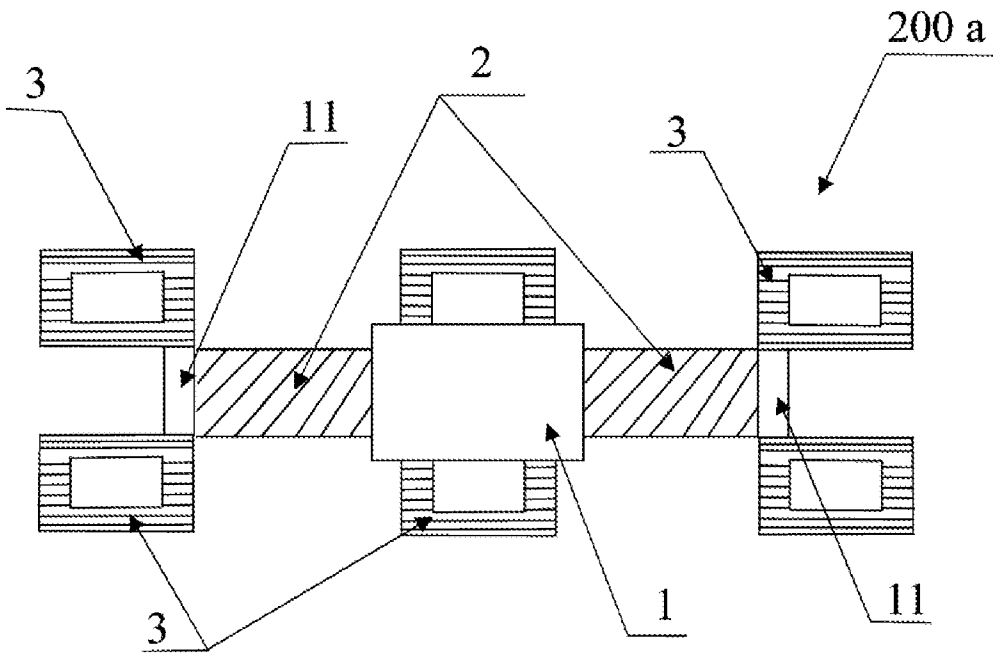

Fig. 16

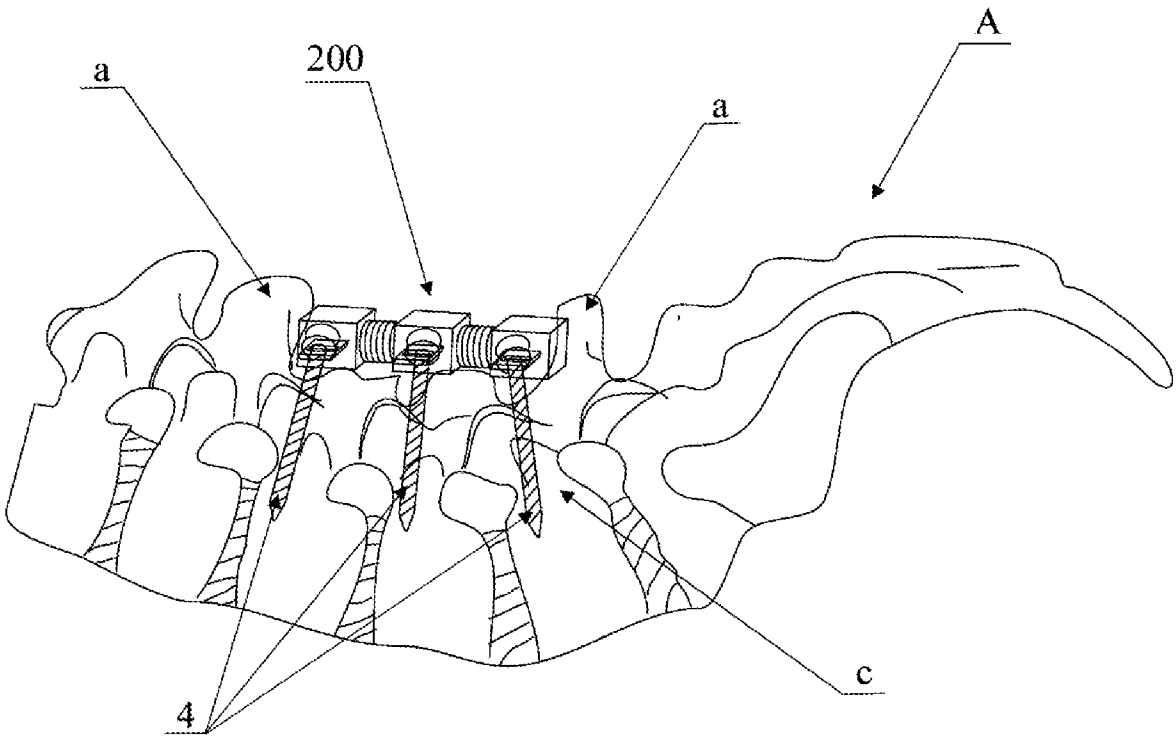

Fig. 17

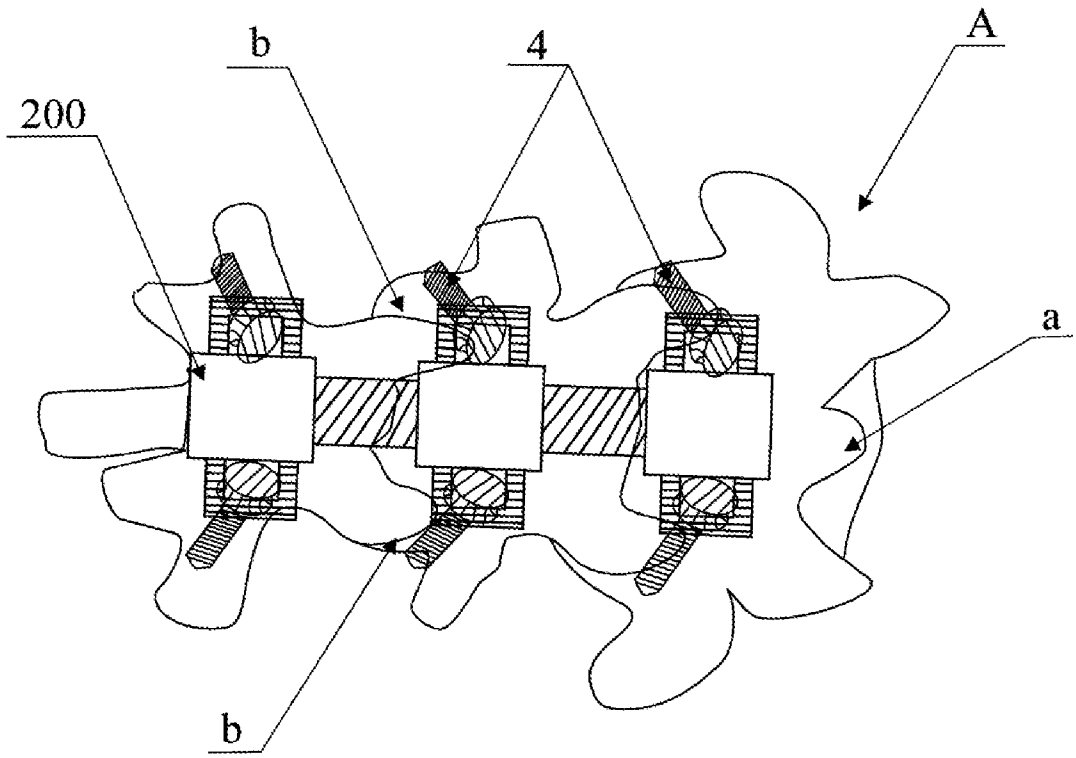

Fig. 18

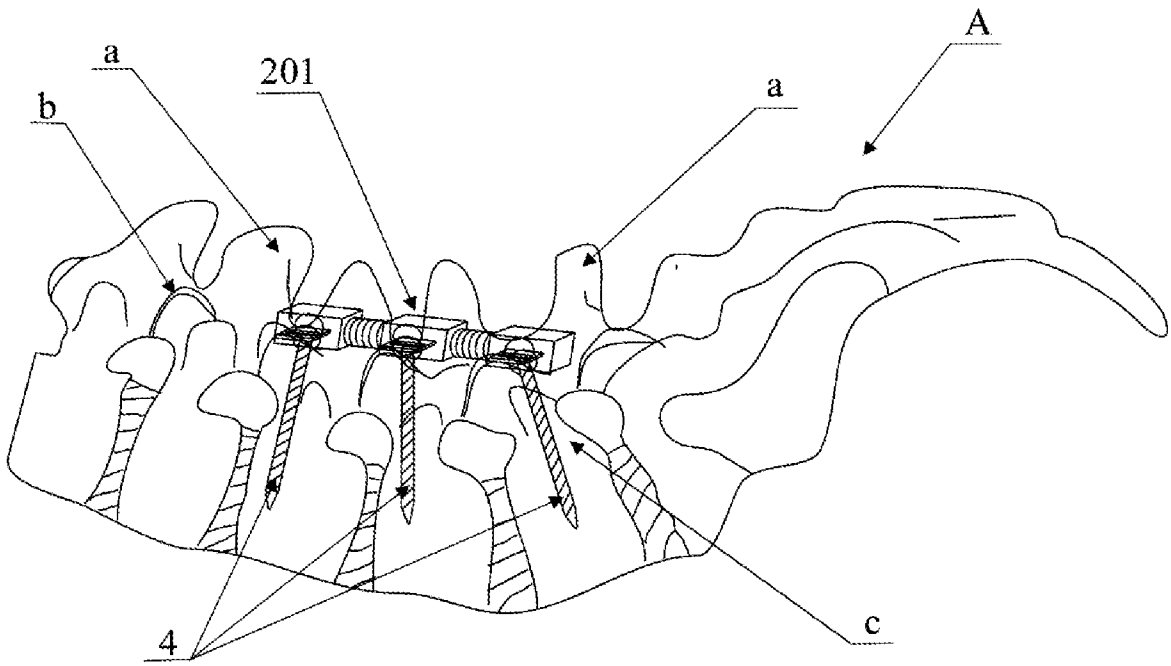

Fig. 19

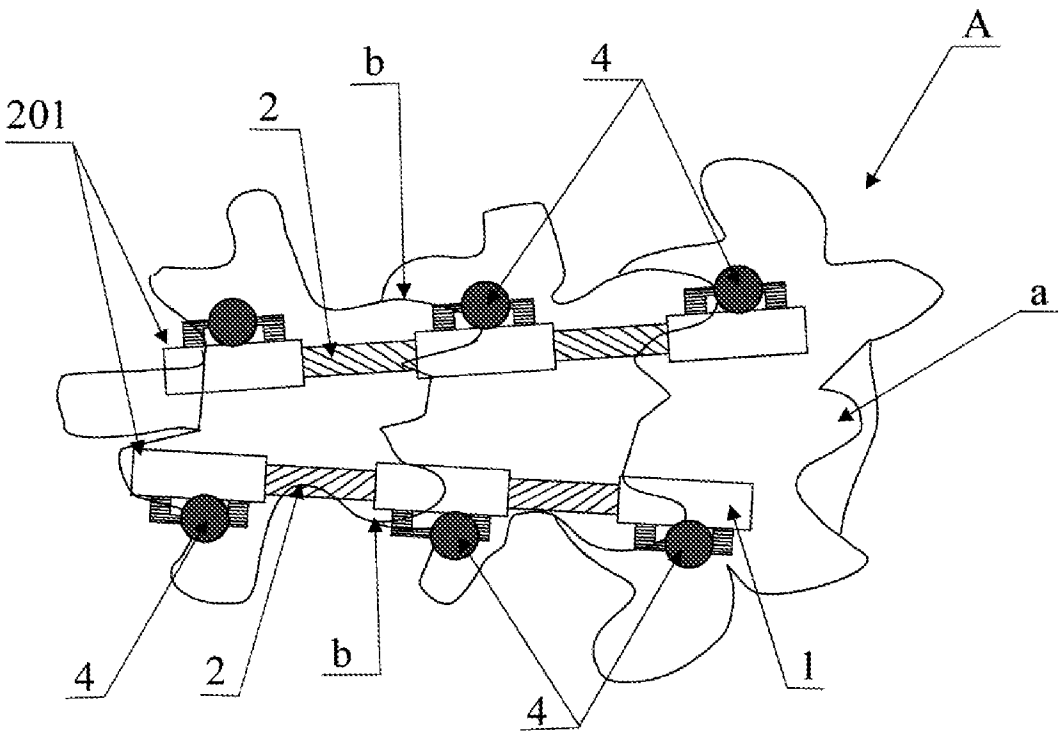

Fig. 20

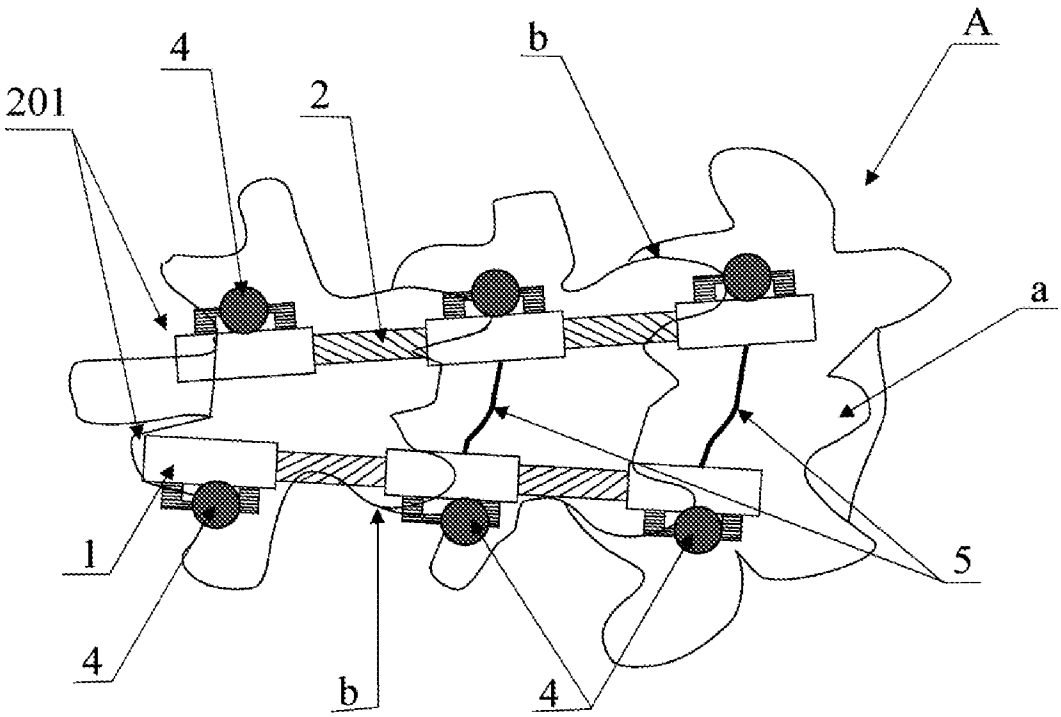

Fig. 21

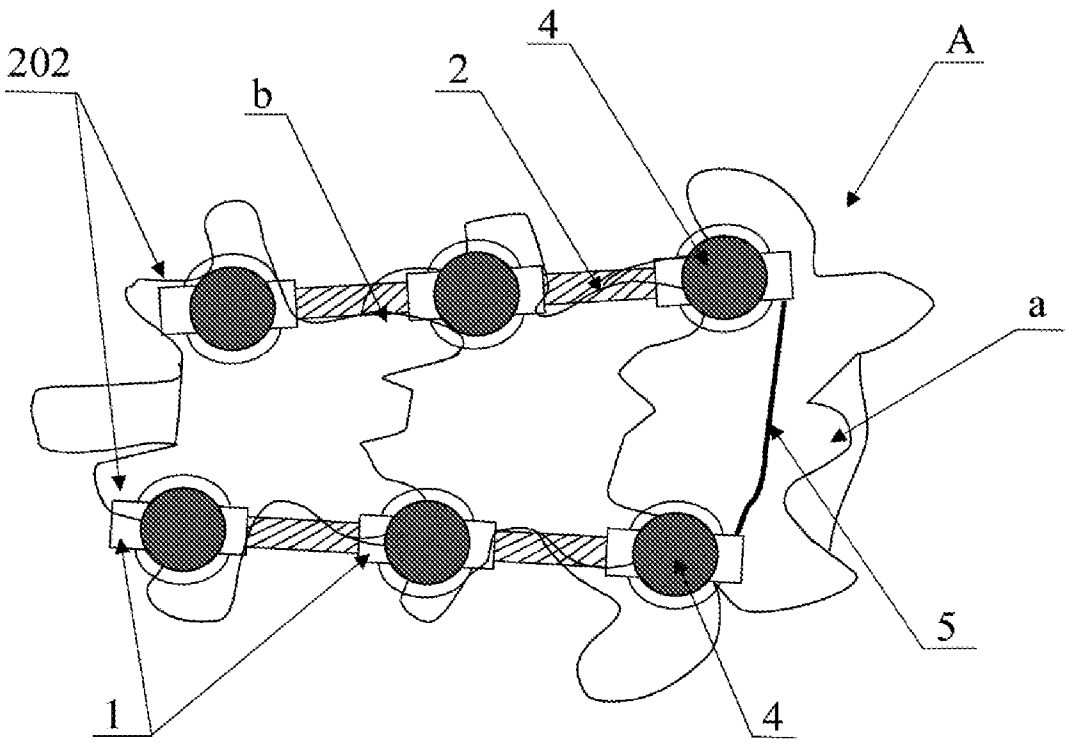

Fig. 22

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/055574

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/70
ADD. A61B90/00

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 practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/146377 