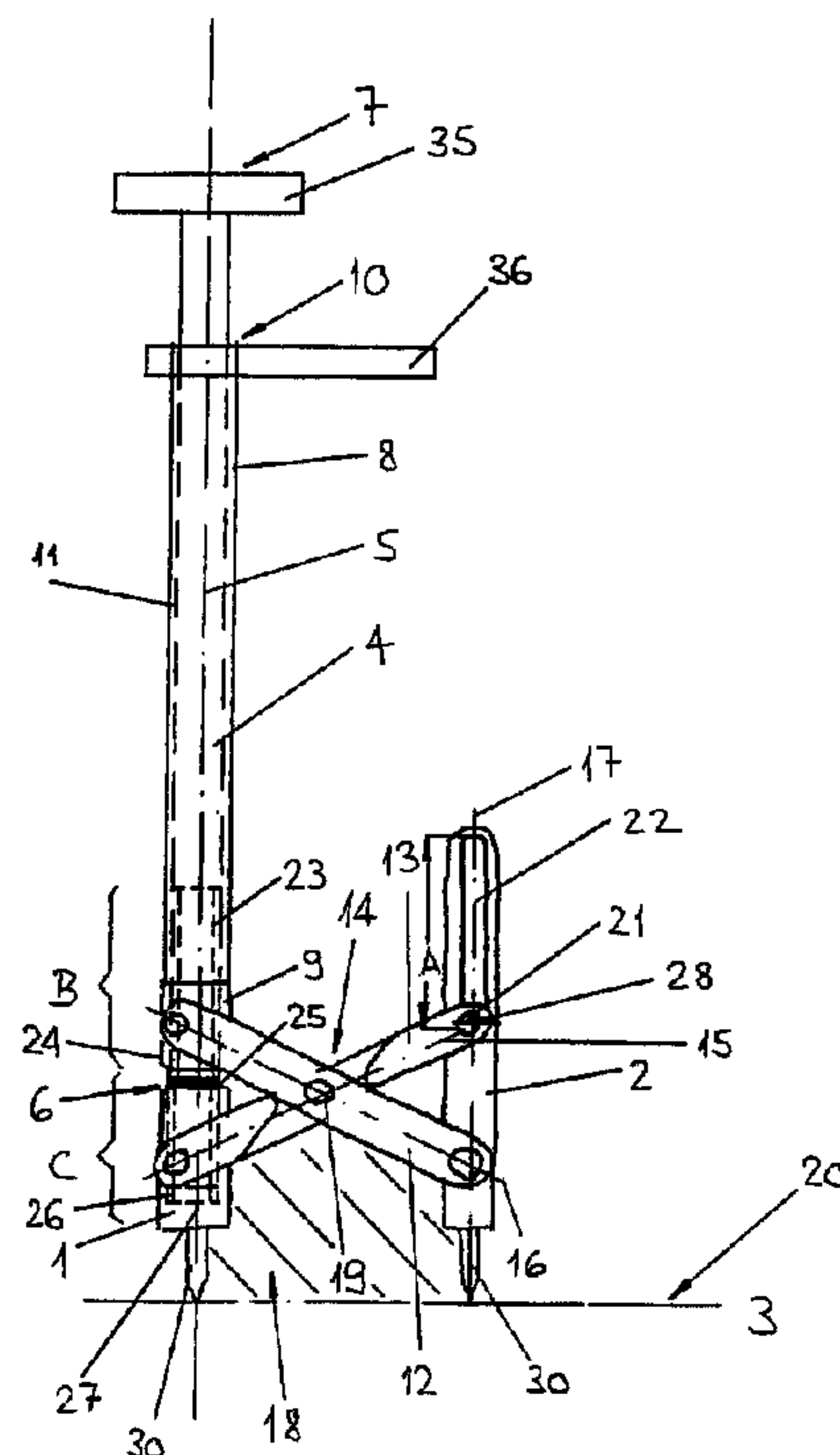




(86) Date de dépôt PCT/PCT Filing Date: 1999/12/10
(87) Date publication PCT/PCT Publication Date: 2001/06/14
(45) Date de délivrance/Issue Date: 2008/03/11
(85) Entrée phase nationale/National Entry: 2003/06/10
(86) N° demande PCT/PCT Application No.: CH 1999/000598
(87) N° publication PCT/PCT Publication No.: 2001/041652

(51) Cl.Int./Int.Cl. *A61B 17/02* (2006.01),
A61B 17/58 (2006.01), *A61B 17/88* (2006.01),
A61B 17/66 (2006.01)
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(54) Titre : DISPOSITIF POUR TENDRE OU COMPRIMER DES OS OU DES PARTIES OSSEUSES
(54) Title: DEVICE FOR DISTRACTING OR COMPRESSING BONES OR BONE FRAGMENTS



(57) **Abrégé/Abstract:**

The invention relates to a device for exerting axial forces on bone fragments or vertebral bodies. The inventive device comprises A) a first connecting element (1); B) a second longitudinal connecting element (2) which is displaceable relative to the first connecting element (1); C) a longitudinal support (4) with a longitudinal axis (5) and a front end (6) that can be linked with the first connecting element (1); D) a tubular sleeve (8) that is coaxial relative to the longitudinal axis (5) in which the longitudinal support (4) is displaceable parallel to the longitudinal axis (5) and that comprises a front end (9) that is directed against the first connecting element (1); E) at least one first lever (12) that rotatably links the front end (9) and the second connecting element (2); F) at least one second lever (13) that is rotatably disposed on the first connecting element (1) and on the second connecting element (2) so that G) a relative movement between the front end (9) and the first connecting element (1) results in a relative movement between the first and the second connecting element (1; 2) along a line (20) that substantially extends transversely to the longitudinal axis (5).



