



(51) International Patent Classification:
A63C 5/00 (2006.01) *A63C 5/03* (2006.01)

(21) International Application Number:
PCT/IT2009/000485

(22) International Filing Date:
27 October 2009 (27.10.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
TO2008A000824 10 November 2008 (10.11.2008) IT

(71) Applicants (for all designated States except US): **PAN-INFARINA EXTRA S.R.L.** [IT/IT]; Via Nazionale 30, I-10020 Cambiano (TO) (IT). **POLITECNICO DI TORINO** [IT/IT]; Corso Duca Degli Abruzzi 24, I-10129 Torino (IT).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **CHIANDUSSI Giorgio** [IT/IT]; Via Porta Palatina 2, I-10122 Torino (IT). **AMATI, Nicola** [IT/IT]; Via Bardonecchia 20, I-10091 Alpignano (TO) (IT). **GAVIGLIO, Ivan** [IT/IT]; Via Paolini 19, I-10138 Torino (IT). **GIORDA, Andrea** [IT/IT]; Via Mortera 37- Frazione Bertassi, I-10051 Avigliana (TO) (IT).

(74) Agent: **GARAVELLI, Paolo**; A. Bre.Mar. S.R.L., Via Servais 27, I-10146 Torino (IT).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

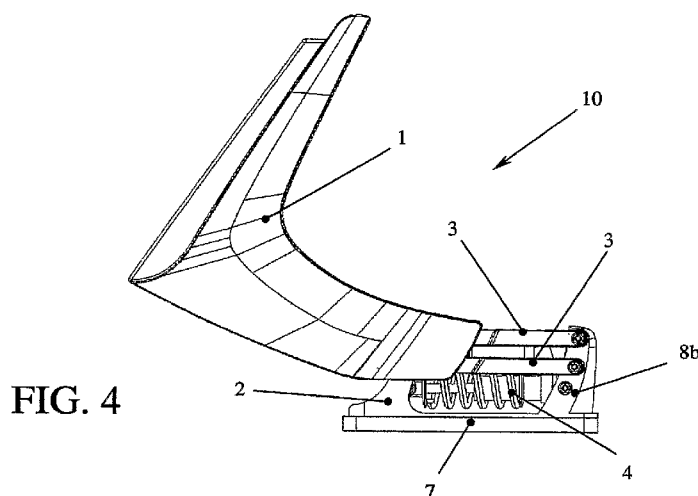
Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

(54) Title: SUSPENSION SYSTEM FOR MOBILITY SYSTEMS, FOR SUPPORTS USE FOR HANDICAPPED PEOPLE



(57) Abstract: A suspension system (10) for mobility systems is described, interposed between at least one suspended load and at least one non-suspended part, comprising at least one motion guiding system (20), at least one motion transmitting system (6), at least one dampening system (4) interposed between the motion guiding system (20) and the motion transmitting system (6), articulated connecting means to such suspended load and connecting means to such non-suspended part, the motion transmitting system (6) being interposed between the motion guiding system (20), the dampening system (4) and the articulated connecting means to the suspended load; the suspended load is a handicapped user in his legs and the non-suspended part is at least one snow-type ski equipped with conventional connection.



SUSPENSION SYSTEM FOR MOBILITY SYSTEMS, FOR SPORTS**5 USE FOR HANDICAPPED PEOPLE**

The present invention refers to a suspension system for mobility systems, aimed for sports use for connecting to a common ski equipped with
10 conventional connection and to the support of an handicapped user suffering an invalidity or paralysis of his/her lower limbs.

As it is evident, for people that suffered lesions of their spinal column, and have partially
15 or completely lost the mobility of the lower part of the column and therefore of their lower limbs, the chances of practising winter sports and, in particular, skiing, is constrained to the use of unconventional structures and devices with respect
20 to typical tools and sportswear of a person without handicap.

For the practice of skiing, the art proposes some dampening systems, which allow the handicapped athlete to be interfaced with the sports tool, in
25 particular a ski.

The known system developed by Alois PRASCHBERGER provides for the use of a single ski with standard sizes and connections comprising a seat for containing the pelvis and a bag, connected
5 to the seat itself, for supporting and protecting the lower limbs. Such components are connected to the ski with a connection through a dampening mechanism adapted to rigidly constrain the suspended system to the ski orthogonally to the
10 plane defined by the shaking direction and the advancement direction and to allow controlling the shaking motion of the suspended load with respect to the fixed direction. The control of the shaking motion of the suspended load is performed by using
15 an elastic and dampening element that takes care of balancing the weight force and provides the dampening of oscillations in the vertical system dynamics. In order to accommodate for the reduced control capability through the use of the upper
20 part of the body, it is foreseen that the rackets have their ends equipped with blades shaped as skis, which the handicapped sportsman uses as support for controlling the balance.

