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(71) Applicants:
• **Université de Genève**
1211 Genève 4 (CH)
• **Hopitaux Universitaires de Genève**
1205 Genève (CH)
• **Sagawa Junior, Yoshimasa**
39700 Etrepigny (FR)

• **Watelain, Eric**
83136 Neoules (FR)

(72) Inventors:
• **Sagawa Junior, Yoshimasa**
39700 Etrepigny (FR)
• **Watelain, Eric**
83136 Néoules (FR)
• **Armand, Stéphane**
74800 La Roche sur Foron (FR)

(74) Representative: **KATZAROV S.A.**
European Patent Attorneys
19, rue des Epinettes
1227 Genève (CH)

(54) Propulsion device for a manual wheelchair

(57) Propulsion device for a manual wheelchair, comprising at least one manual wheelchair handrim (10), at least one freewheel (50) for coupling the handrim (10) to a rear wheel (1) of a manual wheelchair such that the handrim (10) is engaged with the rear wheel (1) when the handrim (10) is rotated in a forward direction and disengaged from the rear wheel (1) when the handrim (10) is rotated in a backward direction; at least one energy

storage device (51) coupled to the handrim (10) for storing energy from the handrim (10) when the handrim (10) is coupled to a rear wheel (1) of a manual wheelchair and turned in a backward direction, wherein the energy storage device (51) is configured such that energy stored therein is provided for driving a wheel (1) of a manual wheelchair coupled to said propulsion device. Wheelchair comprising such a propulsion device.

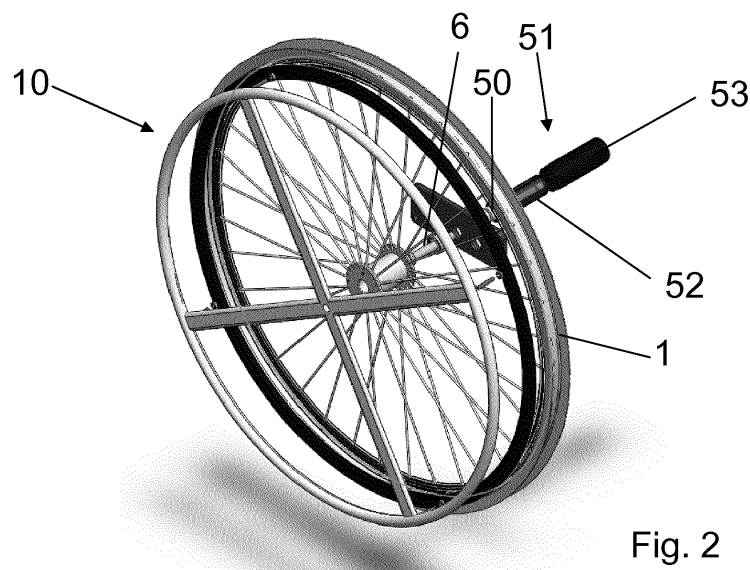


Fig. 2

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Description

[0001] The present invention relates to a propulsion device for a manual wheelchair and to a manual wheelchair comprising such a propulsion device. The present invention relates in particular to a propulsion device for a manual wheelchair that provides for a better leveling of the effort provided by a user for propelling the manual wheelchair.

[0002] The propulsion cycle of a manual wheelchair can be divided essentially in two phases: a propulsion phase during which the user pushes with his or her upper limbs on the handrims, which lasts about 30-40% of the propulsion cycle and contributes effectively to the forward displacement of the manual wheelchair, and a recovery phase during which the user's upper limbs are not in contact with the handrims, which lasts about 60-70% of the propulsion cycle and doesn't contribute to the forward displacement of the manual wheelchair.

[0003] During a forward displacement with a conventional manual wheelchair, at the recovery phase of the propulsion cycle, the handrims turn with the rear wheels of the manual wheelchair in a forward direction. The recovery phase thus only contributes to replace the user's upper limbs for the beginning of another propulsion phase. The recovery phase does not contribute to the manual wheelchair's forward displacement.

[0004] Furthermore, people regularly using manual wheelchairs often feel pain in the upper limbs, the shoulders and the neck due to the intense and repeated efforts provided during the relatively short propulsion phases.

[0005] An aim of the present invention is thus to provide a propulsion device for a manual wheelchair and a corresponding manual wheelchair that helps preventing or at least reducing the occurrence of pain for the user.

[0006] Another aim of the present invention is to provide a propulsion device for a manual wheelchair and a corresponding manual wheelchair allowing for a better leveling of the effort of a user for moving the manual wheelchair in a forward direction.

[0007] The above aims and other advantages are achieved by a propulsion device for a manual wheelchair and by a manual wheelchair according to the corresponding independent claim.

