United States Patent [19]

Lode et al.

[11] **3,915,160**

[45] **Oct. 28, 1975**

[54] **APPARATUS FOR EXERTING FORCES AND/OR TORQUES ON THE HUMAN SPINE**

[75] Inventors: **Freerk Lode**, Groningen; **Christiaan J. Snijders**, Nuenen; **Jan Gerardus Nicolaas Snijder**, Geldrop; **Antonius Wilhelmus M. Schijvens**, Hilvarenbeek; **Jan Mathijs Seroo**, Maarheeze; **Freerk Lode**, Groningen, all of Netherlands

[73] Assignee: **Lode Instrumenten B. V.**, Groningen, Netherlands

[22] Filed: **May 28, 1974**

[21] Appl. No.: **473,554**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 351,986, April 17, 1973, abandoned.

[52] **U.S. Cl.** **128/69**

[51] **Int. Cl.** **A61f 5/00**

[58] **Field of Search** ..... 128/69, 83, 92 E, 92 EA

[56] **References Cited**

UNITED STATES PATENTS

1,424,884 8/1922 Deane 128/69

OTHER PUBLICATIONS

Carrell, JAMA 2-28-31 p. 673 FIG. 12.

Levinthal, Journal of Bone & Joint Surgery, Vol. 13, 1931 p. 378 FIG. 1(*a*).

