(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 165 207 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.05.2017 Bulletin 2017/19

(51) Int Cl.:
A61G 15/02 *(2006.01)*

(21) Application number: **16197167.6**

(22) Date of filing: **03.11.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **05.11.2015 IT UB20154959**

(71) Applicant: **CEFLA SOCIETA' COOPERATIVA**
40026 Imola (BO) (IT)

(72) Inventor: **TROMBETTI, Maurizio**
40026 Imola (BO) (IT)

(74) Representative: **Karaghiosoff, Giorgio Alessandro**
Studio Karaghiosoff e Frizzi S.r.l.
Via F. Baracca 1R 4° piano
17100 Savona (IT)

(54) **DENTAL PATIENT CHAIR**

(57) Patient chair (1) preferably for dentistry, comprising a lifting group comprising a base (4) on which a pantograph arm (5) is hinged, which is hinged on and shifts a turret (14), a moving group for relatively moving said seat (3), comprising an under seat (15) which is in its turn hinged to said turret (14) through two piston rods (6 and 7), wherein the reclining of the backrest (2) occurs according to an arc of a circle, said chair (1) having moreover a longitudinal compensation mechanism. According to the invention, said reclining and compensation movements are obtained thanks to the combination of an arc prismatic guide system for backrest reclining, dynamically combined with a four-bar linkage for moving the under seat (15) and seat (3), said four-bar linkage comprising said two piston rods (6 and 7), said turret (14) and an under seat (15) which links said seat (3) to said turret (14) and said movements are obtained through an actuator only.

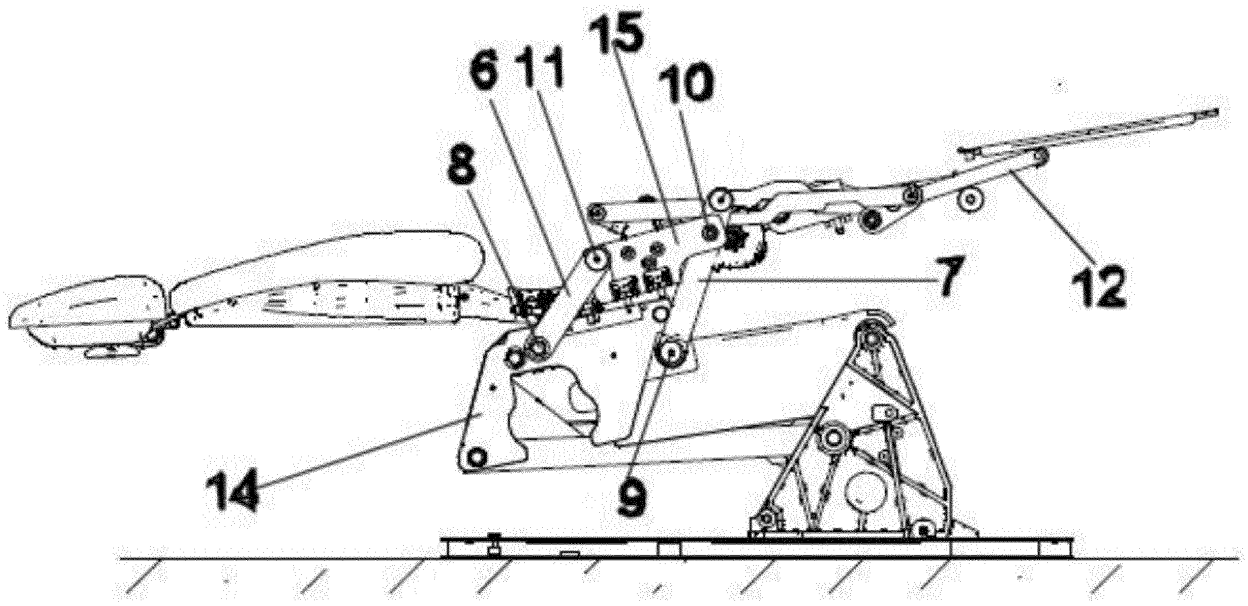

FIG. 6

EP 3 165 207 A1

Description

[0001] The present invention relates to the technical field of patient chairs used in dentistry. More particularly, the invention relates to an apparatus according to the preamble of claim 1 and a method according to the preamble of claim 9 allowing patient chair's movements.

[0002] In the history of dentistry, until at least 1960s, dentists used to work standing, while today dentists work mainly sitting. Dental chair manufacturers strive to provide dental treatment units allowing the dentist to work ergonomically, i.e. comfortably, without damaging dentist's musculoskeletal system.

[0003] At the same time, patient chairs must be comfortable for patients: comfortable patients are more relaxed, and for dentists working is easier.

[0004] An appreciated feature of dental patient chairs is the possibility of holding the patient in Trendelemburg position. Trendelemburg position, or anti-shock position, is the position wherein a patient is placed in case of shock or during the performance of specific operations: the patient is supine, lying so that her/his head is lower than her/his knees and pelvis, to help maintain blood flow to the brain. Moreover, Trendelemburg position reclines patient's head allowing chest and legs to form an angle, instead of having chest and legs aligned in a position that can be uncomfortable for the patient. Trendelemburg position eases dentist's work in performing some kind of therapies.

[0005] A problem linked to the reclining of backrest is that while the backrest reclines, patient's head, on which the dentist operates, progressively relocates in space, from a position substantially aligned with her/his hip joint, to a position wherein patient's head is at a marked distance from patient's hip, say in the order of 50-70 cm. This forces the dentist, normally positioned on patient's side or behind the patient, to replace with respect to the room and the dental treatment unit along with backrest reclining. Figures, particularly Figures 3 and 4, will help to better clarify this effect.

[0006] Moreover, when the working position is aligned with the chair longitudinal axis, and therefore the dentist is positioned behind patient's head, often when reclining the chair no room is left for the dentist. Therefore, wide spaces become necessary to accommodate the dental treatment unit and all the accessories and tools needed by the dentist.

