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(54) **Arm support**

(57) The present invention relates to arm support, comprising: a carrier, connectable to or forming part of a user support, such as a (wheel) chair; a first arm-part, pivotably connected to the carrier; a second arm-part, rotatably connected to the first arm-part, comprising a

support, such as a scale, for an fore arm; a first spring-element, for exerting a force on the first arm-part with respect to the carrier, and a second spring-element, for exerting a force on the second arm-part with respect to a reference outside the second arm part.

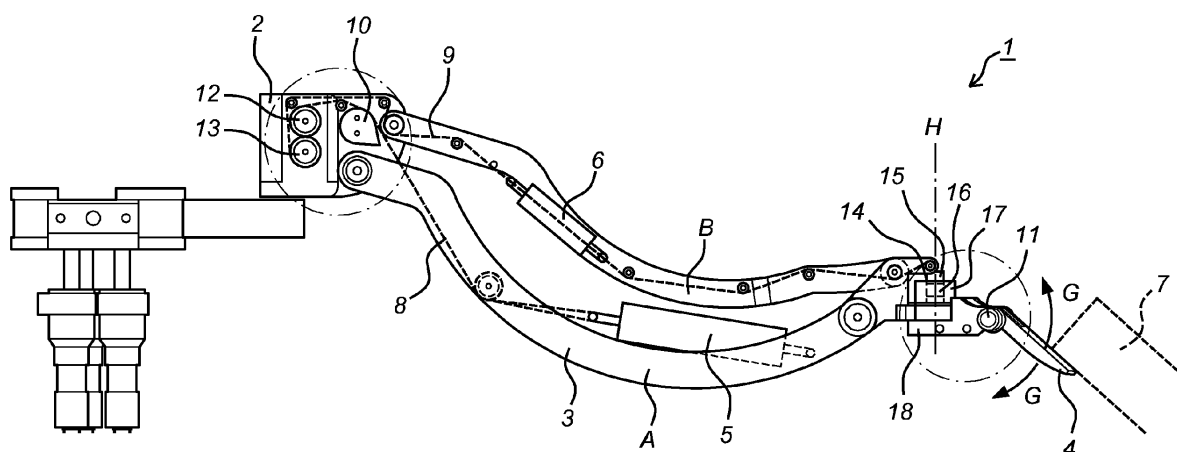


Fig. 2

Description

[0001] The present invention relates to an arm support, in particular an arm support for use on a wheelchair, but it may also be used on other devices, like a working chair, a carriage or a table.

[0002] Arm supports are generally known in the art. They may be considered as part of a general class of devices for supporting body parts, often referred to as orthotics or orthosis devices. Arm supports, also mobile arm supports or dynamic arm supports, can be seen as a separate class of active orthotics, distinguished from other classes due to its connection on one side to the fixed world.

[0003] Dynamic arm supports are mechanic devices that serve to carry the weight of an arm and a hand of a user. They compensate for the weight of the arm and hand, and allow a user to control the motion of their arm and/or hand by transferring a force or their remaining capacity exerted by minimal movement of the shoulder girdle.

[0004] A general property of dynamic arm supports is that they are connected to the solid world, formed for example by a chair, wheelchair, table or movable support. Since the device follows natural movement of the arm, it is also referred to as exoskeleton. In medical technology, the term active orthosis (device) may be found as well.

[0005] A purpose of arm supports is their use to extend the use of the senso-motoric functioning of the user. In this aspect, an arm support is distinguished from a so called robot-manipulator, that takes over human functions as a whole. An arm support thus offers a user more possibilities to use even minimal remaining body functions leading to prolonged health, a higher participation level and more independence.

[0006] Two types of arm supports may be recognised. First is a traditional Mobile Arm Support (MAS) that encounters the forearm from below. The arm then rests on the support, that balances the bottom side. Second is a so called sling-type, wherein counter-weights compensate for the weight of the arm via counter weights, that act on a sling that supports the arm. All types may be powered or unpowered, by active (e.g. electric engine) or passive (e.g.) spring elements. A further difference can be made between adaptive and non-adaptive supports, the adaptation being on the required movement force.