Such known system, though being widely used,
25 has however a series of objective critical points.

In particular, the big mass and the difficulty in using the chair-lifts are surely the most evident limits of such system; in fact, in order to be able to use the chair-lifts, it is necessary that the sportsman lifts himself with the rackets and manually actuates a disconnecting system that allows lifting the seat up to a height which is compatible with the chair-lift seat: the two operations must be performed simultaneously and this is particularly difficult.

FR-A-2611515 instead discloses a system comprising a supporting cradle for the handicapped person. The suspension system is characterised by a rigid arm and an equaliser. The skier's seat is constrained at its rear end to the equaliser (mobile anchoring point) and at its front end to the rigid arm. The equaliser rotates around a pin fastened along the rigid arm and is connected on its rear side to the seat and on its front side to the fixed arm by means of a helical spring. The seat rotates around the connection point with the rigid arm and the oscillation amplitude is controller by the spring.

FR-A-2798072 discloses a suitably shaped rigid support structure on which there is a second rigid

structure whose rear part is used as seat and whose front part is used as directional 'rudder'. The system is comparable with a snow scooter and has not been designed for being used by a person with
5 physical handicaps.

GB-A-2340739 discloses a system composed of a seat and a support for controlling a water ski for users that have no chance of using their lower limbs. The seat is connected to the ski through two
10 pairs of connecting rods. The system provides for the use of a spring-shock absorber system arranged longitudinally for controlling the seat movement. In particular, the longitudinal and vertical movements of the seat remain mutually coupled.

15 DE-A-3402966 discloses a system equipped with a supporting cradle for a handicapped person. Such cradle is constrained to the ski by means of a cylindrical hinge that constraints the longitudinal motion in addition to being a lever point for the
20 structure barycentre. The cradle motion around such point is contrasted by two helical springs.

WO-A-9516504 discloses a system for people with a handicap in their legs. The seat is connected to a base plate in turn connected to the
25 ski by means of an arm. The arm rotates with

respect to the base and its oscillation is controlled by an interposed spring. The spring operates both on the longitudinal and on the vertical seat movement and such movements remain
5 mutually coupled.

Therefore, object of the present invention is solving the above prior art problems by providing a suspension system for mobility systems, for sports use for handicapped people, which is compact and
10 with reduced overall spaces in height.

Another object of the present invention is providing a suspension system, which allows the connection between a supporting seat with a disabled user and a conventional connection of a
15 common ski.

Another object of the present invention is providing a suspension system, which allows a wide rear free space for the supporting seat in order to allow the insertion of a chair-lift seat without
20 interventions by the user.

Another object of the present invention is providing a suspension system equipped with a motion transmitting system, which allows arranging the dampening system itself in a horizontal
25 position.

The above and other objects and advantages of the invention, as will appear from the following description, are obtained with a suspension system as claimed in claim 1. Preferred embodiments and
5 non-trivial variations of the present invention are the subject matter of the dependent claims.

It will be immediately obvious that numerous variations and modifications (for example related to shape, sizes, arrangements and parts with
10 equivalent functionality) can be made to what is described, without departing from the scope of the invention as appears in the enclosed claims.

The present invention will be better described by some preferred embodiments thereof, provided as
15 a non-limiting example, with reference to the enclosed drawings, in which:

- Figure 1 shows a diagram which schematically represents the dynamics of a preferred embodiment of the suspension system according to the present
20 invention;
- Figure 2 shows a diagram which schematically represents the dynamics of another preferred embodiment of the suspension system according to the present invention;
- 25 - Figure 3 shows a diagram which schematically

represents the dynamics of a preferred embodiment of a motion guiding system of the suspension system according to the present invention;

- Figure 4 shows a side view of a preferred embodiment of the suspension system according to the present invention;
- Figure 5 shows a rear perspective view of the suspension system of Figure 4;
- Figure 6 shows a perspective view of a preferred embodiment of a motion guiding system of the suspension system of Figure 4;
- Figure 7 shows a perspective view of a preferred embodiment of a motion transmitting system of the suspension system of Figure 4; and
- Figure 8 shows an exploded view of the suspension system according to the present invention.

