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(72) Inventors:  
• **JOSIPOVIC, PETRA**  
**52100 PULA (HR)**  
• **SIRONIC, FILIP**  
**52100 PULA (HR)**  
• **NIKOLIC, FILIP**  
**52100 PULA (HR)**

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(74) Representative: **Marsic, Natasa**  
**CPZ - Centar za patente d.o.o.**  
**Kutinska 2**  
**10000 Zagreb (HR)**

(71) Applicant: **Fizio Tech d.o.o.**  
**52100 PULA (HR)**

(54) **THE APPARATUS FOR TRACTION AND VIBRATION OF THE HIP JOINT**

(57) The invention discloses the apparatus for traction and vibration of the hip joint, and its use in the treatment of therapy and management of pain caused by the hip condition related to coxarthrosis, nerve compression syndrome, hip labral tear and the like. The apparatus for traction and vibration of the hip joint, comprises base (1), main housing (7) with electronical components, wherein assembly for moving along Z axis (2) by making use of central linear electric motor (13), assembly for moving along X axis (3) containing bearings (17), horizontal linear electric motor (14) and ventral-caudal traction mechanism having fixator of the proximal part of the lower leg (4) and fixator of the distal part of the lower leg (5), lateral traction mechanism (12), fixing mechanism and vibration unit and operating software. This method of treatment is superior to manual traction and vibration technique since it is not dependent on the human factor and more efficiently alleviates pain and postpones or even eliminates the need for surgery of the hip.

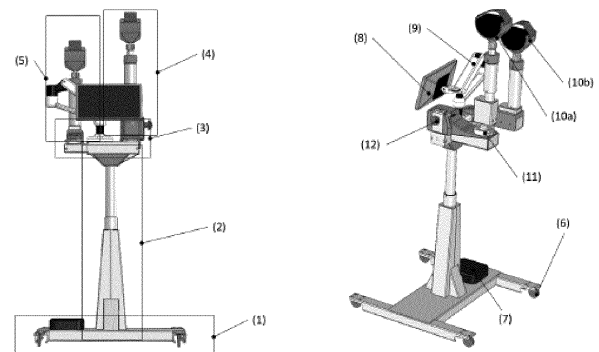


FIGURE 1

## Description

### FIELD OF THE INVENTION

**[0001]** Present invention related to medical equipment used in therapy and management of pain caused by the hip condition related to coxarthrosis, nerve compression syndrome, hip labral tear and the like.

### BACKGROUND AND THE PRIOR ART

**[0002]** Painful hip condition is usually related to the coxarthrosis, nerve compression syndrome, hip labral tear and the like. Depending on the severity of the underlying disease, various treatment options are available: cold and warm presses, pain medication, physical therapy and surgery. Quality of life of such a patient is hugely affected by this condition and it is important that it is treated efficiently and appropriately according to the degree of the progression of the underlying disease. In cases with mild to moderate pain, physical therapy is proved to be useful in alleviating pain, postponing or even avoiding surgery. Successful physical therapy usually includes traction, most commonly manual, very often accompanied with the manually produced vibrations on the surrounding structures and soft tissues. However, quality and efficiency of such a therapy depends on the possibility of the application of the specific force and uniformity of the vibrations applied, which is, on the other hand, largely dependent on the skill of the physiotherapist, strength, tiredness etc. For example, it is known that physical therapist can not apply constant force for longer than 20 minutes. Also, it is not possible to measure the force that has been applied manually, so it is very likely that manually applied force is not optimal, usually is either too weak or too strong. Due to the pain and various other conditions, it is often very difficult to fix the pelvis of the patient as well as the torso. Proper fixing mentioned above is also one of the main factors influencing successful traction and vibration treatment.

**[0003]** There are several attempts to automatise the manual traction and vibration technique, however all these efforts have number of drawbacks. For example, the HipTrac (MedRock Inc. 101 SW Madison, Suite 9262, Oregon) which has shown to be beneficial in clinical studies (Madeiros JM and Rocklin T: Manual Therapy, Therapeutic Exercise, and HipTrac™ for Patients with Hip Osteoarthritis: A case Series. Ortopaedic Practice Vol 29:1:17) has only the long-axis traction (progressive and prolonged) functionality thus limiting its therapeutic use, does not provide vibration function. Similar solution is provided with Tombo-brace which is also limited to the axial traction of the hip joint which helps in compression reduction and alleviates pain (Gustin S and Hespeel C (2018): The clinical use of a hip traction device in conservative treatment of femoroacetabular impingement: a comparative and randomised controlled clinical trial. Dissertation, Ghent University). Again, since only one trac-

tion axis could be used for stimulation and the lack of vibration component, Tombo-brace has severe limitations for use in clinical setting. Another example is given in US 2009/0259253 A1 (Bensoussan C: Apparatus for stretching the vertebral column of the person, July 9, 2007) which discloses an apparatus for stretching the vertebral column of a person, comprising a table equipped with a traction system which effect traction of the legs and the column, and oscillating means that act so as to obtain movements of lateral oscillation of both legs. The lateral oscillation movements and traction movements are combined and the effects of the lateral oscillation movements are used for muscle relaxation in the region of pelvis and the lumbar regions, which makes the subsequent stretching of the lower back more effective. Unlike present invention, the apparatus of US 2009/0259253 A1 has only possibility for one traction direction (long-axis or caudal), the oscillation is provided separately from traction, the muscle relaxation of the lumbar region provides limited fixation of the pelvis and torso region and could therefore used only for traction of vertebral column.

