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(54) Title: AN EXOSKELETON SYSTEM

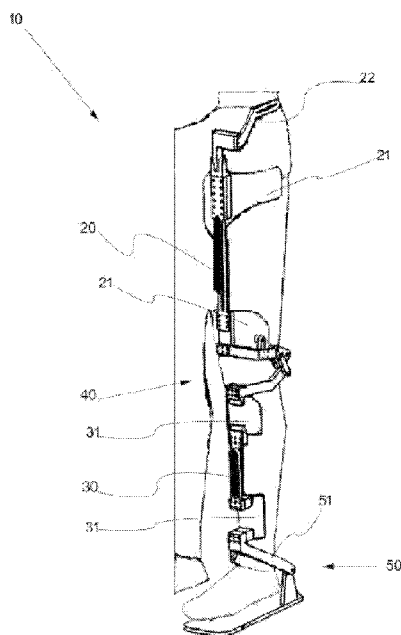


Figure 1

(57) Abstract: The present invention relates to at least one exoskeleton system (10) in order to provide walking support to people who have disability in walking or in order to provide performance improvement to healthy people, and having at least one first body (20) for being connected to the motionless upper part of the leg and at least one second body (30) for being connected to the motionless lower part of the leg and at least one knee embodiment (40) provided between said first body (20) and said second body (30) in a manner allowing motion of the knee joint, and at least one leg embodiment (50) for forming support to the foot part by being connected to the second body (30). The improvement of the present invention is that said knee embodiment (40) comprises at least one isogram mechanism (M) provided in a manner supporting the bio-mechanical motion of the knee joint from the side (sagittal plane) part of the knee joint, said isogram mechanism (M) comprises at least one movement element (44) which can be manipulated by means of at least one energy storage element (42) which allows carrying load, in order to compensate translational motion realized by the knee joint while rotating.



## AN EXOSKELETON SYSTEM

### 5 TECHNICAL FIELD

The present invention relates to at least one exoskeleton system in order to provide walking support to people who have disability in walking or in order to provide performance improvement to healthy people, and having at least one first body for being connected to the motionless upper part of the leg and at least one second body for being connected to the motionless lower part of the leg and at least one knee embodiment provided between said first body and said second body in a manner allowing movement of the knee, and at least one leg embodiment for forming support to the foot part by being connected to the second body.

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### PRIOR ART

Mechanical exoskeleton has been designed for supporting the person who wears it, for walking assistance and/or for increasing performance thereof. For instance, mechanical exoskeleton is used for supporting and/or for increasing performance of soldiers or construction workers. Moreover, development of exoskeletons which can support movement of elderly people and individuals with injuries, i.e. spinal cord injury or stroke, enables a wide medical market in the future. The other areas where advantage is provided are rescue works; heavy debris can be lifted by a lifeguard who wears this machine in collapsed buildings and at the same time, protection can be provided against falling taluses.

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In the Chinese application with number CN201110292009, an exoskeleton rehabilitation robot is described. Proposed robot provides supporting of the foot of the user from the base, it is a circular support mechanism developed beside the knee. While the leg support is provided by means of a rod-like structure provided at the side part, it is apparent that ergonomic problems also occur.

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The mechanical exoskeleton can also be used in military fields for augmenting the performance development of the soldiers. However, around the knee joint, ergonomics problems occur which result from the unfavorable coinciding of the inner frame and the exoskeleton system.

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As a result, because of the aforementioned problems, an improvement is required in the related technical field.

## BRIEF DESCRIPTION OF THE INVENTION

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The present invention relates to an exoskeleton system, for eliminating the aforementioned disadvantages and for bringing new advantages to the related technical field.

10 An object of the present invention is to provide an exoskeleton system which allows ergonomic usage such that it does not project from the leg periphery.

