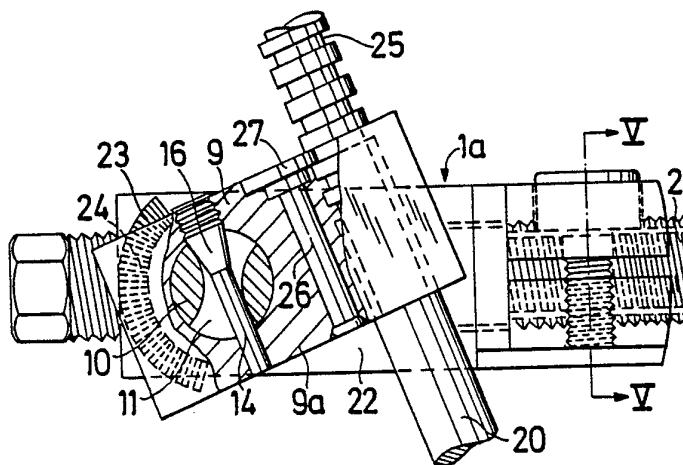


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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**(54) Title:** FIXING INSTRUMENT FOR USE IN SPINAL SURGERY



**(57) Abstract**

A fixing instrument intended to adjust and lock in adjusted position vertebrae in relation to each other includes a unit comprising two support members which are mutually connected by means of a screw spindle extending through said support members such that the support members are moved towards each other upon rotation of the screw spindle in one direction and away from each other upon rotation in the opposite direction. The support members are pivotally connected to securing members which by means of bone screws are intended to be secured each to a vertebra. The pivot stud has a transverse hole through which extends a locking screw threaded into the support member and having a tapered part by means of which it is actively screwed in position by abutment against the wall portion which surrounds the hole in the stud presses the securing member and the support member against each other. Since the bone screw extends through an opening in the support member which is open in the direction facing the support member such that the periphery of the bone screw will be located outside the surface of the securing member a locking of the bone screw is also accomplished when the locking screw is tightened. The bone screw further has a plurality of circumferential grooves and the securing member has a turning bolt provided with a projection which can penetrate into one of said grooves for fixing the bone screw against displacement. All of these lockings thus are carried out from one single position. Instead of the transverse hole (11) the stud may have an annular groove with a tapered limiting surface with which two locking screws may cooperate.

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## FIXING INSTRUMENT FOR USE IN SPINAL SURGERY

The present invention refers to a fixing instrument which is intended to secure two vertebrae in position relative to each other also in cases when one or several vertebrae remain unfixed between said vertebrae.

5 More specifically the invention refers to fixing instruments which include two support members which are so connected to each other by means of a screw spindle that they will move towards each other when the screw spindle is rotated in one direction and away from each other when the screw spindle is rotated in the opposite direction and where each of said  
10 support members is pivoted to a securing member which latter is provided to be secured to a vertebrae at least by means of a screw provided to pass through an opening in said securing member.

In instruments of the kind referred to it is of utmost importance that every adjustment can be secured rapidly and effectively and for such a  
15 purpose special locking or fixing constructions are used.

A serious drawback of the instruments referred to and now on the market is that said constructions are so designed that the surgeon has to work from various directions and also deep in the body of the patient. In order to lock the securing members in place relative to the members bolts  
20 with nuts are used which makes it necessary to operate one wrench at the front side of the instrument and one at the back side thereof. The screw spindle is further threaded in both ends which means that also in this respect the surgeon has to operate two wrenches, one at each end of the instrument. It is self-explanatory that such an operating is time consum-  
25 ing and troublesome and that the encroach in the back of the patient has to be unnecessarily extensive. The constructions known in the art further -in spite of a complicated structure- lack sufficient security and effectiveness, partly upon the fact that they have an unsatisfactory stability as refers to turning.

30 Thus- the primary object of the invention has been to provide a simple

and sturdy instrument of the kind referred to, by means of which a safe and effective fixing is obtained and which is designed so as to make it possible for the surgeon to accomplish the necessary lockings from one single position and in a very simple manner, i.e. by tightening screws or similar fastening elements at the same time offering the advantage of a reduced encroachment in the back of the patient.