[0008] The above aims are achieved in particular by a propulsion device for a manual wheelchair, comprising at least one manual wheelchair handrim, at least one freewheel for coupling the handrim to a rear wheel of a manual wheelchair such that the handrim is engaged with the rear wheel when the handrim is rotated in a forward direction and disengaged from the rear wheel when the handrim is rotated in a backward direction; at least one energy storage device coupled to the handrim for storing energy from the handrim when the handrim is coupled to a rear wheel of a manual wheelchair and turned in a backward direction, wherein the energy storage device is configured such that energy stored therein is provided for driving a wheel of a manual wheelchair coupled to

said propulsion device.

[0009] The above aims are achieved also by a manual wheelchair comprising a frame with a seat for a user; front wheels attached to the frame, two rear wheels attached on opposite sides of the frame for manually propelling said wheelchair; a propulsion device as described above, wherein the handrim of the propulsion device is coupled over the freewheel of the propulsion device to one of the rear wheels such that the handrim drives the rear wheel when rotated in a forward direction and disengages from the rear wheel when rotated in a backward direction, and energy from the handrim is stored in the energy storage device when the handrim is turned in a backward direction and released from the energy storage device for driving the rear wheel.

[0010] In embodiments, the propulsion device of the invention comprises two handrims, one for each rear wheel of a manual wheelchair, at least two freewheels to couple each handrim to a corresponding rear wheel, and two storage devices, each storage device being coupled to another handrim and acting on the corresponding rear wheel of the manual wheelchair.

[0011] Thanks to the freewheel, the propulsion device of the invention allows the user to turn the handrims in a backward direction, opposite to the forward direction in which the handrims are turned during the propulsion phase, without blocking the manual wheelchair's rear wheels. When the user turns the handrims in the backward direction, at least part of the energy developed by the user for turning the handrims is stored in the energy storage device (or devices) of the propulsion device. In the next propulsion phase, at least part of the stored energy is released and contributes positively to the forward displacement of the manual wheelchair, thereby reducing the effort that the user has to provide during this propulsion phase for moving the manual wheelchair.

[0012] Thus, according to the invention, efforts provided by the user during both phases of the propulsion cycle contribute to the forward displacement of the manual wheelchair. The propulsion of the manual wheelchair is thus executed by different muscle groups and in a more efficient way: during the propulsion phase, the user pushes with his upper limbs on the handrims to move them in a forward direction and thereby moves the wheelchair forward move, and during the recovery phase, while the wheelchair still moves forward under the effect of its inertia, the user pulls on the handrims with his upper limbs to move them in the backward direction, thereby storing energy in the one or more energy storage devices. The recovery phase is thus active and contributes to the propulsion in at least the next propulsion cycle (i.e., the recovery phase provides energy for the propulsion phase).

[0013] In embodiments, a locking device, placed for example on both sides of the manual wheelchair, for example at the freewheels, allows locking the handrims relative to the rear wheels of the manual wheelchair, thereby permitting the manual wheelchair to retain its classical characteristics, i.e. that the rear wheels of the wheelchair

are stopped when the handrims are immobilized and turned backwards when the handrims are turned in the backward direction. This for example facilitates the use of the manual wheelchair in confined spaces, for example at home, by preserving its maneuverability.

[0014] The invention will be better understood by reading the following detailed description, illustrated by the enclosed figures, where:

Figure 1 shows an example of a prior art manual wheelchair;

Figure 2 is an exploded perspective view of a rear wheel of a manual wheelchair equipped with a propulsion device according to an embodiment of the invention;

Figure 3 is a side view of the rear wheel and propulsion device of figure 2;

Figure 4 shows elements of the rear wheel and propulsion device of figure 2;

Figure 5 is a diagram illustrating the physical effort developed by a user of a wheelchair comprising a propulsion device according to the invention.

Figure 6 is an exploded perspective view of another embodiment of the propulsion device of the invention with a rear wheel of a wheelchair.

Figure 7 and 8 show details of a manual wheelchair equipped with the propulsion device of figure 6.

[0015] Figure 1 shows an example of a conventional prior art manual wheelchair comprising a frame 12 having a seat 13 for a user. Caster wheels 11 are attached to either sides of the front of the frame 12, while rear wheels 1 comprising each a handrim 10 are attached to the back of the frame 12. Each handrim 10 is fixedly attached to the corresponding rear wheel 1, such that no rotation of the handrim 10 relative to the corresponding rear wheel 1 is possible. The rear wheels 1 are preferably attached on either side of the seat 13, such that a user seating in the seat 13 can grip on the handrims 10 and push them with his upper limbs in a forward direction for turning the rear wheels 1 in said forward direction and thereby moving the manual wheelchair 1 forwards. By pulling on the handrims 10 with his upper limbs in a backward direction, a user sitting in the seat 13 of a manual wheelchair as illustrated in figure 1 can turn the rear wheels 1 in said backward direction and move the manual wheelchair backwards.