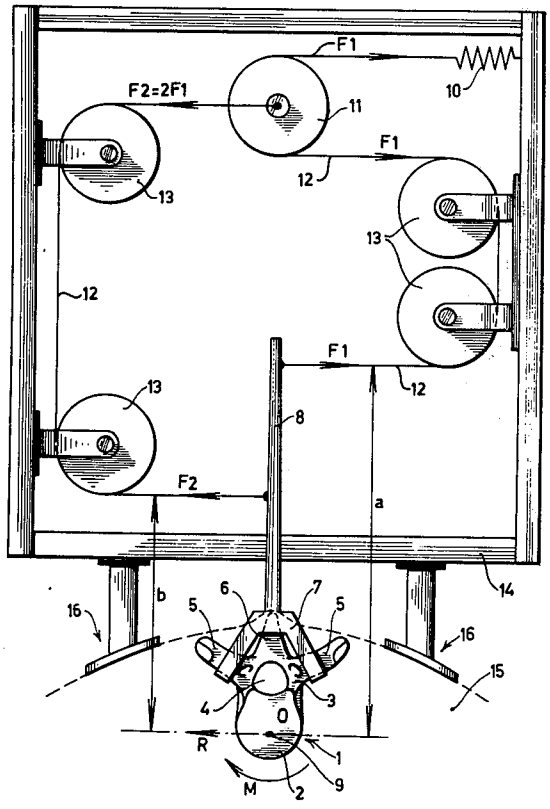
Primary Examiner—Lawrence W. Trapp

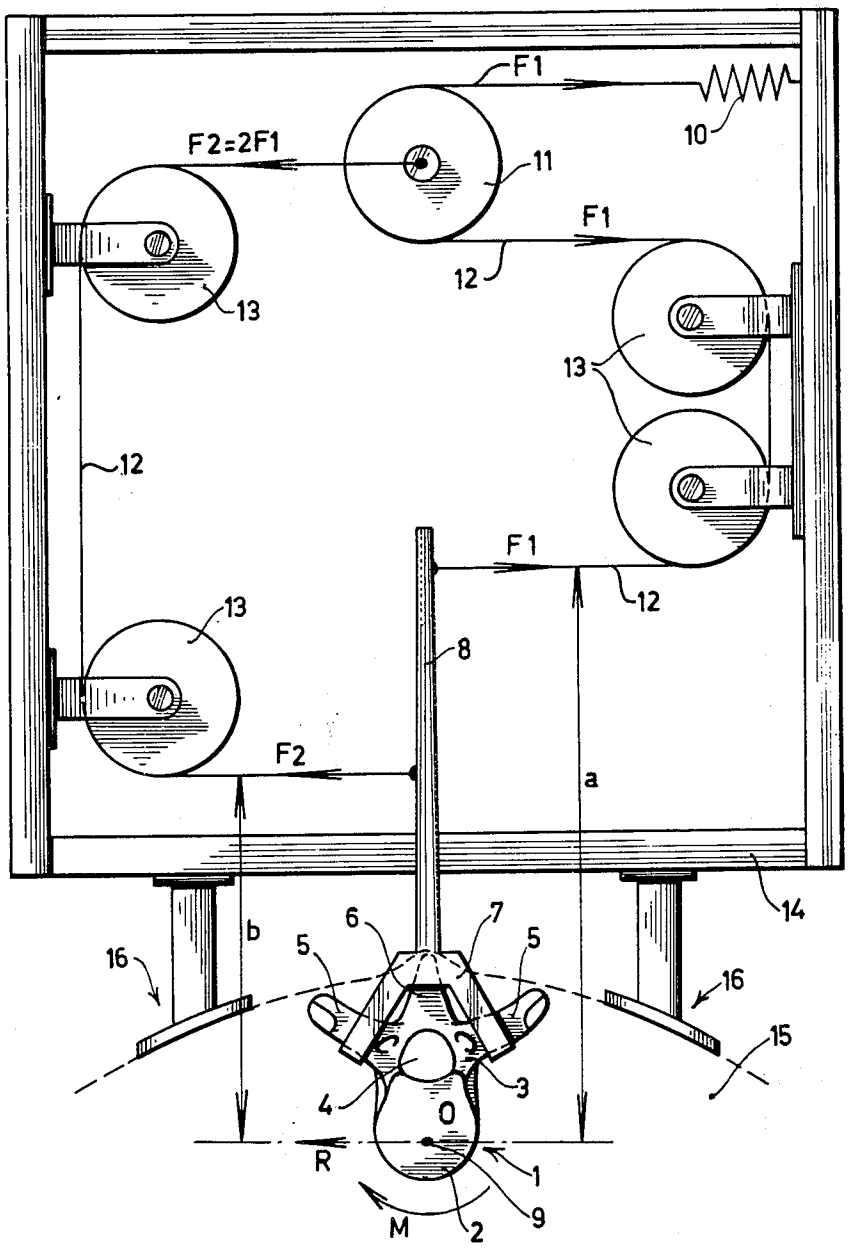
Attorney, Agent, or Firm—Wigman & Cohen

[57] **ABSTRACT**

Apparatus consisting of a fastener or clamp, adapted to be mounted on a vertebra of a spine, said fastener comprising a rod extending mainly perpendicular to the spine, means being provided for exerting a force at one or at two different locations on said rod for creating a resultant force or a torque upon said vertebra.

10 Claims, 10 Drawing Figures




F1
10
F2=2F1
11
F1
12
13
13
12
F1
12
13
8
F2
a
14
b
6
7
5
5
16
16
15
4
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O
R
1
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M
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Fig. 1.

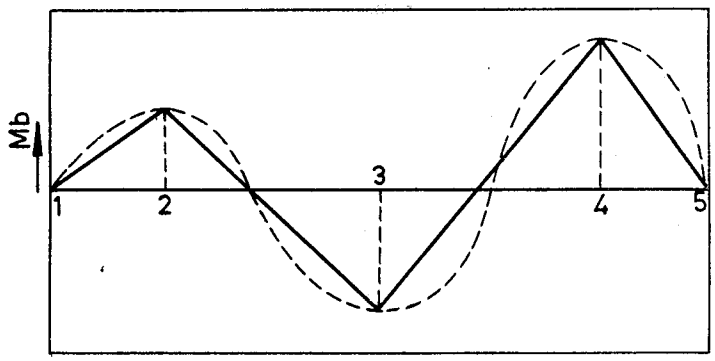

Fig: 2.