(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES
PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG(19) Weltorganisation für geistiges Eigentum
Internationales Büro(43) Internationales Veröffentlichungsdatum
14. Juni 2001 (14.06.2001)

PCT

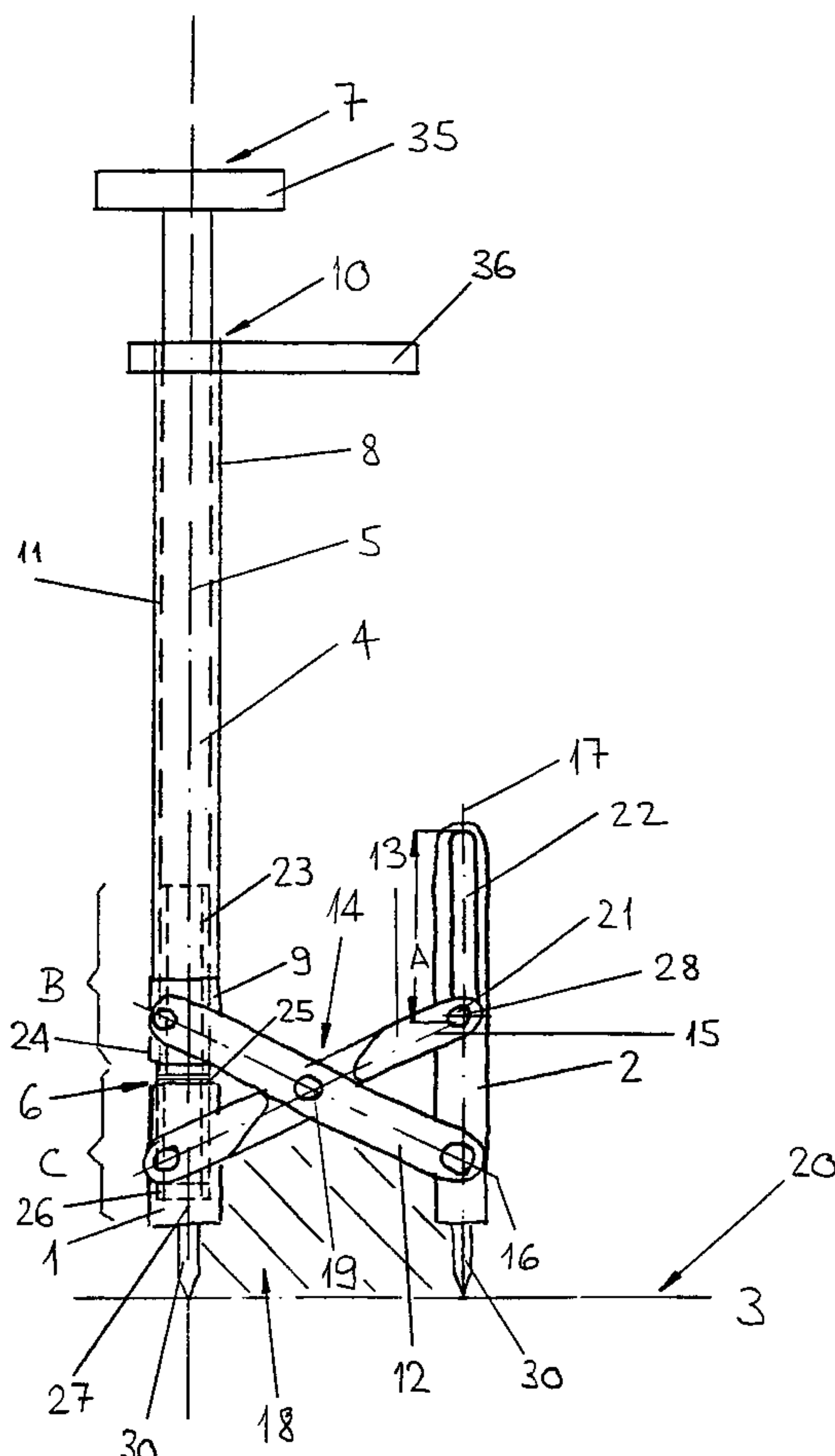
(10) Internationale Veröffentlichungsnummer
WO 01/41652 A1

- (51) Internationale Patentklassifikation⁷: **A61B 17/02, 17/58** (71) Anmelder (für alle Bestimmungsstaaten mit Ausnahme von CA, US): **SYNTHES AG CHUR [CH/CH]**; Grabenstrasse 15, CH-7002 Chur (CH).
- (21) Internationales Aktenzeichen: **PCT/CH99/00598** (71) Anmelder (nur für CA): **SYNTHES (U.S.A.) [US/US]**; 1690 Russell Road, P.O. Box 1766, Paoli, PA 19301-1222 (US).
- (22) Internationales Anmeldedatum:
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- (26) Veröffentlichungssprache: Deutsch

[Fortsetzung auf der nächsten Seite]

(54) Title: DEVICE FOR DISTRACTING OR COMPRESSING BONES OR BONE FRAGMENTS

(54) Bezeichnung: VORRICHTUNG ZUM DISTRAHIEREN ODER KOMPRIMIEREN VON KNOCHEN ODER KNOCHENTEILEN



(57) Abstract: The invention relates to a device for exerting axial forces on bone fragments or vertebral bodies. The inventive device comprises A) a first connecting element (1); B) a second longitudinal connecting element (2) which is displaceable relative to the first connecting element (1); C) a longitudinal support (4) with a longitudinal axis (5) and a front end (6) that can be linked with the first connecting element (1); D) a tubular sleeve (8) that is coaxial relative to the longitudinal axis (5) in which the longitudinal support (4) is displaceable parallel to the longitudinal axis (5) and that comprises a front end (9) that is directed against the first connecting element (1); E) at least one first lever (12) that rotatably links the front end (9) and the second connecting element (2); F) at least one second lever (13) that is rotatably disposed on the first connecting element (1) and on the second connecting element (2) so that G) a relative movement between the front end (9) and the first connecting element (1) results in a relative movement between the first and the second connecting element (1; 2) along a line (20) that substantially extends transversely to the longitudinal axis (5).

(57) Zusammenfassung: Vorrichtung zur Ausübung von axialen Kräften auf Knochenfragmente oder Wirbelkörper, mit A) einem ersten Verbindungselement (1); B) einem zweiten longitudinalen Verbindungselement (2), welches relativ zum ersten Verbindungselement (1) verschiebbar ist; C) einem Längsträger (4) mit einer Längsachse (5) und einem vorderen, mit dem ersten Verbindungselement (1) verbindbaren Ende (6); D) einer zur Längsachse (5) coaxialen rohrartigen Hülse (8), worin der Längsträger (4) parallel zur Längsachse (5) verschiebbar ist, und welche ein vorderes gegen das erste Verbindungselement (1) gerichtete Endstück (9) umfasst; E) mindestens einem ersten, das vordere Endstück (9) und das zweite Verbindungselement (2) drehbar verbindenden Hebel (12); F) mindestens einem zweiten Hebel (13), welcher am ersten Verbindungselement (1) und am zweiten Verbindungselement (2)

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Veröffentlicht:

— *Mit internationalem Recherchenbericht.*

(81) **Bestimmungsstaaten** (*national*): AU, CA, JP, NZ, US,
ZA.