A1 (KERFLIN ORTHOPEDIC INNOVATIONS [US]; KERCHER JAMES [US] ET AL.) 3 December 2009 (2009-12-03)	1-3,6,7, 9,11-13, 19
A	paragraph [0082] - paragraph [0083]; figure 17 paragraph [0051]	10,20

X	US 2018/028234 A1 (SIMPSON JOSHUA W [US] ET AL) 1 February 2018 (2018-02-01) paragraph [0042] paragraph [0050] - paragraph [0058]; figures 2, 3 paragraph [0059]; figure 4 paragraph [0071] - paragraph [0072]	1-3,6-8, 11,19,22

	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] 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

"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
14 November 2019	25/11/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Filali, Salima

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/055574

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/191844 A1 (CARLS THOMAS A [US] ET AL) 16 August 2007 (2007-08-16)	1,4, 14-17, 21,22
A	paragraph [0034] - paragraph [0036]; figure 5	5,18

X	EP 2 849 663 A1 (STICHTING TECH WETENSCHAPP [NL]; UNIV TWENTE [NL]) 25 March 2015 (2015-03-25) paragraph [0031] - paragraph [0037]; figures 2,3	1-3,6,7

X	FR 2 846 223 A1 (FORTIN FREDERIC [FR]) 30 April 2004 (2004-04-30) page 4, line 4 - page 5, line 33; figure 3	1,2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2019/055574

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. [X] Claims Nos.: 23
because they relate to subject matter not required to be searched by this Authority, namely:

see FURTHER INFORMATION sheet PCT/ISA/210

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 an 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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.1

Claims Nos.: 23

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgeryClaim 23 relates to subject-matter considered by this Authority to be covered by the provisions of Rule 67.1(iv) PCT. Consequently, no opinion will be formulated with respect to the subject-matter of these claims (Article 34(4) (a)?(i) PCT).

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2019/055574

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009146377 A1	03-12-2009	EP 2293727 A1	16-03-2011
		US 2009306717 A1	10-12-2009
		US 2016346009 A1	01-12-2016
		WO 2009146377 A1	03-12-2009
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		US 2018028235 A1	01-02-2018
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		EP 2849663 A1	25-03-2015
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