In order to realize the abovementioned objects and the objects which are to be deduced from the detailed description below, the present invention is at least one exoskeleton system in order to provide walking support to people who have disability in walking or in order to provide performance improvement to healthy people, and having at least one first body for being connected to the motionless upper part of the leg and at least one second body for being connected to the motionless lower part of the leg and at least one knee embodiment provided between said first body and said second body in a manner allowing movement of the knee, and at least one leg embodiment for forming support to the foot part by being connected to the second body. Accordingly, the improvement of the present invention is that said knee embodiment comprises at least one isogram mechanism provided in a manner supporting the bio-mechanical motion of the knee joint from the side (sagittal plane) part of the knee, said isogram mechanism comprises at least one movement element which can be manipulated by means of at least one energy storage element which allows carrying load, in order to compensate for the translational motion realized by the knee joint while rotating. Thus, an ergonomic usage is provided by supporting the bio-mechanical motion of the knee joint from the side part.

30 In a possible embodiment of the present invention, at least one first part of the knee embodiment where the knee embodiment is connected to the first body and at least one second part where the knee embodiment is connected to the second body are provided in a manner extending from the front part of the knee towards the rear part of the knee in a compliant manner to the bio-mechanics of the knee joint. Thus, coinciding of the inner frame of the user and the exoskeleton system is provided, and thus, an ergonomic usage is provided.

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In another possible embodiment of the present invention, for supporting the foot ankle from the front part thereof, said foot embodiment comprises at least one connection bracket connected to the second body so as not to project from the foot periphery. Thus, the foot and ankle joint is supported in a manner not protruding outwardly.

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In another possible embodiment of the present invention, the foot embodiment comprises at least one foot plate which can be connected to the foot base, and at least one finger plate associated with said foot plate in a movable manner with respect to each other. Thus, the foot base and the finger part are supported.

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In another possible embodiment of the present invention, the first body is connected to the leg upper part by means of at least one thigh connection element. Thus, the first body is connected to the thigh part of the leg in a manner completely seating from the front side thereof.

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In another possible embodiment of the present invention, the second body is connected to the leg lower part by means of at least one calf connection element. Thus, the second body is connected to the shank (tibia) part of the leg in a manner completely seating from the front side thereof.

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In another possible embodiment of the present invention, the isogram mechanism is configured to fit the user around the knee and the foot part of the foot embodiment. Thus, it is enabled that the exoskeleton system fits the leg and foot periphery, and since it does not project outwardly, a usage advantage is provided.

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### **BRIEF DESCRIPTION OF THE FIGURES**

In Figure 1, a representative perspective view of the subject matter exoskeleton system is connected onto a leg is given.

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In Figure 2, a representative perspective view of a leg embodiment of the subject matter exoskeleton system is given.

In Figure 3, a representative perspective view of isogram mechanism in a knee embodiment of the subject matter exoskeleton system is given.

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In Figure 4, a representative perspective view of a condition where the support of the subject matter exoskeleton system is disengaged is given.

5 In Figure 5, a representative perspective view of a condition where the support of the subject matter exoskeleton system is engaged is given.

In Figure 6, a representative perspective view where a plantar-flexion support element is positioned in a leg embodiment of the subject matter exoskeleton system is given.

## 10 DETAILED DESCRIPTION OF THE INVENTION

In this detailed description, the subject matter exoskeleton system (10) is explained with references to examples without forming any restrictive effect only to make the subject more understandable.

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In Figure 1, a representative perspective view where the subject matter exoskeleton system (10) is connected onto a leg is given. Accordingly, the exoskeleton system (10) is a mechanical support associated with the leg from outside for providing walking support in people who have disability in walking or for providing performance improvement in healthy  
20 people. In humans, leg is the organ which extends from the waist part to the foot part by means of two motionless parts and two joints. The part which extends from the buttock to the knee joint is named as thigh and the part which extends from the knee joint to the ankle joint is named as shank. The exoskeleton system (10) comprises at least one first body (20) for being connected to the thigh part of the leg from the front side thereof. Said first body (20) is  
25 a structural support element and it is essentially a frame. The first body (20) comprises at least one waist connection element (22) provided in a manner connected to the waist part of the user. The first body (20) comprises at least one thigh connection element (21). Said thigh connection element (21) is essentially a holder structure and provides the connection of the first body (20) to the thigh part of the leg. In a possible embodiment of the present invention,  
30 two thigh connection elements (21) are provided where one of them is connected to the upper region of the thigh part and where the other one of them is connected to the part of the thigh part which is relatively close to the knee.