(84) **Bestimmungsstaaten** (*regional*): europäisches Patent (AT,
BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,
NL, PT, SE).

*Zur Erklärung der Zweibuchstaben-Codes, und der anderen
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drehbar angeordnet ist; so dass G) eine Relativbewegung zwischen dem vorderen Endstück (9) und dem ersten Verbindungselement (1) eine Relativbewegung zwischen dem ersten und dem zweiten Verbindungselement (1; 2) entlang einer im Wesentlichen quer zur Längsachse (5) verlaufenden Linie (20) bewirkt.

Device for Distracting or Compressing Bones or Bone Fragments

This invention relates to a system for applying axial forces on at least two bone fragments or vertebral bodies with which the system can be connected, encompassing

A) a first connecting element (1), with a longitudinal axis (27), that can be connected to a bone fragment or a vertebral body, and

B) a second longitudinal connecting element (2), with a longitudinal axis (17), that can be connected to another bone fragment or vertebra, with the longitudinal axes (17, 27) defining a plane (18) while the second connecting element (2) is movable relative to the first connecting element (1) in a manner whereby the longitudinal axis (17) travels within the plane (18); characterized in that the system

C) also includes, coaxially with the longitudinal axis (27), a longitudinal support (4) with a longitudinal axis (5), a back end (7) and a front end (6) that can be connected to the first connecting element (1), with the longitudinal axis (5) extending parallel to the plane (18);

D) includes a tubular sleeve (8) that extends coaxially with the longitudinal axis (5) and is provided with a coaxial end-to-end bore (11) within which the longitudinal support (4), featuring a forward end piece (9) that faces the first connecting element (1) as well as a rearward end piece (10), is movable parallel to the longitudinal axis (5);

E) comprises a first lever (12) that connects the forward end piece (9) to the second connecting element (2), that has a longitudinal axis (16) that extends essentially parallel to the plane (18) and which is attached to the end piece (9) in rotatable fashion, whereby the longitudinal axis (16) can be swiveled in a direction essentially parallel to the plane (18); also

F) includes at least one second lever (13) whose longitudinal axis extends essentially parallel to the plane (18) and which is pivotably attached to the first connecting element (1) and to the second connecting element (2) in a manner whereby the longitudinal axis (15) can be swiveled essentially parallel to the plane (18), so that

G) a relative movement between the forward end piece (9) and the first connecting element (1) parallel to the longitudinal axis (5) produces a relative movement between the first and the second connecting element (1, 2) along a line (20) that extends parallel to the plane (18) and essentially in a transverse direction relative to the longitudinal axis (5).--.

For example, if a vertebra is diseased or damaged, it may have to be removed from the spine. In place of that vertebra a spacer implant is grafted in. Implants usually encompass mutually shiftable components as well as two special end plates serving to anchor the implant in the adjoining healthy vertebrae. In many other cases an internal fixation system is attached in a manner whereby it connects two vertebrae, with the fixation system bridging one or even several defective vertebrae. In the case of these predominantly plate-shaped implants the end-plate sections are fastened to the vertebrae by means of bone screws. The connecting elements between the end-plate sections are of a telescoping design, allowing the vertebrae next to the defective vertebral bodies to move parallel to the spinal axis in expansile or contractile fashion. Yet other spinal fixation systems consist of rod-shaped longitudinal supports that can be attached to pedicle screws via connecting elements. These connecting elements are so designed that they can slide along the longitudinal supports in an axial direction, again permitting expansile and contractile movement between the vertebrae. These provisions often require a spreading or compression of vertebrae or implant segments by means of appropriate instruments.

A system for spreading vertebrae has been described in US 4,898,161 by GRUNDEI. This earlier spreading system features a pincer-like design of two levers axially extending into two jaws that can be equipped with pins. The jaws include special guide yokes and move in a parallel direction to each other when the pincers are opened or closed. By means of an adjustable bolt-and-nut joint

between the two levers the pincer-like spreading system can be locked in position. A shortcoming of that earlier spreading system lies in its inability to produce any compressive displacement.

This invention is designed to remedy that problem. It is the objective of this invention to provide a system capable of spreading and compressing bone fragments, vertebral bodies or implant sections while at the same time permitting a very precise fine adjustment of the jaw spacing.

The invention achieves this by means of a system for applying axial forces on at least two bone fragments or vertebrae to which the system is connected.

The system according to the invention comprises the following:

- A) a first connecting element, extending along a longitudinal axis and designed to connect to a bone fragment or vertebra;
- B) a second connecting element, extending along a longitudinal axis and designed to connect to another bone fragment or vertebra, with the longitudinal axes defining a plane and the second connecting element being movable relative to the first connecting element in a way as to cause the latter's longitudinal axis to move within the said plane;
- C) a longitudinal support, extending coaxially with the longitudinal axis of the first connecting element, with a back end as well as a front end that can be connected to the first connecting element, its longitudinal axis extending parallel to the said plane;
- D) a tubular sleeve, extending coaxially with the longitudinal axis and provided with a coaxial end-to-end bore in which the longitudinal support can slide parallel to the said longitudinal axis, and equipped with a forward end piece that faces the first connecting element, as well as a rearward end piece;
- E) at least one first lever, having a longitudinal axis that extends essentially parallel to the said plane and connects the forward end piece to the second connecting element, said lever being pivotably mounted on the end piece in such fashion that the longitudinal axis can be rotated essentially parallel to the said plane; and

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- F) at least one second lever whose longitudinal axis extends essentially parallel to the said plane and which is so connected in pivotable fashion to the first connecting element and to the second connecting element that the longitudinal axis can be rotated essentially parallel to the said plane; whereby**
- G) a relative movement between the forward end piece and the first connecting element parallel to the longitudinal axis results in a relative movement between the first and the second connecting element along a line or curve that extends parallel to the said plane and in an essentially transverse direction relative to the longitudinal axis.**

The longitudinal axes of the two levers intersect at a crossover point and are rotatably connected to each other by means of a pivot joint provided at that point of intersection. The levers may also be attached in pairs in which case the respective first and second set of levers include each one pair of levers opposite the sleeve and the connecting element. On the other hand, the first and second set of levers may also include on the same side of the sleeve or, respectively, of the connecting elements two or several levers that can extend in a parallel direction.

