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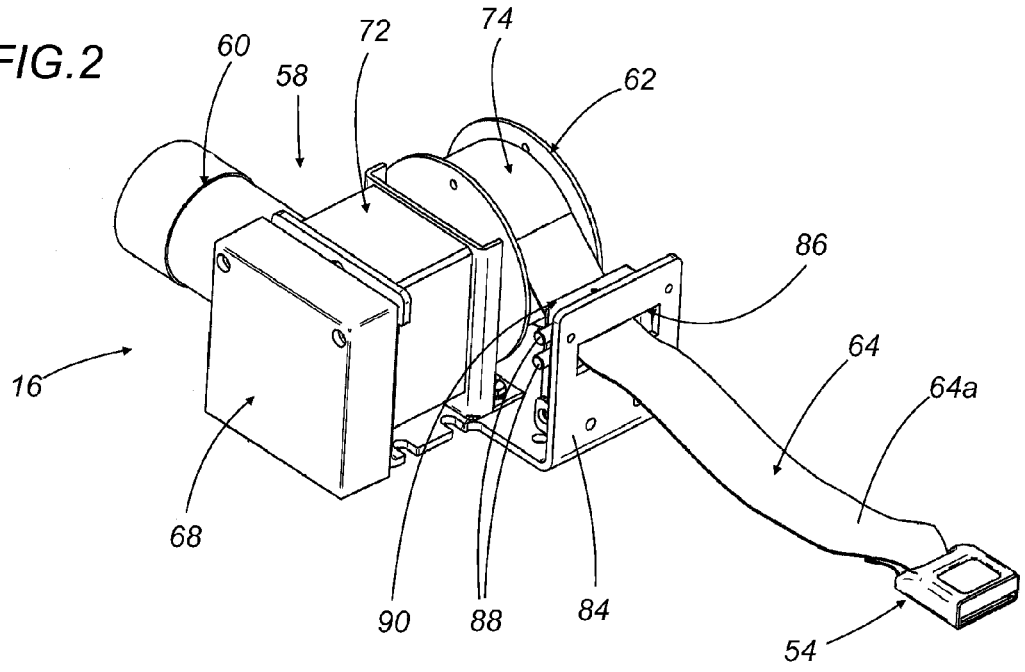
(54) A power transfer device for wheelchair mobility on inclined planes

(57) A power transfer device for the mobility of a wheelchair for the physically challenged on inclined planes comprises a winch (58) driven by a motor (60). The winch (58) comprises a belt reel (62) rotationally connected to the motor (60), a drive belt (64) wound round the reel (62) and equipped with at least one hook (66) for fastening to the wheelchair (2), and a control unit (68) for driving the motor (60). The power transfer device also comprises a command device (70) which can be connected to the control unit (68) and which can be operated manually by a user in order to allow the user to adjust the advancing speed of the wheelchair (2) in real time.

FIG.2



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Description

[0001] This invention relates to a power transfer device for the mobility of a wheelchair for the physically challenged on inclined planes.

[0002] Prior art devices of this type comprise a motor-driven winch, a belt wound round the winch and a device for driving the winch motor.

[0003] More specifically, prior art devices are driven by a control of the "on-off" type. In other words, when the motor is turned on, it immediately delivers the maximum power it can provide.

[0004] This aspect means a wheelchair with a physically challenged person confined thereto is started with a jolt. The forward jolt not only makes it difficult to control the direction of movement but also subjects the physically challenged person to strain that may be both unpleasant and harmful. Furthermore, the prior art devices drive the winch at a constant rotation speed, making it impossible to control the advancing speed at which the wheelchair moves.

[0005] This aspect makes manoeuvring up and down the inclined plane particularly awkward, with the risk of causing falls and injuries to the physically challenged person.

[0006] The non-controllability of the speed is disadvantageous especially when moving down the inclined plane because it increases the risk of falls and injuries.

[0007] This invention therefore has for an aim to provide a device for driving a wheelchair on inclined planes which overcomes the above mentioned disadvantages of the prior art.

[0008] These and other aims are substantially achieved by a power transfer device for wheelchair mobility on inclined planes as described in the independent claim 1 appended hereto.