The exoskeleton system (10) comprises at least one second body (30) to be connected to  
35 the calf part of the leg from the front side thereof. Said second body (30) is a structural support element and is essentially a frame. The second body (30) comprises at least one shank connection element (31). Said shank connection element (31) is essentially a holder

structure and provides the second body (30) to be connected to the calf part of the leg. In a possible embodiment of the present invention, two shank connection elements (31) are provided where one of them is connected to the upper region of the calf part and where the other one of them is connected to the part of the calf part which is relatively close to the foot.

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In Figure 2, a representative perspective view of a leg embodiment (50) of the subject matter exoskeleton system (10) is given. Accordingly, said foot embodiment (50) is a support frame provided for forming support to the foot part of the exoskeleton system (10) and particularly for forming support to the ankle joint. The foot embodiment (50) is connected to the second  
10 body (30). The foot embodiment (50) comprises at least one foot plate (53). Said foot plate (53) is a partially flat plate provided at equal dimensions as the user foot base. The foot embodiment (50) comprises at least one finger plate (54). Said finger plate (54) is a plate which allows partially positioning on the finger parts of the user. The finger plate (54) and the foot plate (53) are configured to be movable with respect to each other. The movement is  
15 formed naturally in the walking behavior that is supported. The foot plate (53) and the finger plate (54) are moved concerning for walking behavior during walking, and the foot embodiment (50) supports the ankle joint of the user. The foot embodiment (50) comprises at least one plantar-flexion support element (55). Said plantar-flexion support element (55) is an auxiliary item for supporting the leg in the movement towards the plantar side during ankle  
20 push off.

The foot embodiment (50) comprises at least one connection bracket (51) for supporting the ankle joint from the front part thereof. Said connection bracket (51) provides the leg embodiment (50) to be connected to the second body (30) in a manner fitting the leg and not  
25 protruding from the leg periphery. The connection bracket (51) essentially has a geometric structure that is similar to inverse V comprising two arms. The connection bracket (51) is connected to the foot plate (53) by means of at least one plate connection element (52). Said plate connection element (52) is essentially a supporting part. The plate connection element (52) is mutually provided to be connected with both arms of the connection bracket (51).

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The exoskeleton system (10) comprises at least one knee embodiment (40). Said knee embodiment (40) provides the knee joint to move between the first body (20) and the second body (30). The knee embodiment (40) comprises at least one isogram mechanism (M) provided in a manner supporting the bio-mechanical motion of the knee joint from the rear  
35 part of the knee. Said isogram mechanism (M) is a movement mechanism for compensating the translational motion realized by the knee joint while rotating. The isogram mechanism (M) is connected to the first body (20) by means of at least one first part (41). The isogram

mechanism (M) is connected to the second body (30) by means of at least one second part (45). Said first part (41) and said second part (45) are provided in a manner extending from the front part of the knee joint towards the rear part of the knee joint in the sagittal plane in a compliant manner to the bio-mechanics of the knee joint.

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The isogram mechanism (M) comprises at least one movement element (44). Said movement element (44) is a movable plate provided essentially in triangular form. The movement element (44) is associated with the first part (41) from one end of the long edge and is associated with the second part (45) from the other part thereof. The movement

10 element (44) is connected to at least one energy storage element (42) from another end thereof. Said energy storage element (42) is essentially a spring and provides driving of the movement element (44). The energy storage element (42) is connected to at least one positioning element (43) from the other side thereof. Said positioning element (43) is a support which provides connection of the energy storage element (42) to the first body (20).