[0016] Figures 2 and 3 are exploded views of a rear wheel 1 of a manual wheelchair with a propulsion device according to an embodiment of the invention, some details of the propulsion device being better visible in figure 4. According to the invention, a propulsion device com-

prises a handrim 10, for example a circular handrim with a rotation axis in its symmetry center. In the illustrated example, the handrim 10 comprises two circular rings that are attached to each other over spacers. Any type or profile of handrim can however be used within the frame of the invention, the handrim being adapted for example to the size and type of the rear wheel and/or to particular ergonomic requirements. The propulsion device of the invention further comprises a freewheel 50 for coupling the rotation axis of the handrim 10 to the rotation axis 6 of the rear wheel 1. In embodiments, the rotation axis of the handrim 10 is coaxially aligned with the rotation axis 6 of the rear wheel 1. The axis of the handrim 10 is for example located inside the axis 6 of the wheel 1. The axis 6 of the wheel 1 is coupled to the axis of the handrim 10 such that, once the rear wheel 1 and the propulsion device are mounted on a manual wheelchair, a rotation of the handrim 10 in a forward direction creates an engagement of the axis 6 of the rear wheel 1, while the axis 6 of the rear wheel 1 is disengaged when the handrim 10 is rotated in a backward direction.

[0017] According to the invention, the propulsion device further comprises an energy storage device 51. The energy storage device 51 for example comprises a spring 52 housed in a casing 53. The spring 52 is for example attached on one end to the axis of the wheel 1 and on the other end to the axis of the handrim 10, such that when the handrim 10 is turned in the backward direction relative to the rear wheel 1, the spring 52 is loaded, i.e. either compressed or stretched out of its rest position, and energy is thus stored in the energy storage device 51. The energy stored in the energy storage device 51 is then released for example in that the spring 52 acts, i.e. either pulls or pushes, on the axis of the rear wheel 1 for participating in rotating it in the forward direction, thereby participating in the propulsion of the wheelchair in a forward direction.

[0018] Preferably, the energy storage device of the invention further comprises attachment means 2 for attaching said device to the frame of a manual wheelchair.

[0019] In the illustrated embodiment, the energy storage device 51 comprises a spring 52 for storing the energy developed by a user turning the handrim 10 in a backward direction relative to the wheel 1. Other types of energy storage devices are however possible within the frame of the invention. In embodiments, the energy developed by the user during the recovery phase is for example stored in the form of electrical energy, in that the rotation of the handrim in a backward direction for example activates a dynamo that generates electrical energy which is then stored in an accumulator. The stored electrical energy is then for example used for powering an electrical motor that acts on the axis of the wheel 1, thereby participating in the rotation of the wheel 1 in a forward direction.

[0020] In embodiments, the propulsion device of the invention further comprises a locking device, which is not represented on the figures, for locking the handrim 10 to

the corresponding rear wheel 1, such that no rotation of the handrim 10 relative to the rear wheel 1 is allowed.

[0021] The propulsion device of the invention is illustrated in the figures by way of an illustrative but in no way limiting example, for use with one rear wheel 1 of a manual wheelchair. The one skilled in the art will however understand that, in embodiments, the propulsion device of the invention comprises the same elements for both rear wheels of a manual wheelchair. The propulsion device then comprises for example two handrims 10, one for each rear wheel of a manual wheelchair, at least two freewheels for coupling the axis of each handrim 10 to the axis of the corresponding rear wheel 1, and for example two energy storage devices 51, each storage device 52 being associated with another one of the two handrims 10 and the corresponding rear wheel 1.

[0022] A manual wheelchair equipped with the propulsion device provides for a better leveling out of the effort that a user must provide for moving the wheelchair forward. Indeed, when the user pushes on the handrims 10 in a forward direction, during the propulsion phase of a propulsion cycle, the handrims 10 engage the rear wheels 1 through the freewheel 50. The rear wheels thus in turn rotate in a forward direction, thereby moving the wheelchair forward.

[0023] At the end of the propulsion phase, when the user can no longer push the handrims 10, he doesn't need to release the handrims 10 for allowing the wheelchair to continue moving forward, but instead pulls on the handrims 10 in a recovery phase, turning them in a backward direction, opposite to the forward direction. When the handrims 10 are turned in said backward direction, the freewheel disengages the axis of the rear wheels from the axis of the handrims 10, thereby allowing the wheelchair to continue moving forward under the effect of its inertia, despite the fact that the handrims turn in a direction opposite that of the rear wheels 1. During the recovery phase, while the handrims 10 are turned in said backward direction, at least part of the energy provided by the user for turning the handrims 10 is stored in the energy storage device 51, for example by transferring the energy of the handrims' 10 movement, and consequently of the spring's 52 movement, into potential energy stored in the spring 52. Other types of energy storage devices are however possible within the frame of the invention, such as for example, but not exclusively, pneumatic actuators, hydraulic actuators, or any combination thereof.

[0024] At the end of the recovery phase, the user can enter a new propulsion phase without releasing the handrims 10, by pushing again in a forward direction. The energy stored in the recovery phase is then released and participates to the propulsion of the manual wheelchair in a forward direction, thereby helping the user moving the wheelchair forward at a desired speed.