[0009] These and other features of the invention will become more apparent from the following detailed description of a preferred, non-limiting example embodiment of it, with reference to the accompanying drawings, in which:

- Figure 1 illustrates a device according to this invention;
- Figure 2 is a perspective view illustrating a first detail from Figure 1;
- Figure 3 is an exploded perspective view illustrating the detail from Figure 1;
- Figure 4 is a perspective view illustrating a second detail from Figure 1;
- Figure 5 is an exploded perspective view illustrating the detail of Figure 4;
- Figure 6 is a schematic side view illustrating a third detail from Figure 1.

[0010] As illustrated in Figures 1 to 5, the numeral 16 denotes a power transfer device according to the invention for the mobility of a wheelchair 2 on inclined planes.

[0011] As illustrated, in particular, in Figures 2 and 3, the device 16 comprises a winch 58 driven by a motor 60, the winch 58 comprising a belt reel 62 rotationally connected to the motor 60, a drive belt 64, wound on the reel 62 and equipped with at least one hook 66 (Figure 6) for fastening to the wheelchair 2 and a control unit 68 for driving the motor 60.

[0012] The device also comprises a command device 70 which can be connected to the control unit 68 and which can be operated manually by a user in order to allow the user to adjust the advancing speed of the wheelchair 2 in real time. More specifically, the advancing speed of the wheelchair 2 can be adjusted both when driving up and when driving down the inclined plane.

[0013] In this description, reference is made to driving the wheelchair 2 up and down the inclined plane with its user seated in it but without limiting the scope of the invention since, for example, only the wheelchair 2, without anyone seated in it, might be driven.

[0014] Furthermore, the term "user" is used without distinction to mean both the wheelchair confined user and a third-party operator in the event that the wheelchair confined user is unable to operate the command device 70 unaided.

[0015] As illustrated in Figures 2 and 3, the winch 58 comprises a frame 84 mounting the reel 62, the motor 60 and the control unit 68.

[0016] More specifically, the frame 84 has a slot 86 for the passage of the drive belt 64. A pair of guide rollers 88 for the belt 64 is mounted at the slot 86.

[0017] Also mounted at the slot 86 there is a microswitch 90 for controlling the belt 64 and designed to stop it from being wound onto the reel 62 when the limit stop position has been reached.

[0018] More specifically, when the belt 64 has been wound completely on the reel 62, the microswitch 90 stops the motor 60, thus preventing the motor 60 from being subjected to dangerous overloading and overheating.

[0019] The winch also preferably comprises a reduction gear 72 mounted on the frame 84 and connected to the output shaft of the motor 60.

[0020] The belt reel 62 mounts a roll 74 of belt 64 and is connected to the output of the reduction gear 72 of the winch 58.

[0021] The reel 62 comprises a first plate 76 and a second plate 78, opposing each other and between which the roll 74 of belt 64 is mounted by means of a first pin 80 which connects the plates 76, 78. The reel 62 further comprises a second pin 82 extending from the first plate 76 on the side opposite the roll 74, the second pin 82 connecting the reel 62 the output of the reduction gear 72.

[0022] In the preferred embodiment, the first belt 64 comprises a first portion 64a and a second portion 64b connected to each other by a disconnectable coupling 54. The first portion 64a consists of the belt wound on the roll 74 and, at the free end of it, has a first part of the

disconnectable coupling 54, as shown more clearly in Figure 2. The second portion 64b has, at a first end of it, a second part of the disconnectable coupling 54 and, at the opposite end of it, at least one fastening hook 66. This feature facilitates fastening the hook 66 to the wheelchair 2 and makes it easier to adapt the device 1 to different types of wheelchairs by simply substituting the second portion 64b of the belt 64 for a suitable one.

[0023] As shown in Figures 4 and 5, the command device 70 comprises a support 100, a potentiometer 96 mounted on the support 100 and able to send to the control unit 68 a signal characteristic of the rotation speed and/or torque which the motor 60 must deliver in connection with the advancing speed of the wheelchair 2 desired by the user at any one instant, and a lever 98 mounted on the support 100 for controlling the potentiometer 96.