[0007] In the known art, there are two kinds of patient chairs:

- Patient chairs having the seat consisting in a unique part, whose only articulation is at the level of patient's hip; this means that thighs and distal portion of legs form a steady angle;
- Patient chairs having a two-part seat, having a first articulation at the level of patient hip, and a second articulation at the level of patient knees. In these two-part seat chairs, patients can seat upright as in any chair, with the distal leg portion forming an angle of about 90° with respect to thighs. In this kind of chairs there is a seat, which remains substantially parallel to the floor, from the leg-rest, which can rotate from a positions substantially parallel to the floor, to a position substantially perpendicular to the floor; i.e. the angle between thighs and distal portion of legs is variable.

[0008] Manufacturers have industrially produced dental patient chairs for over a hundred years; a known document is e.g. EP0253943B1 of Castellini, wherein Trendelemburg position is reached through a hydraulic system. Document EP0253943 discloses a four bar linkage of the seat which is linked to the backrest by means of a connecting link comprising two pivot connections and displacing the backrest together with the seat by means of a common actuator.

[0009] Document US3,934,929 discloses an arc bracket supporting the backrest and a sliding movement of the bracket. This bracket is however not linked with a four-bar linkage for controlling the motion of the seat.

[0010] The above-quoted patents, with many others, describes patient chair internal structure, allowing the movement of the chair. In fact, while in use the chair has typically a position wherein its backrest is at about 90° with respect to the floor (upright position) and a position wherein the backrest is substantially parallel to the floor (reclined position), with all the intermediate positons between said two extremities. Said positions are obtained through a wide variety of relatively complex mechanisms and actuators. Moreover, when modifying the law of relative motion between backrest and seat, the replacement or alteration of parts of said mechanism is complex and time-consuming, as it requires accessing and disassembling a high number of parts of the kinematic chain of articulation between backrest and seat.

[0011] Aim of the present invention is providing a mechanism allowing to bring the backrest from the upright position to the reclined position and vice versa, which is efficient and cost-effective to manufacture.

[0012] A second aim of the present invention consists in limiting the dentist's relocation connected to chair reclining. The mechanism of the present invention allows a backrest movement that is coordinated with the seat, which shifts until it reaches an ergonomically correct position for the patient, in case of need until the maximal extension in Trendelemburg position. In other words, during the reclining of the backrest, there is also a shifting of the backrest towards patient's feet of the backrest itself and contextually of the seat too, to compensate the sheer shift due to backrest reclining, would it be hinged to a stationary pivoting axis. This has the aim of maintaining as much as possible patient's head in the same position as when patients seats upright (longitudinal compensation movement). This movement allows to maintain the relative patient's head position with respect to water group, instruments table and operating lamp and with

respect to the room (furniture and walls of the dental practice).

[0013] A further aim is obtaining a chair structure having a manufacturing modularity:

- Simple patient chair having 1) Trendelemburg position obtained through backrest reclining, wherein longitudinal compensation movement is absent;
- Patient chair with unique-part seat, reaching 1) Trendelemburg position and 2) longitudinal compensation;
- Patient chair with two-part seat comprising 1) Trendelemburg position, 2) longitudinal compensation, 3) relative movement between seat and leg-rest.

Starting from the same basic structure for lifting the chair and adding the structure seat-backrest, modifying the system of movement of the structure seat-backrest, and applying some leverages, the performance of the patient chair can be differentiated from low-end to high-end product. In this way, the client can be provided with a complete range of performances with a reduced production cost, linked to the limitation of production codes.

[0014] This object is achieved by an apparatus and a method having the features of the independent claims. Advantageous embodiment and refinements are specified in the claims dependent thereon.

[0015] Substantially the present invention consists in obtaining the backrest movement through a combined arc prismatic guide system, through which the backrest is pivoted from the substantially vertical position or upright position to the substantially horizontal position or Trendelemburg position and vice versa. Moreover, the backrest is contextually translated along the chair longitudinal axis, in the direction of the seat and in the opposite direction, respectively, progressively and according to the tilting of the backrest itself, while said oscillation/translation is combined with a corresponding simultaneous translation of the seat, thanks to a four-bar linkage that moves said seat. The arc prismatic guide system is dynamically connected to said four-bar linkage, the assembly being actuated by an actuator only. Optionally, to these two components a third mechanism is connected, which angularly moves the leg-rest with respect to the fixed seat.

[0016] It is worth noting that in the preferred embodiment, the arc prismatic guide is centrally positioned, symmetrically with respect to the longitudinal chair axis, and it allows the articulation between the backrest and the fixed seat around an axis of rotation corresponding with patient's hip.

[0017] In a not shown embodiment, a lateral prismatic guide can be used (positioned either on the right or on the left side of the chair, or on both sides); nonetheless, this configuration has the disadvantage of being more cumbersome, hindering the access of the dentist to the patient in comparison to the preferred embodiment.

[0018] In an embodiment, the backrest has at least an arc bracket supporting on one end the support of backrest upholstery, while its opposing end engages with a carriage in an arc guide. Said arc guide is integral with the mobile structure with respect to the turret, which is in turn hinged with the pantograph arm, while said end supporting said at least one carriage is dynamically connected to at least one element of the four-bar linkage to which the seat supporting frame is connected.

[0019] The dynamic connection between arc guide system, or particularly between the backrest bracket and the four-bar linkage to which the seat is fastened, can be realized according to different modalities, which can be chosen from the different motion transmission system known by the skilled person.

[0020] According to an advantageous feature, a unique motorized actuator is dynamically linked to an element of the prismatic guide system, and moves correspondingly the four-bar linkage, and optionally the leg-rest moving mechanism, when this last is present.

[0021] In particular, the four-bar linkage, the prismatic guide system, the connecting transmission system between said prismatic guide system and four-bar linkage, and also the mechanism moving the leg-rest and the dynamically connecting transmission system between leg-rest and arc prismatic guide system, or the transmission between said system and the four-bar linkage are produced as modular subassemblies which can be assembled as desired on the structure of the chair, in particular on chair turret.