[0025] According to the invention, at least part of the energy developed by the user in the recovery phase assist him in moving the wheelchair forward during the fol-

lowing propulsion phase, thereby allowing him moving the wheelchair at a given speed with reduced efforts during the propulsion phase compared to the efforts that would be necessary in a propulsion for moving at the same speed a manual wheelchair without the propulsion device of the invention.

[0026] This is illustrated in figure 5 in a diagram showing the energy provided over an entire propulsion cycle by a user of a prior art manual wheelchair and by a user of a manual wheelchair comprising the propulsion device of the invention.

[0027] In this diagram, curve 91 illustrates the energy provided by a user of a prior art conventional manual wheelchair during the propulsion cycle, where the propulsion cycle starts with a negative energy peak 911 that corresponds to the moment where the user grasps the handrim and thereby slightly slows down the manual wheelchair, followed by a high positive energy peak 912, corresponding to the actual propulsion of the manual wheelchair by the user, when the user actively pulls on the handrims, and finally a small negative energy peak 913 when the user releases the handrims and again slightly slows down the wheelchair. This propulsion phase, which lasts approximately 30% of the entire propulsion cycle, is followed by a recovery phase during which the user doesn't provide any energy to the chair, but brings his upper limbs back in a position to start another propulsion cycle.

[0028] Curve 92 schematically illustrates the energy provided by a user of a manual wheelchair comprising the propulsion device of the invention.

[0029] Thanks to the freewheels coupling the handrims to the corresponding rear wheel, curve 92 doesn't show any negative peak, since the user doesn't need to grasp and release the handrims of the manual wheelchair respectively at the beginning and the end of the propulsion phase. Even if the user was to grasp and release the handrims as in a conventional prior art manual wheelchair, the short immobilization of the handrims, or even a possible movement thereof in the backward direction, would not result in negative energy for the displacement of the wheelchair since the rear wheels' axis would then disengage from the handrims.

[0030] The positive peak of energy of curve 92 is furthermore more spread over time and the maximal intensity of the effort is reduced compared to the effort that needs to be developed in a conventional prior art manual wheelchair, thanks to the fact that the propulsion device of the invention participates to the propulsion of the wheelchair with the energy stored during the preceding recovery phase. During the recovery phase, the user continues providing energy to the manual wheelchair by pulling on the handrims in a backward direction, thereby storing energy in the energy storage device of the propulsion device, which will then be used for propelling the wheelchair, while also stimulating other muscle groups than during the propulsion phase.

[0031] Further advantages of the propulsion device of

the invention further comprise for example the fact that, when the wheelchair comprising the propulsion device of the invention is stopped, the user can pull on the handrims for storing energy in the energy storage device. The stored energy will then be released when the wheelchair starts moving again, thereby helping the user in his efforts during the start phase, which is a physically difficult phase.

[0032] Another advantage of a wheelchair comprising the propulsion device of the invention is that the wheelchair can't undesirably roll backwards if it stands on a slight slope going up. If the force linked to the slope is stronger than the force linked to the energy storage device, however, the wheelchair will then move backwards and charge the energy storage device, thereby helping the user in the next start phase.

[0033] Figure 6 is an exploded view of another embodiment of the propulsion device of the invention, where the attachment means 2 for attaching the device to a wheelchair forms a housing for lodging the spring 52, which is for example arranged around the wheel's axis, as well as ball bearings for rotatably maintaining the wheel's axis therein. The housing formed by the attachment means 2 is for example closed by a lid 3, thereby protecting the elements therein from dirt that could come from the wheel 1 when the corresponding manual wheelchair is in use. The attachment means 2 is for example configured for attachment to a tube, for example a vertical tube, of the frame of a manual wheelchair.

[0034] Figures 7 and 8 show details of a manual wheelchair equipped with a propulsion device of the invention. Preferably, the propulsion device comprises two handrims, at least two freewheels and two energy storage devices in order to equip both rear wheels of the manual wheelchair in a similar way and independently from each other (see for example figure 8).

[0035] Other solutions are however possible within the frame of the invention. In case of a propulsion device storing electrical energy, the propulsion device may for example comprises two dynamos, one for each rear wheel of a manual wheelchair, two electrical motors for driving each a rear wheel of the manual wheelchair, and a single accumulator for storing electrical energy produced by both dynamos and releasing said energy to both electrical motors.

[0036] In the embodiments described above, the handrim is essentially circular and preferably coaxially aligned with the rear wheels of a manual wheelchair. Other embodiments of handrims for propelling manual wheelchairs are however possible within the frame of the invention, such as for example one or two levers acting on one or two wheels of a manual wheelchair, and coupled to the axis of said wheels through one or more freewheels, similarly to what is described above in the case of the circular handrims. The one or two levers for example each comprise a rotation axis close to one of their extremities, which is for example coaxially aligned with and coupled to the rotation axis of the corresponding

wheel or wheels, so that the rotation of the one or two levers around their rotation axis in a forward direction drives the corresponding wheels in a forward direction, and the rotation of the one or two levers around their rotation axis in a backward direction stores energy in the one or more energy storage device.