The longitudinal support may be designed in simple fashion to permit its axial movement within the sleeve, for which purpose the longitudinal support and the sleeve can be manipulated via simple handles or levers mounted on these elements. In another design version, the longitudinal support and the sleeve can be moved parallel to the longitudinal axis and relative to each other by means of a lever mechanism. Mounted on the longitudinal support and on the sleeve, perpendicular to the longitudinal axis, are rigid levers which by means of a pincer-like device can be moved toward or away from each other. Swivel joints connect the rigid levers to the pincer levers which intersect at a common pivot joint, whereby a squeezing of the pincer levers moves the rigid levers against each other. Forcing the pincer levers apart is accomplished by means of a spring mounted between them.

In another design version of the system according to this invention, the longitudinal support is provided, in an area (B) opposite the forward end piece on the sleeve, with a male thread that matches a corresponding female thread on the forward end piece of the sleeve. The longitudinal support is pivot-mounted in the first connecting element so as to permit rotation around the

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longitudinal axis while in an axially fixed position relative to the longitudinal axis. In this fashion the relative movement, axial in the direction of the longitudinal axis, between the longitudinal support and the sleeve is generated by a rotation of the longitudinal support within the sleeve.

Alternatively, the longitudinal support may be provided, in an area (C) at its forward end that can be connected to the first connecting element, with a second male thread which allows the first connecting element to be connected to the forward end of the longitudinal support via a matching female thread.

The threads may run in the same direction but at a different pitch, or in opposite directions whereby one male thread is a right-hand thread while the other male thread is a left-hand thread. The corresponding female threads are suitably matched. Multiple-thread versions are also possible.

The levers may be attached to both connecting elements in rotatable fashion. If in addition a fulcrum of a lever is movable on a connecting element parallel to the longitudinal axis of the connecting element, a shift between the connecting elements relative to each other is possible, while the longitudinal axes of the connecting elements remain parallel and the connecting elements extend along a straight line perpendicular to their longitudinal axes.

The first lever or levers may also be rigidly attached to the corresponding connecting elements in which case the connecting elements move relative to each other along a flat curve.

Additional advantageous configurations according to this invention are specified in the subordinated claims.

The advantageous features made possible by this invention essentially consist in the fact that the novel system permits both spreading and compressing action with one and the same equipment even over substantial spreading or compression distances while ensuring a parallel movement of

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the bone fragments, vertebrae or implant sections. Moreover, the system permits the feed-through of a graft-specific tool or instrument and for instance of a screwdriver as well.

The following will describe this invention and enhancements thereof in more detail with the aid of partly diagrammatic representations of several design examples in which ?

Fig. 1 illustrates one form of implementation of the system according to the invention;

Fig. 2 shows another design version of the system according to the invention;

Fig. 3 depicts yet another implementation design of the system according to the invention; and

Fig. 4 shows a pincer-like actuating device for manipulating the individual design versions of the system according to the invention.

The design of the system per this invention illustrated in fig. 1 encompasses a first connecting element 1, with a longitudinal axis 27, that can connect to a bone fragment or vertebra, and a second longitudinal connecting element 2, with a longitudinal axis 17, that can connect to another bone fragment or vertebra. The longitudinal axes 17, 27 of the connecting elements define a plane 18. On the side facing the bone or implant the connecting elements 1, 2 are equipped with points 30 which can be brought up against bone fragments, vertebrae or implant sections and which, when the system is actuated, move along a straight line 3 positioned in the plane 18 and extending perpendicular to the longitudinal axes 17, 27. In addition, the second connecting element 2 can be moved relative to the first connecting element 1 in a manner whereby the longitudinal axis 17 travels along the plane 18 parallel to the longitudinal axis 27. For manipulating the system per this

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invention, the system is further equipped with a longitudinal support 4 which extends coaxially with the longitudinal axis 27 of the first connecting element 1 and, having a longitudinal axis 5 concentric with the longitudinal axis 27, features a back end 7 as well as a front end 6 that can be connected to the first connecting element 1. In this design, the longitudinal axis 5 extends along the plane 18. A tubular sleeve 8, extending coaxially with the longitudinal axis 5 and provided with a coaxial end-to-end bore 11, permits the movement of the sleeve 8 coaxially with the longitudinal axis 5 along the longitudinal support 4. The sleeve 8 includes a forward end piece 9 that faces the first connecting element 1, and a rearward end piece 10. The movement of the two connecting elements 1, 2 relative to each other is generated by way of a first lever 12 that connects the forward end piece 9 to the second connecting element 2 and whose longitudinal axis 15 extends essentially parallel to the plane 18, said lever 12 connecting in pivotable fashion to the forward end piece 9 and to the second connecting element 2 in such fashion that, relative to the forward end piece 9 and to the second connecting element 2, the lever 12 can be swiveled, causing the longitudinal axis 15 to move parallel to the plane 18, while a second lever 13, with a longitudinal axis 16 extending essentially parallel to the plane 18, is pivotally connected to the first connecting element 1 and to the second connecting element 2, whereby the longitudinal axis 15 can be rotated parallel to the plane 18. The longitudinal axes 15, 16 of the two levers 12, 13 intersect at a crossover point 19 and are mutually connected via a swivel joint 14 located at the intersecting point 19. The scissor-like configuration of the levers 12, 13 makes it possible for a relative movement between the forward end piece 9 and the first connecting element 1 parallel to the longitudinal axis 5 to effect a movement, parallel to the longitudinal axes 17 and 27, between the first and the second connecting elements parallel to the straight line 3 that extends parallel to the plane 18 and perpendicular to the longitudinal axis 5.

The second connecting element 2 contains a guide 22 whereby the rotation of the second lever 13 relative to the second connecting element 2 is made around the longitudinal axis 28 of a pin 21 that is movable within the guide 22. This guide 22 extends parallel to the longitudinal axis 17 and has a length of A, permitting the pin 21 to move in the guide 22 parallel to the longitudinal axis 17.