[0022] A first advantage of the present invention is the standardization of parts; with a minimal number of additional, modular components, the chair can be provided with more and more refined performances, going from a basic chair to a premium chair.

[0023] A further advantage is linked to the presence of a longitudinal compensation movement, in that the position of the water group and of the dental treatment unit remains about the same on the dentist's side, with any position of the backrest.

[0024] Further advantages and properties of the present invention are disclosed in the following description, in which exemplary embodiments of the present invention are explained in detail based on the drawings:

Figure 1 Lateral view of a patient chair having its backrest in an upright position;

Figure 2 Lateral view of a patient chair having a completely reclined backrest in Trendelemburg position;

Figure 3 Lateral view of a patient chair having its backrest in an upright position, showing its leverages;

Figure 4 Lateral view of a patient chair having a completely reclined backrest in Trendelemburg position, showing its leverages;

Figure 5 Lateral view of a patient chair having its backrest in an upright position, showing a four-bar linkage;

Figure 6 Lateral view of a patient chair having its backrest in reclined position, showing a four-bar linkage.

[0025] Figure 1 shows a typical dental patient chair 1 comprising a backrest 2, a fixed part 3 of the seat hinged with a leg-rest 13, a base 4 and a pantograph arm 5. The chair 1 is shown with an upright backrest, about perpendicular to the floor.

[0026] For simplicity's sake, a two-part seat chair is shown, having two articulations, one at the level of patient's hip and one at the level of patient's knees: therefore, the mobile leg-rest 13 can be hinged with the fixed part 3 of the seat. Anyway, the operation remains the same even for a chair having a unique part seat 3.

[0027] The pantograph arm 5 allows the lifting and lowering of the seat 3, indicatively from a height of 460 to 840 mm with respect to the floor. The top end of the pantograph arm forms a sort of turret 14 supporting the reclining mechanism of the backrest and coordinated movement of the seat. The structure of turret 14, base 4 and pantograph arm 5 is known, and is not the object of the present invention.

[0028] Figure 2 shows the same chair 1 in Trendelemburg position, with completely reclined backrest 2, about parallel to the floor. The reclining of backrest 2 from the upright position shown in Figure 1 to the reclined position shown in Figure 2 occurs through an arc prismatic guide. Comparing Figure 3 and 4 one can appreciate how, while reclining the backrest 2, there is a longitudinal compensation movement, i.e. along the longitudinal axis of the (not shown) patient, towards her/his feet.

[0029] In Figure 3 an arc of a circle simulates the movement of the head-rest and of the backrest 3; in the absence of the compensation movement that is the object of the present invention, patient's head would be in point K. Drawing the (dotted) vertical extension of the K point, in Figure 4 it is shown that, with reclined chair, the distance q from point K projected in point B, with respect to reference point P on the fixed base of the chair is reduced thanks to the longitudinal compensation movement. In other words, in the absence of the four-bar linkage object of the present invention, when the backrest 2 is completely reclined, patient's head travels along an arc of circle and ends in point K, which is at a distance k from the fixed reference point P; said distance k corresponds to the cosine (Figure 3). Using the four-bar linkage according to the present invention, seat 3 is instead translated towards patient's feet, which compensates in the desired quantity, reducing the distance k, which becomes the distance q shown in Figure 4. The compensation is $\Delta = k - q$. To the skilled person it is apparent that modifying the four-bar linkage, and particularly the length of piston rods 6 and 6 and their angles, the distances k and q can be modified as desired.

[0030] Figures 5 and 6 allow to appreciate both the arc guide system moving the leg-rest and the four-bar linkage in its entirety.

[0031] The backrest 2, at its end oriented towards the seat 3, has an arc-shaped bracket 102 connecting the backrest to the under seat 15 mobile with respect to the turret 14 hinged on the pantograph arm 5. The end of said arc bracket 102 is engaged through e.g. a slide or a carriage in at least an arc guide integral to the turret and not visible in the Figures.

[0032] A transmission connects the end of said arc bracket 102 provided with the carriage with an element of the four-bar linkage controlling the movement of the seat, e.g. with one of piston rods 6, 7 or with a shaft coinciding with one of the articulation axis of the four-bar linkage.

[0033] The shifting of backrest 2 is dynamically connected to the shifting of the seat, and thanks to the arc guide system, the backrest not only modifies its tilting, but contextually progressively moves forward toward the seat with the progressive increase in reclining, from substantially upright to substantially horizontal and back with the tilting from substantially horizontal to substantially upright, while the seat follows according to a pre-set relative law of motion the shifting of the backrest in the chair longitudinal direction.

[0034] When a leg-rest 13 is present, it performs a combined pivoting and translating movement, synchronised with the movement of backrest 2 and seat 3.

[0035] Substantially, said four-bar linkage o parallelogram comprises two piston rods 6 and 7, the fixed member turret 14 and mobile member under seat 15 (visible in Figure 6 only). The four-bar linkage articulates on the pivot pins 8, 9, 10, 11 positioned on piston rods 6 and 7. In particular, pivot pins 8 and 9 are hinged on turret 14, while pivot pins 10 and 11 are hinged on under seat 15, to which seat 3 is connected.

[0036] In Figure 6, with reclined chair, one can observe that piston rods 6 and 7, being of different length, are about vertical, while piston rod 7 is in a higher position than piston rod 6, so that the seat is inclined with its part towards patient's feet higher than the part toward patient's head: this allows to obtain Trendelemburg position.

[0037] Observing the position of the two leverages 6 and 7, they pass from being inclined toward patient's head (with upright backrest; Figure 5) to being inclined toward patient's feet (with reclined backrest; Figure 6).

[0038] Suitably choosing the length of piston rods 6 and 7 and the leverages linked to them, and modulating the angles of the four-bar linkage, different patient's positions and dentist's ergonomics can be reached.