Claims

1. Propulsion device for a manual wheelchair, comprising:
 - at least one manual wheelchair handrim (10);
 - at least one freewheel (50) for coupling said at least one handrim (10) to a rear wheel (1) of a manual wheelchair such that said at least one handrim (10) is engaged with said rear wheel (1) when said at least one handrim (10) is rotated in a forward direction and disengaged from said rear wheel (1) when said at least one handrim (10) is rotated in a backward direction;
 - at least one energy storage device (51) coupled to said at least one handrim (10) for storing energy from said at least one handrim (10) when said at least one handrim (10) is coupled to a rear wheel (1) of a manual wheelchair and turned in a backward direction, wherein said at least one energy storage device (51) is configured such that energy stored therein is provided for driving a wheel (1) of a manual wheelchair coupled to said propulsion device.
2. Propulsion device according to the preceding claim, wherein said at least one energy storage device (51) comprises a spring (52) for storing energy.
3. Propulsion device according to claim 1, wherein said at least one energy storage device (51) comprises a dynamo for producing electrical energy, an accumulator for storing said electrical energy and an electrical motor for driving a wheel of a manual wheelchair.
4. Propulsion device according to claim 1, wherein said at least one energy storage device (51) comprises a pneumatic or hydraulic actuator.
5. Propulsion device according to any one of the preceding claims, wherein said at least one handrim (10) is circular and comprises a rotation axis in its center of symmetry, said at least one freewheel (50) being configured for coupling said rotation axis to the rotation axis (6) of a rear wheel (1) of a manual wheelchair.
6. Propulsion device according to any one of the preceding claims, wherein said at least one handrim is

a lever and comprises a rotation axis close to one of its extremities, said at least one freewheel (50) being configured for coupling said rotation axis to the rotation axis (6) of a rear wheel (1) of a manual wheelchair.

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7. Propulsion device according to anyone of claims 5 or 6, wherein said at least one freewheel (50) is attached to and coaxially aligned with said rotation axis of said at least one handrim (10). 10
8. Propulsion device according to any one of claims 5 to 7, wherein said energy storage device (51) is located on said rotation axis of said at least one handrim (10). 15
9. Propulsion device according to any one of the preceding claims, further comprising a locking device for engaging said at least one handrim (10) with a rear wheel (1) of a manual wheelchair when said at least one handrim (10) is rotated both in a forward and in a backward direction. 20
10. Propulsion device according to any one of the preceding claims, comprising two handrims (10), at least two freewheels (50) and two storage devices (51) for coupling to both rear wheels (1) of a manual wheelchair. 25
11. Manual wheelchair, comprising: 30
 - a frame (12) with a seat (13) for a user;
 - front wheels (11) attached to said frame (12);
 - two rear wheels (1) attached on opposite sides of said frame (12) for manually propelling said wheelchair; 35
 - a propulsion device according to any one of claims 1 to 10,

wherein 40

said at least one handrim (10) of said propulsion device is coupled over said at least one freewheel (50) of said propulsion device to one of said two rear wheels (1) such that said at least one handrim (10) drives said one of said two rear wheels (1) when rotated in a forward direction and disengages from said one of said two rear wheels (1) when rotated in a backward direction, and energy from said at least one handrim (10) is stored in said at least one energy storage device (51) when said at least one handrim (10) is turned in a backward direction and released from said at least one energy storage device (51) for driving said one of said two rear wheels (1). 45 50
12. Kit comprising a rear wheel for a manual wheelchair and a propulsion device according to any one of claims 1 to 10. 55