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The longitudinal support 4 is provided, in an area B opposite the forward end piece 9, with a first male thread 23 and the forward end piece 9 is provided with a female thread 24 matching the male thread 23. The longitudinal support 4 is additionally provided, in an area C at its front end 5 that can be connected to the first connecting element 1, with a second male thread 25 and the first connecting element 1 is attached to the front end 5 of the longitudinal support 4 via a female thread 26 that matches the second male thread 25. The male threads 23 and 25 on the longitudinal support 4 feature a mutually opposite pitch, with the male thread 25 in area C being a right-hand thread and the male thread 23 in area B being a left-hand thread. In analogous fashion, the female threads 24, 26 in the forward end piece 9 and in the first connecting element 1 have a mutually opposite pitch. As a result, when the longitudinal support 4 is rotated around the longitudinal axis 5, the forward end piece 9 of the sleeve 8 and the first connecting element 1 will move toward or away from each other, depending on the direction of rotation of the longitudinal support 4. This relative movement of the forward end piece 9 and the first connecting element 1 results in the relative movement between the two connecting elements 1, 2. For a rotation between the longitudinal support 4 and the sleeve 8, the back end 7 of the longitudinal support 4 is provided with a first handle 35 and the back end 10 of the sleeve 8 on its part is provided with a second handle 36.

The longitudinal support 4 and the first connecting element 1 may be provided with bores extending coaxially with their longitudinal axes 5, 27, permitting the insertion of a screwdriver through these bores. Similarly, the second connecting element 2 may be provided with a bore coaxially with its longitudinal axis 17, again permitting the insertion of a screwdriver through that bore.

The design version of the system according to this invention illustrated in fig. 2 differs from the design in fig. 1 only in that the longitudinal axes 15, 16 of the two levers 12, 13 intersect at the far end, respectively relative to the forward end piece 9 and the first connecting element, of the levers 12, 13. Accordingly, the swivel joint 14 connecting the two levers 12, 13 is located at these ends.

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The levers 12, 13 are essentially of the same length. The second connecting element 2 is rigidly attached to the first lever 12, with the longitudinal axis 16 of the lever 12 and the longitudinal axis 17 of the second connecting element 2 intersecting at an angle. When this design version of the system according to the invention is actuated, the connecting elements 1, 2 do not move with their longitudinal axes 17, 27 remaining parallel. Instead, the connecting elements 1, 2 move along a curve extending along the plane 18. It is possible, however, to define on the second connecting element 2 a point X which moves essentially along a straight line 3 parallel to the plane 18. The connecting elements 1, 2 are equipped with U-shaped plates 32 that can be brought in contact with implant or graft sections.

Fig. 3 depicts a design version of the system according to this invention that differs from the design per fig. 2 only to the extent that the longitudinal support 4 can be moved in the sleeve 8 parallel to the longitudinal axis 5 and that its front end 6 is supported in the first connecting element 1 in an axially fixed position relative to the longitudinal axis 27 while permitting rotation around the longitudinal axis 27. In this fashion, the relative movement between the longitudinal support 4 and the sleeve 8 constitutes a purely axial shift attainable by pushing the handles 35 and 36 toward or, respectively, away from each other. The rotatable yet axially fixed attachment of the longitudinal support 4 in the first connecting element 1 is obtained by means of a set-screw 34 that is screwed into the first connecting element 1 and protrudes into a corresponding groove 33 in the longitudinal support 4.

The motion transfer mechanism between the longitudinal support 4 and the sleeve 8 can just as easily be employed in the system per this invention illustrated in fig. 1

Fig. 4 is a partial view of a design version of the system according to this invention, for instance the design per fig. 3, in which the longitudinal support 4 and the sleeve 8 can be shifted, by means of a lever mechanism 29, both parallel to the longitudinal axis 5 and relative to each other. Attached to the ends 7 and 10 of the longitudinal support 4 and the sleeve 8, in a position perpendicular to the longitudinal axis 5, are fixed levers 37 and 38 which by means of a pincer mechanism can be

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moved toward or away from each other. The pincer levers 42 and 43 are attached to the fixed levers 37 and 38 via swivel joints 39 and 40 and intersect at a common swivel joint 41, whereby a squeezing of the pincer levers 42 and 43 causes the levers 37 and 38 to move toward each other. A spring 44 positioned between them serves to pull the pincer levers 42 and 43 apart.

Patent Claims

1. System for applying axial forces on at least two bone fragments or vertebrae to which the system can be connected, encompassing
 - A) a first connecting element (1), with a longitudinal axis (27), that can be connected to a bone fragment or a vertebral body, and
 - B) a second longitudinal connecting element (2), with a longitudinal axis (17), that can be connected to another bone fragment or vertebra, with the longitudinal axes (17, 27) defining a plane (18) while the second connecting element (2) is movable relative to the first connecting element (1) in a manner whereby the longitudinal axis (17) travels within the plane (18);
 characterized in that the system
 - C) also includes, coaxially with the longitudinal axis (27), a longitudinal support (4) with a longitudinal axis (5), a back end (7) and a front end (6) that can be connected to the first connecting element (1), with the longitudinal axis (5) extending parallel to the plane (18);
 - D) includes a tubular sleeve (8) that extends coaxially with the longitudinal axis (5) and is provided with a coaxial end-to-end bore (11) within which the longitudinal support (4), featuring a forward end piece (9) that faces the first connecting element (1) as well as a rearward end piece (10), is movable parallel to the longitudinal axis (5);
 - E) comprises a first lever (12) that connects the forward end piece (9) to the second connecting element (2), that has a longitudinal axis (16) that extends essentially parallel to the plane (18) and which is attached to the end piece (9) in rotatable fashion, whereby the longitudinal axis (16) can be swiveled in a direction essentially parallel to the plane (18); also
 - F) includes at least one second lever (13) whose longitudinal axis extends essentially parallel to the plane (18) and which is pivotably attached to the first connecting element (1) and to the second connecting element (2) in a manner whereby the longitudinal axis (15) can be swiveled essentially parallel to the plane (18), so that
 - G) a relative movement between the forward end piece (9) and the first connecting element (1) parallel to the longitudinal axis (5) produces a relative movement between the first

and the second connecting element (1, 2) along a line (20) that extends parallel to the plane (18) and essentially in a transverse direction relative to the longitudinal axis (5).