[0039] In particular, with respect to chair modularity, the basic version can be obtained with the seat 3 components in use today, which are fixed to the turret 14, in its turn hinged with the pantograph arm 5 through a simpler kit of leverages. Adding the mechanism of the four-bar leverage comprising the two piston rods 6 and 7 with a different kit of leverages, two results are obtained: Trendelemburg position with completely reclined backrest, and longitudinal compensation movement. Adding a fur-

ther leverage 12, the movement of the terminal part of the seat (leg-rest 13) with respect to the fixed seat 3.

[0040] In this case, dynamically connecting through a transmission the leverage 12 for moving the leg-rest 13, the leg-rest movement itself is synchronized to the movement of the seat and of the backrest.

[0041] To the skilled person it is apparent that such movements can be performed through a variety of different actuators: e.g. hydraulic, pneumatic, or electric actuators. In the preferred embodiment, electromechanical actuators were used (endless screw, direct current or alternating current motor).

1	Dental chair
2	Backrest
102	Bracket
3	Seat
4	Chair base
5	Pantograph arm
6	Short piston rod
7	Long piston rod
8	First pivot pin of the short piston rod
9	First pivot pin of the long piston rod
10	Second pivot pin of the long piston rod
11	Second pivot pin of the short piston rod
12	Leverage for the hinging of leg-rest
13	Mobile leg rest
14	Turret
15	Under seat

Claims

1. Patient chair (1) preferably for dentistry, comprising:

- A lifting group comprising a base (4) on which a pantograph arm (5) is hinged, which is hinged on and shifts a turret (14),
- A moving group for relatively moving said seat (3), comprising an under seat (15) which is in its turn hinged to said turret (14) through two piston rods (6 and 7), wherein the reclining of the backrest (2) occurs according to an arc of a circle, said chair (1) having moreover a longitudinal compensation mechanism,

characterized in that

said reclining and compensation movements are obtained thanks to the combination of an arc prismatic guide system for backrest reclining, dynamically combined with a four-bar linkage for moving the under seat (15) and seat (3), said four-bar linkage comprising said two piston rods (6 and 7), said turret (14) and an under seat (15) which links said seat (3) to said turret (14) **and in that**

- said movements are obtained through an actuator only and
- wherein the arc guide system comprises a supporting arc bracket (102) of the backrest (2), said arc bracket slidingly engages with its end opposed to the backrest (2) in an arc guide and stationary with respect to said under seat (15) mobile with respect to said turret (14), said sliding of the arc bracket (102) causing a variation of backrest tilting and a contextual translation of the said backrest (2) in the direction of the chair longitudinal axis, and according to the angle of tilting and the direction of tilting.

2. Patient chair (1) according to claim 1 or 2, wherein said actuator is chosen from the group consisting of: hydraulic, pneumatic, electric or electromechanical actuators.

3. Patient chair (1) according to one or more of the preceding claims, wherein said seat (3) is fixed and there is an articulation at patient's knee level with a leg-rest (13) through a leverage (12).

4. Patient chair (1) according to one or more of the preceding claims, wherein said four-bar linkage comprises two piston rods (6, 7) having different length.

5. Patient chair (1) according to claim 5, wherein the shortest piston rod (6) is positioned towards patient's head, while the longest piston rod (7) is positioned towards patient's feet.

6. Patient chair (1) according to one or more of the preceding claims, wherein said arc prismatic guide allowing the hinging between backrest (2) and seat (3) is positioned centrally, symmetrically with respect patient's longitudinal axis.

7. Patient chair (1) according to one of claims 1-6, wherein said arc prismatic guide allowing the hinging between backrest (2) and seat (3) is positioned laterally, on the right or left side with respect to patient's longitudinal axis.

8. Patient chair (1) according to one of claims 1-6, wherein there are two arc prismatic guides allowing the hinging between backrest (2) and seat (3) positioned laterally, on the right and left side with respect to patient's longitudinal axis.

9. Method for the respective moving of a backrest (2), seat (3) and optionally a leg-rest (13), making use of at least an arc prismatic guide system and a four-bar linkage consisting of two piston rods (6, 7) hinged on a fixed member which is the turret (14) and a mobile member which is the under seat (15) connected with seat (3), having as pivots pins (8, 9, 10, 11) on the piston rods (6 and 7), according to claims 1-9, **characterized in that** it uses a supporting arc bracket (102) of the backrest (2), said arc bracket

slidingly engaging with its end opposed to the back-rest (2) in an arc guide and stationary with respect to said under seat (15) mobile with respect to said turret (14) and an actuator only.