To accomplish this and other objectives the invention has the characteristics specified in the claims.

The accompanying drawing illustrates by way of example an embodiment of the invention and a modified locking between the support members and the securing members and more particularly

Fig. 1 shows in perspective from the rear and side some spinal vertebrae with two instruments according to the invention arranged for adjusting displacement of two vertebrae.

Fig. 2 illustrates one of said instruments in a plan view, partly broken.

Fig. 3 shows the instrument as shown in fig. 2 but without securing member in a front view, partly in section.

Fig. 3 shows part of the instrument on a bigger scale in a front view, and partly broken.

Fig. 5 is a section along line V-V in fig. 4,

Fig. 6 is a plan view on a bigger scale of the securing member without screw and

Fig. 7 shows in a plan view a slightly modified instrument according to the invention while

Fig. 8 is a section along line VIII-VIII of fig. 7 and

Fig. 9 finally, shows the instrument according to fig. 7 in an end view.

The instrument as shown in figs 2-6 inclusive comprises two support members 1a, 1b which are mutually connected by means of a screw spindle 2, which as appears from fig. 2 has a threaded portion 3, which engages an internal thread 4 of one of the support members 1b. The screw spindle 2

passes through said internally threaded hole and outside the latter it has a key handle 5. The unthreaded portion 6 of the screw spindle passes through an unthreaded bore 7 in the other support member 1a and also in this case projecting end of the spindle is formed to a key handle 5. The unthreaded portion of the screw spindle is provided with two circumferential grooves 8a, 8b.

In order to make it possible to rotate the spindle but prevent the displacement thereof in relation to the support member 1a the latter comprises a means to be described which is intended to engage the groove.

By this arrangement the support members 1a, 1b will move away from each other when the screw spindle is rotated in one direction and towards each other when the screw spindle is rotated in the opposite direction.

As will appear more clearly from fig. 1 and fig. 4 each support member 1a, 1b is pivotally connected to a securing member 9 which as appears from fig. 2 and fig. 3 consists of a block of a substantially parallelepipedic shape. For this pivotal connection the support member in question has a stud 10 and said studs extend through corresponding holes of the securing member 9 in question. Each stud has a transverse hole 11 which when the support member and the securing member are joined communicates with a through, narrower hole 12 extending from the upper surface of the securing member and which as appears from fig. 3 has an upper portion 13 which is wider and threaded.

A locking member 14, which has an outer threaded portion 15 for engaging the thread 13 of the securing member and a tapered portion 16 as well as a preferably cylindrical narrower portion 17 is threaded according to fig. 3 and it is thus obvious that the locking member by abutment against one of the axial limits of the hole 11 (see fig. 2) limits the displacement of the securing member 9 in relation to the stud 10.

When the locking member 14 only is screwed in to such an extent that the narrower part of the tapered portion thereof contacts the wall of the stud which surrounds the hole the securing member and the support member will be free to move relative to each other in the length direction of

the stud but this movement will successively diminish when the locking member is screwed in.

The more the locking member is screwed in the more the support member and the securing member will approach each other and as will appear from  
5 the following the parts are measured in such a manner that a locking action is accomplished just before the locking member is fully screwed in. As appears from fig. 3 the hole 11 has such a shape in the transverse direction thereof that the support member and the securing member may fulfill a restricted pivotal movement relative to each other as long  
10 as the locking member is not fully tightened. In the securing member 9 there is further provided a through hole 18 extending from the upper side thereof and which as seen in fig. 6 has the centre thereof located at a distance from the surface 19 of the securing member adjacent to the support member which is less than the radius of the hole whereby the hole in  
15 question will be open in direction towards the support member. A so called bone screw 20 the lower end (not shown) of which is threaded and the upper end of which has a plurality of circumferential centimeter indications 21 (see fig. 1) projects through the hole 18.

