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(54) **WHEELCHAIR OR HANDCYCLE WITH REAR SUSPENSION**

(57) A wheelchair (1) or a handcycle (100) comprising:

- a supporting frame (2);
- a seat (3,4,5) fixed to the supporting frame (2);
- a pair of rear wheels (6) and at least one front wheel (8) ;
- a rear suspension (10) operatively interposed between the supporting frame (2) and the pair of rear wheels (6);

characterized in that the rear suspension (10) comprises:

- at least one leaf spring (11) coupled to the supporting frame (2) and arranged between the pair of rear wheels;
- two wheel supporting elements (12), each of which supports a respective rear wheel (6) of the pair of rear wheels (6) and is fixed to the leaf spring (11).

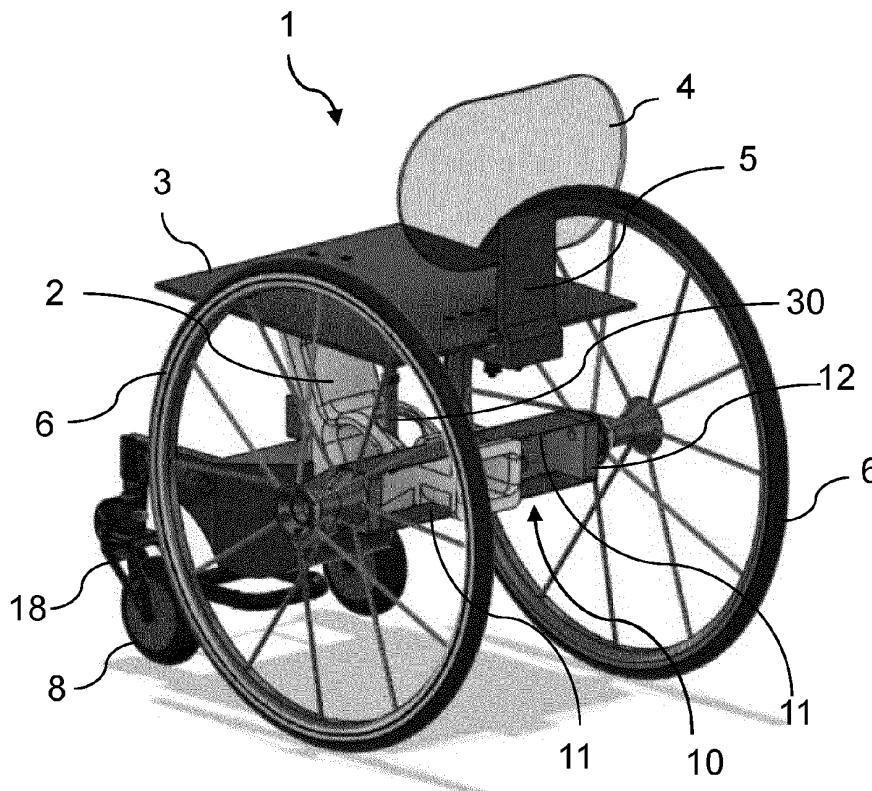


FIG. 2

Description**FIELD OF THE INVENTION**

[0001] The present invention relates to the technical field of wheelchairs or handcycles and, in particular, relates to a wheelchair or handcycle comprising a rear suspension.

BACKGROUND ART

[0002] It is known that wheelchairs are widely used for the transportation and ambulation of people with ambulatory problems, e.g., such as disabled or injured people.

[0003] Since the advent of the first wheelchairs, the manufacturers and users of these vehicles have constantly made innovations aimed at improving, for example, the comfort, use, sturdiness, and lightness of the vehicles. Despite these innovations, a need is still felt to improve the performance of wheelchairs in terms of ease of driving and reliability also in presence of particularly difficult or rough terrains, and in terms of protecting the user from repeated and, therefore, highly damaging stresses.

[0004] Rigid wheelchairs, i.e., free from suspension, which have the problem of losing contact with all support points on the ground on imperfect surfaces, forcing the user to compensate with the limbs and the torso (when possible), with probable collateral damage, are still manufactured and marketed today. Wheelchairs provided with front and/or rear suspensions are also known; however, the performance of these suspensions to date is not satisfactory in terms of cost, construction complexity, weight, and ability to reduce stresses. For example, a rear modular wheelchair suspension is described in the patent application US 2012/0013098 A1.

[0005] The same needs described above concerning wheelchairs are also felt in the field of handcycles, either used by people with disabilities or for sports purposes by able-bodied users.

[0006] It is a general object of the present description to make available a wheelchair or a handcycle which allows to solve the problems described above with reference to the prior art entirely or at least in part.

[0007] The aforesaid purpose, as well as other purposes that will better appear below, are achieved by means of a wheelchair or handcycle as defined in the appended claim 1. Alternative preferred and advantageous embodiments of the aforesaid wheelchair or handcycle are defined in the accompanying dependent claims.

[0008] The invention will be better understood from the following detailed description of particular embodiments thereof, given by way of a non-limiting example, with reference to the accompanying drawings briefly described in the following paragraphs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In the accompanying figures:

- 5 - Figure 1 shows an isometric view of a non-limiting example embodiment of a wheelchair;
- Figure 2 shows a further isometric view of the wheelchair in figure 1;
- 10 - Figure 3 shows an isometric view of the part of a wheelchair in figure 1;
- Figure 4 shows a plan elevation view of the part of a wheelchair in figure 3;
- 15 - Figure 5 shows a further isometric view of the part of a wheelchair shown in figure 3;
- 20 - Figure 6 shows a plan side view of the wheelchair in figure 1;
- Figure 7 shows a plan side view of the part of the wheelchair in figure 1; and
- 25 - Figure 8 shows an isometric view of a non-limiting example embodiment of a handcycle.