Therefore, there is a need for an automated and controllable medical device for treatment of the painful hip condition that would enable traction in all directions (ventral, lateral and caudal) respecting biomechanics of the hip structure, provide vibration component and provide mechanism for the efficient fixation of the pelvis and torso of the patient in order to separate joint parts in the hip joint (acetabulum and femur), relax surrounding structures and soft tissues and initiating flow of the synovial fluid into damaged cartilage. Another technical problem to be solved is to provide additional measurement and control means which can quantitatively measure traction force applied and to adjust it to the force used by manual technique as well as to measure and adjust the vibration mode in order to provide optimal individual treatment.

**[0004]** Also, due to specific variation of the anatomy of the hip damage (left or right sided), it would be important to provide the possibility to enable the optimal intervention of the both left and right sided hip damage.

### BRIEF DESCRIPTION OF THE INVENTION

**[0005]** The invention discloses the apparatus for traction and vibration of the hip joint, and its use in the treatment of therapy and management of pain caused by the hip condition related to coxarthrosis, nerve compression syndrome, hip labral tear and the like.

**[0006]** The apparatus for traction and vibration of the hip joint, comprises base (1), main housing (7) with electrical components, wherein assembly for moving along Z axis (2) by making use of central linear electric motor (13), assembly for moving along X axis (3) containing bearings (17), horizontal linear electric motor (14) and ventral-caudal traction mechanism having fixator of the proximal part of the lower leg (4) and fixator of the distal part of the lower leg (5), lateral traction mechanism (12),

fixing mechanism and vibration unit and operating software and wherein

- fixator of the proximal lower leg (4) contains the ball bearing assembly (11) enabling traction in all direction under 60°, the ball bearing (11) consisting of ball (20), delimiter (21), housing of the ball bearing assembly (23), slider (22), spring (24) and linear electric motor for the ball bearing assembly (25), the slider (22) having the slope where delimiter slides and moves along Z axis, blocking ball (20) into fixed position, the upper part of the fixator of the proximal lower leg (4) contains ball bearing assembly (15) and handle of the proximal part of the lower leg (10a);
- handle of the proximal part of the lower leg (10a) contains proximal sensor (18) which reads intensity of the applied traction force;
- linear electric motor (19) drives fixator of the proximal part of the lower leg (4) which moves along Z axis in the range of 150 mm;
- fixator of the distal part of the lower leg (5) contains in the upper part the ball bearing assembly (15) and handle of the proximal part of the lower leg (10b), the said fixator moving along Z axis in the range of 200 mm using left linear electric motor (16);
- lateral traction mechanism consists of pulley (33), cable (34), thigh belt (35), lateral sensor (36) and lateral DC worm electric motor (37), lateral sensor (36) being placed between lateral DC worm electric motor (37) and the thigh belt;
- housing of the lateral traction mechanism (38) is equipped with emergency button (39);
- assembly for moving along X axis contains the screen (8) and screen reception (9):
  - fixation mechanism contains belt (26), sponge part (27), adjusting means (28) and fastening means (29), part of the being boarded up with thin sponge and covered with leather material or leather imitation material coating the sponge part (24);
  - vibration unit consisting of belt (30), housing of the vibration unit (31) containing electric motor with excentre (32) producing vibrations in the range of 0-33 Hz, while housing of the vibration unit contains belt reception part;
  - software is web based application.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### [0007]

FIGURE 1 shows the exterior components of the apparatus for traction and vibration.

FIGURE 2 shows the cross-section of the assembly for moving along Z axis.

FIGURE 3 shows the cross-section of the assembly

for moving along X axis.

FIGURE 4 shows the cross-section of the fixator of the distal part of the lower leg.

FIGURE 5 shows the cross-section of the fixator of the proximal part of the lower leg.

FIGURE 6 shows the detail of the cross-section of the ball bearing assembly enabling traction in all directions.

FIGURE 7 shows the method for positioning the vibration unit on the thigh which sends low-frequency vibrations into the hip joint and surrounding structures.

FIGURE 8 shows the method for positioning and fixing the pelvis to the bed in order to enable separation of the ball bodies (traction).

FIGURE 9 shows the cross-section of the ball bearing assembly.

#### List of the marking used:

##### [0008]

- |       |   |
|-------|---|
| 1 -   | Base  |
| 2 -   | Assembly for moving along Z axis                    |
| 3 -   | Assembly for moving along X axis                    |
| 4 -   | Fixator of the proximal part of the lower leg       |
| 5 -   | Fixator of the distal part of the lower leg         |
| 6 -   | Four wheels   |
| 7 -   | Main housing  |
| 8 -   | Screen  |
| 9 -   | Screen receptor                                     |
| 10a - | Handle of the proximal part of the of the lower leg |
| 10b - | Handle of the distal part of the of the lower leg   |
| 11 -  | Ball bearing assembly                               |
| 12 -  | Lateral traction mechanism                          |
| 13 -  | Central linear electric motor                       |
| 14 -  | Horizontal linear electric motor                    |
| 15 -  | Ball bearing assembly                               |
| 16 -  | Left linear electric motor                          |
| 17 -  | Bearing   |
| 18 -  | Proximal sensor                                     |
| 19 -  | Right linear electric motor                         |
| 20 -  | Ball  |
| 21 -  | Delimiter   |
| 22 -  | Slider  |
| 23 -  | Housing of the ball bearing assembly                |
| 24 -  | Spring  |
| 25 -  | Linear motor for the ball bearing assembly          |
| 26 -  | Belt  |
| 27 -  | Sponge part   |
| 28 -  | Adjusting means                                     |
| 29 -  | Fastening means                                     |
| 30 -  | Belt  |
| 31 -  | Housing of vibration unit                           |
| 32 -  | Electric motor with excentre                        |
| 33 -  | Pulley  |
| 34 -  | Cable   |
| 35 -  | Thigh belt  |

- 36 - Axial force sensor
- 37 - DC worm electric motor
- 38 - Housing of the lateral traction mechanism
- 39 - Emergency button

## DETAILED DESCRIPTION OF THE INVENTION

**[0009]** The apparatus for traction and vibration of the hip joint, comprises base (1), main housing (7) with electronic components, wherein assembly for moving along Z axis (2) by making use of central linear electric motor (13), assembly for moving along X axis (3) containing bearings (17), horizontal linear electric motor (14) and ventral-caudal traction mechanism having fixator of the proximal part of the lower leg (4) and fixator of the distal part of the lower leg (5), lateral traction mechanism (12), fixing mechanism and vibration unit and operating software.