[0024] In a preferred embodiment, the lever 98 is substantially circular in shape.

[0025] The command device 70 also comprises a case 92 for containing the items just described and having an opening 94 allowing access for operation of the lever 98.

[0026] The control unit 68 controls the motor 60 by regulating the speed of rotation of the motor 60. In an alternative embodiment, the control unit 68 controls the motor 60 by regulating the torque delivered by the motor.

[0027] The control unit 68 can also control the motor 60 by simultaneously regulating both the speed of rotation and the torque delivered.

[0028] More specifically, in the preferred embodiment, the motor 60 rotates at a variable speed, generating an auto sync torque as a function of the advancing speed of the wheelchair 2 to be maintained.

[0029] The command device 70 transmits signals to the control unit 68 through a cable or via remote control. The command device 70 has an ergonomic handgrip allowing it to be held conveniently by the user and allows the lever 98 to be operated with the thumb only (Figure 4).

[0030] The command device 70 also comprises a switch 104 which, when pressed, shuts off the control lever 98 and the potentiometer 96. In other words, the command device 70 can be switched off, for example after reaching the top or the bottom of the inclined plane, in order to avoid accidentally operating the lever 98 with the risk of causing uncontrolled movements of the wheelchair 2. Pressing the switch 104 again resumes communication between the command device 70 and the control unit 68, thereby reactivating the control lever 98 and the potentiometer 96.

[0031] The lever 98 is movable from a non-operating position, where the potentiometer 96 does not send any signal to the control unit 68 and the motor 60 of the winch 68 is stationary, to a first operating position where the motor 60 is set at a rotation speed and/or torque value based on the advancing speed of the wheelchair 2 desired by the user during a step of winding the drive belt 64 on the reel 62.

[0032] The lever 98 is also movable from the non-operating position to a second operating position where the motor 60 is set at a rotation speed and/or torque value based on the advancing speed of the wheelchair 2 desired by the user during a step of unwinding the drive belt 64 from the reel 62.

[0033] More specifically, by first and second operating positions are meant the positions adopted by the control lever 98 in real time based on the advancing speed of the wheelchair 2 which the user desires at any one instant.

[0034] The command device 70 also has a biasing element, represented as a spring 102 in the drawing, which advantageously allows the lever 98 to return automatically to the non-operating position.

[0035] In other terms, the first operating position is defined as the rotation of the lever 98 through an angle α, in a first direction of rotation, while the second operating position is defined as the rotation of the lever 98 through an angle β in a second direction of rotation opposite the first direction.

[0036] The angles α and β thus define specific desired values of the rotation speed of, and/or the torque delivered by, the motor 60 during a step of winding and unwinding the drive belt 64, respectively, and consequently define the advancing speed of the wheelchair 2 up and down the inclined plane, desired by the user at any one instant.

[0037] More specifically, the more the control lever 98 is turned, the higher the rotation speed of, and/or the torque delivered by, the motor 60, and hence the higher the advancing speed of the wheelchair 2. A control of this kind enables the wheelchair to be manoeuvred more safely with the wheelchair confined user seated in it.

[0038] For example, when moving up the inclined plane, starting from a position where it is substantially stationary, the wheelchair 2 can be set in motion gradually since the motor 60 can be set at a low speed or rotation and/or delivered torque so that the wheelchair 2 advances at a slow speed.

[0039] When moving up the inclined plane, represented in the drawing as a ramp 8, the command used to control the motor 60 up to that moment may no longer be sufficient, considering also the weight of the wheelchair 2 and of the user seated in it. At this point, therefore, all the user needs to do is adjust the potentiometer 96 by turning the control lever 98 further in such a way as to increase the power signal to the motor 60 enabling the latter to overcome the upward slope.

[0040] It may also happen that the user must correct the position of the wheelchair 2 relative to the ramp 8 before and/or while moving up the slope.

[0041] Adjusting the advancing speed in real time makes it possible to easily correct the position of the wheelchair 2, avoiding falls or harmful strain to the wheelchair confined user.