15 The isogram mechanism (M) comprises at least one third part (46). Said third part (46) is essentially a linear supporting element connected between the first part (41) and the second part (45).

In Figure 4 and Figure 5, the representative perspective views where the subject matter

20 exoskeleton system (10) support is disengaged and where the subject matter exoskeleton system (10) support is engaged are given respectively. Accordingly, in the isogram mechanism (M), at least one activation housing (60) is provided where the energy storage element (42) can move therein. Said activation housing (60) is essentially a slot which will provide engagement and disengagement of the support. The exoskeleton system (10)

25 comprises at least one locking element (62). Said locking element (62) is essentially provided in a sliding form. The locking element (62) is connected to at least one housing (63) for passing through the foot base part. Said housing (63) is essentially a channel provided at the rear part of the foot embodiment (50). After the foot is elevated from the ground, the locking element (62) moves downwardly by means of at least one spring (61). Said spring (61) is

30 compressed during upward movement of the locking element (62) when the heel touches the ground, and when the heel is elevated from the ground, the spring (61) returns the stored energy and provides downward movement of the locking element (62). When the locking element (62) passes to the high position, it fixes the position of the energy storage element (42) and provides engagement thereof. Thus, during weight acceptance, the energy storage

35 element (42) realizes weight acceptance support by means of storing energy. When the heel is elevated from the ground, the locking element (62) passes to the low position and provides free movement of the energy storage element (42) in the activation housing (60). Thus, since

energy is not stored, the energy storage element (42) has been disengaged, and the free rotation of the knee is provided. This release is needed for not preventing the free flexion of the knee.

5 By means of all these embodiments, the exoskeleton system (10) is connected to the knee periphery by means of the knee embodiment (40) and is connected to the periphery of the ankle joint by means of the foot embodiment (50), and thanks to this, it does not project from the leg and foot periphery. By being completely fit to the user's leg, it is prevented from getting attached to an outer element. By means of the isogram mechanism (M), an  
10 ergonomic usage is presented to the user by means of aligning of the inner frame with the exoskeleton system (10). The energy storage element (42) provides support to the movement of the knee.

The protection scope of the present invention is set forth in the annexed claims and cannot  
15 be restricted to the illustrative disclosures given above, under the detailed description. It is because a person skilled in the relevant art can obviously produce similar embodiments under the light of the foregoing disclosures, without departing from the main principles of the present invention.

20

**REFERENCE NUMBERS**

- 10 Exoskeleton system
  
- 5 20 First body
  - 21 Thigh connection element
  - 22 Waist connection element
  
- 30 Second body
- 10 31 Shank connection element
  
- 40 Knee embodiment
  - 41 First part
  - 42 Energy storage element
- 15 43 Positioning element
  - 44 Movement element
  - 45 Second part
  - 46 Third part
  
- 20 50 Foot embodiment
  - 51 Connection bracket
  - 52 Plate connection element
  - 53 Foot plate
  - 54 Finger plate
- 25 55 Plantar-flexion support element
  