[0007] Various examples of an arm support according to the art are sold by the applicant. These devices certainly fulfil a need in serving users with a decreasing muscular force, but there is always a demand for devices that perform under very challenging physical conditions, that are smaller and more convenient, and that exert a more accurate counterbalancing force on the arm.

[0008] An example of an arm support that provides a balanced force is given in the patent US 6 821 259. This device has two limb sections that each consist of a par-

allelogram construction (referred to as four bar linking), for providing an equilibrium-inducing force. Although this device offers an improvement in the sense of the accuracy of the balancing forces, in practice it appears to be too voluminous to enable an easy use. Further disadvantages are that there are too many construction details underneath as well as beside the lower arm and that the forearm as well as the upper arm need fixations.

[0009] It is a goal of the present invention to provide an arm support that overcomes the above disadvantages, and/or provides a useful alternative to the existing arm supports.

[0010] The invention thereto proposes an arm support for use on a wheelchair, comprising a carrier, connectable to the wheelchair, a first arm-part, pivotally connected to the carrier, a second arm-part, pivotally connected to the first arm-part, comprising a support, such as a scale, for a forearm, a first spring-element, for exerting a force on the first arm-part with respect to the carrier for supporting an upper arm of a user, and a second spring-element, for exerting a force on the second arm-part with respect to a reference outside the second arm part, for supporting a forearm of a user.

[0011] The carrier may be connectable to the wheelchair, but it may also form an integrated part thereof. The second arm-part is preferably connected to the end of the first arm-part that faces away from the carrier. The carrier may be directly or indirectly connected to the wheelchair at the position of a shoulder of a user, which may be a different position for each user. The reference may for example be the carrier, or another point that belongs to the fixed world.

[0012] The term pivotally is used here to indicate a rotational movement about one or more axis of rotation. In general, there may be a free rotation about at least one vertical axis of rotation, and a balanced rotation about at least one horizontal axis of rotation.

[0013] Due to this configuration, both forces the arm-part for the upper arm and fore arm are independent. As a result the arm support according to the invention provides an improved support for the forearm of a user with respect to the prior art. Moreover, the use of a reference point for the second spring element outside the second arm enables to minimise the construction and volume of the second arm part, which results in an increased freedom of movement for the user.

[0014] In an embodiment, the first arm-part comprises a parallelogram. The parallelogram enables to apply a force on the second arm-part which is independent of the angle the first arm-part has with respect to the carrier. As a result, the force applied by the second spring-element in order to counterbalance the weight of the forearm can be controlled separately, and both arm-parts are suspended completely independent.

[0015] The leg of the parallelogram that opposite to the leg coupled to the carrier, forms an extension of the fixed world. A torque exerted on this leg by the second arm part does not influence the rotational position of the first

arm part with respect to the carrier.

[0016] The extension of the fixed world can only move in one degree of freedom, while the forces in the other five degrees of freedom are conducted to the fixed world.

[0017] A parallelogram is to be understood here as a mechanical construction with four legs, as well as equivalents thereof, such as gears or pulleys with a chain or (toothed) belt, constructions wherein the parallelogram function is electronically simulated.

[0018] In a further embodiment, the support or scale is clear at its lower side, to provide a maximum freedom of movement to a user. The lower side can be kept clear for example by using a thin hinge as a second arm-part, to which the scale or support is connected. A further contribution to the freedom of movement for the user may be obtained by the shape of the parallelogram of the first arm-part. When at least one of the four legs of the parallelogram is curved, the user has an increased freedom of movement for his or her upper arm.

[0019] In a preferred embodiment, in the arm support according to any of the preceding claims, at least one of the spring elements is configured for compensating the weight of the upper arm and/or fore arm respectively. With compensation it is meant here, that the support force is very close to the force caused by the weight of the upper arm and/or fore arm of the user. This gives the user the feeling that his or her arm floats, and no force needs to be applied by the user to keep his or her fore- or lower arm in a vertical position. The compensation may further be adjusted for objects carried by the user, such as clothing, or a mug or forces to be exerted by the user.