The bone screws are intended to be screwed into the actual vertebrae and  
20 from the foregoing it is apparent that the securing members 9 can be displaced relative to the bone screws when the surface 19 of the securing members is located at a distance from the corresponding surface 22 of the support member (see fig. 4) which exceeds the difference between the  
25 radius of the bone screw and the distance from the surface 19 to the centre of the hole 18, i.e. the locking member 14 may only be partly screwed in. In this position of the locking member the securing members thus may be freely displaced in relation to the bone screws and the securing member may be pivoted in relation to the support member.

When however the locking member 14 is screwed in such that the tapered  
30 surface 16 thereof will successively act against one of the end surfaces which limit the hole of the stud a locking action takes place which prevents said pivoting movement as well as movement of the bone screw. The first-mentioned effect is increased by a plurality of co-operating ridges and grooves 23,24 in the surfaces of the securing member and the support

member which face each other and the latter effect may be secured by means of the arrangement shown in fig. 4. According to this arrangement the bone screw in the portion thereof which is adjacent to respectively extends into the the securing member has a plurality of circumferential  
5 grooves 25 located at certain axial distances from each other and to the upper side of the securing member and preferably countersunk into the latter there is pivotally mounted and axially secured a bolt 26 having a circular head 27 the thickness of which being substantially equal to the width of the grooves and having in the periphery thereof a recess 28 which  
10 in a first angular position of the bolt by communication with the hole 18 for the bone screw allows the latter to be freely displaced but in a second angular position when the non-recessed portion of the bolt head is in registry with the hole for the bone-screw prevents such a displacement. The bolt has just like the locking member 14 an internal key handle  
15 29. It is obvious that by these arrangements it is possible to fix the angular position of the support member relative to the securing member as well as to fix the bone screw in the actual position from one direction and by using simple tools for instance so called ~~insex~~ wrenches.

In order to be able to fix in the same simple manner also the position  
20 of the support members relative to each other each support member 1a, 1b has a clamping device provided to act against the screw spindle. The support member 1b which has the internal thread 4 has for this purpose a slotted portion 30 to form two resilient portions 31 and 32 which are located one above the other one and which in a manner known per se can be  
25 forced towards each other by means of a clamp bolt 33. The other support member has a similar slotted portion but the distance between the centre of the bore 7 for the screw spindle and the centre of the clamp bolt 34 is so measured that a preferably not threaded portion of the clamp bolt 34 will protrude into the groove 8b or 8a which means that said clamp  
30 bolt will fulfill a double function, i.e. as a locking means to prevent rotation of the screw spindle relative to the support member 1a and as a means to prevent the displacement of the screw spindle relative to the support member in question. Owing to the fact that the screw spindle has two grooves 8a, 8b it may be selectively used for left or right hand connection.  
35

In order to further lock an adjustment of the screw spindle the latter may according to fig. 2 be provided with a number of longitudinal grooves 35 located at a certain angular distance, for instance 90°, from each other and the head 36 of the clamp bolt 33 in question then is free to engage one of said grooves as seen in fig. 5 to obtain said locking action.

Finally it may be appropriate to lock the actual securing member against rotation relative to the bone screw 20 in question and for that purpose each securing member 9 has a through hole 37, extending from the upper side thereof and through this hole a pin, a screw or the like can be driven into the actual vertebrae.

As appears from fig. 1 the instrument usually consists of two separate units each comprising two support members mutually connected by means of a screw spindle and securing members and bone screws connected thereto and fixing can thus be accomplished between two vertebrae with intermediate vertebrae or vertebrae and all operations may be effected from one position and without operating too deep in the body of the patient.

The instrument now described is operated in the following manner:

The bone screws 20 are first screwed into the vertebrae which are to be connected. The support member and the securing member connected thereto is then by means of the screw spindle 2 moved to such a position that the instrument can be slid onto the already located bone screws. The locking members 14 are then loosened to such extent that the bone screws may be introduced through the openings 18 and the bolt 26 is in such an angular position that the recess 28 thereof coincides with the hole 18 and in this position the support members may be swung in relation to the securing members. The bolts 26 having the heads 27 are then turned such that said heads engage one of the grooves 25. A first axial locking then occurs between the actual bone screw and the securing means in question. This locking however does not prevent a further tightening of the bone screws which is a very important feature of the new instrument. After such a tightening the vertebrae may be moved by operating the bone screws.