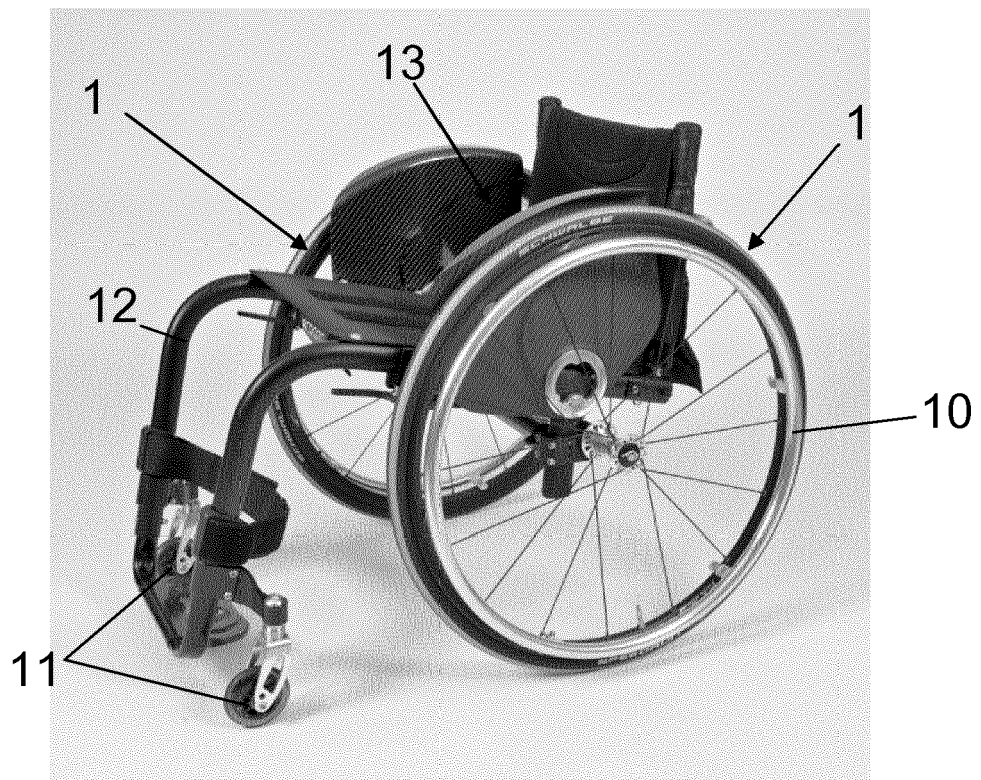


Fig. 1

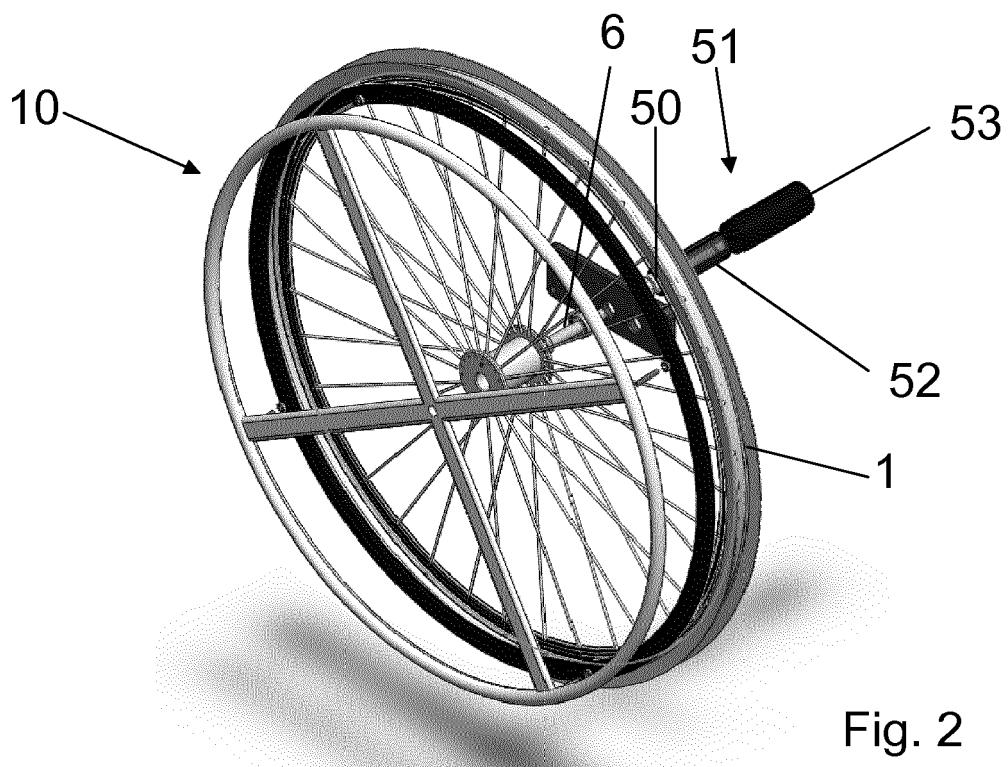


Fig. 2

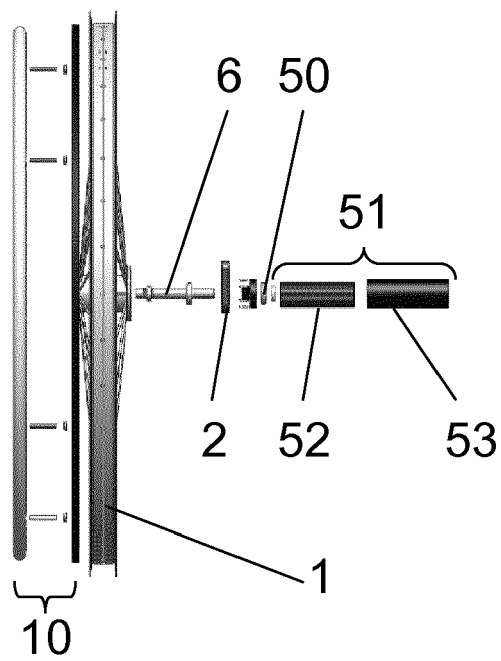


Fig. 3