[0020] In yet another embodiment, the weight-compensation by the first spring-element on the first arm-part is dependent on the rotational angle of the first arm-part with respect to the carrier, and/or the weight compensation on the second spring-element on the second arm-part is dependent on the rotational angle of the second arm-part with respect to the first arm-part. When the user holds his arm horizontally, a maximal support is required while when the arm is held vertically, no or just a little support is required. The first and/or second spring-element may for instance be coupled to the carrier by means of a string or a band, which may be a metal string or band, or a rod or plastic or any other material that can handle forces. Instead or in addition to separate spring elements, the band or string may also fulfil this function itself, and may thereto be made of a material with preselected elastic properties.

[0021] The desired force exerted by the arm-part on the arm of the user, is not necessarily be linearly dependent on the angle of rotation. Therefore, in a further embodiment, the string or band is led over an excentric conductor, for obtaining a disproportional stretch of the spring-element with respect to the rotation. This excentric conductor according to the present invention is a specifically shaped piece. Its shape is the outcome of calculations that arrange the disproportional stretch as desired.

[0022] For enabling adjustment of the arm support to various weights of arms and further loads, at least one spring-element may be tightenable. This can be done manually, but there may also be an actuator available for this purpose, which may be embodied with or without computer steering.

[0023] The string or band for exerting a force on the second arm-part may be led through the rotatable connection between the first and the second arm-part. Therefore, the rotatable connection can comprise an axially translatable beared rotation shaft, at both sides coupled to a section of the string or the band. The sections of the string or the band are then arranged mutually rotatable about the axis of rotation. In particular, an axially beared shaft of rotation comprises two parts that are in line, and that are mutually coaxially rotatable. A goal reached by of this rotatable connection is to prevent for variations in length of the band.

[0024] In yet another embodiment, rotational or pivotable movement of at least one arm part with respect to the carrier or the other arm part is lockable. For example, the connection between the first arm-part and the second arm-part about the elbow of the user can be locked to prevent unintended or uncontrolled sideward movement (in a horizontal plane), while balanced movement up and down (in a vertical plane) is enabled.

[0025] A further improvement of the freedom of movement of a user is obtained when the connection of the first arm-part to the carrier comprises a third arm part, to which the second arm-part is pivotably connected, and which is pivotably connected to the carrier.

[0026] This way, the connection of the first arm part, which is located at the shoulder of a user, can be moved around within certain boundaries. This movement is desired since users move their shoulders in order to move their arms. Preferably, also third arm-part hinged parts, like an independent four-angle, in order to enable movement in a horizontal plane.

[0027] The arm support according to the present invention may offer rotational movement in a horizontal plane at the mutual connections of all arm supports and the carrier. Rotational movement within a vertical plane is balanced or compensated.

[0028] When the carrier of the arm support is coupled to a wheelchair or another movable object, this object may not always be level. This can result in an undesired movement of the arm support, in particular about the unbalanced axis of rotation.

[0029] This may be solved by an adjustable connection of the arm support to the carrier. This connection may thereto comprise at least three points of support, of which at least two have an adjustable height. This way, the arm support can be levelled within certain boundaries. In a preferred embodiment, all points of support have an adjustable height. This enables a height compensation or adjustment of the arm support. The points of support may for example be embodied as telescopic pillars.

[0030] The invention will be explained into more detail

now with reference to the figures, wherein:

- Figure 1 shows a perspective view of an arm support according to the invention;
- Figure 2 shows a side sectional view of an arm support according to the invention;
- Figure 3 shows a first detail of an arm support according to the invention;
- Figure 4 shows a second detail of an arm support according to the invention;
- Figure 5 shows a further view of the invention.

[0031] Figure 1 shows a perspective view of an arm support 1 according to the invention. The device comprises a carrier 2, connectable to or forming part of a user support, such as a (wheel) chair (not shown), a first arm-part 3, rotatably connected to the carrier 2, a second arm-part 4, rotatably connected to the first arm-part 3, comprising a support, such as a scale (not shown), for a fore arm of a user. The arm support further comprises a first spring-element 5, for exerting a force on the first arm-part with respect to the carrier 2 for supporting an upper arm of the user, and a second spring-element 6, for exerting a force on the second arm-part 4 with respect to the carrier 2 for supporting a fore arm of the user.