When the intended adjustment of the vertebrae has taken place the position is fixed by tightening the locking members 14. The securing member is then pressed against the support member and a locking of the bone screws then occurs and simultaneously the securing member is fixed against pivoting in relation to the support member. To prevent a turning movement of the securing member relative to the bone screw the former preferably has a hole 37 through which an anchoring means such as a pin or a screw provided to engage the vertebrae can be introduced. When the screw spindle 2 has been fixed against turning by tightening the clamp bolts 33 and 34 and this locking probably has been locked in that the heads 36 of the clamp bolts 33 have been brought to engage any of the grooves 35 the intended locking has been carried out. In a manner known per se the dispensable upper portion of the bone screws may be removed by cutting by means of a suitable tool. As appears from fig. 2 two instrument units are generally used and it is of course possible to adjust and fix said units relative to each other by means of connection means not shown.

In the modified instrument shown in figures 7-9 inclusive the support members 1a,1b are secured relative to each other by means of a locking screw 40 acting against the screw spindle (see fig.8) and in order to lock the support members to the securing members and at the same time also lock the bone screws 20 the arrangement illustrated in figures 7 and 8 is used. In contradistinction to the embodiment just described the stud which allows the pivoting of the support member relative to the securing member has no transverse opening but the pivot stud 41 instead has an annular groove 42 with a conical surface 43 against which the conical portions 16 of two locking members 14 of the kind described act. It is evident that a tightening of said locking members brings forth the same double-effect as just described, i.e. that the support members and the securing members are locked in their actual angular position relative to each other and that the securing members during said tightening are displaced a little bit towards the support members which brings forth a locking of the bone screws 20 in their set positions. Also in this case the bone screws preferably have a number of axially spaced grooves for cooperation with a bolt 26 with a head 27 to accomplish a first securing against displacement and it is also clear that it also in this case is

possible to tighten the bone-screws as long as the locking members 14 are not fully tightened. In order to increase the action of the locking members 14 the groove 42 in the pivot stud in question preferably has such a depth (see fig. 8) that the conical portions of the locking members 14 will act against the conical surface 43 of the groove as well as against the bottom 44 thereof.

## CLAIMS

1. Fixing instrument for use in spinal surgery and including two support members (1a,1b) being connected to each other by means of a screw spindle (2) so as to be moved towards each other upon turning said screw spindle in one direction and away from each other upon turning said screw spindle in the opposite direction, each of said support members (1a,1b) being pivotally connected to a securing member (9) intended to be secured to a vertebra by means of a bone screw (20) provided to extend through said securing member, c h a r a c t e r i z e d in that each support member (1a,1b) by means of a pivot shaft (10,41) is pivotally connected to a corresponding securing member (9) in such a manner that said members in addition to a pivotal movement can fulfill a minor displacement movement relative to each other, that said pivot shaft (10,41) has an abutment surface for instance in the shape of a wall portion limiting a recess (11, 42) and that at least one locking member in the shape of a locking screw (14) the length axis of which being substantially perpendicular to said pivot shaft (10,41) is threaded into said support or securing member in such a manner that a preferably tapered surface (16) thereof during the turning of the locking screw in one direction will in cooperation with said abutment surface of the pivot shaft bring forth a displacement of the support member and the securing member relative to each other and that the bone screws extend through the securing members in such a manner that they will be clamped between the support members and the securing members such that an operation of said locking screw or said locking screws in a locking direction will bring forth a locking of the support member to the securing member and at the same time a locking of the bone screws to the support members and the securing members.