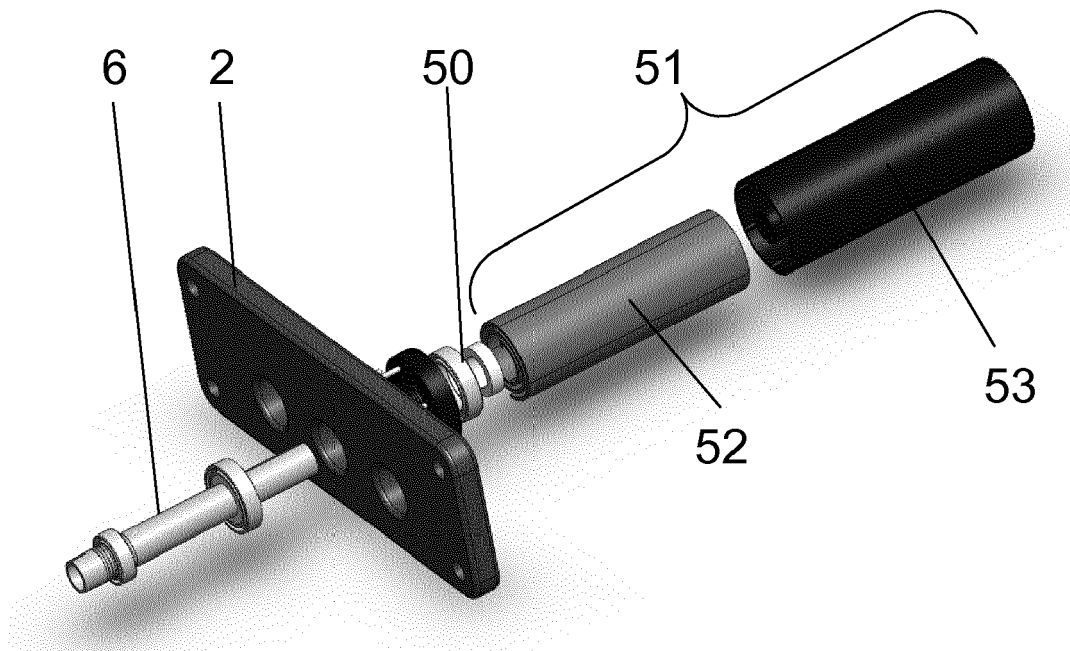


Fig. 4

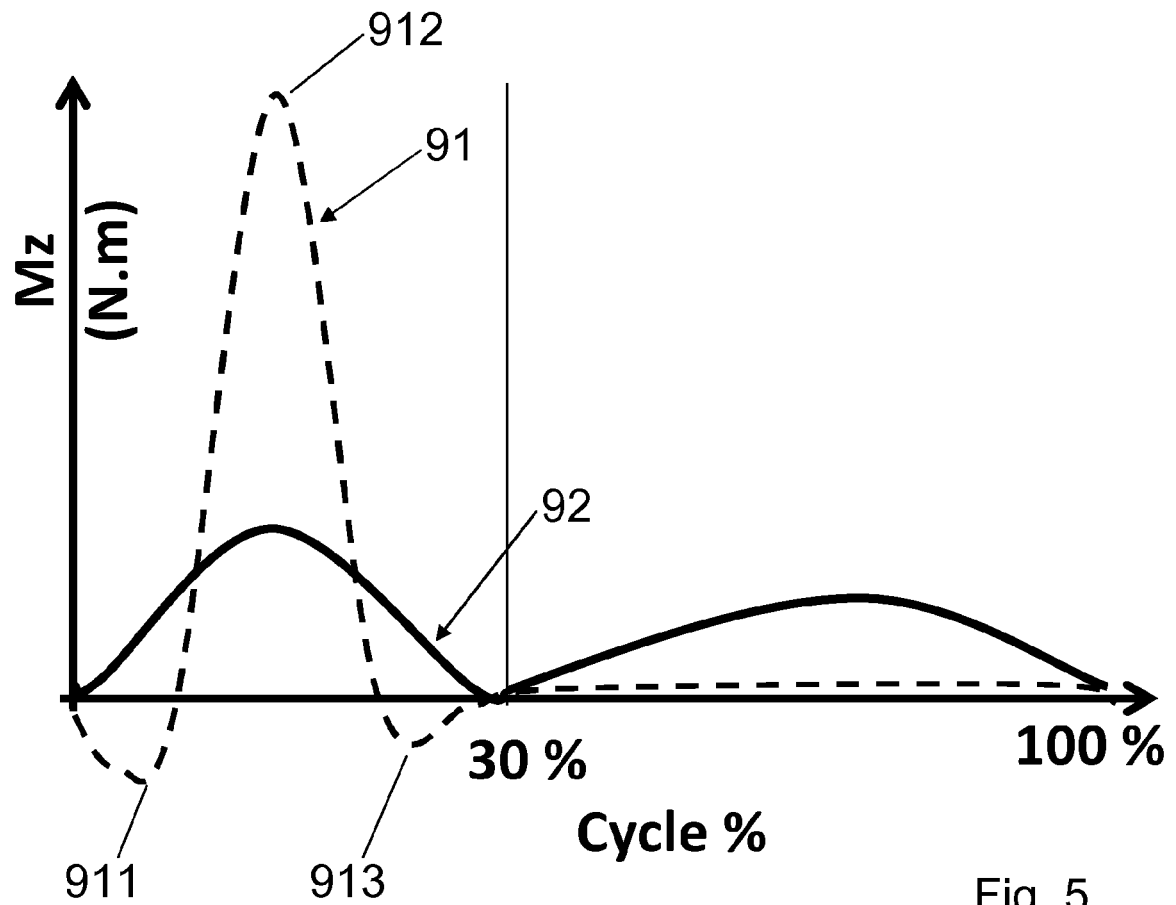


Fig. 5

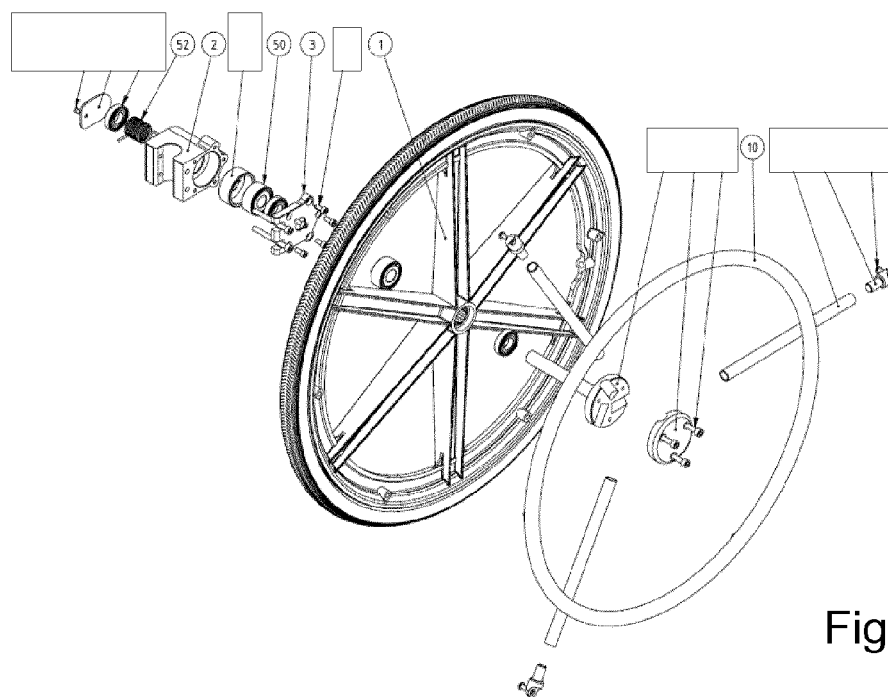


Fig. 6

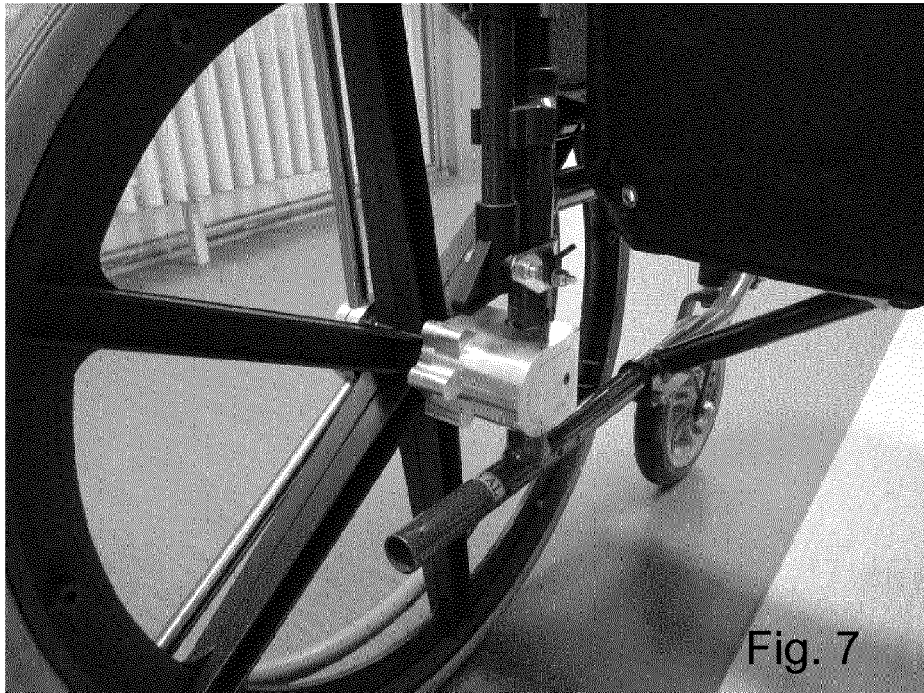


Fig. 8



EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 12 March 2015	Examiner Ong, Hong Djien
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