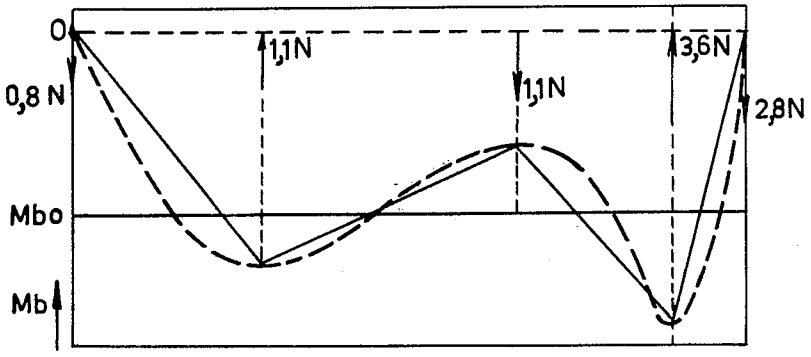

Fig: 3.

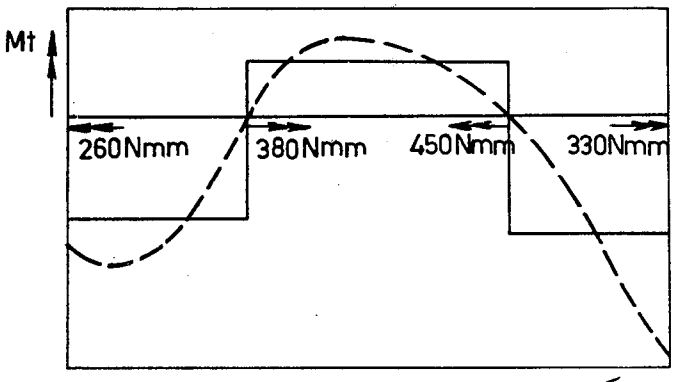

Fig: 4.

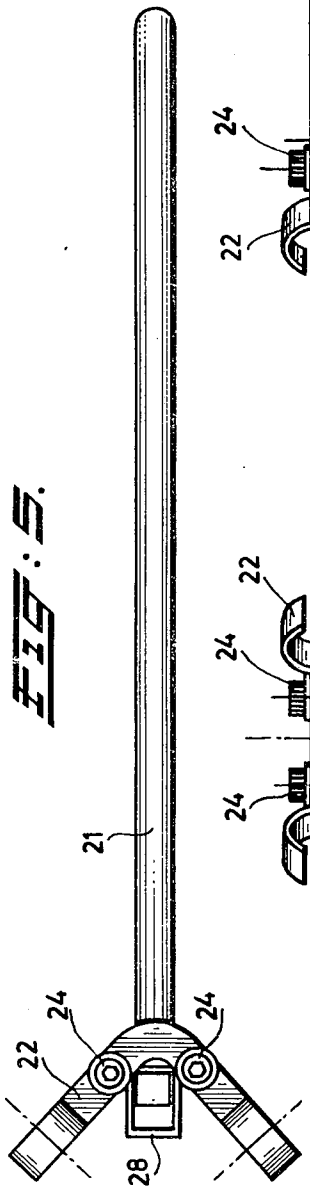

FIG. 5.

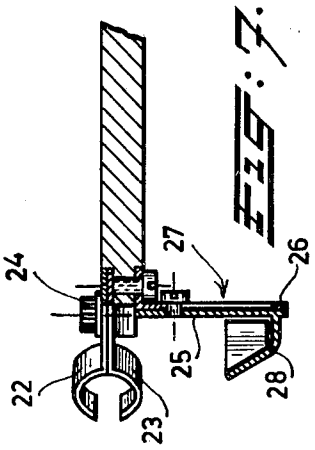

FIG. 7.

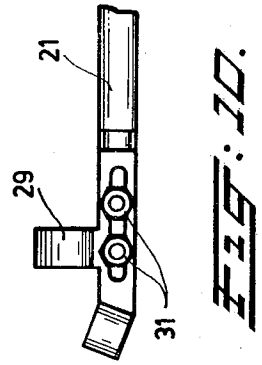

FIG. 10.

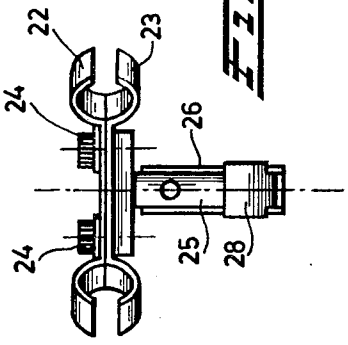

FIG. 6.