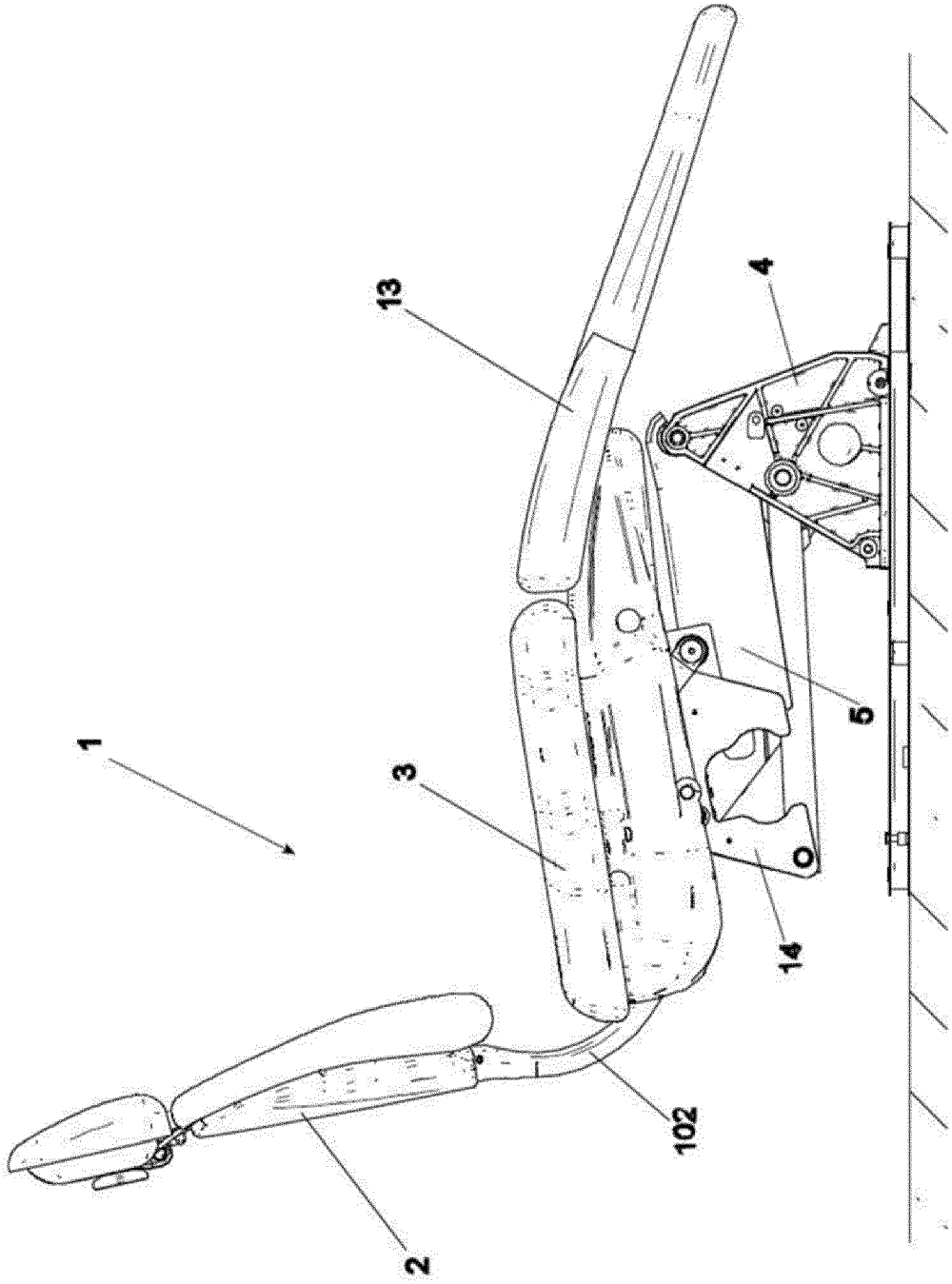

FIG. 1

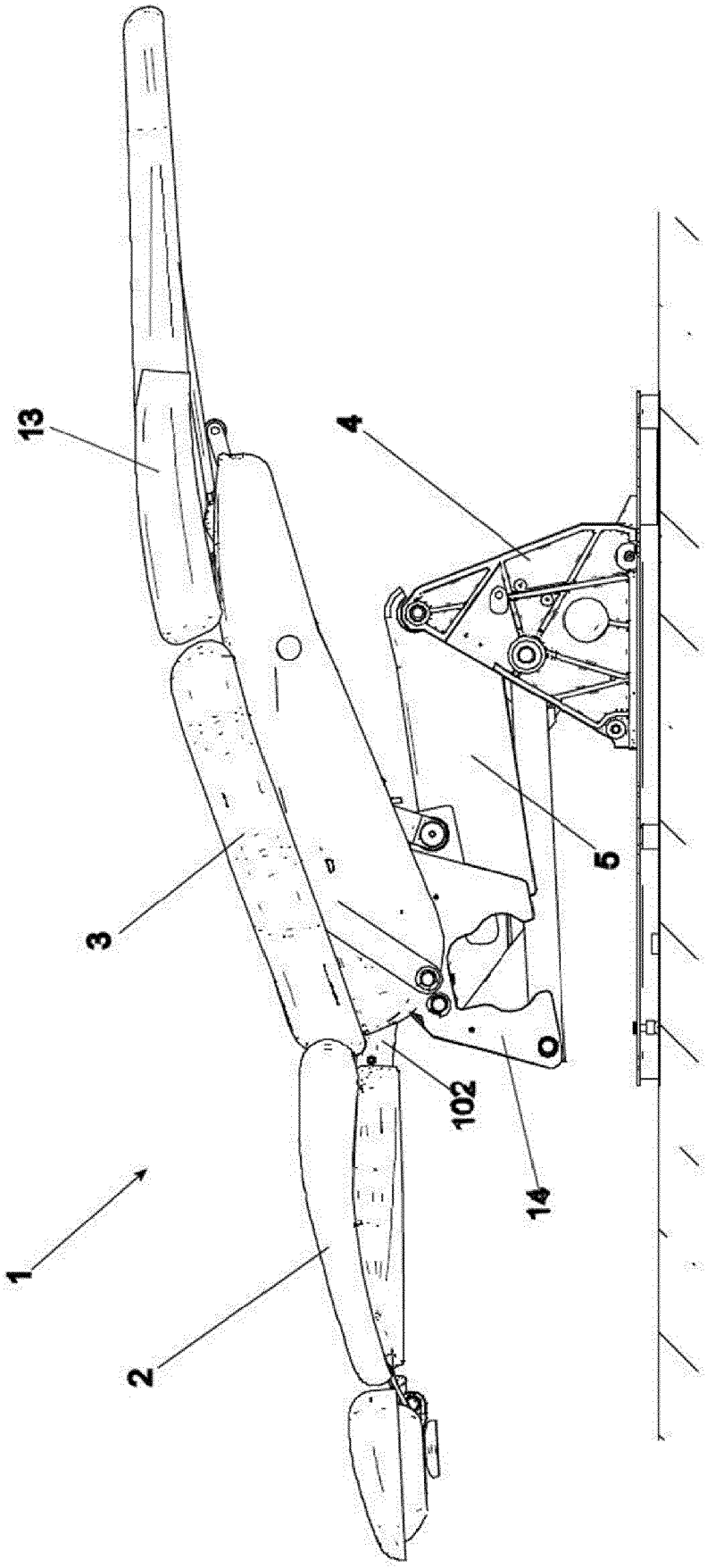

FIG. 2

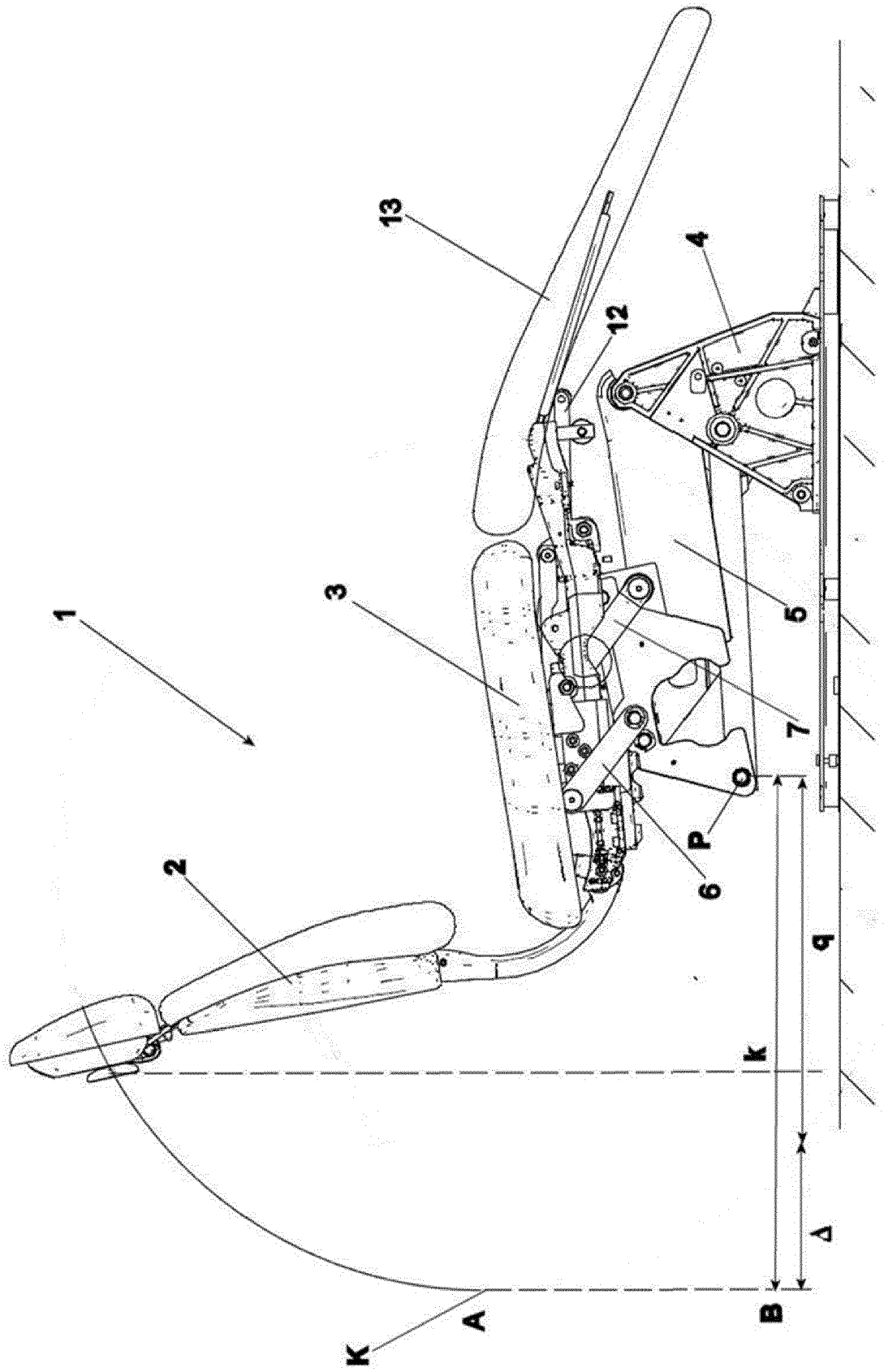

FIG. 3

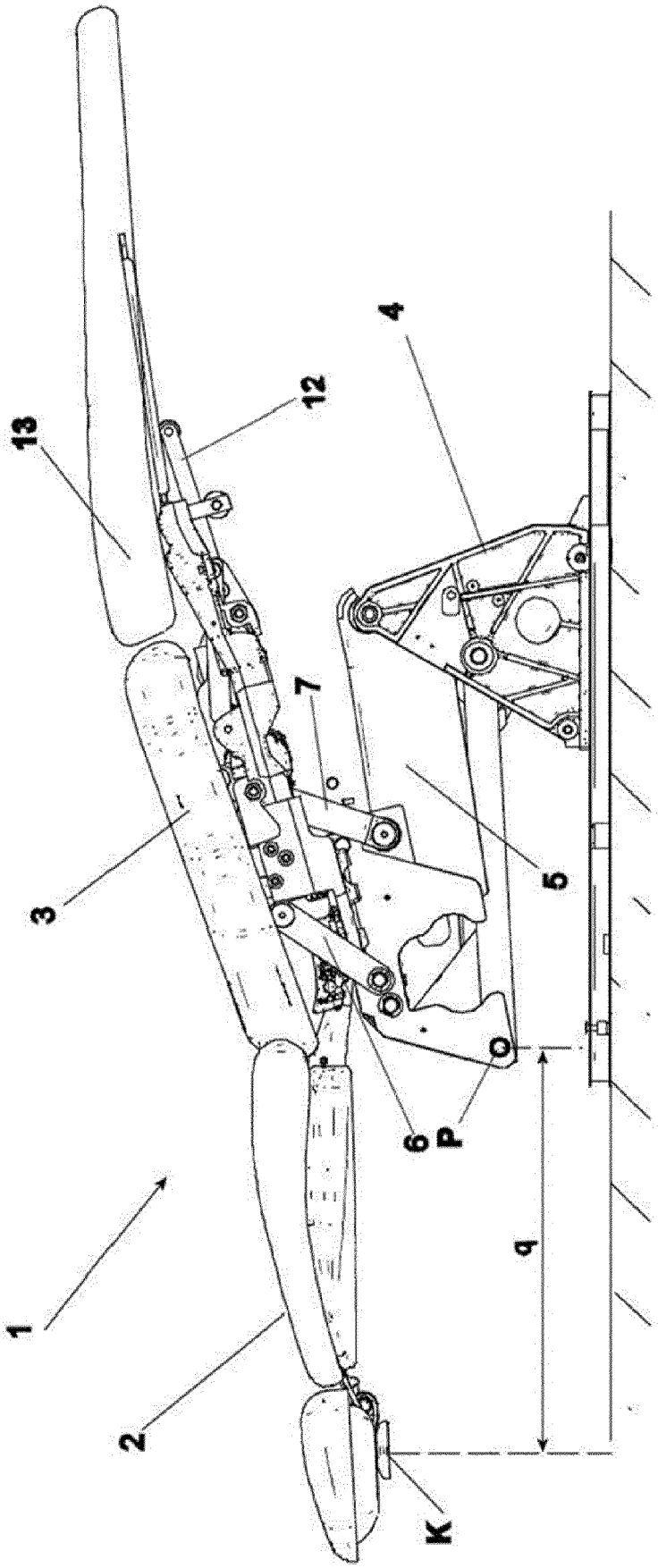

FIG. 4

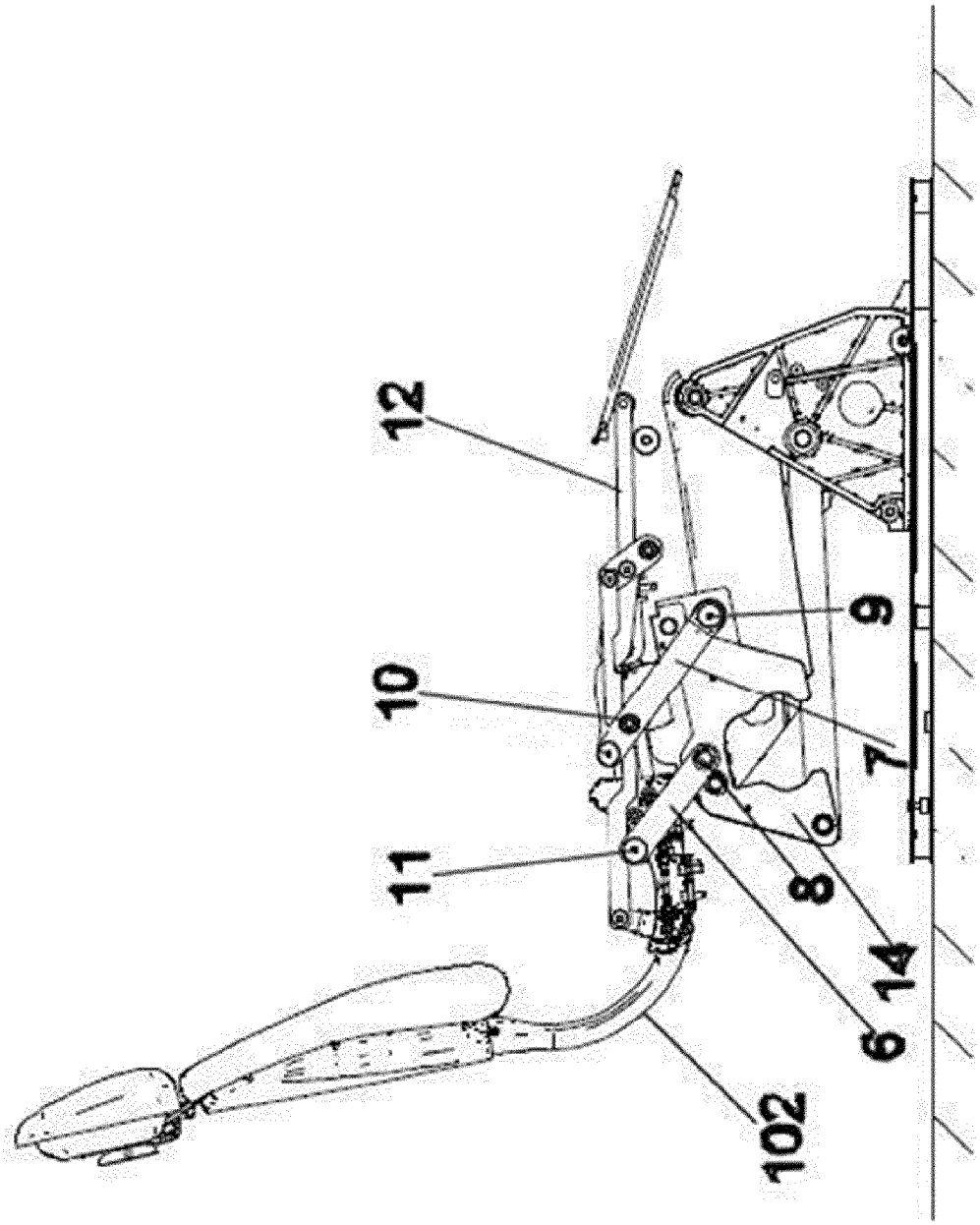

FIG. 5

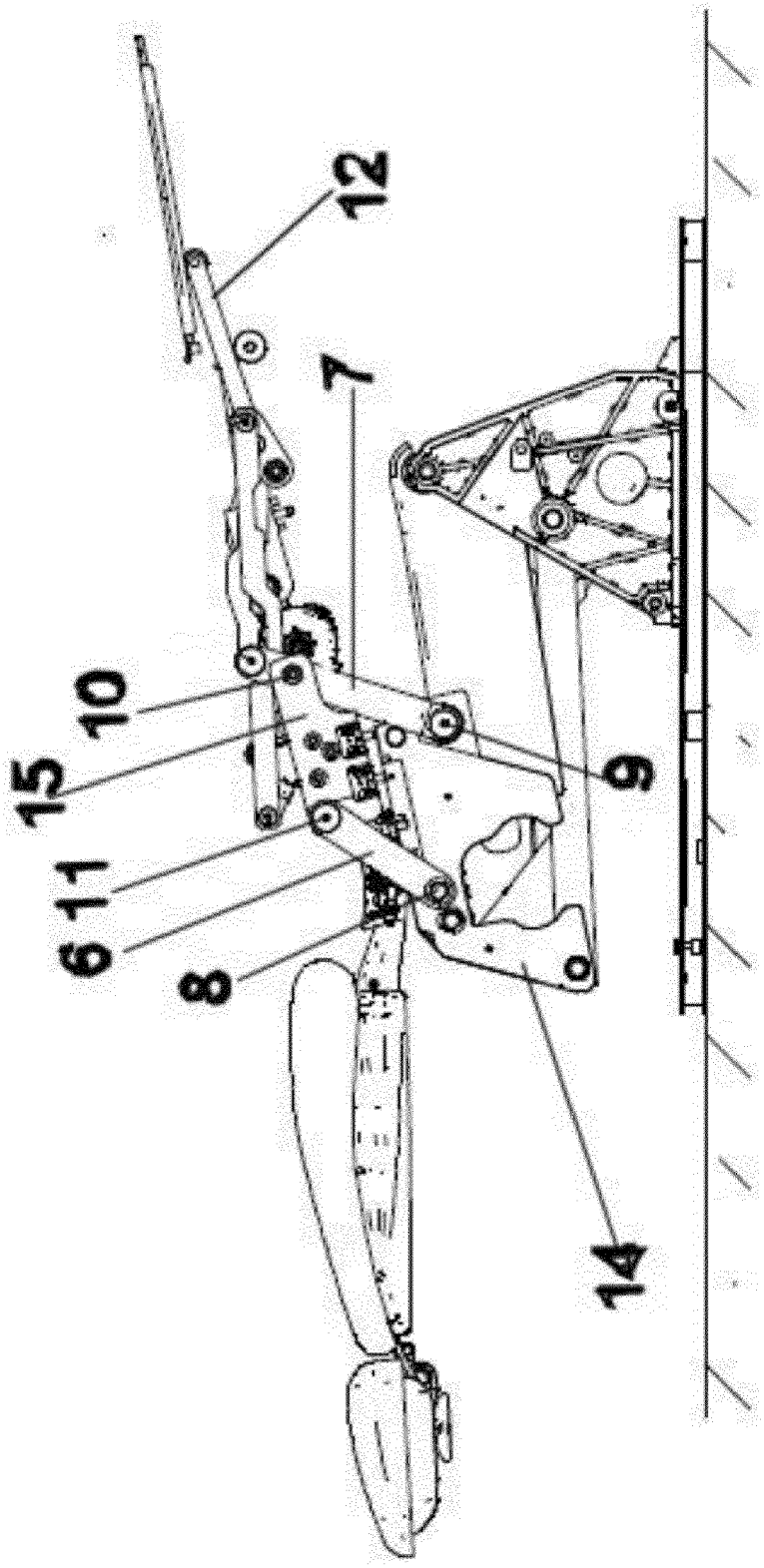

FIG. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 19 7167

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,D	EP 0 253 943 B1 (CASTELLINI SPA [IT]) 15 July 1992 (1992-07-15) * the whole document *	1-9	INV. A61G15/02