[0042] After reaching the top of the ramp 8, the motor 60 can be returned to a suitable value of rotation speed and/or delivered torque in such a way as to more easily control and, if necessary, correct the position of the

wheelchair as it moves off the ramp 8.

[0043] Similarly to what has just been described, when driving the wheelchair 2 down the ramp 8, too, the user can adjust the speed of the wheelchair 2 instant by instant by turning the control lever 98 in the direction opposite to the previous direction, in such a way as to reverse the direction of rotation of the motor 60 and suitably adjust its rotation speed and/or delivered torque. The user can thus drive down the ramp 8 gradually, avoiding accidents and harmful strain in this case, too.

[0044] In one particular embodiment, the device 16 according to the invention is mounted on a vehicle 4 especially adapted to transport physically challenged persons confined to a wheelchair. In Figure 1, the vehicle 4 is a road transport motor vehicle.

[0045] Furthermore, the numeral 6 in Figure 1 denotes in its entirety the rear compartment of the vehicle 4. The access ramp 8 for the wheelchair 2 forms part of the vehicle 4 and leads into the compartment 6 of the vehicle 4. The compartment 6 has a supporting floor 10 to hold the wheelchair 2 during transportation.

[0046] The vehicle 4 also comprises means 12 for securing the wheelchair 2 to the floor 10 of the compartment 6 and means 14 for protecting the user confined to the wheelchair 2 during transportation.

[0047] The compartment 6 is closed by a rear door, not illustrated, of the vehicle 4.

[0048] Since the floor 10 of the compartment 6 is situated at a certain height from the ground, the wheelchair 2 is loaded on board with the aid of the access ramp 8, which is connected to the floor 10 itself. As illustrated in Figures 1 and 6, the wheelchair securing means 12 comprise a plurality of securing belts 20 connected to the floor 10 of the compartment 6, each of which has at least one hook 26 for fastening to the structure of the wheelchair 2.

[0049] The securing belts 20 are preferably connected to the floor 10 of the compartment 6 by a hinged mounting which makes it easier and more practical to fasten the belts 20 to the structure of the wheelchair 2.

[0050] More precisely, the securing means 20 comprise a pair 34 of securing belts 20 located at the entrance to the compartment and constituting a pair of rear securing belts 20 for the wheelchair 2. Generally speaking, the securing belts 20 are fastened to the structure of the wheelchair 2, preferably as close as possible to the floor 10. This not only makes fastening easier both for a third party operator and, if necessary, also for the user confined to the wheelchair 2 but also guarantees greater stability, during transportation, against possible movements of the wheelchair 2 along a direction substantially parallel to the direction of vehicle travel.

[0051] The securing belts 20 of the wheelchair 2 are adjustable in length and are equipped with means - of known type and therefore not illustrated - for locking them at the desired length.

[0052] The securing belts 20 are preferably used in pairs to better balance and compensate movements of the transported wheelchair 2 sideways relative to the direction of vehicle travel.

[0053] Advantageously, the wheelchair securing means 12 are also defined by the winch 58 itself.

[0054] Indeed, to further stabilize the position of the wheelchair 2 during transportation, it must be secured at the front, too, and that is to say, on the side opposite the pair 34 of rear securing belts 20.

[0055] Known in the prior art is the use of front securing belts fastened to the structure of the wheelchair 2 to increase stability against unwanted movements in the direction parallel to the direction of travel of the vehicle 4.

[0056] According to the invention, the winch 58 advantageously not only allows the wheelchair 2 to be loaded into and unloaded from the compartment 6 of the vehicle 4 but also allows the wheelchair 2 to be secured in place during transportation, where it is used in place of front securing belts. Indeed, once the wheelchair 2 has been loaded into the compartment 6, the winch 58 is stopped and is able to keep its belt 64 locked in the position adopted at the moment of stopping, thus holding the wheelchair 2 in place at the front effectively and more securely than front belts of the type known in the prior art.

[0057] Advantageously, implementing the winch 58 in substitution for front belts also simplifies construction and thus reduces production costs, while guaranteeing that the front of the wheelchair 2 is also effectively and safely secured.