[0032] The first arm-part 3 comprises a parallelogram, comprising members A, B, C and D. The parallelogram enables an independent control of the forces exerted by the spring elements 5 and 6 on the first and second arm part respectively. The second arm part 4 is very compact, and serves to carry a (not depicted) arm support, such as a scale (7, see figure 2). As visible in figures 1 and 2, due to the very small dimensions of the second arm-part, the support or scale 7 is clear at its lower side, to provide a maximum freedom of movement to a user.

[0033] The spring elements 5 and 6 are configured for compensating the weight of the upper arm and/or fore arm respectively, wherein the weight-compensation by the first spring-element 5 on the first arm-part 3 is dependent on the rotational angle of the first arm-part 3 with respect to the carrier 2, and the weight compensation on the second spring-element 6 on the second arm-part 4 is dependent on the rotational angle of the second arm-part 4 with respect to the first arm-part 3. It may further be dependent on the carrier 2.

[0034] This dependency on the rotation is on the one hand caused by the property of a spring, that the extent to which the spring is stretched is related via the spring-constant to the force that acts on the spring, but according to the present invention, a non linearity is introduced. This desired non-linearity is obtained as follows.

[0035] Figure 2 shows how the first and second spring-elements 5, 6 are coupled to the carrier 2 by means of metal bands 8, 9, that are led over specifically shaped conductors 10, 11, for obtaining a disproportional stretch of the spring-elements 5, 6 with respect to the rotation. Conductors 10 and 11 are specifically shaped

excentric with respect to the respective points of rotation of the first arm part 3 to the carrier, and the second arm part 4 to the first arm part 3, and/or with respect to the carrier.

[0036] Both spring elements 5 and 6 are tightenable, for adjusting a force on the weight of an arm of a user of the arm support. Tightening is performed by stretching the spring elements via their respective bands 8 and 9. Thereto, electrically controllable coils 12 and 13 are provided.

[0037] Figures 3 and 4 show the conductors 10 and 11 into more detail. Figure 4 furthermore shows that the band 9 for exerting a force on the second arm-part is led through the rotatable connection 17, 18 between the first and the second arm-parts 3, 4. The rotatable connection 17, 18 comprises an axially translatable (directions F) rotation shaft 14, consisting of mutually rotatable parts 15 and 16, which are each coupled to a section of the string or the band 9. When the second arm part 4 is rotated in a direction J around axis H (see figures 1 and 2), the sections of the band 9 are mutually rotated as well, and they can still be translated in a direction F along axis E, when the second arm part 4 is rotated over an angle G, in order to prevent a change of length of the string or band.

[0038] Figure 5 shows a further improvement of the freedom of movement of a user, obtained by the connection of the first arm-part 3 to the carrier 2 that now comprises a third arm part 19, to which the first arm-part 3 is pivotably connected, and which is pivotably connected to the carrier. The connection of the first arm part 3, which is located at the shoulder of a user, can be moved around within certain boundaries. Also this third arm-part 19 comprises an independent four-angle 20, in order to enable movement in a horizontal plane.

[0039] The arm support offers rotational movement in a horizontal plane at the mutual connections of all arm parts 19, 3, 4 and the carrier 2. Rotational movement within a vertical plane is balanced or compensated. Thereto, the arm support is provided with an adjustable connection of the arm support to the carrier. This connection comprises three points 21, 22, 23 of support, which have an adjustable height K, that is adjustable by telescopic movement of the points of support 21, 22, 23, which are embodied as pillars.

[0040] The above embodiments serve as examples only and do not limit the scope of protection as defined by the following claims.

Claims

1. Arm support, comprising:

- a carrier, connectable to or forming part of a user support, such as a (wheel) chair;
- a first arm-part, pivotably connected to the carrier;
- a second arm-part, rotatably connected to the

- first arm-part, comprising a support, such as a scale, for an fore arm;
 - a first spring-element, for exerting a force on the first arm-part with respect to the carrier, and;
 - a second spring-element, for exerting a force on the second arm-part with respect to a reference outside the second arm part.
2. Arm support according to claim 1, wherein the first arm-part comprises a parallelogram.
 3. Arm support according to claim 1 or 2, wherein the support or scale is clear at its lower side, to provide a maximum freedom of movement to a user.
 4. Arm support according to any of the preceding claims, wherein at least one of the spring elements is configured for compensating the weight of the upper arm and/or fore arm respectively.
 5. Arm support according to any of the preceding claims, wherein the weight-compensation by the first spring-element on the first arm-part is dependent on the rotational angle of the first arm-part with respect to the carrier, and/or the weight compensation on the second spring-element on the second arm-part is dependent on the rotational angle of the second arm-part with respect to the first arm-part, wherein the first and/or second spring-element is coupled to the carrier by means of a string or a band, and wherein the string or band is led over an excentric conductor, for obtaining a disproportional stretch of the spring-element with respect to the rotation.
 6. Arm support according to any of the preceding claims, wherein at least one spring-element is tightenable, for adjusting a force on the weight of an arm of a user of the arm support.
 7. Arm support according to claim 5 or 6, wherein a string or band for exerting a force on the second arm-part is led through the rotatable connection between the first and the second arm-part.
 8. Arm support according to claim 7, wherein the rotatable connection comprises an axially translatable beared rotation shaft, at both sides coupled to a section of the string or the band.
 9. Arm support according to claim 8, wherein the sections of the string or the band are mutually rotatable about the axis of rotation.
 10. Arm support according to claim 8 or 9, wherein an axially beared shaft of rotation comprises two parts that are in line, and that are mutually coaxially rotatable.
 11. Arm support according to any of the preceding claims, wherein rotational or pivotable movement of at least one arm part with respect to the carrier or the other arm part is lockable.
 12. Arm support according to any of the preceding claims, wherein at least one of the legs of the parallelogram is curved.
 13. Arm support according to any of the preceding claims, comprising a third arm part, to which the second arm-part is pivotably connected, and which is pivotably connected to the carrier.
 14. Arm support according to of the preceding claims, wherein the third arm-part comprises an independent four-angle.
 15. Arm support according to any of the preceding claims, wherein a connection of the arm support to the carrier comprises at least three points of support, of which at least two have an adjustable height.

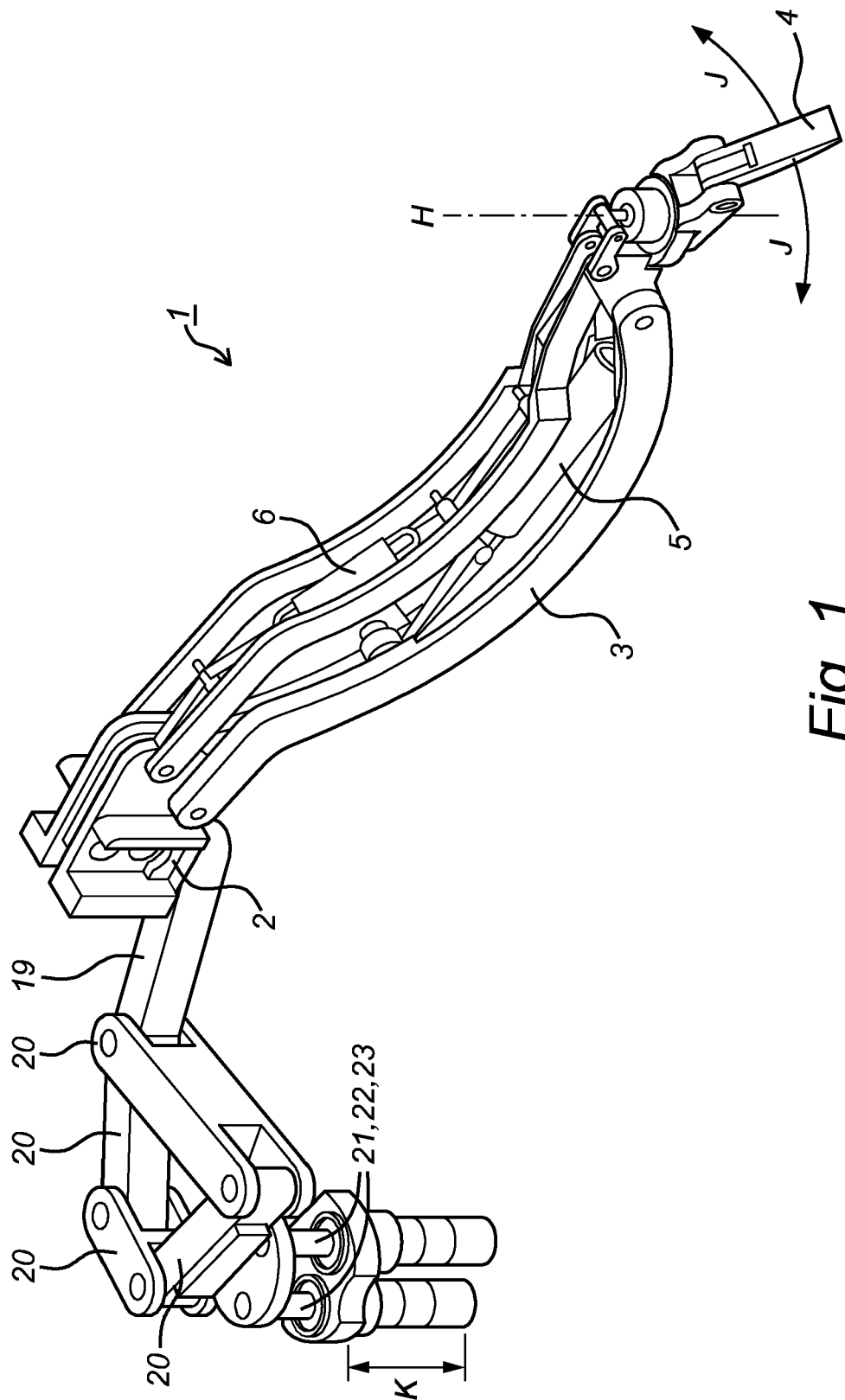
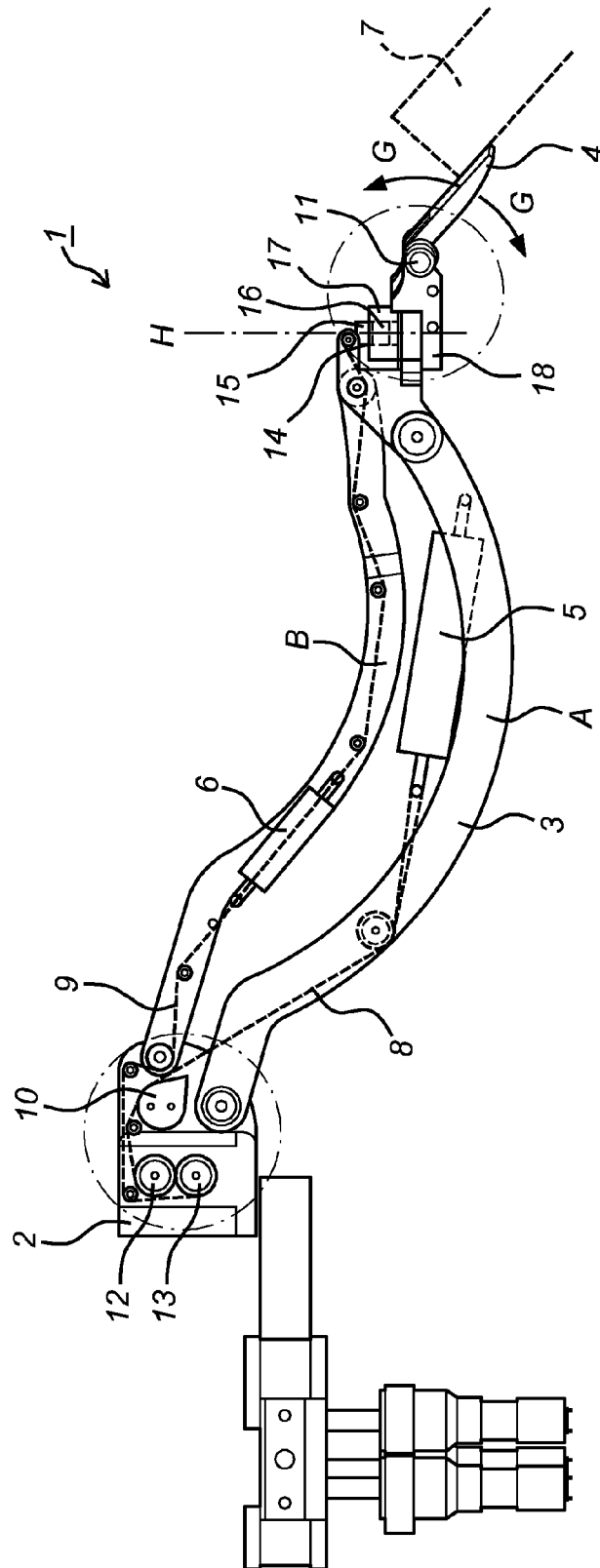