A,D	US 3 934 929 A (RABINOWITZ AZRIEL JAY) 27 January 1976 (1976-01-27) * figure 1 * * column 2, lines 40-68 * * column 3, lines 44-46 *	1-9	
A	US 5 790 997 A (RUEHL JOHN W [US]) 11 August 1998 (1998-08-11) * figures 3,5,6 *	1	
A	FR 2 598 911 A1 (DIRECT USINE SALONS [FR]) 27 November 1987 (1987-11-27) * page 2, lines 34-39; figure *	1	
A	EP 1 652 505 A2 (KALTENBACH & VOIGT [DE]) 3 May 2006 (2006-05-03) * figures 1,5,7 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

A61G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 March 2017	Mammeri, Damya

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 19 7167

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-03-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0253943 B1	15-07-1992	CA 1270179 A	12-06-1990
		DE 253943 T1	01-06-1989
		DE 3686054 D1	20-08-1992
		DE 3686054 T2	24-12-1992
		EP 0253943 A2	27-01-1988
		ES 2032754 T3	01-03-1993
		IT 1200176 B	05-01-1989
		JP H0245901 B2	12-10-1990
		JP S6329644 A	08-02-1988
		US 4722566 A	02-02-1988
US 3934929 A	27-01-1976	CA 1040996 A	24-10-1978
		DE 2538944 A1	18-03-1976
		US 3934929 A	27-01-1976
US 5790997 A	11-08-1998	AT 470372 T	15-06-2010
		AU 704795 B2	06-05-1999
		BR 9609885 A	25-05-1999
		EP 0957712 A1	24-11-1999
		EP 1459722 A2	22-09-2004
		US 5790997 A	11-08-1998
		WO 9705803 A1	20-02-1997
FR 2598911 A1	27-11-1987	NONE	
EP 1652505 A2	03-05-2006	AT 427726 T	15-04-2009
		DE 102004052924 A1	04-05-2006
		EP 1652505 A2	03-05-2006
		JP 2006122688 A	18-05-2006

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 0253943 B1 **[0008]**
- EP 0253943 A **[0008]**
- US 3934929 A **[0009]**