2. System as in claim 1, characterized in that in special cases the term parallel to the plane (18) signifies in the plane (18).
3. System as in claim 1 or 2, characterized in that the line (20) is a straight line (3).
4. System as in one of the claims 1 to 3, characterized in that on the second connecting element (2) a point (X) is defined which during the relative movement between the forward end piece (9) and the first connecting element (1) travels essentially along the straight line (3) that extends essentially parallel to the plane (18).
5. System as in claim 3 or 4, characterized in that the straight line (3) extends in a direction perpendicular to the longitudinal axis (5).
6. System as in one of the claims 1 to 5, characterized in that the longitudinal axes (15, 16) intersect at a crossover point (19).
7. System as in claim 6, characterized in that the levers (12, 13) are connected to each other by means of a swivel joint (14) positioned at the crossover point (19).
8. System as in one of the claims 1 to 7, characterized in that the levers (12, 13) are of essentially the same length.
9. System as in one of the claims 1 to 8, characterized in that the second connecting element (2) can be shifted relative to the first connecting element (1) in an essentially parallel direction.

10. System as in claim 9, characterized in that the second connecting element (2) can be shifted relative to the first connecting element (1) in a direction essentially parallel to the longitudinal axis (5).
11. System as in one of the claims 1 to 10, characterized in that the first lever (12) is pivotably attached to the second connecting element (2) in a manner whereby the longitudinal axis (16) can be rotated in a direction essentially parallel to the plane (18).
12. System as in one of the claims 1 to 11, characterized in that the second connecting element (2) includes a guide (22) and that the rotation of the second lever (13) relative to the second connecting element (2) takes place around the longitudinal axis (28) of a pin (21) that is movably positioned in the guide (22).
13. System as in claim 12, characterized in that, parallel to the longitudinal axis (17), the guide (22) is of a length (A) that allows the pin (21) to move in the guide (22) parallel to the longitudinal axis (17).
14. System as in one of the claims 1 to 8, characterized in that the second connecting element (2) and the first lever (12) are rigidly connected to each other.
15. System as in claim 14, characterized in that the levers (12, 13) form an isosceles triangle.
16. System as in one of the claims 1 to 15, characterized in that
 - A) the longitudinal support (4) is provided with a male thread (23) in an area (B) opposite the forward end piece (9);
 - B) the forward end piece (9) is provided with a female thread (24) matching the male thread (23);
 - C) the longitudinal support (4) is pivotably attached to the first connecting element (1) in a way as to permit its rotation around the longitudinal axis (5); and
 - D) the longitudinal support (4) is attached to the first connecting element (1) in a position that is axially fixed relative to the longitudinal axis (5).

17. System as in one of the claims 1 to 15, characterized in that
- A) the longitudinal support (4) is provided in an area (B) opposite the forward end piece (9) with a first male thread (23);
 - B) the forward end piece (9) is provided with a female thread (24) that matches the male thread (23);
 - C) the longitudinal support (4) is provided with a second male thread (25) in an area (C) at its front end (6) that can be connected to the first connecting element (1); and
 - D) the first connecting element (1) can be connected to the front end (6) of the longitudinal support (4) by means of a female thread (26) that matches the second male thread (25).
18. System as in claim 17, characterized in that the male threads (23, 25) are equidirectional but differ in their pitch.
19. System as in claim 17, characterized in that the male threads (23, 25) are mutually reversed.
20. System as in claim 19, characterized in that the male thread (25) in area (B) is a right-hand thread.
21. System as in claim 19 or 20, characterized in that the male thread (23) in area (B) is a left-hand thread.
22. System as in one of the claims 17 to 21, characterized in that the male thread (23) in area (B) is multi-pitched.
23. System as in one of the claims 17 to 21, characterized in that the male thread (25) in area (C) is multi-pitched.
24. System as in one of the claims 1 to 16, characterized in that the longitudinal support (4) is attached to the first connecting element (1) in an at least axially fixed position relative to the longitudinal axis (5).

25. System as in one of the claims 1 to 16 and 24, characterized in that by means of a lever mechanism (29) the longitudinal support (4) and the sleeve (8) can be shifted parallel to the longitudinal axis (5) and relative to each other.
26. System as in claim 25, characterized in that the lever mechanism (29) is configured in pincer-like fashion with a spring (44) serving to elastically spread the lever mechanism (29) apart.
27. System as in one of the claims 1 to 26, characterized in that the longitudinal support (4) and the first connecting element (1) are provided with bores coaxially with their longitudinal axes (5, 27), permitting the insertion of a screwdriver through these bores.
28. System as in one of the claims 1 to 27, characterized in that the second connecting element (2) is provided with a bore coaxially with its longitudinal axis (17), permitting the insertion of a screwdriver through said bore.
29. System as in one of the claims 1 to 28, characterized in that the connecting elements (1, 2) are equipped with points (30) that can be connected to bone fragments, vertebrae or implant and graft sections.
30. System as in one of the claims 1 to 28, characterized in that the connecting elements (1, 2) are equipped with blades (31) that can be brought in contact with bone fragments, vertebrae or implant and graft sections.
31. System as in one of the claims 1 to 28, characterized in that the connecting elements (1, 2) are equipped with U-shaped plates (32) that can be brought in contact with implants or grafts.
32. System as in one of the claims 1 to 28, characterized in that
 - A) the junctions between the connecting elements (1, 2) and the implants such as bone screws which are solidly connected to the vertebrae or bone fragments, are designed in a form similar to ball-and-socket joints; and
 - B) the ball-and-socket-like junctions can be reversibly locked in an angularly fixed position.