[0058] The wheelchair confined user protection means 14 comprise, as shown Figures 1 and 6, a first belt 36 equipped with at least one fastening element 42 for the belt 36 itself. More specifically, the first belt 36 is connected, at a first end of it 38, to the loading compartment 6, whilst a second, opposite end of it 40 can be connected, during transportation of the wheelchair 2, to the floor 10 of the loading compartment 6 using the aforementioned fastening element 42.

[0059] In the preferred embodiment, the first belt 36 has two fastening elements 42. Each fastening element 42 engages, at a respective point, not shown, with a respective rear fastening hook 26.

[0060] As shown more clearly in Figure 6, the first belt 36 allows the user to be secured to the wheelchair 2 safely and firmly during transportation.

[0061] The first belt 36 encircles the user's body from above and prevents the user from, for example, falling forward during a sudden brake or violent impact, while at the same reducing the stress and strain inevitably present during transportation. The wheelchair confined user protection means 14 also comprise an automatic device 48 for rewinding the first belt 36 and located at the first end 38. The device 48 is of known type and basically comprises a reel, not illustrated, for rewinding the first belt 36, and means, not illustrated, for automatically retracting the first belt 36.

[0062] The automatic device 48 for rewinding the first belt 36 is located beside the wheelchair confined user.

[0063] In the preferred embodiment shown in Figure

1, the automatic rewinding device 48 is located substantially at the floor 10 of the compartment 6. The first belt 36 is also wound round an idler pulley 50 mounted on the top wall or on a side wall of the compartment, in particular, on the same side as the automatic rewinding device 48. More precisely, the idler pulley 50 is located at a position such that, as mentioned above and as clearly shown in Figure 1, the first belt 36 can encircle from above the user confined to the wheelchair 2.

[0064] The invention described offers numerous advantages. The device 16, because it allows the winch motor 60 to be controlled instant by instant and the advancing speed of the wheelchair 2 to be adjusted in real time, enables the wheelchair 2 to be set in motion very gradually, without the risk of the user of the wheelchair 2 falling, or suffering from dangerous impacts or stress.

[0065] Moreover, the device 16 is practical and convenient to use, not only for a third-party operator but also, if necessary, for a user confined to the wheelchair 2.

[0066] Owing to its constructional simplicity, the device 16 can be adapted to a very wide range of vehicles 4 and wheelchairs 2 and considerably reduces installation times.

[0067] The device 16 also has low production costs and low costs of installation on vehicles.

[0068] The invention described above is susceptible of industrial application and may be modified and adapted in several ways without thereby departing from the scope of the inventive concept. Moreover, all the details of the invention may be substituted for technically equivalent elements.

Claims

1. A power transfer device for the mobility of a wheelchair for the physically challenged on inclined planes, comprising a winch (58) driven by a motor (60); the winch (58) comprising a belt reel (62) rotationally connected to the motor (60), a drive belt (64) wound round the reel (62) and equipped with at least one hook (66) for fastening to the wheelchair (2), and a control unit (68) for driving the motor (60), and a command device (70) which can be connected to the control unit (68) and which can be operated manually by a user in order to allow the user to adjust the advancing speed of the wheelchair (2) in real time,
   characterized in that the command device (70) comprises a support (100), a potentiometer (96) mounted on the support (100) and able to send to the control unit (68) a signal characteristic of the rotation speed and/or torque which the motor (60) must deliver, based on the advancing speed of the wheelchair (2) desired by the user at any one instant, and a lever (98) mounted on the support (100) for controlling the potentiometer (96).

2. The device according to claim 1, **characterized in that** the control lever (98) is movable from a non-operating position, where the potentiometer (96) does not send any signal to the control unit (68), keeping the motor (60) stationary, to a first operating position where the motor (60) is set at a rotation speed and/or torque value based on the advancing speed of the wheelchair (2) desired by the user during a step of winding the drive belt (64) on the reel (62); the lever (98) being also movable from the non-operating position to a second operating position where the motor (60) is set at a rotation speed and/or torque value based on the advancing speed of the wheelchair (2) desired by the user during a step of unwinding the drive belt (64) from the reel (62).