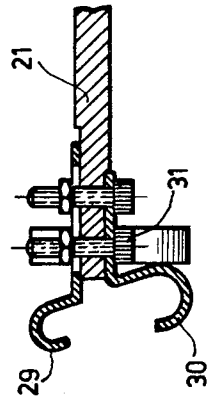

FIG. 9.

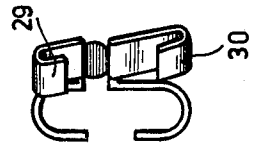

FIG. 8.

APPARATUS FOR EXERTING FORCES AND/OR TORQUES ON THE HUMAN SPINE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of abandoned copending application Ser. No. 351,986, filed Apr. 17, 1973.

INTRODUCTION TO THE SUBJECT MATTER

The human spine consists of hard and soft parts constituting a unit in mechanical respect. The hard parts or vertebrae are provided with projections, the shape and dimensions of which are depending on the spine's location. The soft parts consist of the intervertebral discs which on the one hand firmly interconnect the adjacent vertebrae and on the other hand allow a considerable mobility in between the vertebrae.

The mobility of two adjacent vertebrae with respect to each other can be subdivided into the following two movements:

1. a change of position in a plane through the centre line of the vertebrae, i.e., a forward, backward or lateral flexion;
2. a change of position consisting of a rotation around the centre line of the vertebrae, i.e., an axial rotation.

Although the two movements mentioned hereinbefore can appear independent of one the other, it is of importance to mention that a lateral flexion is normally attended with an axial rotation.

Position faults of the vertebrae occur regularly. Some examples thereof are:

a. Vertebrae shifting (Spondyclisthesis) which may be attended with an axial rotation;
b. too strong a curve of the thoracic backbone (Schauermann) in the sagittal plane;
c. a lateral curvature of the spine (Scoliosis).

DISCUSSION OF THE PRIOR ART

A number of systems are known in the medical field aiming to correct the abovementioned imperfections, only two of these methods being mentioned here viz. the method of HARRINGTON and the method according to GRUCA. These methods are based on the provision of a power device, completely situated under the patient's skin. There are also other systems, like a plaster redress and the MILWAUKEE corset. All those known systems have the drawback of a poor correction, the forces exerted being too great on the one hand and not capable of bringing the spine into the correct position on the other hand. This is due to the fact that in all the prior art systems a force is exterted in the longitudinal direction of the spine. Principally this force is unfit for adequately stretching the spine. The treatments in question are time-consuming and are experiences by the patient as being unpleasant.

SUMMARY OF THE INVENTION

My invention aims to provide an apparatus for exerting forces and/or torques on the human spine such that these forces are exactly applied to the correct location, act in the correct direction and therefore can be limited to a minimal value. The invention is based on the book "On the form of the Human Thoracolumbar Spine and some Aspects of its mechanical Behaviour" by Dr. Ir. C. J. SNIJDERS, in which the fundamentals are laid for the analysis of the mechanical conduct of the spine.

This publication allows to calculate with a proper approximation the (optimal) forces and torques which should be applied to correct a fault position of the vertebrae.

My invention particularly seems to provide apparatus enabling to exert for a rather long time, forces and torques in the correct direction and of the correct value through the skin, directly on one or more vertebrae. The apparatus thereto comprises:

— a frame adapted to bear on the body,
— at least one power source disposed in this frame, and
— means by which on at least one vertebrae a force is exerted transverse to the longitudinal centre line of the spine.

Due to these features it is possible to modify, externally or outside the body during the correction process, the value and the direction of the forces exerted on the vertebra, and to adapt them to the progress of the position correction. The patient is also able to walk during the correction process which is advantageous not only in physical respect, but also physiologically, because the tissues and members can reorganize during the slowly proceeding correction process. It is even possible to obtain correction of Spondylolisthesis by means of a force directly applied to a vertebra.

My invention particularly provides apparatus which is distinguished in that the means for exerting a force consists of at least a rod-shaped fastener which can be connected with a vertebrae, while means can be applied to that member for simultaneously exerting various forces. Each fastener lends itself for exerting two forces which are applied at different locations, for generating in that manner the transverse force and/or the torque required for the position correction aimed at.