- 60 Activation housing
  - 61 Spring
  - 62 Locking element
- 30 63 Housing
  
- M Isogram mechanism
  
- 35

## CLAIMS

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1. At least one exoskeleton system (10) in order to provide walking support to people who have disability in walking or in order to provide performance improvement to healthy people, and having at least one first body (20) for being connected to the motionless upper part of the leg and at least one second body (30) for being connected to the motionless lower part of the leg and at least one knee embodiment (40) provided between said first body (20) and said second body (30) in a manner allowing motion of the knee joint, and at least one leg embodiment (50) for forming support to the foot part by being connected to the second body (30), **wherein** said knee embodiment (40) comprises at least one isogram mechanism (M) provided in a manner supporting the bio-mechanical motion of the knee joint from the side (sagittal plane) part of the knee joint, said isogram mechanism (M) comprises at least one movement element (44) which can be manipulated by means of at least one energy storage element (42) which allows carrying load, in order to compensate translation motion realized by the knee joint while rotating.
  2. The exoskeleton system (10) according to claim 1, **wherein** at least one first part (41) of the knee embodiment (40) where the knee embodiment (40) is connected to the first body (20) and at least one second part (45) where the knee embodiment (40) is connected to the second body (30) are provided in a manner extending from the front part of the knee towards the rear part of the knee in a compliant manner to the bio-mechanics of the knee joint.
  3. The exoskeleton system (10) according to claim 1, **wherein** for supporting the ankle joint from the front part thereof, said foot embodiment (50) comprises at least one connection bracket (51) connected to the second body (30) so as not to project from the foot periphery.
  4. The exoskeleton system (10) according to claim 1, **wherein** the foot embodiment (50) comprises at least one foot plate (53) which can be connected to the foot base, and at least one finger plate (54) associated with said foot plate (53) in a movable manner with respect to each other.

5. The exoskeleton system (10) according to claim 1, **wherein** the first body (20) is connected to the leg upper part by means of at least one thigh connection element (21).
- 5      6. The exoskeleton system (10) according to claim 1, **wherein** the second body (30) is connected to the leg lower part by means of at least one shank connection element (31).
- 10     7. The exoskeleton system (10) according to claim 1, **wherein** the isogram mechanism (M) is configured to fit the user around the knee and the foot part of the foot embodiment (50).

15

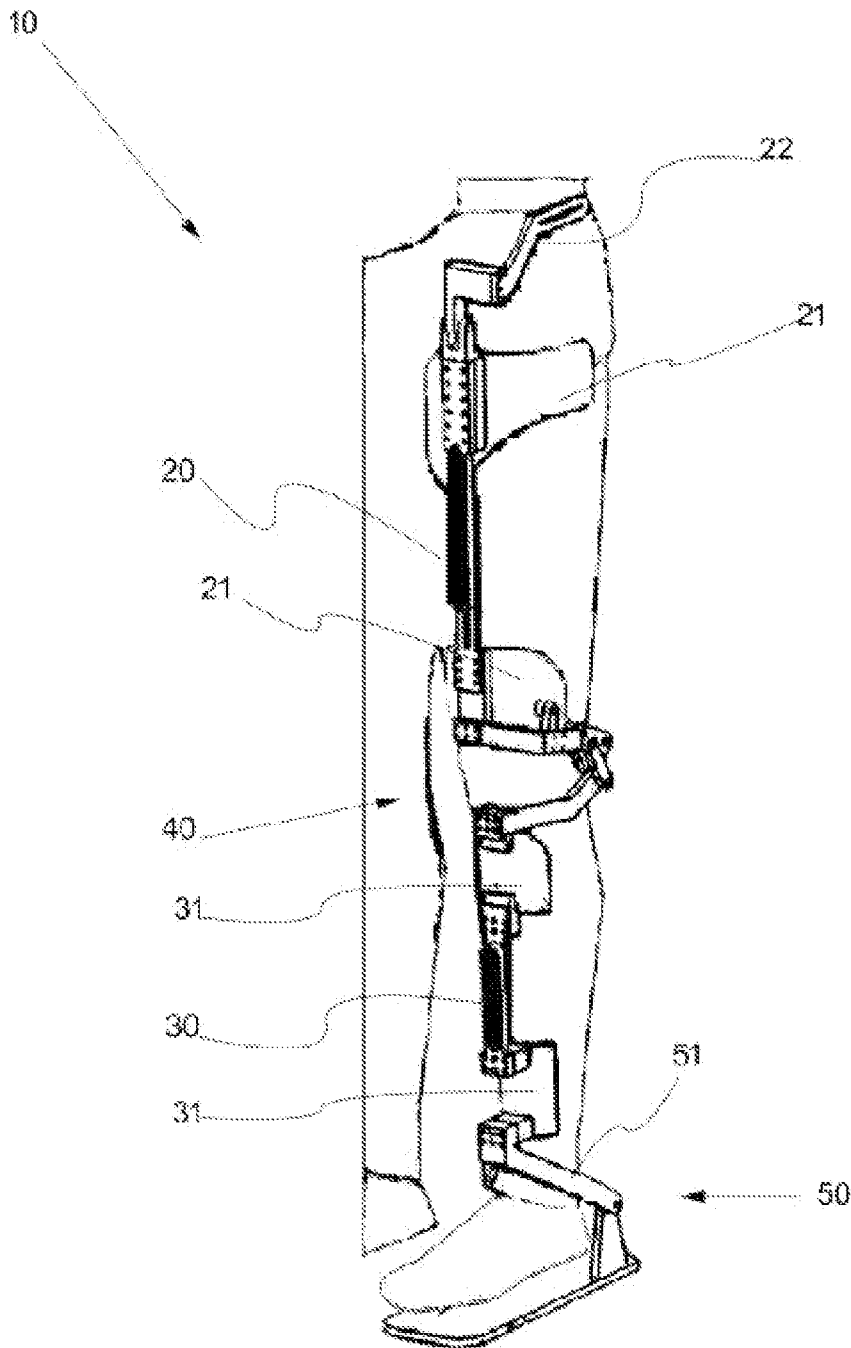


Figure 1

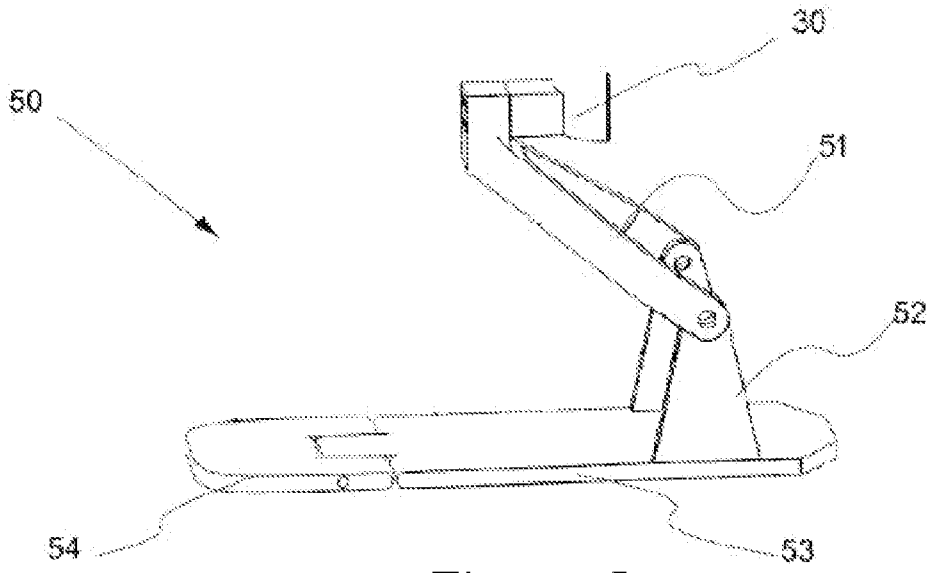


Figure 2

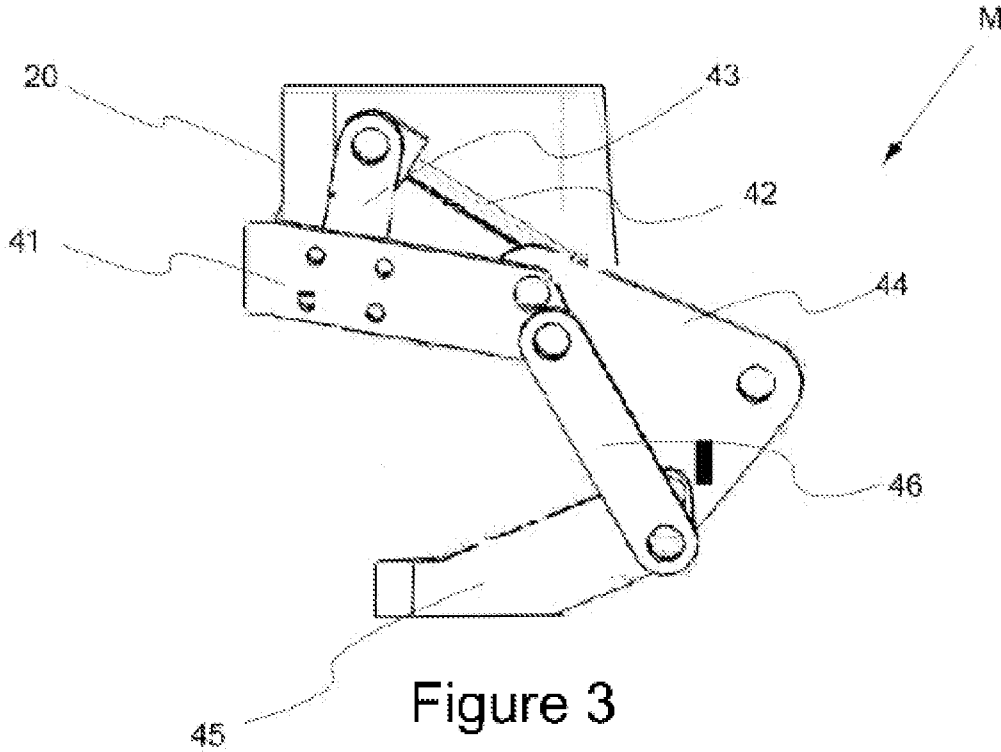


Figure 3

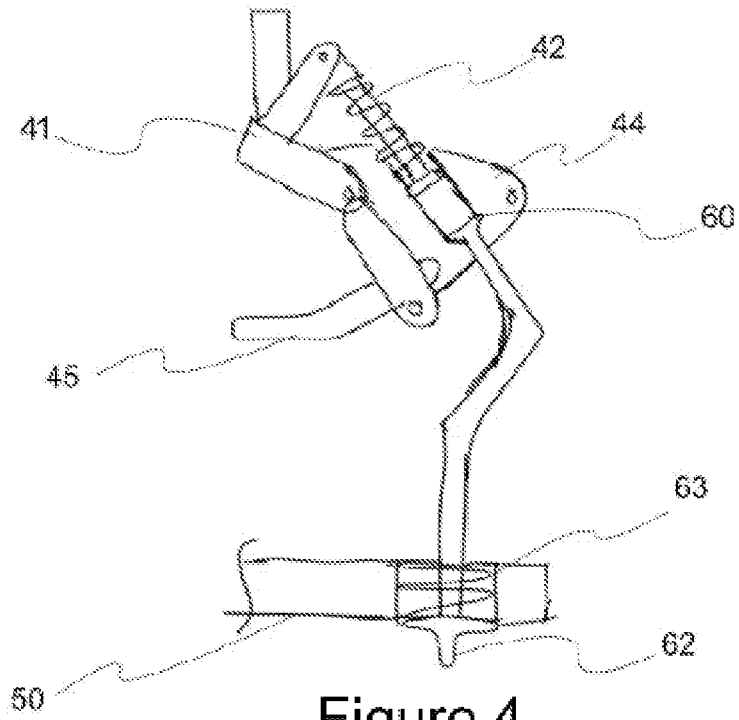


Figure 4

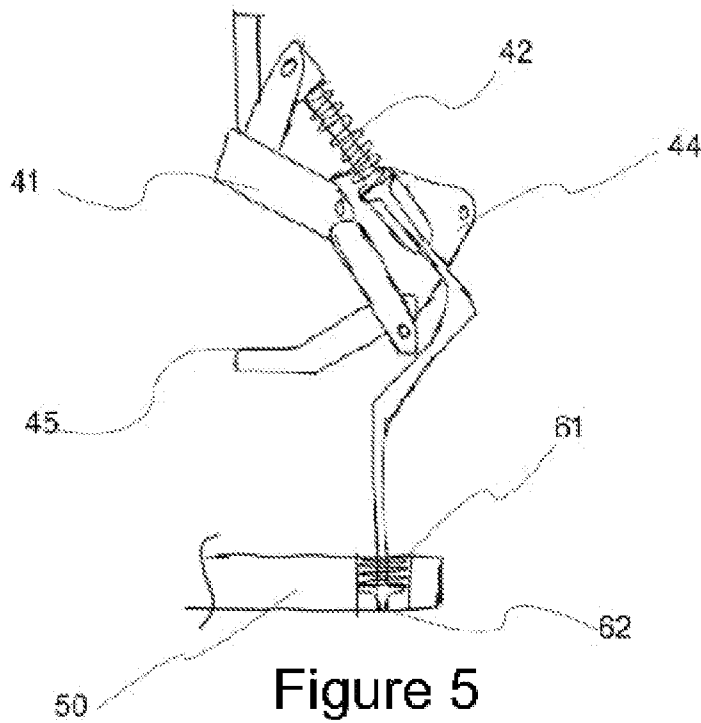


Figure 5

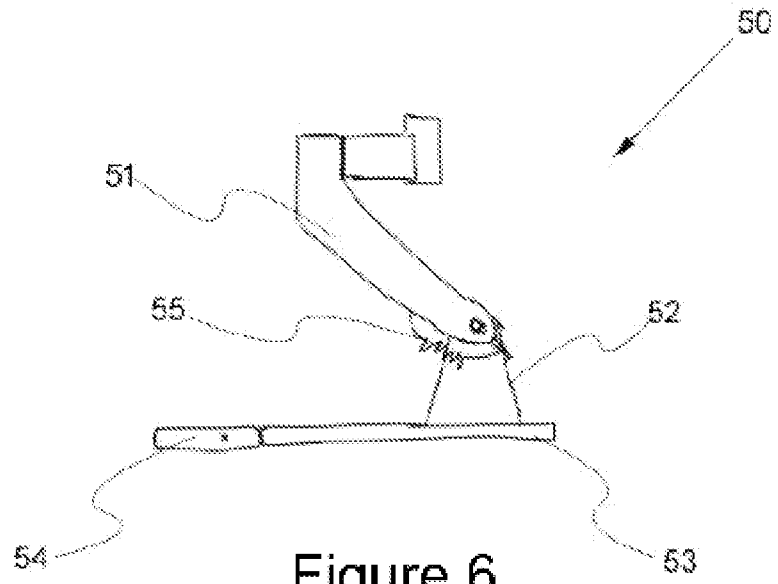


Figure 6

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/TR2020/051460

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
A61H 1/02 (2006.01)i; A61H 3/00 (2006.01)i; B25J 9/00 (2006.01)i		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) A61H; B25J		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 2015321341 A1 (SARCOS LC [US]) 12 November 2015 (2015-11-12) Abstract; Figures 3A, 3B; Paragraphs 25, 32-37	1-7
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<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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Date of the actual completion of the international search <b>27 September 2021</b>		Date of mailing of the international search report <b>27 September 2021</b>
Name and mailing address of the ISA/TR <b>Turkish Patent and Trademark Office (Turkpatent) Hipodrom Caddesi No. 13 06560 Yenimahalle Ankara Turkey</b> Telephone No. (90-312) 303 11 82 Facsimile No. +903123031220		Authorized officer  <b>MERYEM ERKEN TÜRKMEN</b>  Telephone No. 00905053034618

**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No. <b>PCT/TR2020/051460</b>
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