DETAILED DESCRIPTION

[0010] Figures 1-7 show an embodiment of a wheelchair 1 by way of a non-limiting example.

[0011] The wheelchair 1 comprises a supporting frame 2 and a seat 3,4,5 fixed to supporting frame 2. The seat 3,4,5 preferably comprises a seating surface 3, generally horizontal, and a backrest 4, generally vertical. Preferably, the seat 3,4,5 comprises a supporting bracket 5 of the backrest 4, e.g., an L-shaped bracket, operatively interposed between the seating surface 3 and the backrest 4 to fix the backrest 5 to the seating surface 3, either in a fixed manner or in a manner adjustable in height and/or tilt. For example, the supporting bracket 5 has an end portion fixed to the seating surface 3, e.g., by means of mechanical coupling elements 51, such as screws, pins, bolts, or rivets, and an opposite end portion fixed to the backrest 4, again in this case by means of screws, pins, bolts, or rivets.

[0012] The wheelchair 1 comprises a pair of rear wheels 6, i.e., two rear wheels 6, and at least one front wheel 8. The at least one front wheel 8 is preferably a steering wheel. In the non-limiting example shown in figures 1-7, the two rear wheels 6 are the main wheels and preferably the traction wheels of the wheelchair 1. Each of the rear wheels 6 includes, for example, a circular gripping handle, mounted laterally cantilevered with respect to the rear wheel 6 and not shown in the figures, adapted to allow a user to apply a manual pushing force to impart a traction torque to the rear wheels 6. In any case, the

wheelchair 1 can be either a human-powered wheelchair or an electric-powered wheelchair, or both a human-powered and electric-powered wheelchair.

[0013] In the particular non-limiting embodiment shown in figures 1-7, the wheelchair 1 comprises two steering front wheels 8 and two rear wheels 6. The two rear wheels 6 have a larger diameter than the two front steering wheels 8.

[0014] The wheelchair 1 further comprises a rear suspension 10 operatively interposed between the supporting frame 2 and the pair of rear wheels 6.

[0015] The rear suspension 10 comprises at least one leaf spring 11 coupled to the supporting frame 2 and further comprises two wheel supporting elements 12 each of which supports a respective rear wheel 6 and is fixed to the leaf spring 11. The leaf spring 11 is arranged between the two rear wheels 6, in particular, the leaf spring 11 is arranged transversely, e.g., perpendicularly, to the rear wheels 6.

[0016] According to an advantageous embodiment, the leaf spring 11 is a plate-like spring and preferably, in absence of external stresses, a straight and planar plate-like spring.

[0017] According to the embodiments, the leaf spring 11 may comprise a stack of two or more mutually stacked plate-like elastic elements. According to an embodiment, the leaf spring 11 may further comprise a single plate-like spring element. In the latter case, the leaf spring 11 is thus a single-leaf spring.

[0018] The one or more plate-like elastic elements of the leaf spring 11 are advantageously made of metal material, e.g., steel or aluminum, or a reinforced composite material, such as carbon fiber.

[0019] The wheel supporting elements 12 are preferably plate-like elements, e.g., shaped metal plates, and each of them is configured to constrain the hub 26 of a respective rear wheel 6 to it so that the rear wheel 6 is rotatably connected to the wheel supporting element 12. In this regard, for example, each wheel supporting element 12 comprises a through-hole 12c crossed by a hub coupling pin 26, wherein the axis of the coupling pin defines the rotation axis A of the respective rear wheel 6.

[0020] According to a particularly advantageous embodiment, the leaf spring 11 comprises two end portions 11a opposite to each other, and each of the wheel supporting elements 12 is fixed to a respective end portion 11a of the leaf spring 11. Advantageously, the leaf spring 11 comprises a central portion 11b, interposed with respect to the two end portions 11a, fixed to supporting frame 2. Mechanical coupling elements, preferably of a removable type, e.g., such as screws or pins, are conveniently provided for fixing the wheel supporting elements 12 to the leaf spring 11. Mechanical coupling elements, preferably of a removable type, such as screws or pins, are conveniently provided for fixing the central portion 11b of the leaf spring 11 to the supporting frame 2.

[0021] According to a particularly advantageous embodiment, the at least one leaf spring 11 comprises a first

leaf spring 11 and a second leaf spring 11 mutually spaced apart and preferably parallel to each other. In this embodiment, it is particularly advantageous to provide that each of the wheel supporting elements 12 comprises a fixing portion 12a that is interposed and clamped between the first leaf 11 and the second leaf spring 11.

[0022] According to a particularly advantageous embodiment, the supporting frame 2 comprises a fixing portion 21 which is interposed and clamped between the first leaf 11 and the second leaf spring 11. Conveniently, the fixing portion 21 of the supporting frame 2 is a first end portion of the supporting frame 2. Advantageously, the fixing portion 21 of the supporting frame 2 comprises at least one fixing recess adapted to receive the middle portion 11b of said leaf spring 11. Since in the example shown in the figures, the rear suspension 10 comprises two leaf springs 11 mutually spaced apart, the fixing portion 21 of the supporting frame 2 comprises two fixing recesses arranged on the fixing portion 21 in mutually opposite positions.

[0023] According to an advantageous embodiment, the supporting frame 2 is a single-arm frame, preferably arranged centrally with respect to the seat 3,4,5. For example, the supporting frame 2 is manufactured by 3D printing and is made of a metal material, or a plastic material, or a composite material.

[0024] According to a particularly advantageous embodiment, a housing compartment 22 is defined within the supporting frame 2. The housing compartment 22 is, for example, adapted and configured to house possible electronic components of the wheelchair 1, and a rechargeable power supply battery if the wheelchair 1 is motorized. For example, the housing compartment 22 has an access opening, which faces the fixing portion 21 of the supporting frame 2.

[0025] According to an advantageous embodiment, the supporting frame 2 is either L-shaped or V-shaped and for this purpose comprises a crank portion 24 arranged in an intermediate position between the fixing portion 21 and a second end portion 23 of the supporting frame 2.

[0026] According to an embodiment, the seat 3,4,5 comprises a seating surface 3 fixed to the second end portion 23 of the supporting frame 2. Advantageously, the seating surface 3 comprises a front portion 3a rigidly fixed to the second end portion 23 of the supporting frame 2 and comprises a free rear portion 3b, wherein the seating surface 3 is elastically flexible so that the rear portion 3b is free to bend with respect to the front portion 3a. For example, the seating surface 3 is made by 3D printing or composite material, such as carbon fiber.

[0027] For example, the front portion 3a of the seating surface 3 is rigidly fixed to the first end portion 23 of the supporting frame 2 by means of fixing elements 31, e.g., such as screws, bolts, pins, or rivets.

[0028] According to a particularly advantageous embodiment, the wheelchair 1 further comprises a damper 30 having a first end portion fixed to the seating surface

3 at an intermediate position between the front portion 3a and the rear free portion 3b and a second end portion fixed to the supporting frame 2. The aforesaid intermediate position is preferably an adjustable position. The damper 30 is, for example, a pneumatic or oil-pneumatic cylinder and preferably comprises a sleeve and a sliding stem within the sleeve.

[0029] To allow the adjustment of the fixing position of the first end portion of the damper 30 to the seating surface 3, the first end portion of the damper 30 is, for example, fixed to the seating surface 3 by a slider 35, which can be moved to assume a discrete or continuous plurality of fixing positions.

[0030] According to an advantageous embodiment, the wheelchair 1 comprises a front footboard 7 fixed to the supporting frame 2. Conveniently, the front footboard 7 is removably fixed to the supporting frame 2. According to an embodiment, the front footboard 7 comprises an upper portion 7a and a lower portion 7b, which are made in two separate pieces mechanically coupled together. For example, the upper portion 7a is conformed to have a U- or C-shaped cross section, and the lower portion 7b has an L-shaped profile in the vertical plane. In figures 6 and 7, footboard 7 differs slightly from the footboard shown in figures 1 and 2. These differences are limited to the shape of the lower portion 7b and the mutual positioning between the upper portion 7a and the lower portion 7b.

[0031] Preferably, the front footboard 7, in particular the upper portion 7a of the front footboard, is fixed to the crank portion 24 of the supporting frame 2. For example, a hole 25 is defined in the crank portion 24 of the supporting frame 2 in which a fixing pin (not shown in the figures) of the supporting footboard 7 is engaged, e.g., a pin integral with the upper portion of supporting footboard 7. Obviously, in a variant embodiment, the arrangement of the hole 25 and the fixing pin can be mutually reversed.

[0032] According to a particularly advantageous embodiment, the wheelchair 1 further comprises at least one swing arm front suspension 18, 19 adapted to constrain said at least one front wheel 8 to the supporting frame 2. Preferably, the aforesaid swing-arm front suspension 18, 19 is such that at least one front wheel 8 is constrained to the front footboard 7. In the particular example shown in figures 1-7, in which the wheelchair 1 comprises two front wheels 8, preferably two steering front wheels 8, the wheelchair 1 comprises two swing-arm front suspensions 18, 19 each adapted and configured to constrain a respective front wheel 8 to the front footboard 7.

[0033] The swing arm front suspension 8 advantageously comprises a fork 18, which rotatably supports the front wheel 8. The fork 18 is the swing arm of swing arm suspension 18, 19 and can be a single-arm fork or a double-arm fork. The fork 18 is rotatably hinged to the front footboard 7 to rotate around a rotation axis B, which is, for example, a horizontal rotation axis.

[0034] According to an advantageous embodiment,

the swing arm front suspension 8 further comprises a damper 19. Preferably, the damper 19 has a first end portion fixed to the swinging arm 18, i.e., to the fork 18, and a second end portion fixed to the front footboard 7.

The damper 19 is, for example, a pneumatic or oil-pneumatic cylinder and preferably comprises a sleeve and a sliding stem within the sleeve.

[0035] With reference to figure 6, according to a particularly advantageous embodiment, the wheelchair 1 comprises at least one traction motor 60, e.g., an electric motor, operatively connected to the rear wheels 6. The traction motor 60 is powered by a battery, preferably rechargeable, provided on board the wheelchair 1, which is, for example, housed within a housing 22 defined within the supporting frame 2. Conveniently, the wheelchair 1 comprises two traction motors 60, each of which is operatively connected to a respective rear wheel 6. According to a particularly advantageous embodiment, the traction motors 60 are fixed to a respective wheel supporting plate 12 and operationally connected to the respective rear wheel 6 by means of a drive belt 61, such as a toothed belt.

[0036] According to a particularly advantageous embodiment, the wheelchair 1 comprises an electronic control unit (not shown in the figures). Said electronic control unit is, for example, adapted and configured to control the stiffness of the dampers 30, 19, e.g., actively according to the characteristics of the surface on which the wheelchair 1 moves and/or according to the configuration selectable by a user. For active control of the stiffness of the dampers, one or more sensors operatively connected to the electronic control unit, for example, an optical sensor and/or a vibration sensor can be provided. For example, the electronic control unit is attached and configured to control traction motors 60, e.g., to provide adjustable traction torque based on commands given by the wheelchair user 1 or commands given by a remote control system.

[0037] Referring now to figure 7, it can be appreciated that the supporting frame 2 and the rear suspension 10 described above for the wheelchair 1 are also employable in a handcycle 100. In particular, the supporting frame 2 and the rear suspension 10 may constitute a modular assembly, which can be coupled, e.g., removably, to other modules or modular assemblies to enable manufacturers to provide wheelchairs 1 or handcycles 100 using the same aforesaid modular assembly and/or to enable a user to convert a wheelchair 1 into a handcycle 100 and vice versa. The aforesaid transformation is particularly easy in the embodiment in which the supporting frame 2 is a single-arm frame.

[0038] From the above, it is apparent that a wheelchair 1 or handcycle 100 of the type described above make it possible to fully achieve the proposed objects in terms of overcoming the drawbacks of the prior art. Indeed, by virtue of the special rear suspension described above, it is possible to significantly limit the stresses to which a user is subjected and ensure high comfort. Furthermore,

a wheelchair 1 or handcycle 100 of the type described above can be manufactured easily as a modular composition of parts, wherein many of those parts can be 3D printed while also ensuring a large margin for customization and design and relatively low production costs.

[0039] Without prejudice to the principle of the invention, the embodiments and the manufacturing details may be broadly varied with respect to the above description merely given by way of a non-limiting example, without departing from the scope of the invention as defined in the appended claims.

Claims

1. A wheelchair (1) or a handcycle (100) comprising:

- a supporting frame (2);
- a seat (3,4,5) fixed to the supporting frame (2);
- a pair of rear wheels (6) and at least one front wheel (8) ;
- a rear suspension (10) operatively interposed between the supporting frame (2) and the pair of rear wheels (6) ;

characterized in that the rear suspension (10) comprises:

- at least one leaf spring (11) coupled to the supporting frame (2) and arranged between the pair of rear wheels (6) ;
- two wheel supporting elements (12), each of which supports a respective rear wheel (6) of said pair of rear wheels (6) and is fixed to the leaf spring (11).

2. A wheelchair (1) or a handcycle (100) according to claim 1, wherein the leaf spring (11) comprises two end portions (11a) opposite to each other and wherein each of the wheel supporting elements (12) is fixed to a respective end portion (11a).

3. A wheelchair (1) or a handcycle (100) according to claim 2, wherein the leaf spring (11) comprises a middle portion (11b) fixed to the supporting frame (2).

4. A wheelchair (1) or a handcycle (100) according to any one of the preceding claims, wherein said at least one leaf spring (11) comprises a first leaf spring (11) and a second leaf spring (11) mutually spaced apart and preferably parallel to each other.

5. A wheelchair (1) or a handcycle (100) according to claim 4, wherein each of the wheel supporting elements (12) comprises a fixing portion (12a) which is interposed and clamped between the first leaf spring (11) and the second leaf spring (11).

6. A wheelchair (1) or a handcycle (100) according to claim 4 or 5, wherein the supporting frame (2) comprises a fixing portion (21) which is interposed and clamped between the first leaf spring (11) and the second leaf spring (11).

7. A wheelchair (1) or a handcycle (100) according to claim 6, wherein the fixing portion (21) of the supporting frame (2) is a first end portion of the supporting frame (2) .

8. A wheelchair (1) or a handcycle (100) according to claim 6 or 7, wherein the fixing portion (21) of the supporting frame (2) comprises at least one fixing recess adapted to receive the middle portion (11b) of said leaf spring (11).

9. A wheelchair (1) or a handcycle (100) according to any one of the preceding claims, wherein said at least one leaf spring (11) is a plate-like spring and preferably, in the absence of external stresses, a straight and planar plate-like spring.

10. A wheelchair (1) or a handcycle (100) according to any one of the preceding claims, wherein the supporting frame (2) is a single-arm frame.

11. A wheelchair (1) or a handcycle (100) according to any one of the preceding claims, wherein the seat (3,4,5) comprises a seating surface (3) fixed to a second end portion (23) of the supporting frame (2).

12. A wheelchair (1) or a handcycle (100) according to claim 11, wherein the seating surface (3) comprises a front portion (3a) rigidly fixed to the second end portion (23) of the supporting frame (2) and comprises a free rear portion (3b), wherein the seating surface (3) is elastically flexible so that the rear portion (3b) is free to bend with respect to the front portion (3a).

13. A wheelchair (1) or a handcycle (100) according to claim 12, comprising a damper (30) having a first end portion fixed to the seating surface (3) in an intermediate position between said front portion (3a) and said free rear portion (3b) and a second end portion fixed to the supporting frame (2), wherein said intermediate position is preferably an adjustable position.

14. A wheelchair (1) or a handcycle (100) according to any one of the preceding claims, further comprising at least one front swing arm suspension (18, 19) adapted to constrain said at least one front wheel (8) to the supporting frame (2).

15. A wheelchair (1) or a handcycle (100) according to any one of the preceding claims, wherein the sup-

porting frame (2) is either L-shaped or V-shaped.

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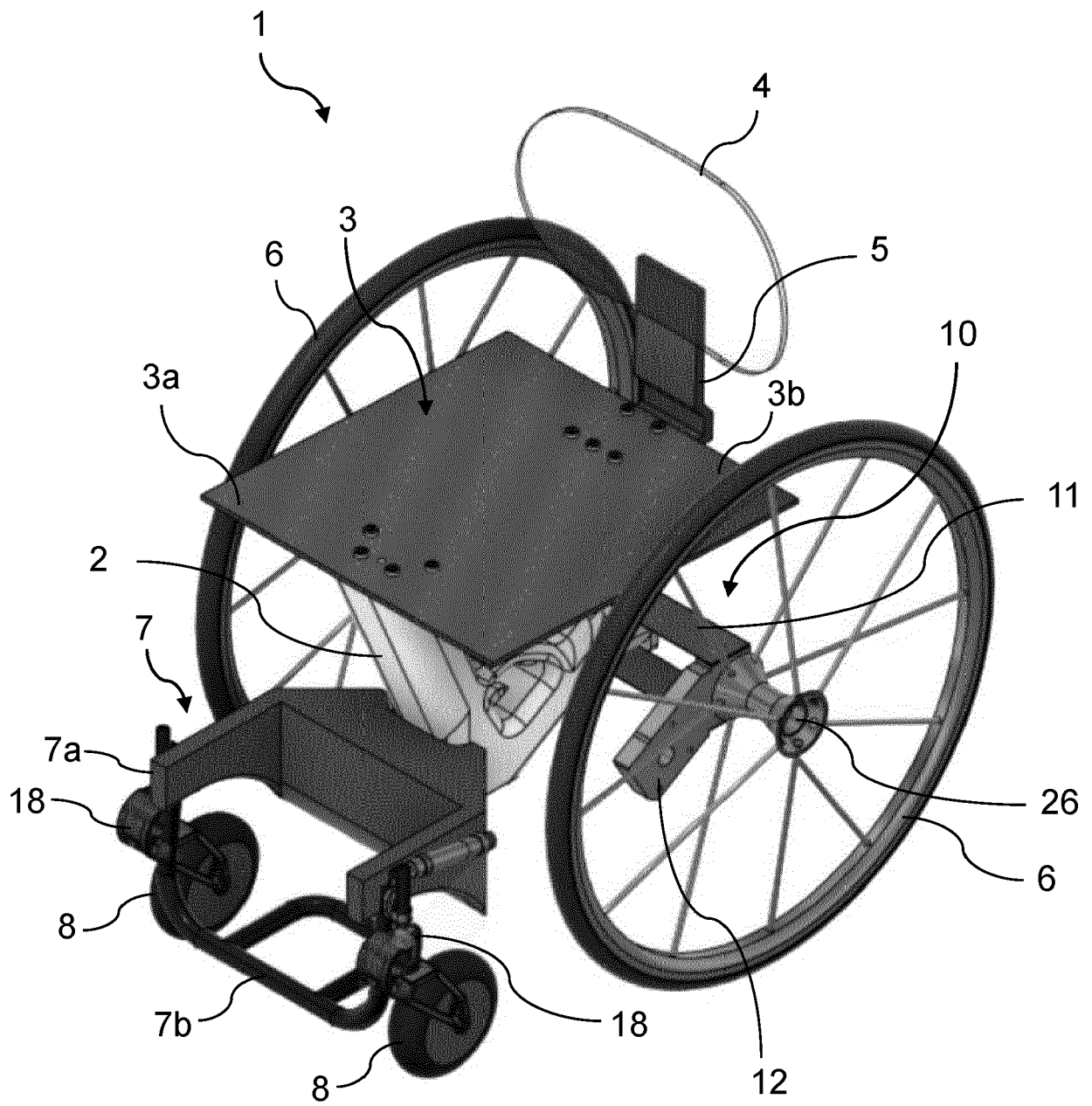
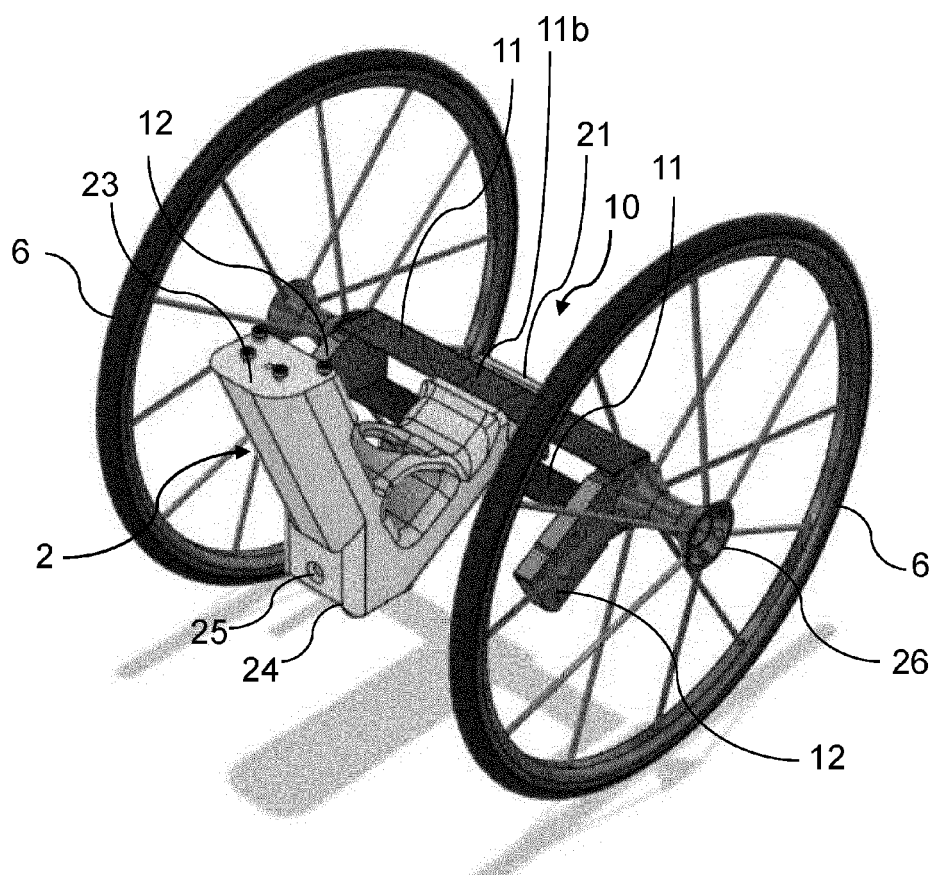
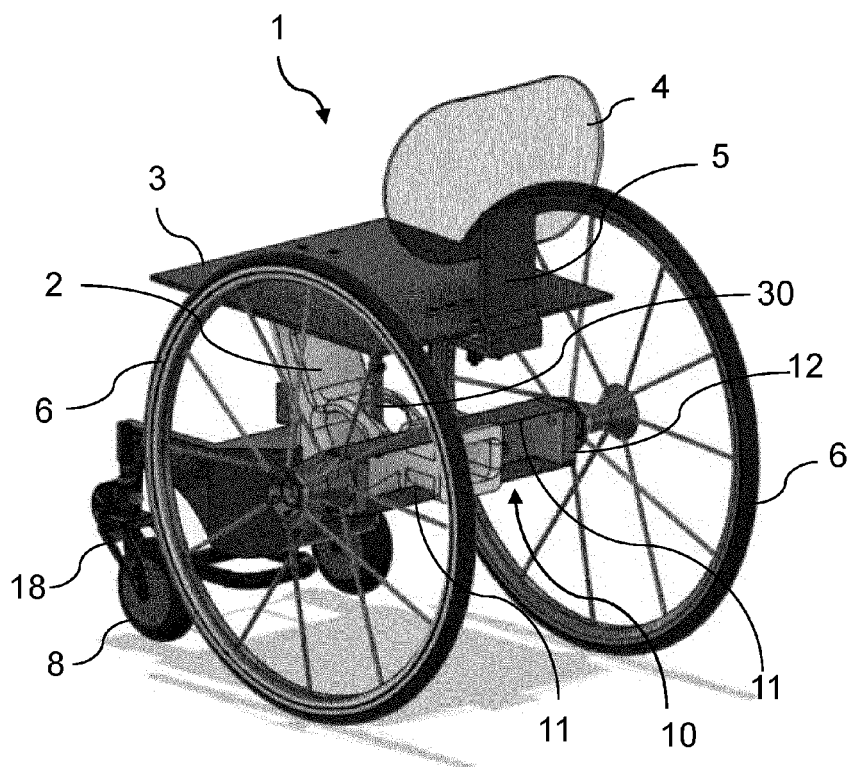


FIG. 1



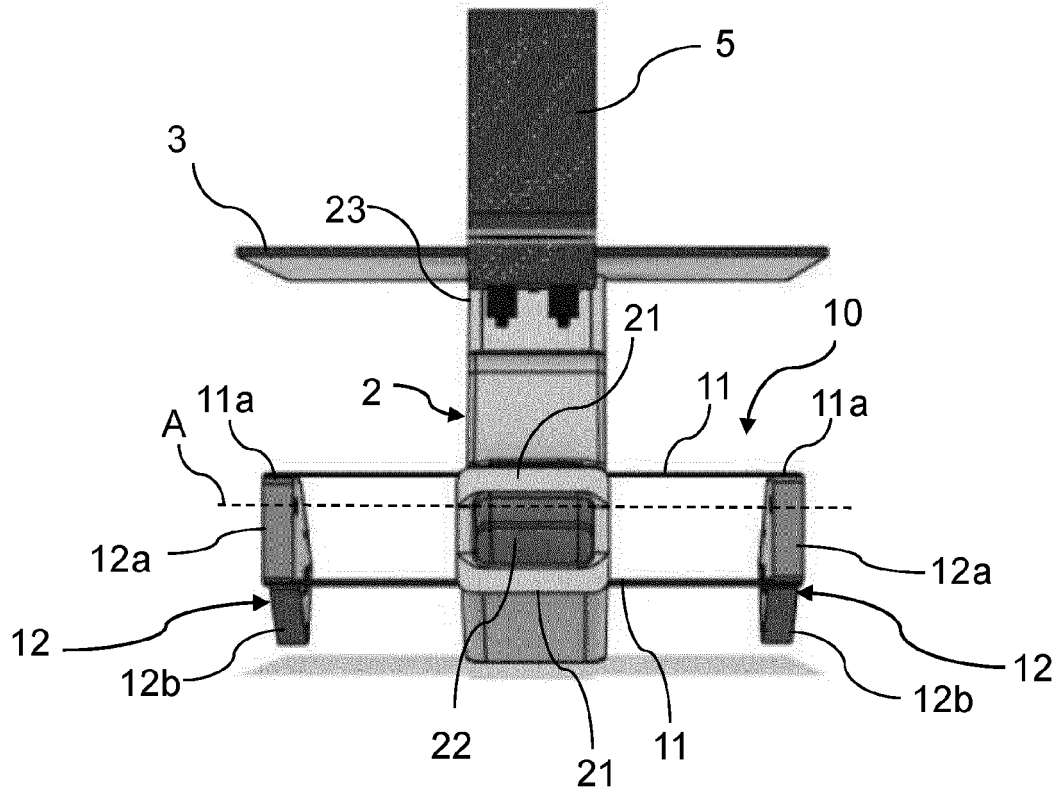


FIG. 4

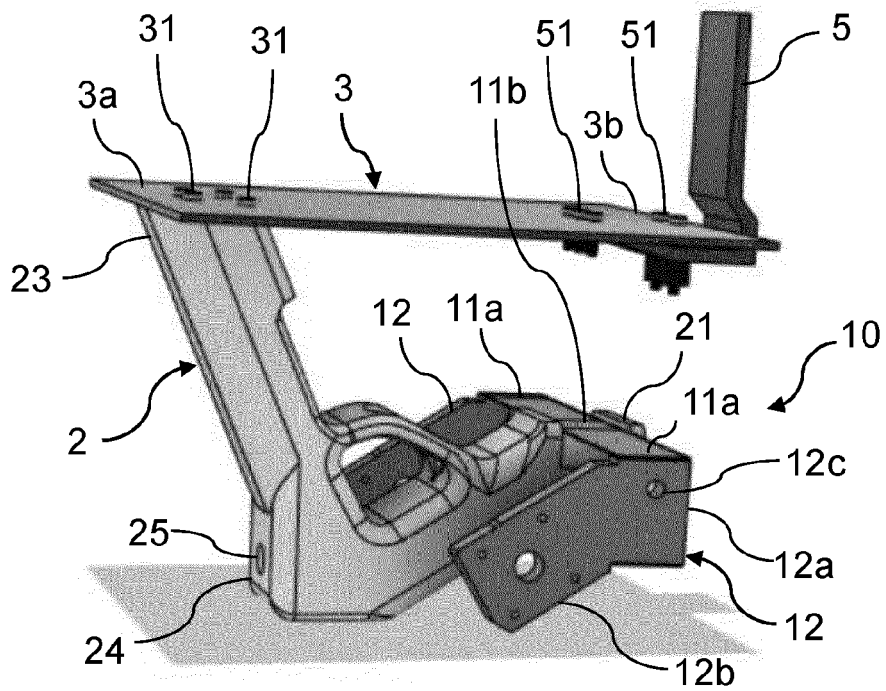


FIG. 5

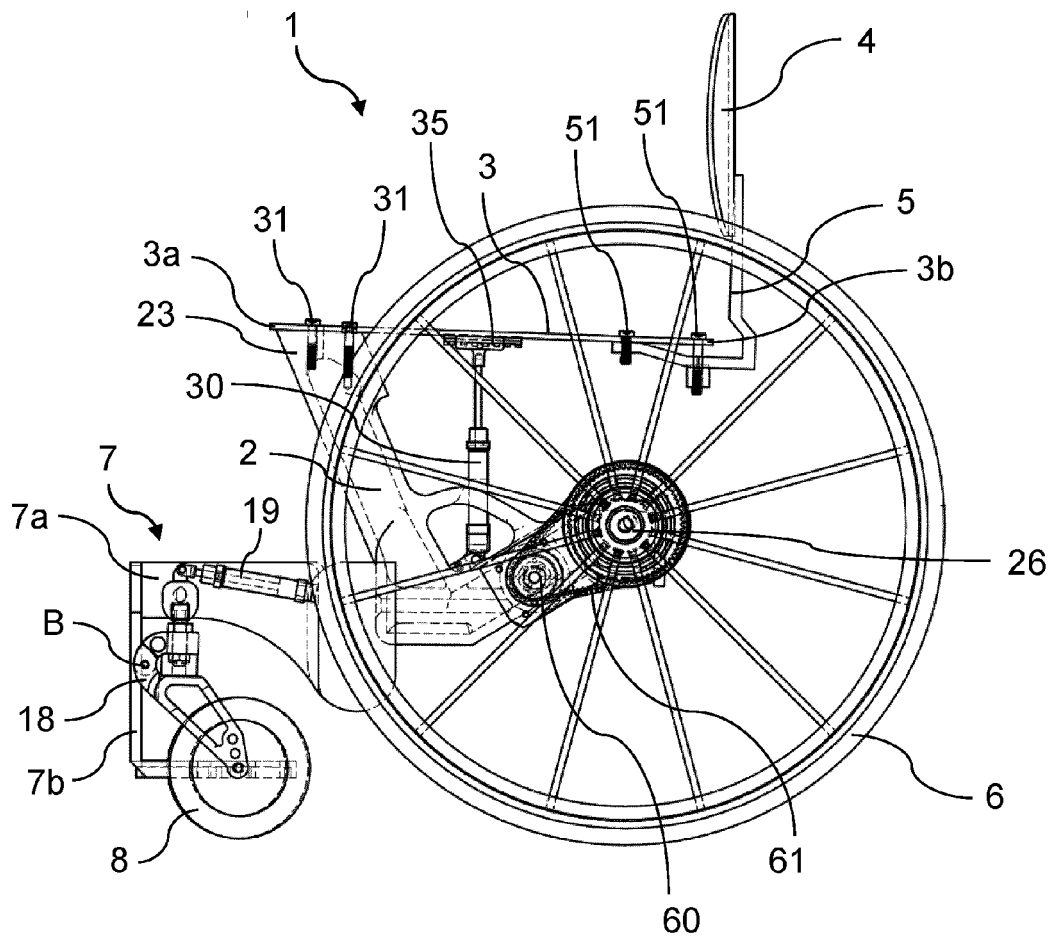


FIG. 6

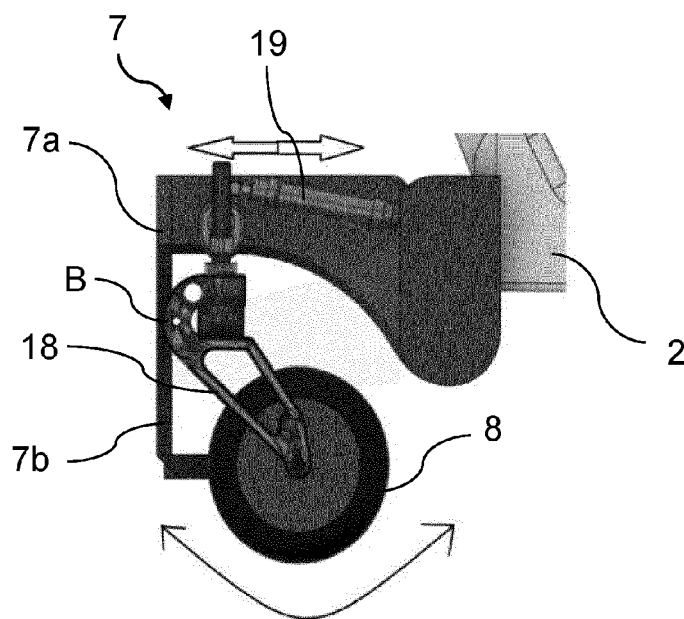


FIG. 7

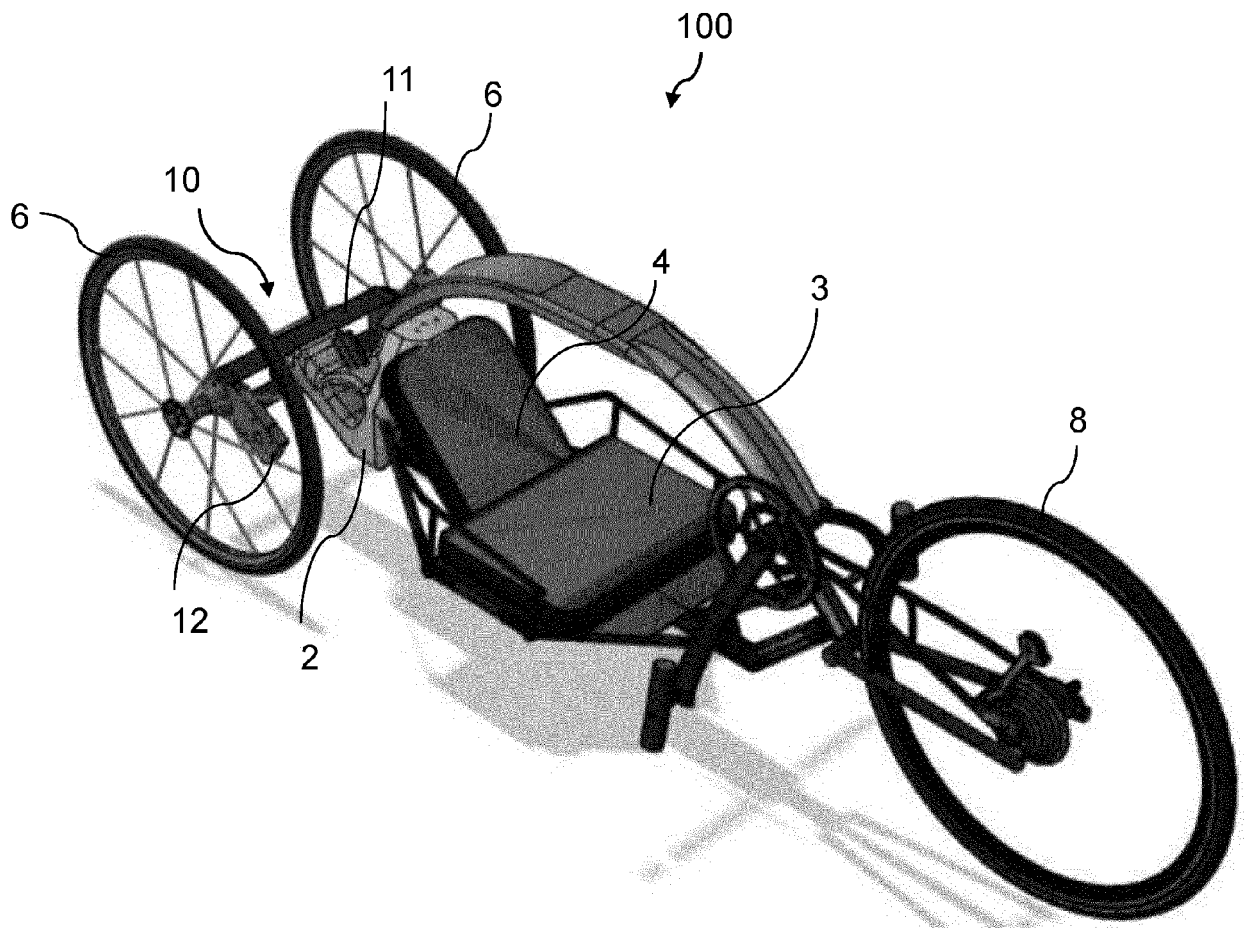


FIG. 8



EUROPEAN SEARCH REPORT

Application Number

EP 22 20 2943

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EPO FORM 1503 03.82 (P04C01)

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 2010/123296 A1 (CHELGREN ERIC MARK [US]) 20 May 2010 (2010-05-20) * paragraph [0021]; figures 1-7 * -----	1-9, 11, 14, 15	INV. A61G5/10 A61G5/12
X	US 6 672 606 B1 (DWYER JR EDWARD JOSEPH [US] ET AL) 6 January 2004 (2004-01-06) * figures 1,4-7 * -----	1-3, 9-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			A61G
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 5 April 2023	Examiner Gkama, Alexandra
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10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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