3. The device according to claim 1 **characterized in that** the winch (58) comprises a frame (84), mounting the reel (62), the motor (60) and the control unit (68), and having a slot (86) for the passage of the drive belt (64); the winch (58) comprising, at the slot (86) of the frame (84), a pair of guide rollers (88) for the belt (64).

4. The device according to claim 2 **characterized in that** the winch (58) comprises a microswitch (90) for controlling the drive belt (64) and designed to stop it from being wound onto the reel (62) when the limit stop position has been reached.

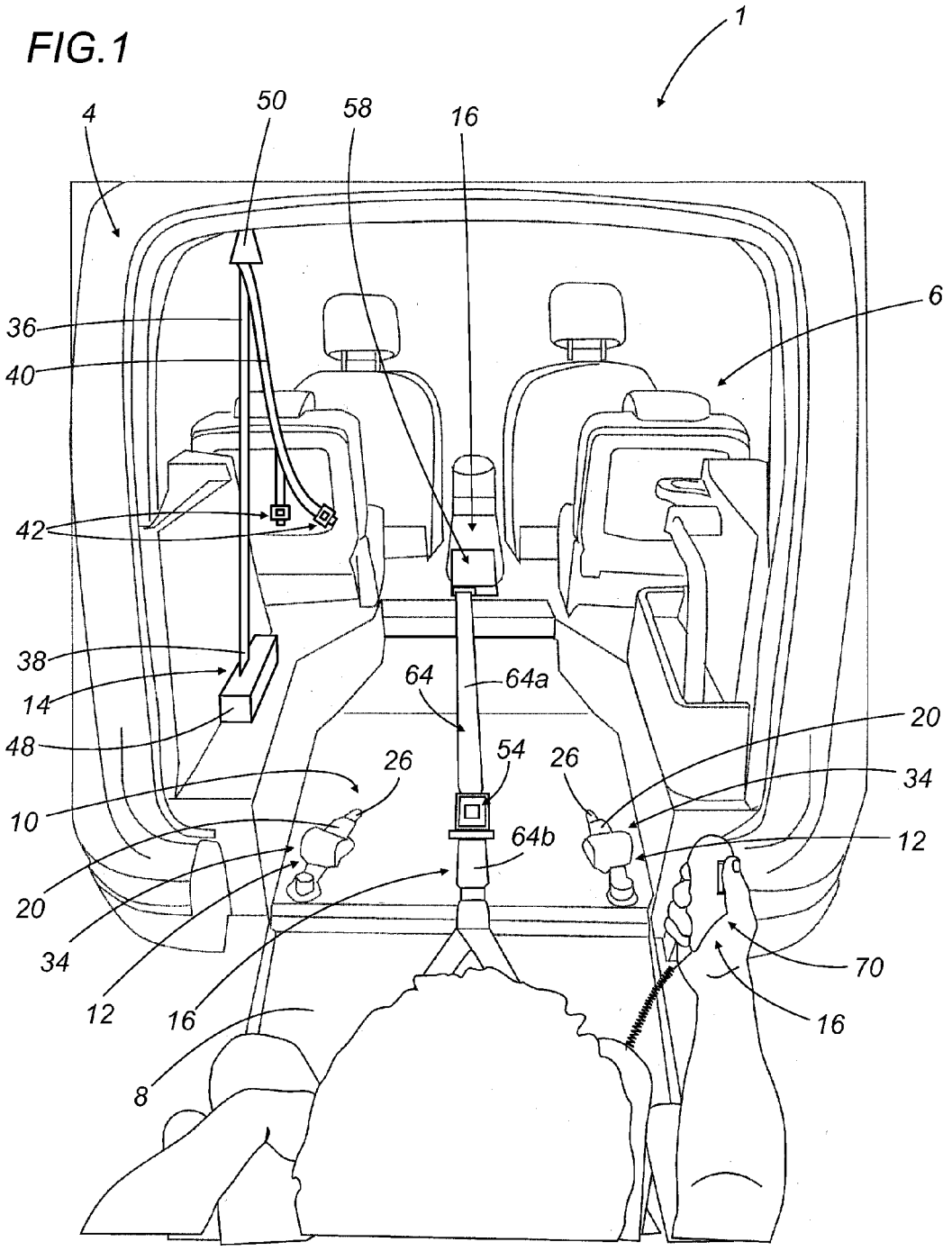
5. The device according to claim 1 comprising means (12) for securing the wheelchair (2), and means (14) for protecting the user seated in the wheelchair (2) during transportation, **characterized in that** the securing means (12) comprise the winch (58), which is able to keep its belt (64) locked in the position adopted at the moment of stopping, thus securing the wheelchair (2) at the front.