33. A system for distracting or compressing bone fragments comprising: (A) a first connecting element configured to be operably connected to a first bone fragment; (B) a second connecting element configured to be operably connected to a second bone fragment; (C) a longitudinal support having a longitudinal axis and connected to a first handle; wherein the longitudinal support is associated with the first connecting element; wherein the second connecting element is pivotally associated with the longitudinal support; and wherein the movement of the first handle axially along the longitudinal axis translates the second connecting element in a direction substantially transverse to the longitudinal axis.
34. The system of claim 33, further comprising a tubular sleeve encompassing at least a portion of the longitudinal support, the tubular sleeve connected to a second handle.
35. The system of claim 34, wherein the longitudinal support is rotatable within the tubular sleeve.
36. The system of claim 33, wherein the first and second connecting elements include bone screws.
37. The system of claim 33, wherein the first and second connecting elements include U-shaped structures.
38. The system of claim 33, further comprising a second handle connected to the longitudinal support.
39. The system of claim 33, wherein the first and second bone fragments are adjacent vertebrae.
40. The system of claim 33, wherein the first connecting element has a longitudinal axis, and wherein the longitudinal axes of the longitudinal support and the first connecting element are coaxial.
41. The system of claim 33, wherein the second connecting element has a longitudinal axis substantially parallel to the longitudinal axis of the longitudinal support.
42. The system of claim 33, wherein the first and second connecting elements are connected by a lever, and wherein the lever is pivotally associated with both the first and second connecting elements.
43. The system of claim 33, wherein the first connecting element is configured to be rigidly fixed to the longitudinal support.

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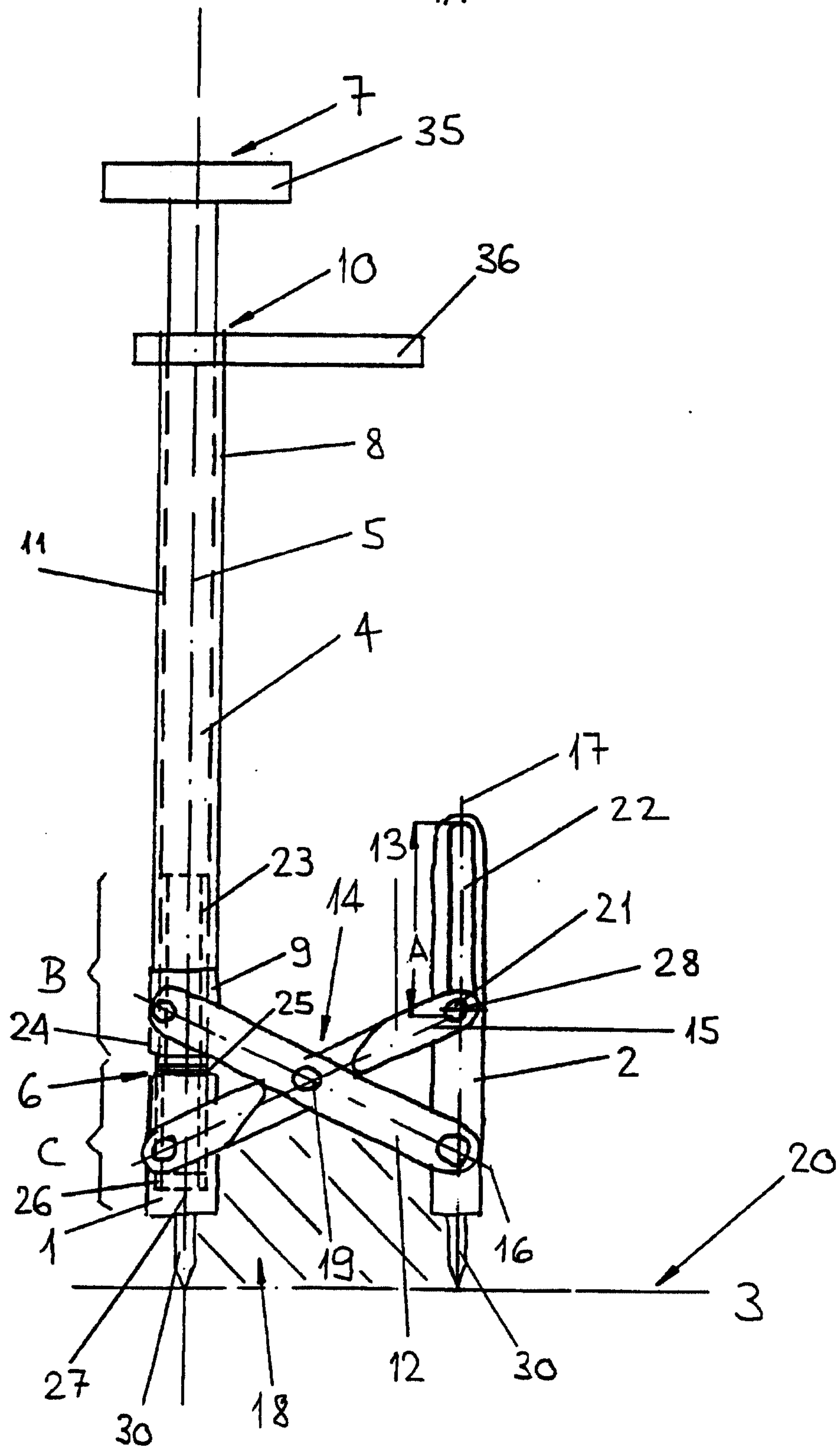
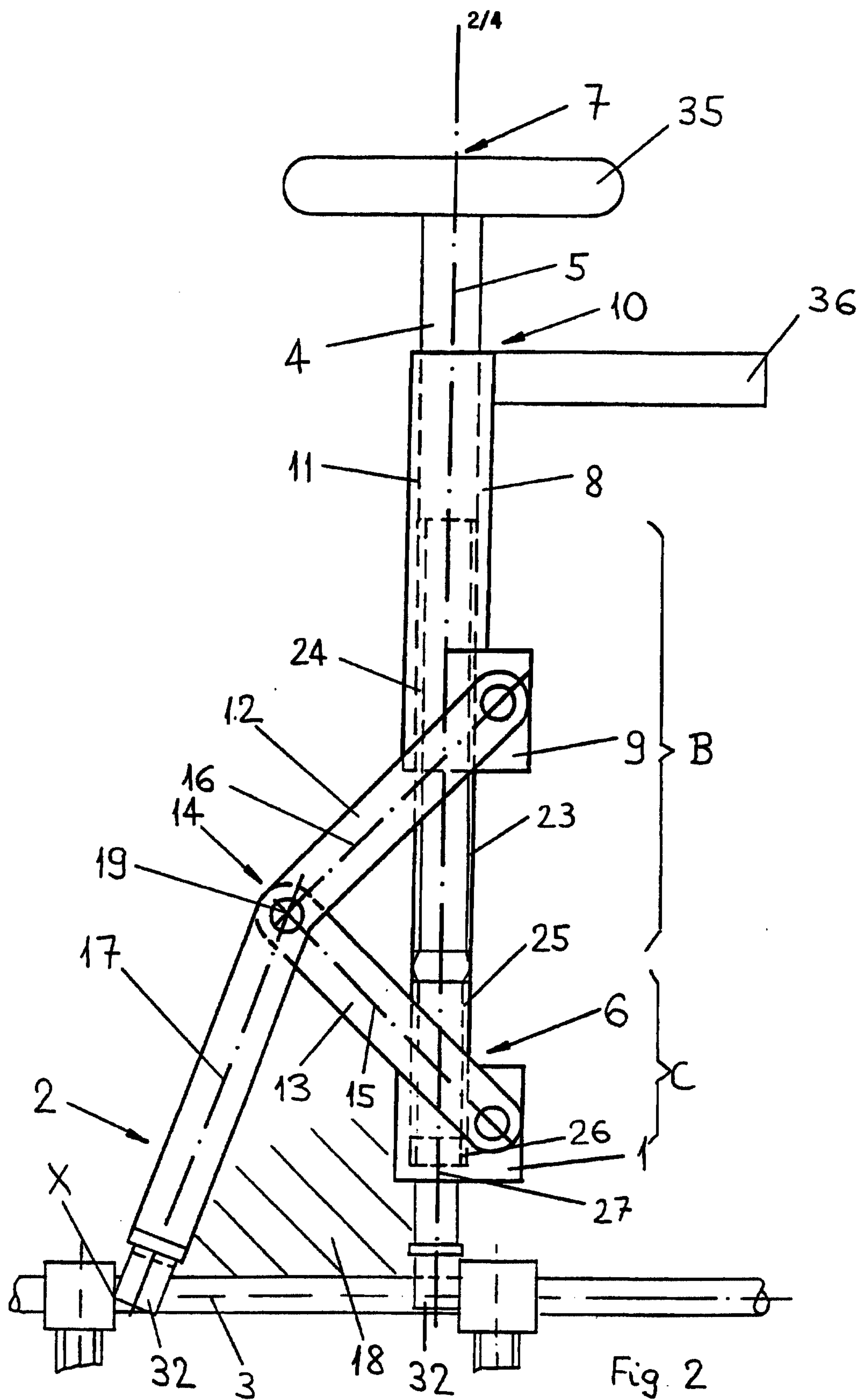