2. Fixing instrument as claimed in claim 1, c h a r a c t e r i z e d in that each bone screw (20) extends through an opening in the securing member (9) and that the latter has the centre thereof located at a dis-

tance from that surface (19) of the securing member which faces the support member which is less than the radius of the opening in question such that the opening will be open in direction towards the support member causing the bone screw to project outside the securing member and be  
5 clamped between the securing member (9) and the actual support member (1a,1b) when they are pressed against each other during the fixing operation.

3. Fixing instrument as claimed in claim 1, characterized  
10 in that each bone screw (20) in that portion thereof which is intended to face respectively extend into the securing member (9) is provided with a plurality of axially equidistant circumferential grooves (25) and that the securing member is provided with a projection (27) which is rotatable about an axis which preferably is parallel to the opening for the bone screw and which has a thickness that is substantially equal to the width  
15 of the grooves and which in a first angular position is located outside the periphery of the actual bone screw but in a second angular position engages one of said grooves thus locking the bone screw against displacement relative to the securing member.

4. Fixing instrument as claimed in claim 1, characterized  
20 in that the pivot shaft (10) is axially fixed in relation to the support member (1a,1b) or the securing member (9) and has a through transverse opening (11) through which extends a locking member (14) which also extends through an opening in one of said members, that the locking member (14) has a thread (15) for cooperation with a corresponding thread in  
25 said opening and has a tapered portion (16) which when the locking means is screwed in successively comes into contact with one of the walls which axially limit the transverse opening (11) in the pivot shaft (10) and moves the support member and the securing member towards each other such that they eventually will be locked to each other and that further said  
30 opening has such an extension in the transverse direction thereof that the support member and the securing member prior to the locking may fulfill a limited pivotal movement relative to each other.

5. Fixing instrument as claimed in claim 1, characterized  
in that the pivot shaft (41) has a recess (42) which at least in one

direction is limited by a tapered surface (43) and that the locking members (14) are so designed and arranged that they when turned in one direction will have a preferably tapered surface (16) thereof in such an engagement with said tapered surface (43) of the pivot shaft that the support and securing members (1a,1b,9) as a consequence thereof will be displaced towards each other so as to lock them against turning.

5  
6. Fixing instrument as claimed in claims 1-5, characterized in that the screw spindle (2) extends through one of the support members (1a) with a smooth portion (6) and thus is able to rotate relative to  
10 said support member but not be displaced relative thereto whereas it is threaded through the other support member (1b) and that further the screw spindle in the threaded part thereof which extends through said support member has a number of grooves (35) extending in the length direction of the spindle and that a clamp bolt (33) acting upon said support member is  
15 provided to have the head (35) thereof engaging one of said grooves to lock the screw spindle against rotation.

7. Fixing instrument as claimed in claim 6, characterized in that the clamp bolt (34) which is intended to act upon that support member (1a) which receives the unthreaded part of the screw spindle (2)  
20 in order to lock the screw spindle against rotation has the centre thereof situated so close to the centre of the opening in the support member through which the screw spindle extends that it engages a circumferential groove (8a respectively 8b) provided in the unthreaded portion of the screw spindle to lock the screw spindle against displacement relative to  
25 the support member.

8. Fixing instrument as claimed in claim 1, characterized in that the support member (1a,1b) and the securing member (9) in the surfaces thereof which face each other are provided with cooperating ridges and grooves (23,24) being radially oriented with the axis (10) for the  
30 pivotal connection between said members as centre and preferably located at that side of the axis in question which is remote to the side where the actual bone screw (20) extends through the support member in question.