6. The device according to claim 5 **characterized in that** the means (12) for securing the wheelchair (2) comprise a plurality of belts (20) for securing the wheelchair (2) and each of which has at least one hook (26) for fastening to the structure of the wheelchair (2).

7. The device according to claim 5 or 6, **characterized in that** the wheelchair confined user protection means (14) comprise a first belt (36) equipped with at least one fastening element (42) for the belt (36) itself.

8. A vehicle comprising a device according to any of the claims from 1 to 7.

FIG.1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64b
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FIG.2

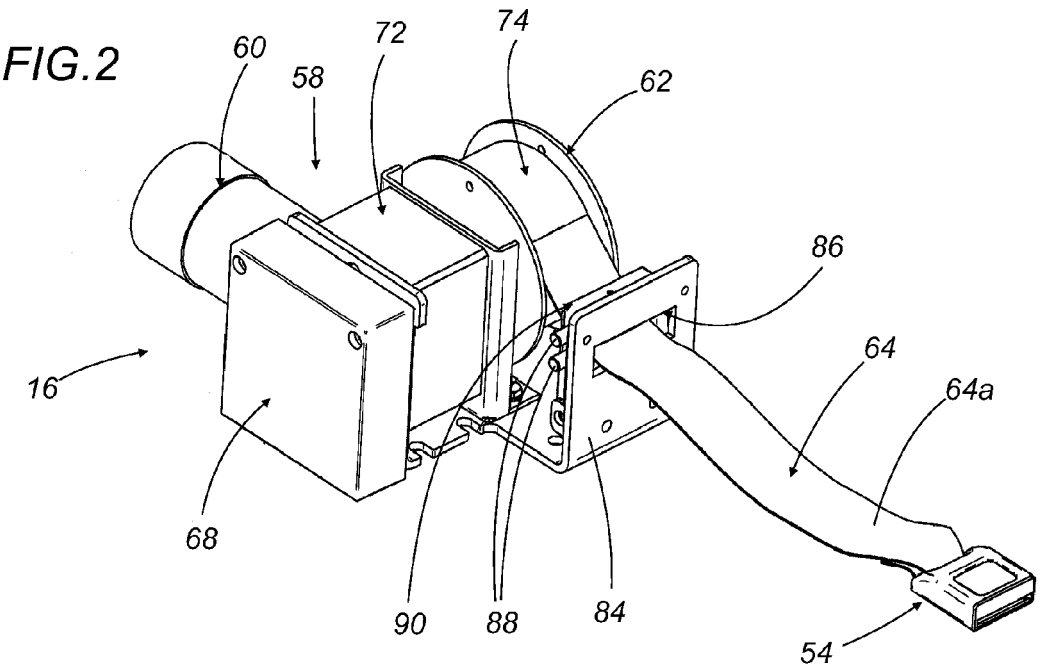
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FIG.3