Fig. 1



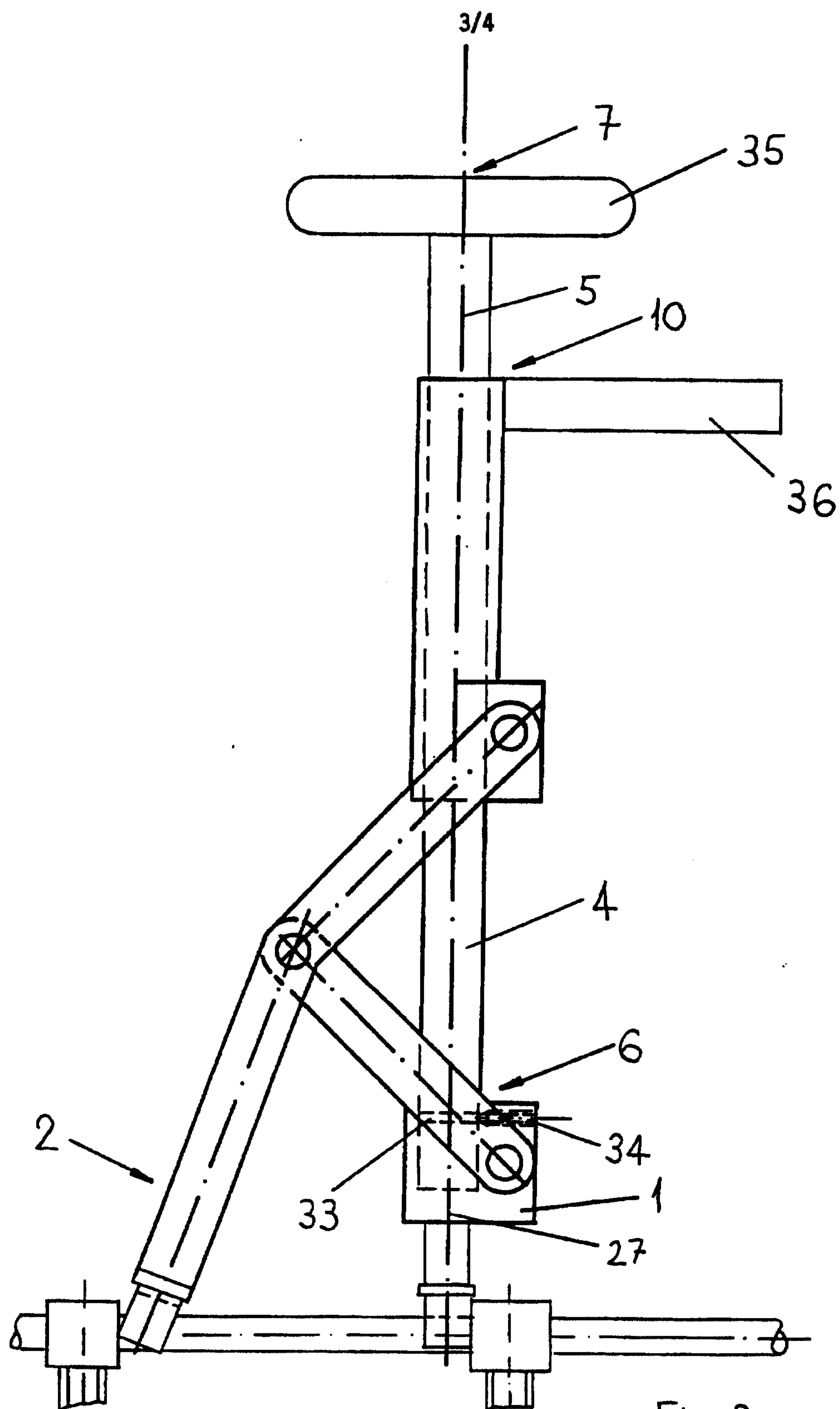


Fig. 3

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