**[0010]** Traction mechanism comprises base (1) positioned on four wheels (6) which provide the mobility of the whole apparatus according to the invention. The base (1) comprises main housing (7) which contains electronic components (Figure 1). The assembly for moving along Z axis (2) is placed on the base (1) which moves by making use of central linear electric motor (12) in order to enable height adjustments of the physiotherapeutic table (Figure 2). The assembly for moving along X axis (3) is used to make possible adjustment on the individual length of the lower leg so the patient's leg could be easily accommodated (Figure 3).

**[0011]** The assembly for moving along X axis (3) also comprises bearings (17) which enable bilateral use of the apparatus so it can be put on either left or right side of the physiotherapeutic table depending on the side of the patient's hip damage (Figure 4). Moving is accomplished by making use of horizontal linear electric motor (14) (Figure 3). The assembly for moving along X axis (3) is further connected to the fixator of the proximal part of the lower leg (4) and the fixator of the distal part of the lower leg (5) (Figure 1). The fixator of the proximal part of the lower leg (4) is used for placing and accommodation of the proximal part of the patient's leg and enables the traction force in the range of 0-1000 N (Figure 5). The fixator of the proximal part of the lower leg (4), in its lower part comprises ball bearing assembly (11) which enables traction (ventral/lateral/caudal) by rotation in all directions of 60 degrees (Figure 1). Ball bearing assembly (11) consists of ball (20), delimiter (21), housing of the ball bearing assembly (23), slider (22), spring (24) and linear electric motor (25) for the ball bearing assembly (Figure 9). Activation of the linear electric motor (25), causes oppression of the spring (24) which then causes moving of the slider (22) (Figure 9). Slider (22) is construed in a way that it has a slope on which the delimiter (21) slides and by this delimiter is moved along Z axis. In this way, ball (20) is blocked to a certain position which is optimal for the position of the patient's leg and particular traction direction (Figure 6). Upper part of the fixator of

the proximal part of lower leg (4) comprises ball bearing assembly (11) which enables more comfortable accommodation of the leg and the handle of the proximal part of the lower leg (10a) (Figure 1). Handle of the proximal part of the lower leg (10a) comprises sensor (18) which reads the intensity of the applied traction force (Figure 5). Right linear electric motor (19) drives fixator of the proximal part of the lower leg (4) which moves along Z axis in the range of 150 mm. Fixator of the distal part of the lower leg (5) contains in the upper part the ball bearing assembly (15) and handle of the proximal part of the lower leg (10b), the said fixator moving along Z axis in the range of 200 mm using left linear electric motor (16) (Figure 4). Ball bearing assembly (11) which are part of the fixator of the proximal part of the lower leg (4) and the fixator of the distal part of the lower leg (5) enable the mobility of the handle of the proximal part of the lower leg (10a) and the handle of the distal part of the lower leg (10b) in order to place the thigh and lower part of the leg in optimal position according to patient's hip damage characteristics and respecting the type of traction force to be applied (ventral/caudal/lateral) (Figure 1). Screen (8) and screen receptor (9) are installed on the assembly for moving along X axis (3) (Figure 1). Screen 8 serves in the process of controlling all electric motors comprised by the apparatus according to the invention. These could be operated by mobile devices, tablets or computers enabling the physical therapist to set and modulate the intensity, direction and the duration of the application of the traction force, in any point of time, to be applied on the patient.

**[0012]** Lateral traction mechanism consists of pulley (33), cable (34), thigh belt (35), lateral sensor (36) and lateral DC worm electric motor (37), lateral sensor (36) being placed between lateral DC worm electric motor (37) and the thigh belt. Housing of the lateral traction mechanism (38) is equipped with emergency button (39).

**[0013]** Fixation mechanism contains belt (26), sponge part (27), adjusting means (28) and fastening means (29), part of the being boarded up with thin sponge and covered with leather material or leather imitation material coating the sponge part (24) (Figure 8). Sponge part (27) is placed on the pelvis of the patient on the level of the hip and it is adjusted by the adjusting means (28) and fastening means (29) which is under the table. By making use of the belt and fixing it, the pelvis is put in the fixed position enabling successful traction of the femur in relation to the acetabulum (Figure 8).

**[0014]** Vibration unit consists of belt (30), housing of the vibration unit (31) containing electric motor with ex-centre (32) producing vibrations in the range of 0-33 Hz, while housing of the vibration unit contains belt reception part. Intensity and the duration of the vibration is determined and controlled through web based software using screen/mobile phone/computer. Vibration unit is placed on the thigh and the vibrations produced thereby cause muscle and surrounding structures relaxation (Figure 7).