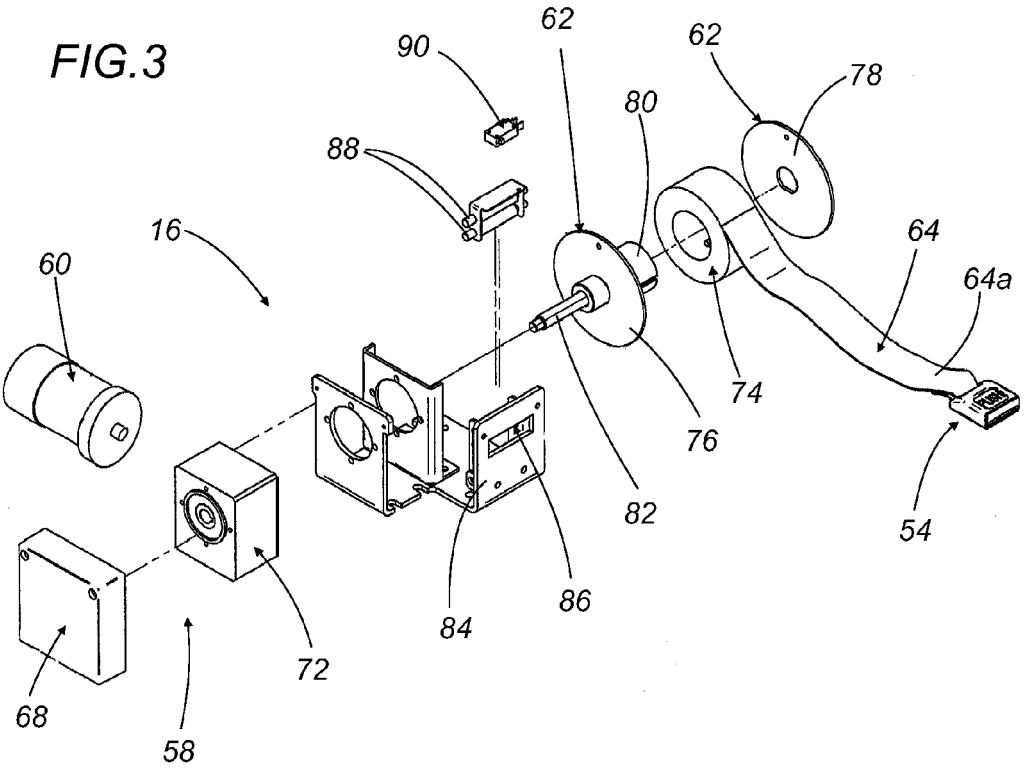
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FIG.4

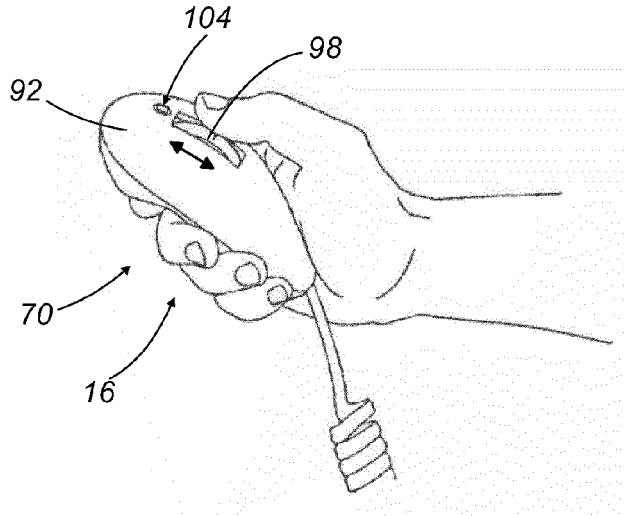

FIG.5

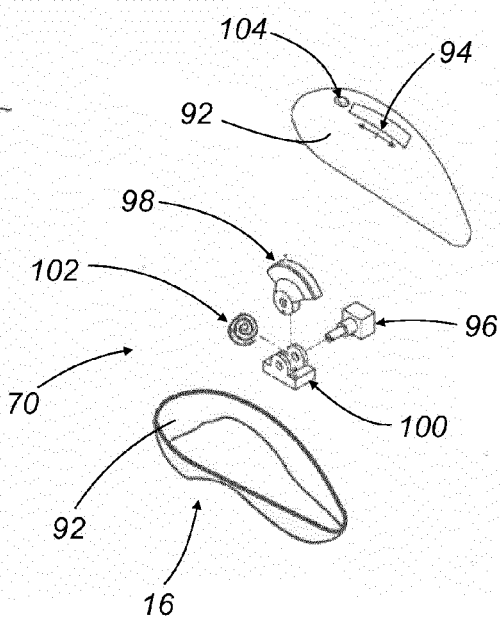

FIG.6