Fig. 1



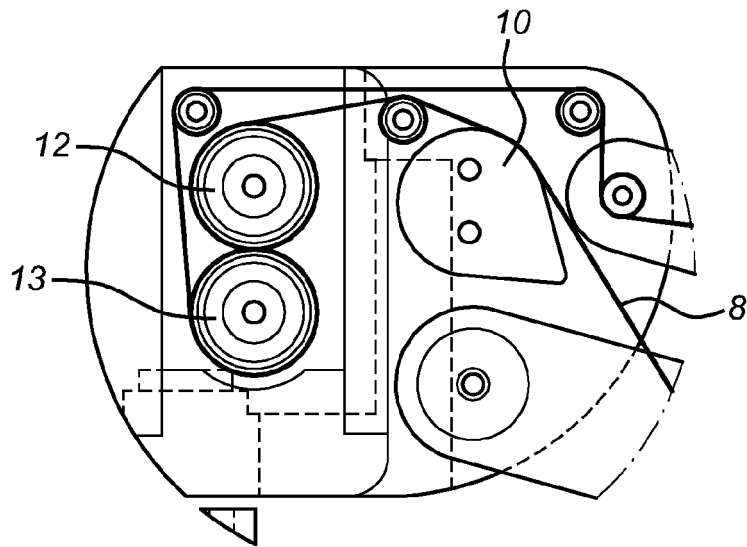


Fig. 3

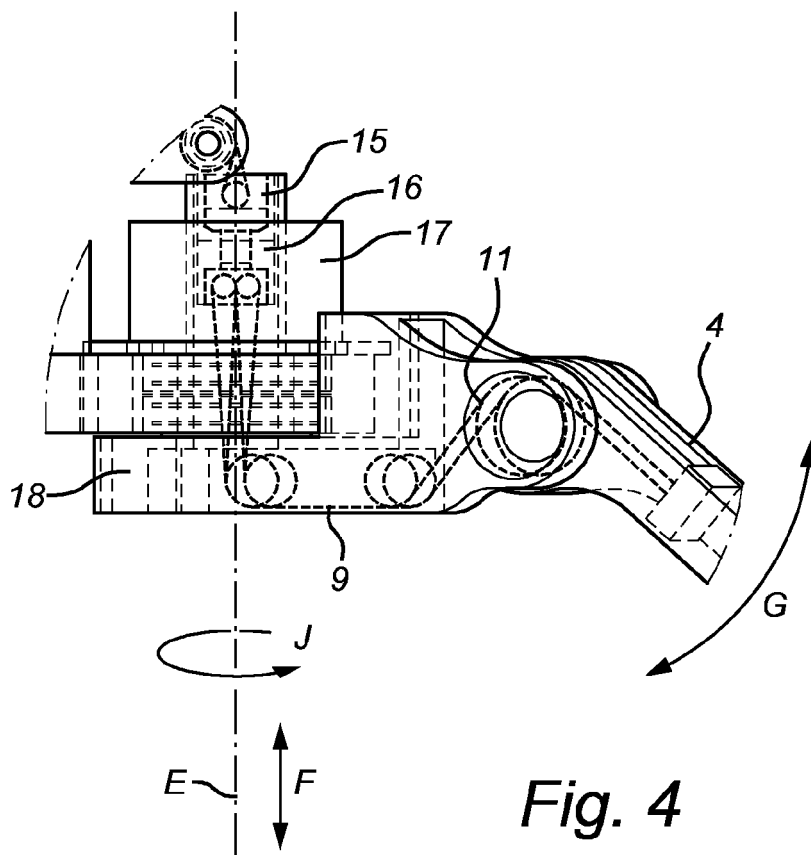


Fig. 4

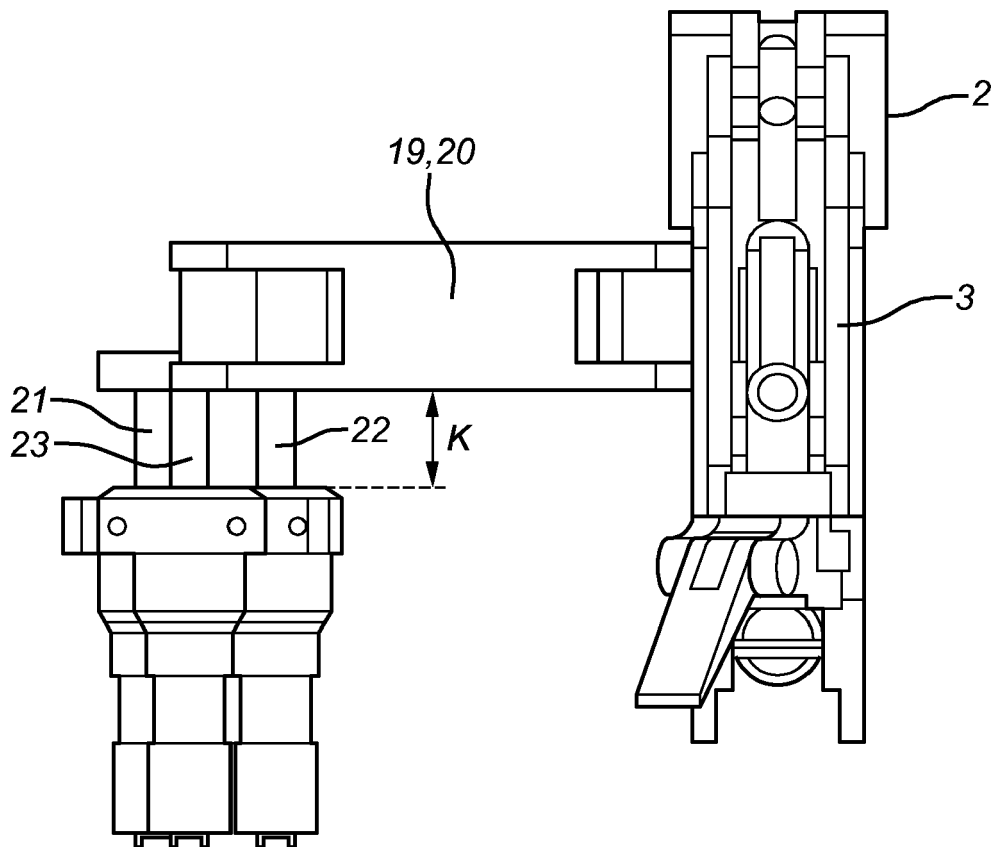


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 12 18 3426

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2003/023195 A1 (RAHMAN TARIQ [US] ET AL) 30 January 2003 (2003-01-30) * abstract * * paragraphs [0019], [0037] - [0043] * * figures *	1-7,15	INV. A47C1/03 A61G5/10
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			TECHNICAL FIELDS SEARCHED (IPC)
			A47C A61F A61G
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 December 2012	Examiner MacCormick, Duncan
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 18 3426

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The members are as contained in the European Patent Office EDP file on
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19-12-2012

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REFERENCES CITED IN THE DESCRIPTION

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