**[0015]** Additionally, synergistic action of the traction and vibration enables synovial liquid, present in the joint,

to be evenly distributed and to get through the damaged parts of the cartilage. The software enables the user to operate all the electric motors (13, 14, 16, 19, 32, 37) and set up and modulate duration, direction and intensity of the traction force and duration and intensity of the vibration in any point of time. 5

**[0016]** The apparatus is intended for use in a clinical setting. The treatment duration is approximately 20 minutes and it repeated according to the severity of the underlying disease, typically 3 times a week during 1-2 months. 10

**[0017]** The traction force used is mostly around 400 N and the vibration frequency is around 7 Hz (relaxation of the muscles and surrounding structures). 15

**[0018]** This method of treatment is superior to manual traction and vibration technique since it is not dependent on the human factor and more efficiently alleviates pain and postpones or even completely eliminates the need for surgery of the hip in patients with coxarthrosis, nerve compression syndrome, hip labral tear and the like. 20

## Claims

1. The apparatus for traction and vibration of the hip joint, comprising base (1), main housing (7) with 25  
electronical components, wherein assembly for moving along Z axis (2) by making use of central linear electric motor (13), assembly for moving along X axis (3) containing bearings (17), horizontal linear 30  
electric motor (14) and ventral-caudal traction mechanism having fixator of the proximal part of the lower leg (4) and fixator of the distal part of the lower leg (5), lateral traction mechanism (12), fixing mechanism and vibration unit and operating software and 35  
wherein

- fixator of the proximal lower leg (4) contains the ball bearing assembly (11) enabling traction in all direction under 60°, the ball bearing (11) 40  
consisting of ball (20), delimiter (21), housing of the ball bearing assembly (23), slider (22), spring (24) and linear electric motor for the ball bearing assembly (25), the slider (22) having the slope where delimiter slides and moves along Z 45  
axis, blocking ball (20) into fixed position, the upper part of the fixator of the proximal lower leg (4) contains ball bearing assembly (15) and handle of the proximal part of the lower leg (10a);
- handle of the proximal part of the lower leg 50  
(10a) contains proximal sensor (18) which reads intensity of the applied traction force;
- linear electric motor (19) drives fixator of the proximal part of the lower leg (4) which moves 55  
along Z axis in the range of 150 mm;
- fixator of the distal part of the lower leg (5) contains in the upper part the ball bearing assembly (15) and handle of the proximal part of

the lower leg (10b), the said fixator moving along Z axis in the range of 200 mm using left linear electric motor (16);

- lateral traction mechanism consists of pulley (33), cable (34), thigh belt (35), lateral sensor (36) and lateral DC worm electric motor (37), lateral sensor (36) being placed between lateral DC worm electric motor (37) and the thigh belt;
- housing of the lateral traction mechanism (38) is equipped with emergency button (39);
- assembly for moving along X axis contains the screen (8) and screen reception (9):

- fixation mechanism contains belt (26), sponge part (27), adjusting means (28) and fastening means (29), part of the being boarded up with thin sponge and covered with leather material or leather imitation material coating the sponge part (24);
- vibration unit consisting of belt (30), housing of the vibration unit (31) containing electric motor with excentre (32) producing vibrations in the range of 0-33 Hz, while housing of the vibration unit contains belt reception part;
- software is web based application.

2. Use of the apparatus for traction and vibration of the hip joint, according to claim 1, in the treatment, therapy and management of pain caused by the hip condition related to coxarthrosis, nerve compression syndrome and hip labral tear.

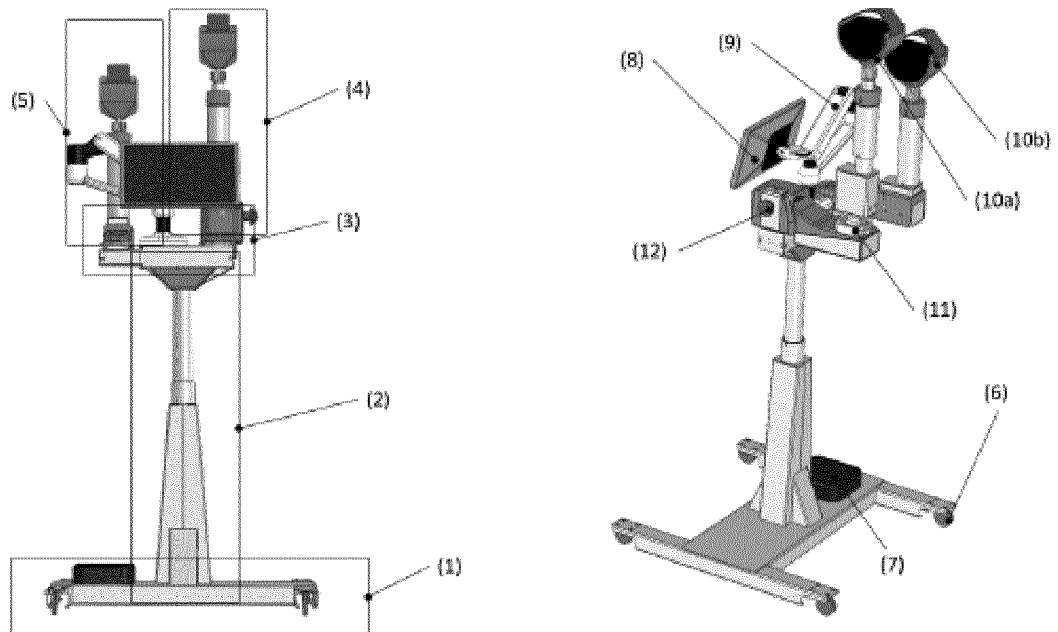


FIGURE 1

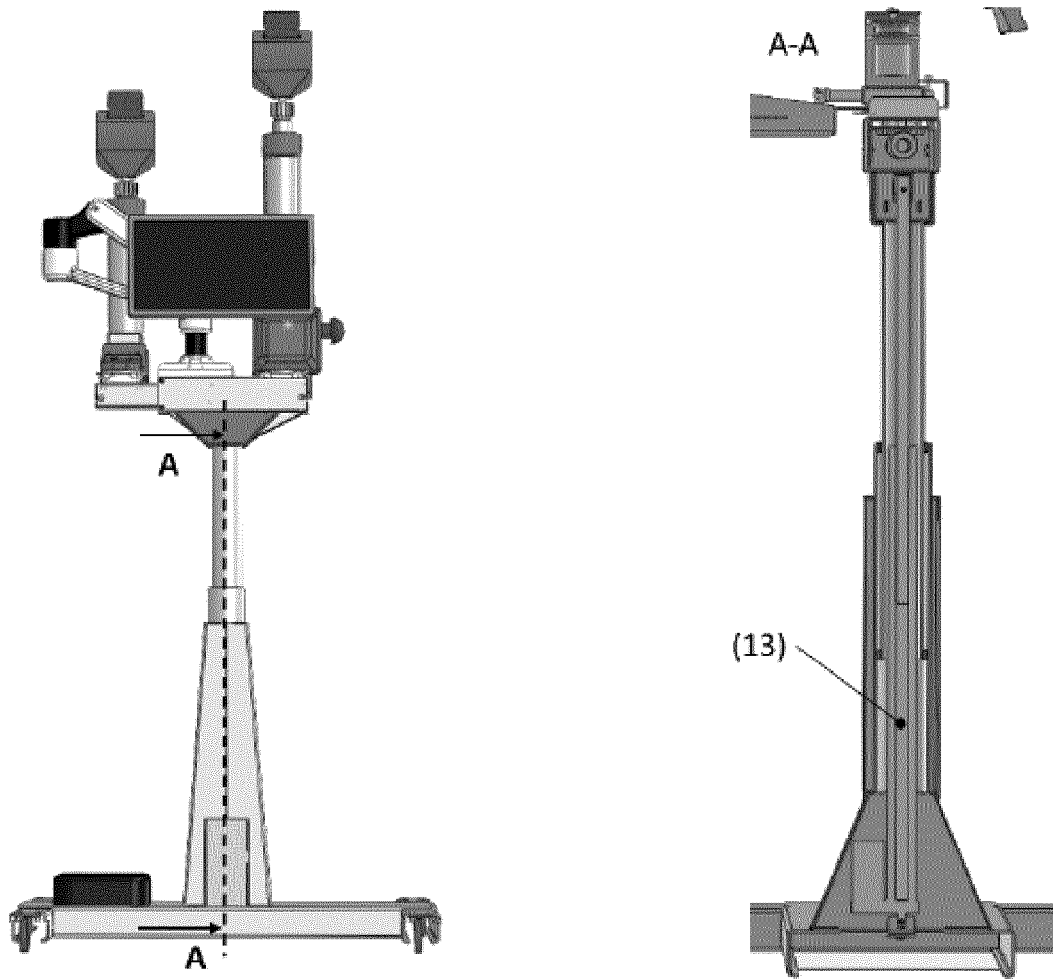


FIGURE 2

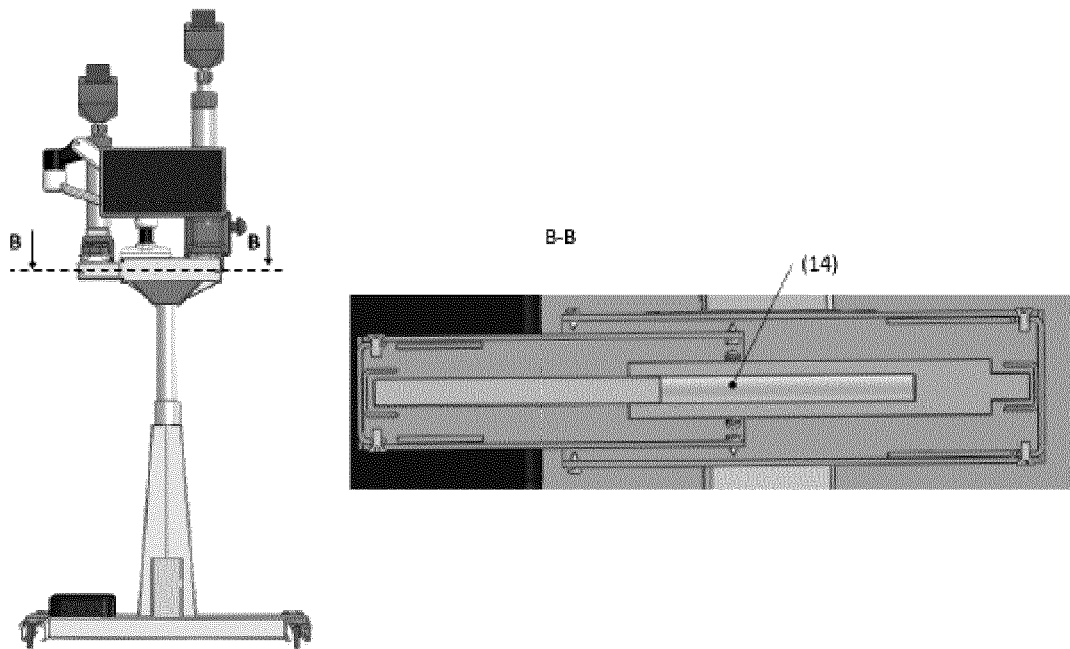


FIGURE 3



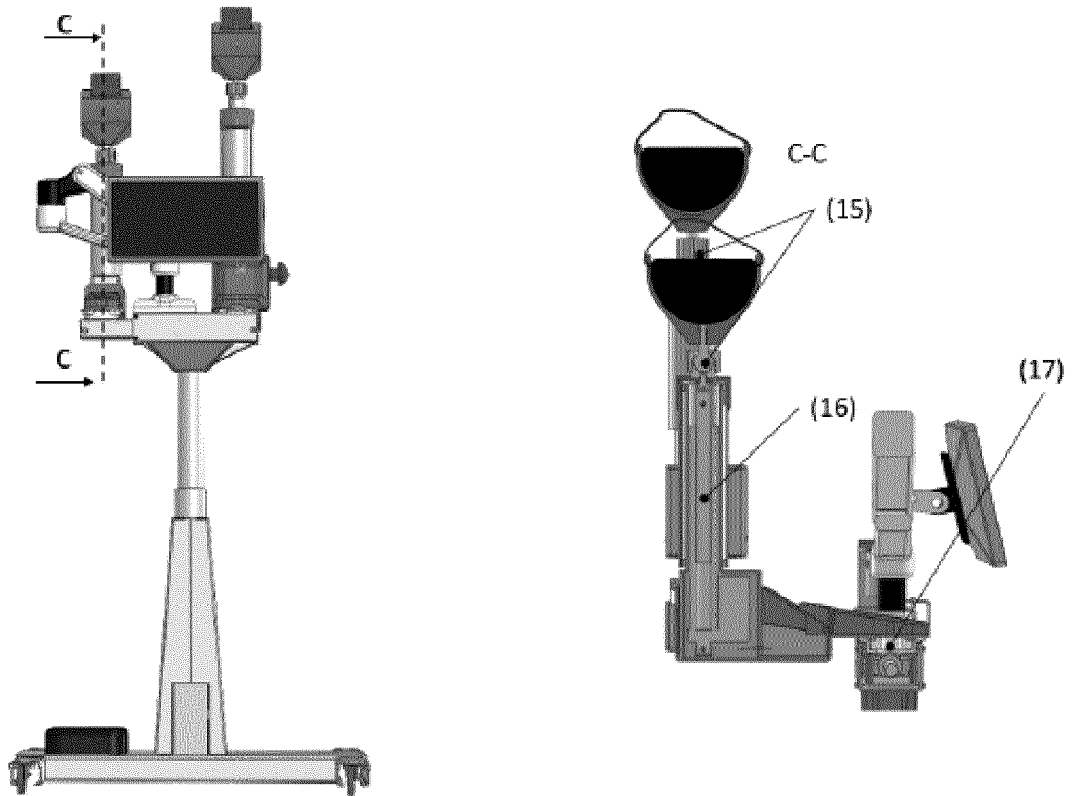


FIGURE 4

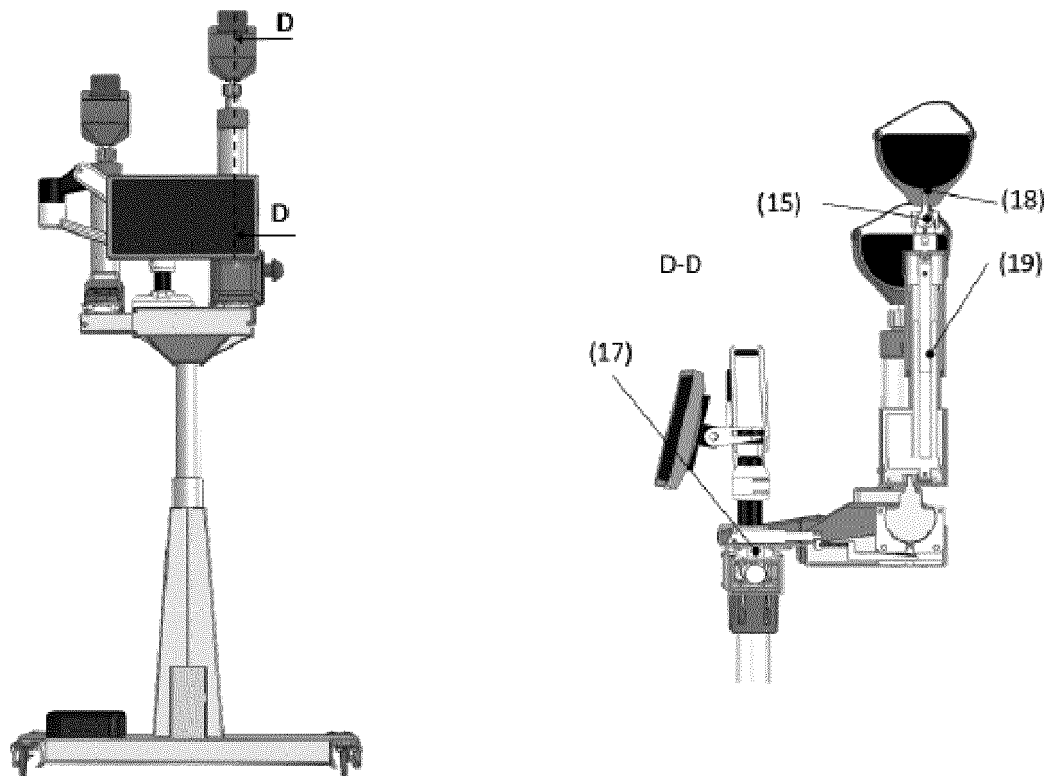


FIGURE 5

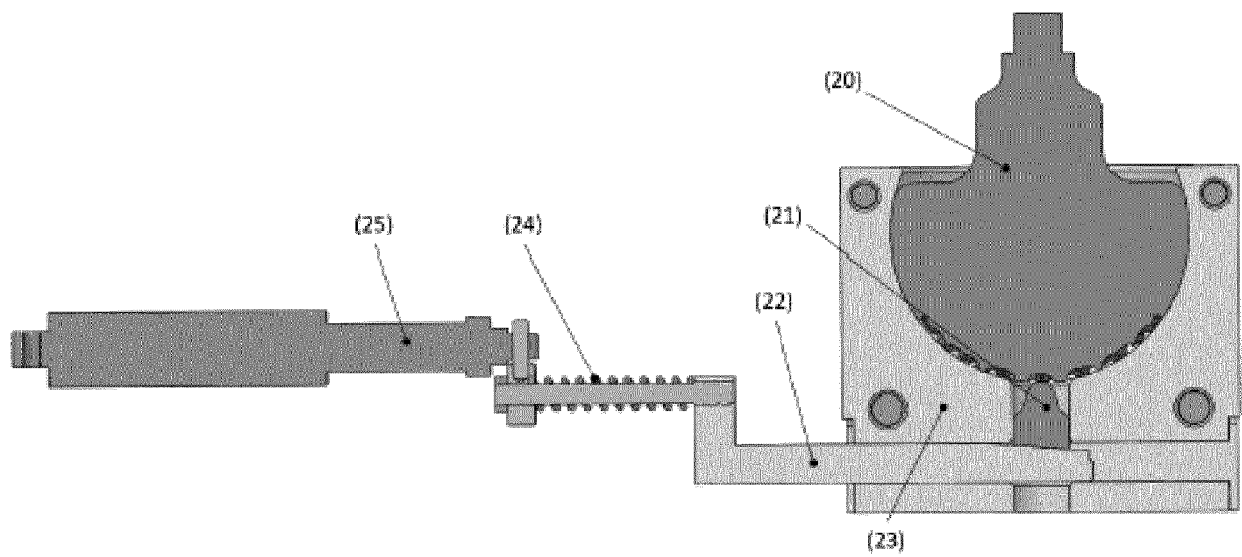


FIGURE 6

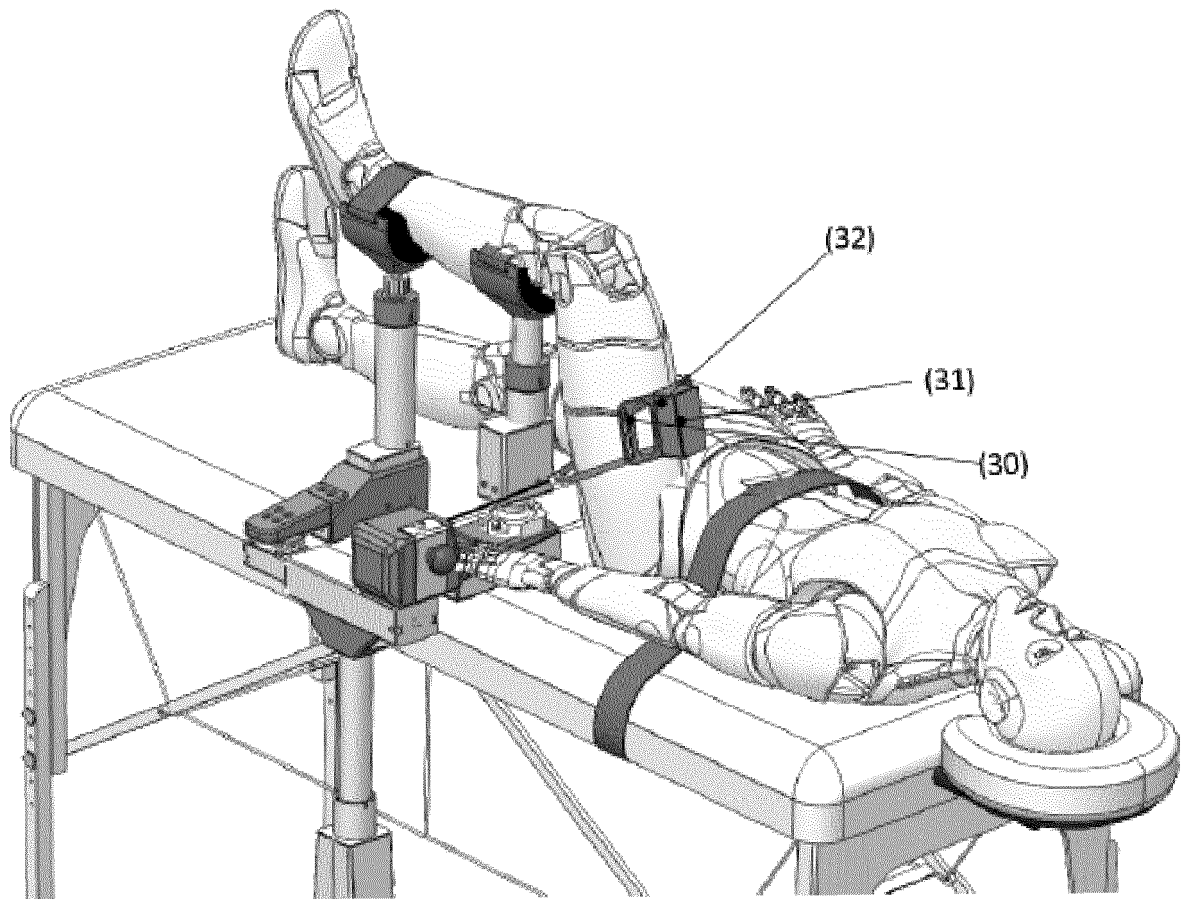


FIGURE 7

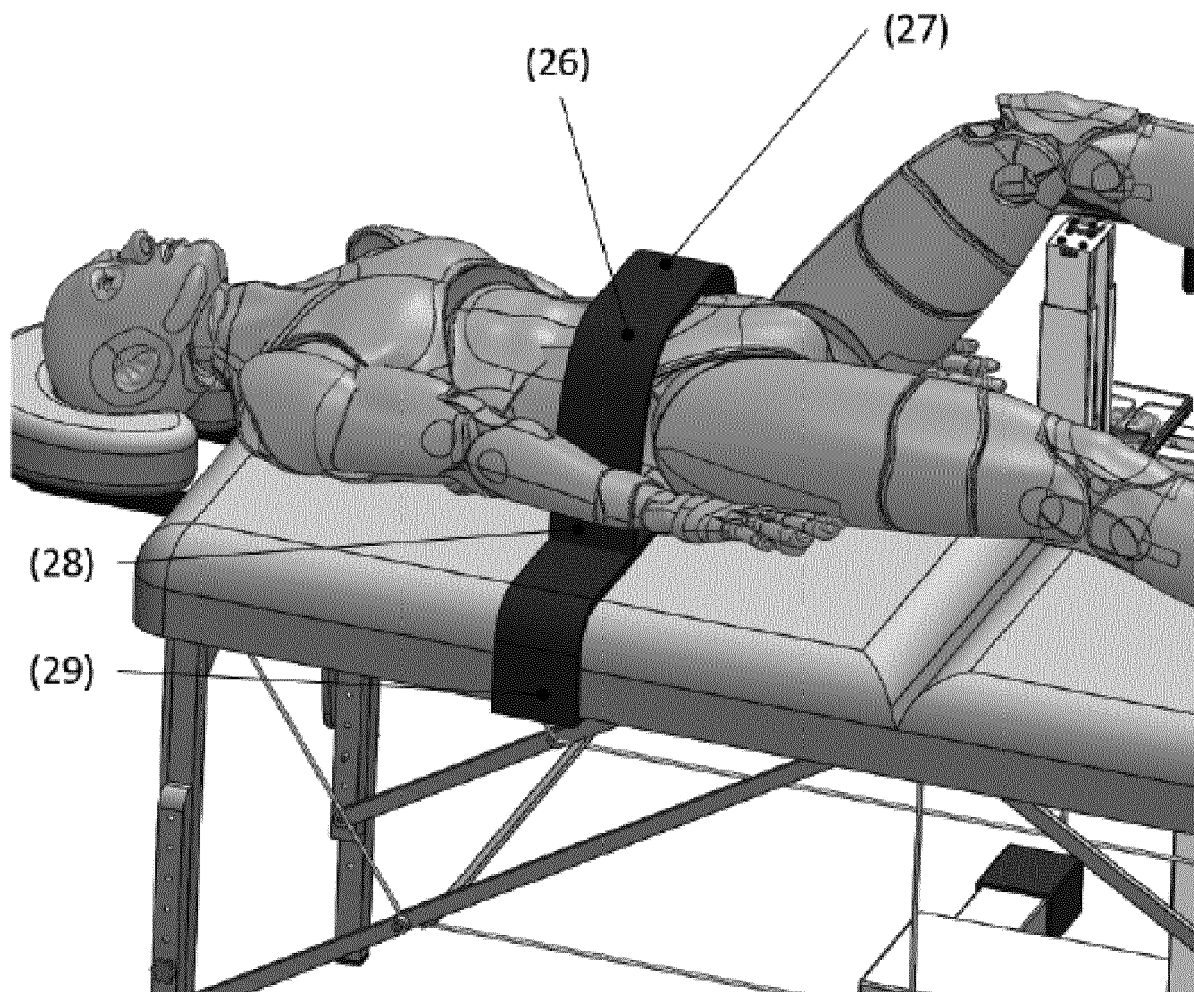


FIGURE 8

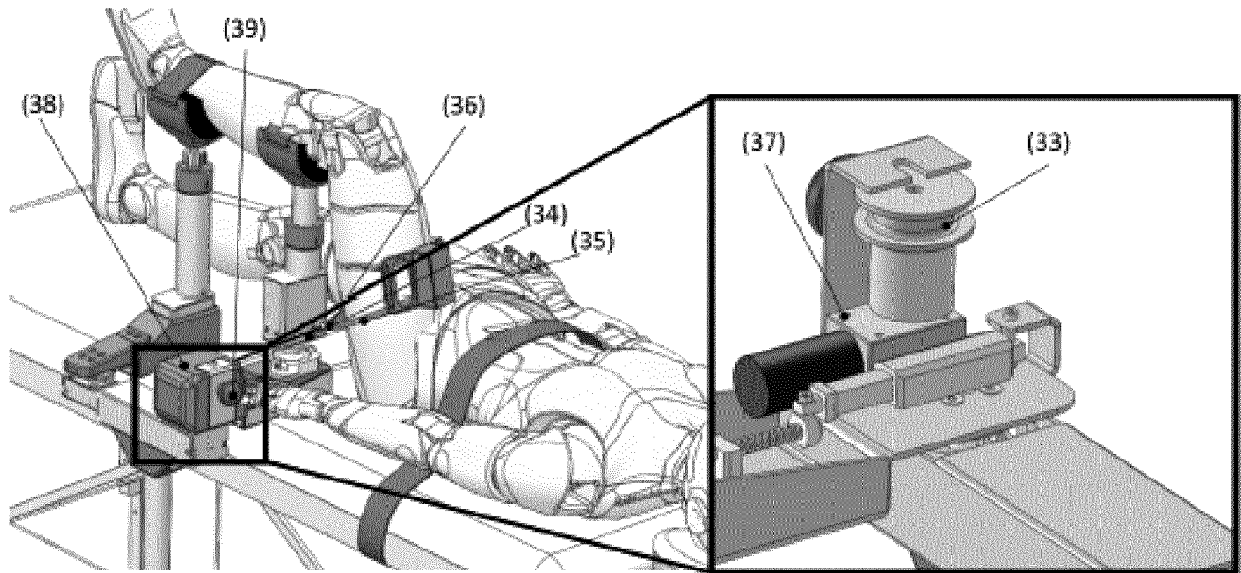


FIGURE 9



## EUROPEAN SEARCH REPORT

Application Number  
EP 21 17 5657

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2017/039550 A1 (KALKAN ÖZCAN [TR]) 9 March 2017 (2017-03-09) * figure 19 *	1	INV. A61H1/02 A61F5/00
A	FR 2 995 781 A1 (GERMAIN FRANCK [FR]) 28 March 2014 (2014-03-28) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			A61H A61F
The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>6 October 2021</b>	Examiner <b>Squeri, Michele</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EP 21 17 5657

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06-10-2021

10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
	WO 2017039550 A1	09-03-2017	NONE	
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15	FR 2995781 A1	28-03-2014	NONE	
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