Preferably the apparatus is constructed in such a way that the means for exerting forces on each fastener are connected with the forces via a balancing mechanism. This bears upon the safety of the apparatus, for, if one of the forces fails (e.g. owing to a fracture in the transmission device such as a rope), a sudden change in the condition of load might occur, which could damage the spinal marrow.

In structural respect it is desirable when the means for exerting forces on each fastener, allow a stepwise increase of the various forces such, that each of the forces is equal to one time or a number of times, the smallest force. Consequently a pulley can be applied as a balancing mechanism and each group of forces or all groups of forces together can be generated by means of a single power source. Since in this manner the forces are one time or a whole number of times the smallest force. Consequently a pulley can be applied as a balancing mechanism and each group of forces or all groups of forces together can be generated by means of a single power source. Since in this manner the forces are one time or a whole number of times the smallest force, it is possible in case of SCOLIOSIS' correction to achieve in a smiple way that the resultant of all transverse forces exerted on the spine, is naught. The resultant of the forces exerted on the frame is then likewise naught, so that the frame is in balance with respect to the body, whereby the frame is prevented from shifting with respect to the body. One also avoids that sore spots form on the skin. This measure could be used too for torsional torques.

SURVEY OF THE DRAWINGS

FIG. 1 shows schematically a vertebra and a fastener in combination with a frame including a balancing mechanism;

FIGS. 2–4 give three pictures of the various torques which may be produced.

FIGS. 5–7 show three views of a thoracic fastener.

FIGS. 8–10 show three views of a lumbal fastener.

DESCRIPTION OF A PREFERRED EMBODIMENT:

FIG. 1 shows a theracic vertebrae 1 consisting of the body 2 with the arch 3, leaving a space 4 for the spinal marrow. There are furthermore two laterally directed projections 5 (processus transversi) and one backwardly directed projection 6 (processus spinosus). A fastener or clamp 7 is applied to the projections 5 and 6, the clamp being provided with a rod 8 extending perpendicularly to the vertebra 1. FIG. 1 relates to the condition in which a transverse force R and a torque M should be exerted on the vertebra 1. This is achieved by arranging that two forces are applied to the rod 8, to wit the force F_1 at a distance a from the centre line (or the axis of axial rotation) 9 of the vertebrae and a force F_2, acting in the opposite direction, at a distance b from the centre line 9.

It is evident that the following equations are valid:

$R = F_2 - F_1$

$M = F_1a - F_2b$

By correctly determining the value of the two forces, and of the distances a and b either the resulting transverse force or the torque M can be reduced to naught, so that then only one torque or a transverse force in frontal direction, remains.

It should be noted that the shape of the fastener or clamp 7 can be adapted to the shape of the vertebrae concerned. Thus one can possible apply besides the thoracic clamp as shown in FIG 1, a lumbar clamp which is applied about the arch 3 and the projections 5 and 6. The apparatus according to my invention is suitable for generating transverse forces both in the plane through the back of the patient and perpendicular thereto. The same applies to the generation of torques the axis of rotation of which is perpendicular to the centre line of the spine and which can lie in the plane of the back or extend perpendicular thereto.

The apparatus also is schematically shown in FIG. 1. The frame 14 shown as being perpendicular to the human body 15, is in the preferred embodiment parallel to the back of the body.

The frame 14 of the apparatus which may have a rectangular shape, is secured to the patient by means of e.g. the MILWAUKEE-corset 16 (very schematically shown in FIG. 1). As shown in FIG. 1 one or more power sources 10 are disposed in the apparatus as well as one or more balancing mechanisms embodied as one or a number of wheels 11 (not fixed to the frame 14) working as pulleys. Preferably the power source consists of a spring or a tension spring. The forces (F_1,F_2) are transmitted to the rod 8 of the fasteners 7 by means of wires 12 and wheels 13, which wheels 13 are supported by the frame 14. The fastener (shown in a thoracic fastener 7) is fixed operative to the protuberance (processus transversi processus spinosus) 5 of the vertebra 1 under the skin of a human body 15. The fastener 7 is not fixed to the frame 14, the mentioned advantage of safety of the apparatus appears.