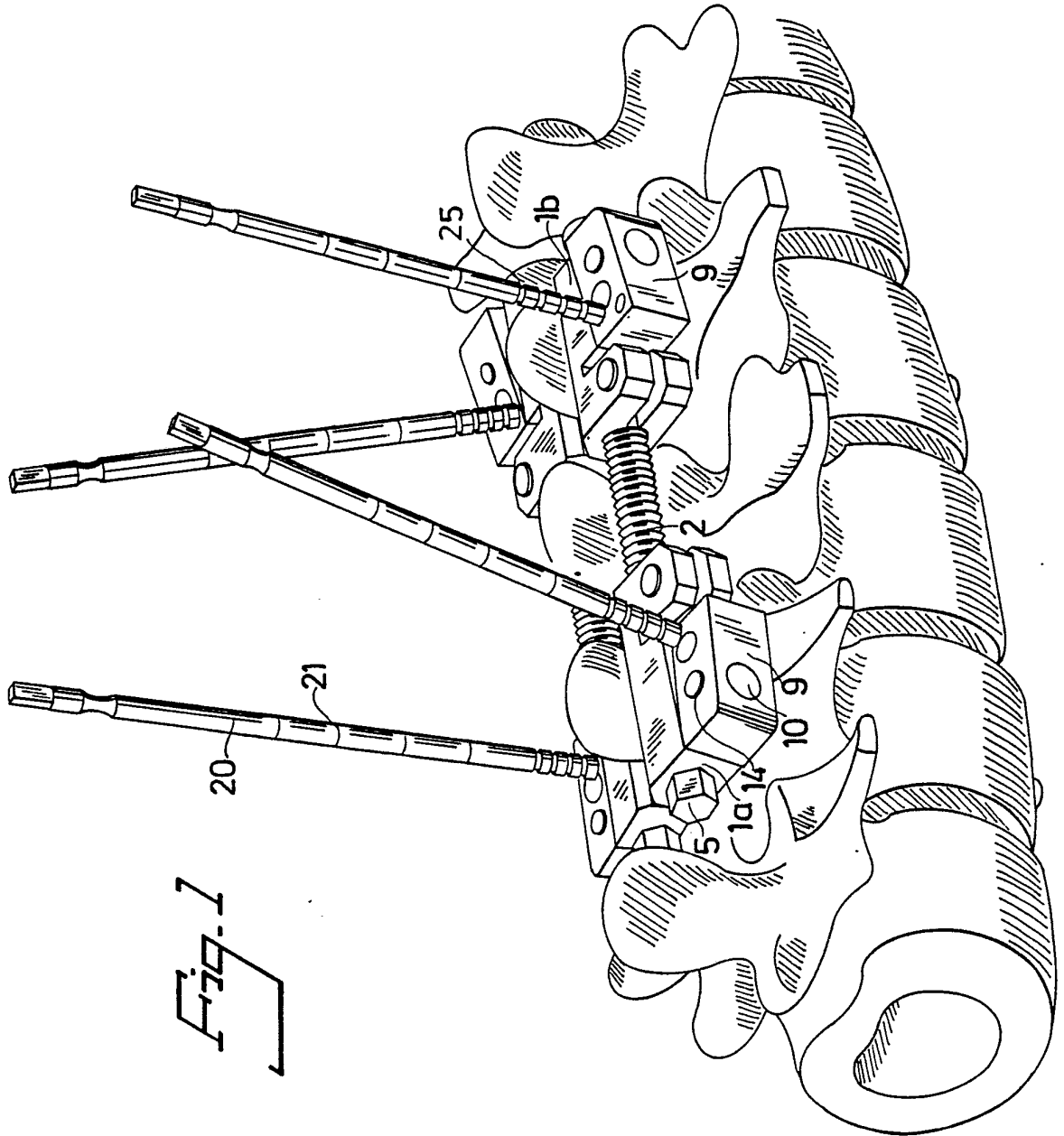


Fig. 1

Fig. 2

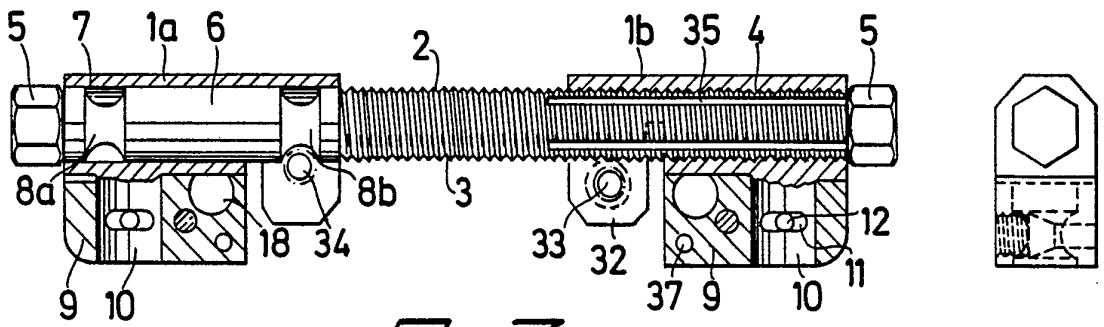


Fig. 3

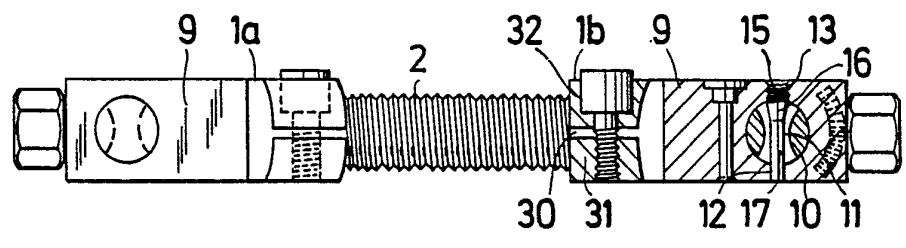


Fig. 4

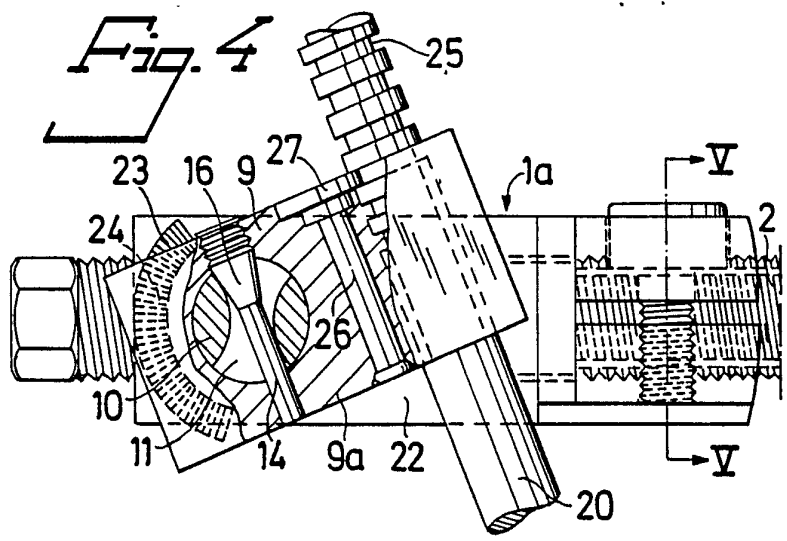


Fig. 5

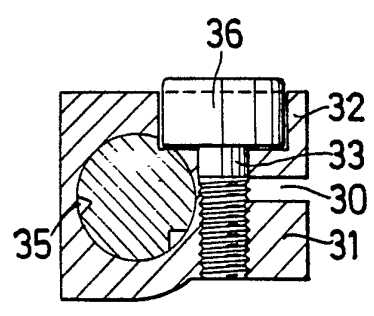
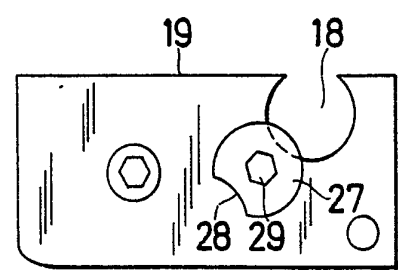
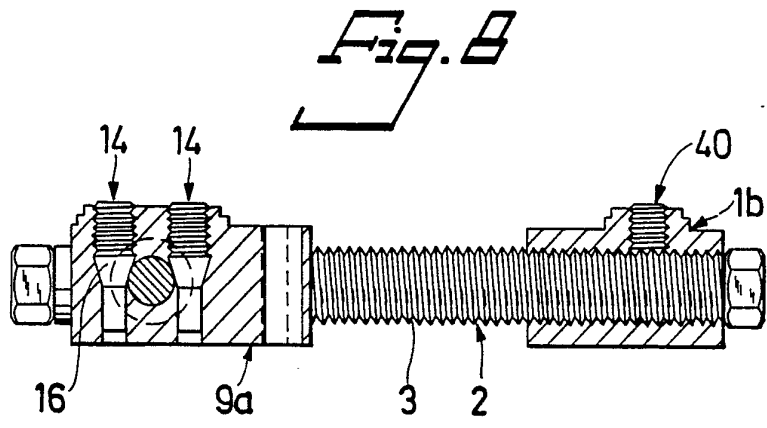
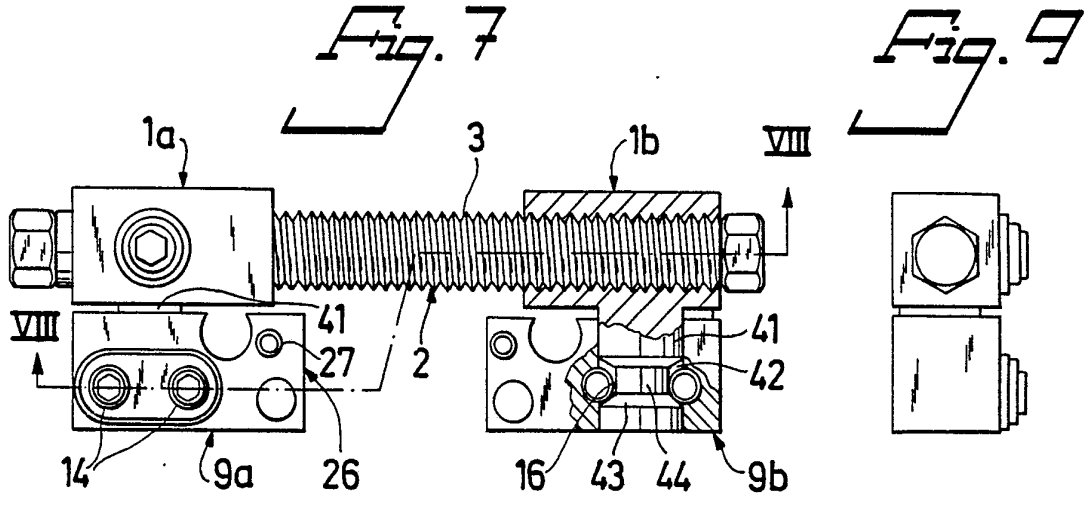


Fig. 6




3.



# INTERNATIONAL SEARCH REPORT

PCT/SE86/00365

International Application No

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC <sup>4</sup>		
A 61 B 17/56, A 61 B 17/60		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
<b>Classification System</b>	<b>Classification Symbols</b>	
IPC 4	A 61 B 17/56-/60; A 61 F 5/00, /01, /04	
IPC 3	A 61 B 17/18	
US Cl	128:92, 87, 83, 84, 69, 71, 72, 75	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
SE, NO, DK, FI classes as above		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b>		
<b>Category <sup>9</sup></b>	<b>Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup></b>	<b>Relevant to Claim No. <sup>13</sup></b>
A	DE, C, 3 132 520 (GEBR. SULZER AG) 16 June 1982	
A	US, A, 2 251 209 (STADER) 29 July 1941	
A	US, A, 4 488 542 (HELLAND) 18 December 1984	
A	US, A, 4 299 212 (GONDFROOY) 10 November 1981	
A	US, A, 2 391 693 (ETTINGER) 25 December 1945	
A	US, A, 4 475 546 (PATTON) 9 October 1984	
<p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"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.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1986-10-27	1986 -10- 29	
International Searching Authority	Signature of Authorized Officer	
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