With reference to the Figures, it is possible to note that the suspension system 10 according to the present invention for mobility systems arranged to be interposed between at least one suspended load and at least one non-suspended part, and in particular for sports use for the connection to a common ski equipped with conventional connections (representing the non-suspended part) and to the

support of a user (representing the suspended load) having an handicap affected by invalidity or paralysis of his lower limbs comprises:

- at least one motion guiding system 20;
- 5 - at least one motion transmitting system 6;
- at least one dampening system 4 interposed between the motion guiding system 20 and the motion transmitting system 6; in particular, the motion transmitting system 6 allows placing the dampening
- 10 system 4 in the most suitable position for its specific purpose of use;
- articulated connecting means to the suspended load; and
- connecting means to the non-suspended part,
- 15 the motion transmitting system 6 being interposed between the motion guiding system 20, the dampening system 4 and the articulated connecting means to the suspended load.

The suspension system 10 then generates the

20 relative motion of the suspended body with respect to the non-suspended part. Depending on the type of application, the movement needs of the suspended load and the encumbrance constraints, such system

10 can be preferably made through different

25 kinematism types.

With reference, for example, to Figure 1, it is possible to note that the suspension system 10 according to the present invention can be made as double-pendulum kinematism. Assuming that the advancement motion of the system 10 occurs along a horizontal plane and that the shaking motion of the suspended load occurs in a vertical plane, the movement of the suspended load is composed of a vertical motion coupled with a horizontal motion. The horizontal motion is function of the arm length and the vertical shaking according to the expression:

$$x = l \cdot \left(1 - \cos \left(\arcsin \left(\frac{z}{l} \right) \right) \right)$$

where l and z are respectively the arm length and the vertical shaking.

Instead, with reference to Figure 2, it is possible to note that the suspension system 10 according to the present invention can be made with a simple-pendulum kinematism. In this case, assuming that the advancement motion of the system 10 occurs along a horizontal plane and that the shaking motion of the suspended load occurs in a vertical plane, the moving part is constrained to rotate around the arm hinge point. Therefore, to

the vertical movement of the suspended load a horizontal movement is associated, which is described by the following expression and a rotation α :

5
$$\alpha = \arcsin\left(\frac{z}{l}\right)$$

Also in this case, l and z are respectively the arm length and the vertical shaking.

The shaking motion of the suspended load is transformed into a motion along the working direction of the guiding system 20 of the suspension motion. The motion transmitting system 6 can be composed of an element with three non-aligned hinge points: the transmission system 6 is then characterised by a rotation and translation motion in the plane defined by the shaking and advancing directions. Figure 3 shows an example of a transmission system 6 in which the main element transforms the vertical motion (as shown by arrows V) into a horizontal motion (as shown by arrows H) rotating around a fixed point O. Such transmission system 6 can require the use of an additional connection element for making the kinematics compatible with the motion law of the suspended load with respect to the non-suspended part. This

10
15
20
25

allows making the suspension system 10 according to the present invention extremely compact.

Herein below, merely as an example, a preferred embodiment of the suspension system 10 according to the present invention will be described, such system aimed to be used with a mobility system composed of at least one single snow-type ski by users with physical handicaps and/or scarce/absent mobility of their lower limbs.

10 In such specific case, the suspended load is composed of the user and the system for containing and anchoring the user (not shown), while the non-suspended part is composed of a common mountain ski equipped with a conventional connection for ski

15 boots (not shown): in this specific case, the advancement motion of the non-suspended part (the ski) is parallel to the ground while the shaking motion is orthogonal therewith.

With reference then to Figures 4 to 8, it is possible to note that, preferably, the articulated connecting means to the suspended load (user) can be made as at least one rigid structure 1, possibly shaped according to an aerodynamic outline, on the top of which at least one seat of a known type (not

25 shown) is connected, aimed to house the user in a

sitting position. In particular, the specific and preferred arc shape of the rigid structure 1 advantageously allows guaranteeing a wide rear free space for the seat, in order to allow the user to
5 access without obstacles to the chair-lift seat: in such a way, the user is not compelled any more to perform any operation apart from the one of arranging himself waiting for the seat to arrive from his rear part, as do all skiers without
10 handicaps.

In this specific application, with particular reference to Figure 7, it is possible to note that the motion guiding system 20 comprises, or is integrated with, the connecting means to the non-
15 suspended part (ski) instead made as at least one interface base 2 equipped with at least one lower plate 7 suitably shaped as nose 7a and heel 7b, operatively and functionally compatible with a conventional ski connection.

20 The motion guiding system 20 further comprises at least one front bracket 8a and at least one rear bracket 8b arranged on the upper surface of the lower plate 7 and in opposite positions on this latter one. In particular, the front bracket 8a
25 allows, in respective connection points, hinging

the motion transmitting system 6 while the rear bracket 8b allows hinging an end of at least one pair of small arms 3 and hinging an end of the dampening system 4, traditionally composed of
5 spring and shock-absorber, arranged horizontally along the plate 7 and parallel to the advancement motion direction of the non-suspended part, and in particular the ski: the same small arms 3 are arranged in a substantially parallel position to
10 the dampening system 4. A opposite end of such small arms 3 is instead hinged to the articulated connecting means to the suspended load, and in particular to the rigid structure 1.

In order to make the motion guiding system 20, preferably a kinematic scheme of the double-
15 pendulum type is realised. Due to structural and encumbrance reasons, two pairs of parallel small arms 3, two right and two left ones overlapping, are hinged on the rear part of the rear bracket 8b
20 of the base 2 and on the front part to the articulated connecting means to the suspended load, and in particular to the rigid structure 1 for connecting with the seat. It is clear that the kinematic functionality is also guaranteed even if
25 the suspension is shaped with two small arms only

or with many small arms.

With particular reference to Figure 7, it is possible to note that a preferred embodiment of the motion transmitting system 6 comprises at least one structure substantially shaped as a triangle having three hinge points at its vertexes: a first hinge point 6a is a fixed point and is adapted for hinging the motion transmitting system 6 itself to a respective connection point of the front bracket 8a of the motion guiding system 20, a second hinge point 6b is adapted for hinging with a free end of the dampening system 4, a third hinge point 6c is adapted for hinging with at least one end of at least one connecting rod 5, an opposite end of such connecting rod 5 being hinged in a respective connection point of the articulated connecting means to the suspended load, and in particular of the rigid structure 1. The motion transmitting system 6 hinged to the front bracket 8a of the guiding system 20 therefore allows transforming the vertical shaking motion into a horizontal advancement motion suitable for the dampening system 4.

The connecting rods 5 guarantee the kinematic compatibility between the motion of the

transmission system 6 and the motion of the rigid structure 1, guided by the small arms 3. For structural and encumbrance reasons, it has resulted convenient in the preferred embodiment of the system 10 according to the present invention to use a pair of double connecting rods 5, a right one and a left one with respect to the motion transmitting system 6.

As clearly appears from what has been described above, the suspension system 10 according to the present invention is a possible construction solution optimised depending on needs of minimum weight and maximum compactness. In particular, the suspension system 10 according to the present invention is compact and concentrated in a very 'low' position near the non-suspended part, and in particular near the connection system to the ski.

Obviously, the range of application of the above described suspension system 10 is merely an example. In fact, by suitably modifying the preferred embodiment as described, and in particular the type of connecting means being used, the suspension system 10 can be used as interface for various types of mobility systems, of suspended loads and non-suspended parts, making, for example:

- a suspension for water ski;
- a connection system between skis and structures of airplanes arranged for mooring;
- a suspension for toboggans, towing sleighs and
5 sleighs that facilitate the motion in strongly
slanted areas;
- a suspension for snow-type ski (winter ski and the like).

CLAIMS

1. Suspension system (10) for mobility systems interposed between at least one suspended load and at least one non-suspended part, characterised in that it comprises at least one motion guiding system (20), at least one motion transmitting system (6), at least one dampening system (4) interposed between said motion guiding system (20) and said motion transmitting system (6), articulated connecting means to said suspended load and connecting means to said non-suspended part, said motion transmitting system (6) being interposed between said motion guiding system (20), said dampening system (4) and said articulated connecting means to said suspended load, said suspended load being at least one handicapped user in his legs and said non-suspended part being at least one snow-type ski equipped with conventional connection.
2. Suspension system (10) according to claim 1, characterised in that said articulated connecting means to said suspended load are at least one rigid structure (1) on the top of which at least one seat is connected.
3. Suspension system (10) according to claim 1,

characterised in that said connecting means to said non-suspended part are at least one interface base (2) equipped with at least one lower plate (7) suitably shaped as nose (7a) and heel (7b) 5 operatively and functionally compatible with said connection of said ski.

4. Suspension system (10) according to claim 1, characterised in that said motion guiding system (20) comprises at least one front bracket (8a) and 10 at least one rear bracket (8b) arranged on an upper surface of at least one lower plate (7), said front bracket (8a) being adapted to allow hinging said motion transmitting system (6), said rear bracket (8b) being adapted to allow hinging an end of at 15 least one pair of small arms (3) and hinging an end of said dampening system (4), said small arms (3) having an opposite end hinged to said articulated connecting means to said suspended load.

5. Suspension system (10) according to claim 5, 20 characterised in that said dampening system (4) is horizontally arranged along said plate (7) and parallel to a direction of the advancement motion of said non-suspended part and said small arms (3) are arranged in a substantially parallel position 25 to said dampening system (4).

6. Suspension system (10) according to claim 1, characterised in that said motion guiding system (20) operates according to a double-pendulum kinematic scheme.

5 7. Suspension system (10) according to any one of the previous claims, characterised in that said motion transmitting system (6) comprises at least one structure substantially shaped as a triangle having at its vertexes respectively a first hinge
10 point (6a) adapted to hinge said motion transmitting system (6) to a respective connection point of said front bracket (8a) of said motion guiding system (20), a second hinge point (6b) adapted to hinge a free end of said dampening
15 system (4), a third hinge point (6c) adapted to hinge at least one end of at least one connecting rod (5), an opposite end of said connecting rod (5) being hinged in a respective connection point of said articulated connecting means to said suspended
20 load.

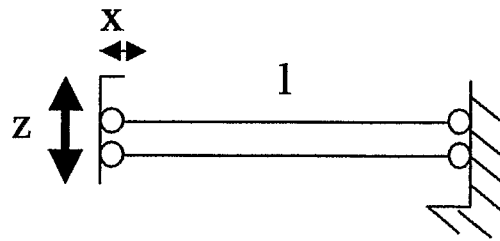


FIG. 1

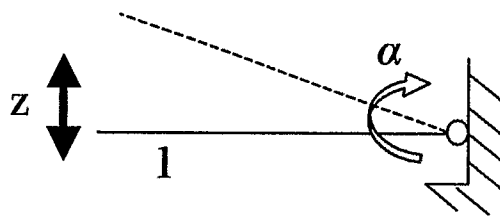


FIG. 2

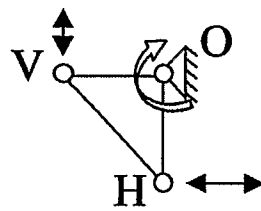


FIG. 3

2/4

FIG. 4

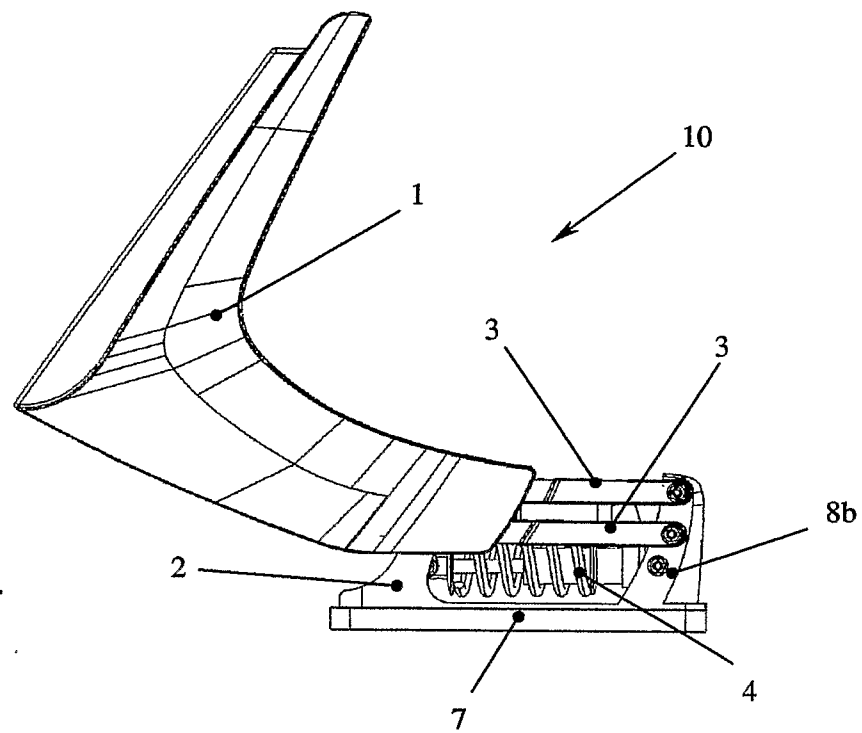
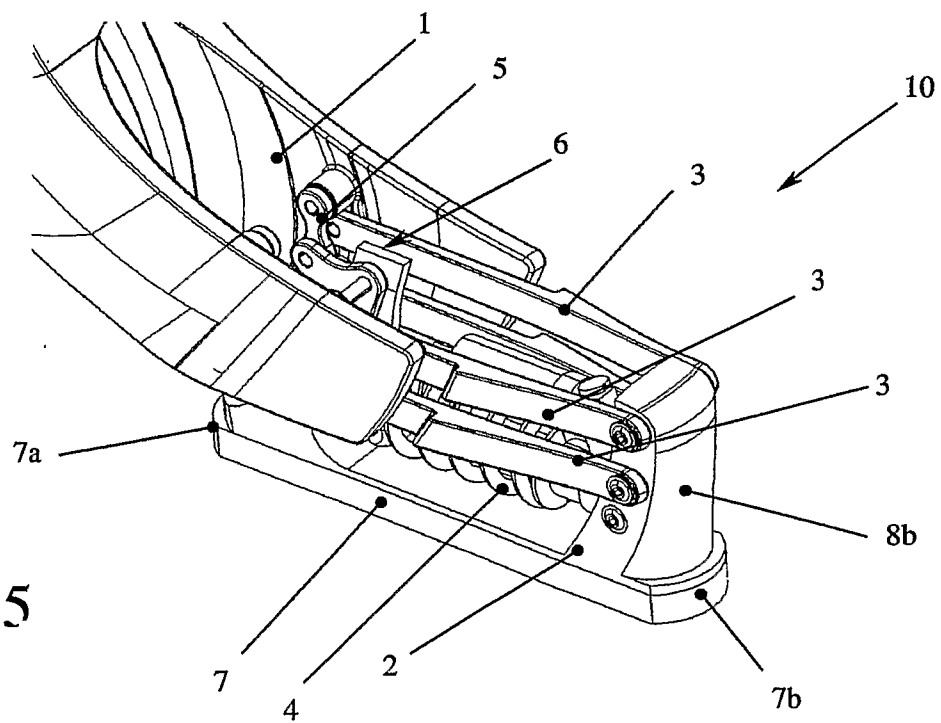
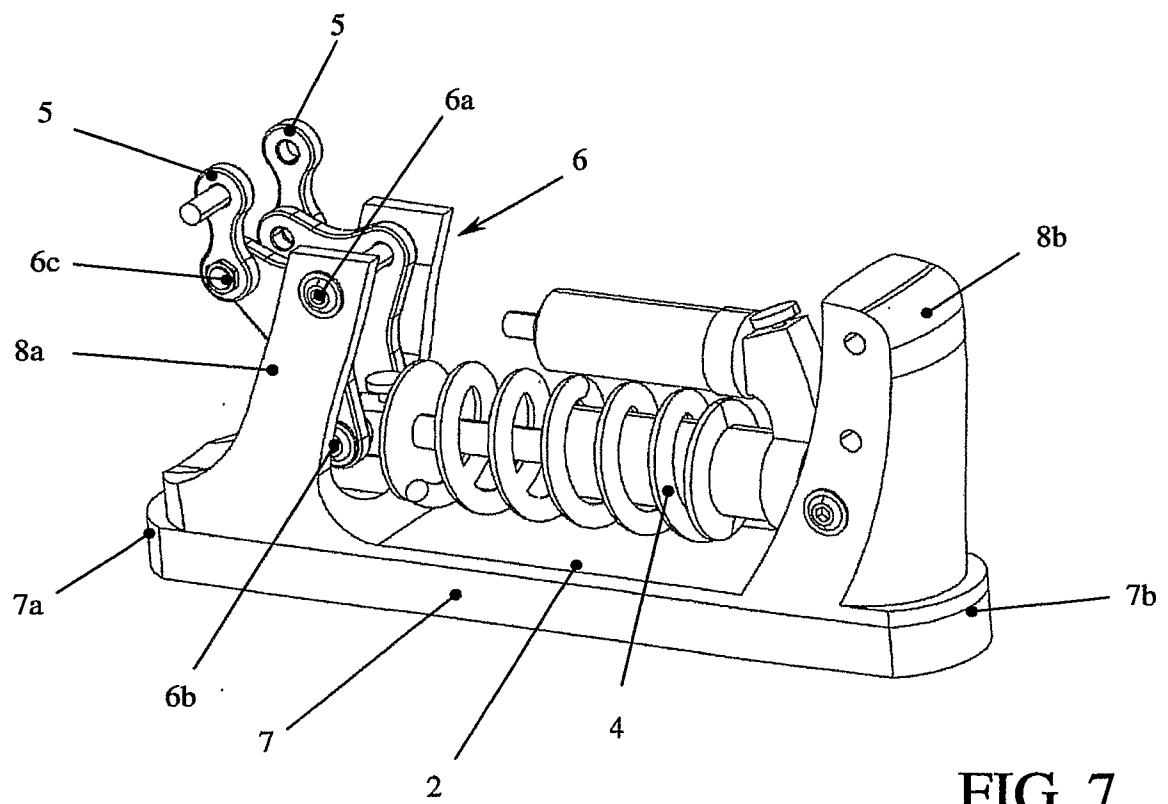
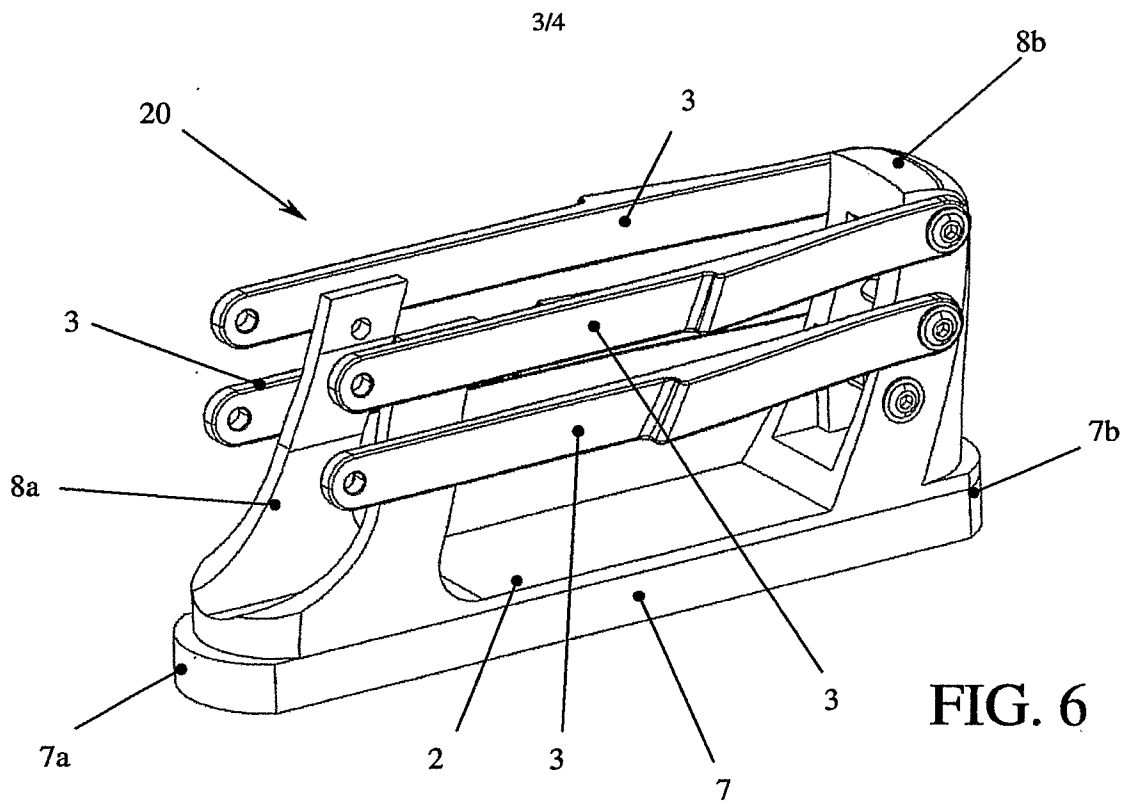


FIG. 5





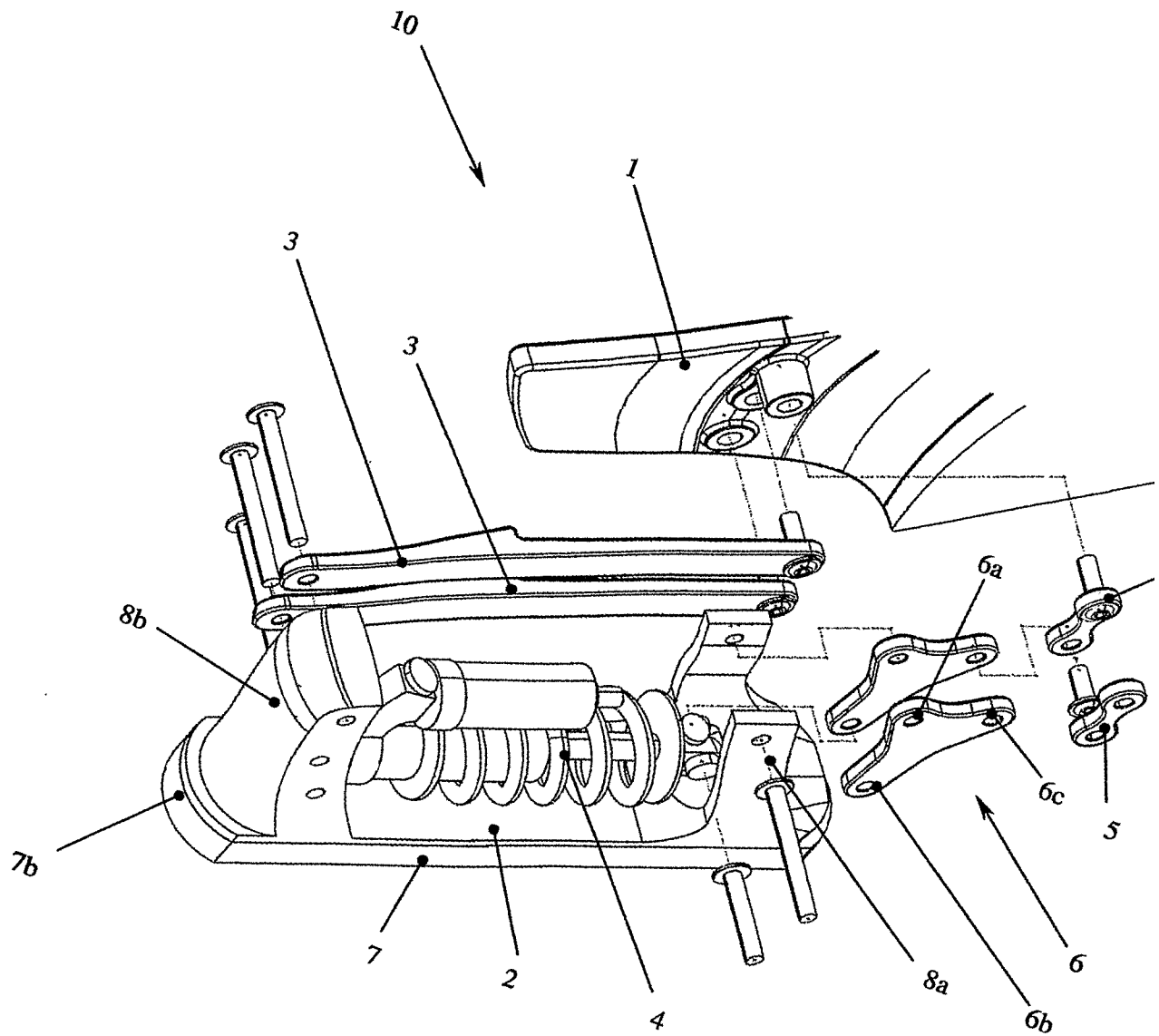


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2009/000485

A. CLASSIFICATION OF SUBJECT MATTER
 INV. A63C5/00 A63C5/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 A63C

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 practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 340 739 A (MATTHEW NICHOLAS ROBERT JOHN [GB]) 1 March 2000 (2000-03-01)	1-3,6
A	the whole document	4-5,7
X,P	EP 2 022 544 A (TESSIER [FR]) 11 February 2009 (2009-02-11)	1-7
	the whole document	
X	US 6 019 380 A (GOODMAN MICHAEL L [US] ET AL) 1 February 2000 (2000-02-01)	1-3,6
A	the whole document	4-5,7
X	US 6 036 202 A (LACOME KENNETH PAUL [US]) 14 March 2000 (2000-03-14)	1-3,6
A	the whole document	4-5,7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

10 February 2010

Date of mailing of the international search report

18/02/2010

Name and mailing address of the ISA/
 European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

Authorized officer

Haller, E

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IT2009/000485

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 2340739	A	01-03-2000	NONE	
EP 2022544	A	11-02-2009	FR 2919507 A1	06-02-2009
US 6019380	A	01-02-2000	CA 2244642 A1	30-03-1999
US 6036202	A	14-03-2000	NONE	