If one of the forces fails (e.g. owing to a fracture of one of the wires 12) also the other force will no longer act on the fastener and there is no risk of damage of the spinal marrow.

FIG. 2 shows how a particular bending torque curve (bending torque Mb where M stands for torque or moment and b stands for bending) is approximated in which case no transverse force need to be exerted on the vertebrae.

FIG. 3 represents a more complicated situation in which the bending torque curve does not begin and end with a naught value (constant bending torque Mbo where M stands for moment or torque, b stands for bending, and o stands for constant). The generation of a torsional torque (M_t, where M stands for moment or torque and t stands for torsional) is represented in FIG. 4 in which the dotted line represents the value to be strived after and the full line the torque which can be applied by means of the apparatus according to the invention. The latter figure illustrates that the resulting torque is naught since 380 Nmm + 330 Nmm is equal to 260 Nmm + 450 Nmm, where N_{mm} stands for Newtonmeter $\times 10^{-3}$.

In the FIGS. 5, 6 and 7 a rod 21 and fixing plates 22, 23 joined together by means of bolts 24 are shown. By means of an other bolt a movable part 25 can be fixed to a plate 26, in which an oblong hole 27 is made. On the bottem of the movable part 25 a bowl-shaped part can be pushed around the processus spinosus. In the FIGS. 8, 9 and 10 also a rod 21 is joined with two fixing plates 29, 30. The said plates partly curved, can hook around the arch of a vertebra and the processus spinosus and can be fixed by means of bolts 31 to a vertebra as well as to the rod 21.

This fastener can by a surgeon very easily be introduced under the skin of a human body and fixed to a vertebra.

What I claim is:

1. Apparatus for exerting forces and/or torques on the human spine, comprising a frame adapted to be carried on the body of an individual and to bear externally thereon, at least one power source carried in said frame, and means operatively connected to said power source and extending into the body of the individual, said means being adapted to be connected to at least one vertabra for exerting a force thereon transverse to the longitudinal center line of the spine.

2. Apparatus according to claim 1, in which the means for exerting a force consist of at least one rod-shaped fastener which can be connected with a vertabra, while means can be applied to this member for simultaneously exerting various forces.

3. Apparatus according to claim 2, the means for exerting the forces on each fastener being connected via a balancing mechanism with the power source.

4. Apparatus according to claim 3, in which the balancing mechanism consists of some wheels and of chains or wires which run over the said wheels and are connected to the power source.

5. Apparatus according to claim 2 in which the means for exerting forces on each fastener allow a stepwise increase of the various forces in such a manner that each of the forces is equal to one time, or a number of times the smallest force.

6. Apparatus according to claim 5, in which on at least one of the fasteners two dissimilar forces are exerted acting in apposite directions and applied in

spaced relationship from each other, whereby in the concerned vertabra both a transverse force and a torque is generated.

7. Apparatus according to claim **2** in which each fastener consits of a rod with on one end fixing means which can be fixed to a vertabra such that the rod being perpendicular to the spine.

8. Apparatus according to claim **7,** in which the fixing means which can be fixed partly around the laterally directed projections (processus transversi) by means of bolts and partly to the downwardly directed projection (processus spinoses) by means of a bowl-shaped part of the fixing means and bolts (thoracal fastener).

9. Apparatus according to claim **3** in which the balancing mechanism consists of some wheels and of chains or wires which runs over the said wheels and said wires are connected to one or more pulleys which pulleys are in connection with the powr source.

10. Apparatus according to claim **7,** in which the fixing means consists of curved parts which hook around the arch of a vertabra and around the downwardly directed projection (processus spinosus) of the said vertabra and the rod and fixing means are joined together by means of a bolt (lumbar fastener).

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,915,160 Dated October 28, 1975

Inventor(s) FREERK LODE ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading of the patent, delete "Freerk Lode, Groningen", second occurrence;

Column 2, line 60, change "smiple" to --simple--;

Column 3, line 37, change "possible" to --possibly--;

Claim 9, line 5, change "powr" to --power--.

Signed and Sealed this

seventeenth Day of *February 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks