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STAIR LIFT DRIVE WITH ROTATABLE MOUNTING PART FOR SEAT

The present invention relates to a drive for a stair lift. In particular, the invention relates to a stair lift for use on a curved rail track.

Drives for stair lifts are generally designed to propel a stair lift over a double tube rail or a monorail with strips and/or racks added to the rail along a staircase. In particular when the stair lift has to perform a sharp turn or when the longitudinal guide changes in slope or when the stair lift has to drive over a twisted profiled rail track, these drives have a high risk to jam, since these drives do not allow orientation differences between the left side and the right side of the drive.

It is therefore the goal of the present invention to overcome these drawbacks, or at least to offer a suitable alternative.

The invention thereto proposes a stair lift drive, comprising a rail, extending along a track, a first frame part, provided with at least one pair of wheels engaging the rail, a second frame part, provided with at least one pair of wheels engaging the rail, a propulsion, for driving at least one of the wheels, a mounting part, for mounting a carrier for a load such as a seat for a user of the stair lift, wherein the mounting part is connected to the first frame; and wherein the mounting part is freely rotatably connected to the second frame part about two axes which are perpendicular to each other and perpendicular to the tangential direction of the track; and wherein the mounting part is rotatably connected to the second frame part about or rotatable about an axis parallel to the tangential direction of the track.

It is to be noted here that the above mentioned mutual orientations are to be regarded when the stair lift drive according to the invention is on a straight part of the track.

The free rotation about the two orthogonal axes allow the stair lift drive to take corners and move fluently through tracks with different sloping parts, bends, twists and turns. Because the different frame parts are placed in sequence on the track, the turns, twists, corners and bends in the track impose a difference in orientation between the freely
rotatable second frame part and the first frame part, which can be rigidly connected to
the mounting part.

The rotation of the mounting part about or rotatable about an axis parallel to the
tangential direction of the track relative to the second frame part allows the second
frame part to follow the movement of the first frame part along corners, bend, twists and
changing slopes.

In an embodiment of the present invention the mounting part is freely rotatably
connected to the first frame part about two axes which are perpendicular to each other
and perpendicular to the tangential direction of the track; and the mounting part is
rotatably connected to the first frame part about the tangential direction of the track.

These rotations allow the levelling of the mounting part and therefore the load carrier
such as the user seat, keeping the seat horizontal during bends, twists and corners. The
mounting part is rotatable with respect to the first and second frame parts, about the axis
of transportation.

In an embodiment the mounting part is connected to the first frame part by a first
bracket, wherein the connection between the mounting part and the first bracket
comprises a first of two rotation axes, and the connection between de first bracket and
the first frame part comprises a second of two rotation axes; and wherein the mounting
part is connected to the second frame part by a second bracket, wherein the connection
between the mounting part and the second bracket comprises a first of two rotation axes,
and the connection between the second bracket and the second frame part comprises a
second of two rotation axes.

The brackets act as so-called gimbal brackets, wherein the brackets each allow rotation
about two rotational axes, which are typically orthogonal.

In an embodiment of the present invention the connection between the first bracket and
the mounting part comprises a first levelling body, with respect to which the first
bracket and the mounting part are rotatable about the tangential direction of the track;
and the connection between the second bracket and the mounting part comprises a
second levelling body, with respect to which the second bracket and the mounting part are rotatable about the tangential direction of the track.

The levelling bodies of the connections of the brackets and the mounting part add the possibility to level the mounting part in all directions. When differences in orientation between the first and second frame parts are observed, the levelling bodies can be used to counteract these differences and maintain a levelled seat during the transportation of a load over the track.

In an embodiment of the invention, one of the rotations of the first bracket or the rotation of the mounting part with respect to the first levelling body is controllably drivable, and wherein the other rotation is limited; and wherein one of the rotations of the second bracket or the rotation mounting part with respect to the second levelling body is controllably drivable, and wherein the other rotation is limited.

If for instance the rotation of the first bracket with respect to the first levelling body is controllably drivable, the rotation of the mounting part with respect to the first levelling body is limited (and vice versa). The brackets can for instance be gimbal brackets, allowing rotation in multiple directions. The limited rotation is required to be able to follow twists and bends in the track smoothly, whereas the differences in orientation can be corrected using the controlled drive of the levelling bodies.

In an embodiment of the present invention, the stairway drive comprises a scale, by which the mounting part is suspended between the first and the second levelling body. The weight of the user and the lift are then suspended substantially equally on the frame parts, and via the wheels on the rail. This effect is larger when the inclination angle of the track is lower, and the highest at horizontal parts of the track.

The scale allows the twisting of the track to be averaged between the first and the second levelling body, to minimize the strain on one of the levelling bodies. Furthermore an equal division of the weight reduces wear of the wheels.

In an embodiment the balance comprises a sensor, to sense a twist in the track when driving up or down said track, and to generate a sensor signal representing the
correction to be made to level the user platform in order to keep it substantially horizontal.

The amount of twist, and its influence on the levelling of the mounting part and if applicable the user seat, can be counteracted by rotation of the levelling bodies. These bodies can be controlled based on the sensor signal measured by the balancing sensor.

In an embodiment of the present invention the stair lift drive comprises a first gear, connected to the mounting part and controllably driveable, engaging on a first rack that is connected to the first bracket; and a second gear, connected to the mounting part and controllably driveable, engaging on a second rack that is connected to the second bracket.

This could also be applied vice versa, wherein the racks are mounted on the mounting parts and the gears are located on the brackets. The racks are typically arced with a centre located around the tangential axis of the rail.

In an embodiment of the present invention the rail is provided with at least one recess, extending along the tangential direction of the track; and wherein the first and second frame part are each provided with at least a pair of wheels, of which at least one engages the rail in the at least one recess, wherein the wheels are each rotatable along an axis which extends substantially both perpendicular to a direction perpendicular to the tangential direction of the rail and to the direction from the position where they encounter the rail to the centre of the rail, wherein the running surfaces of the wheels engage on at least a part of the recess; and the cross part of the rail has a substantially smooth shape. In an embodiment the cross section of the rail is substantially apple-core-shaped.

The invention will now be elucidated into more detail with reference to the following figures, wherein:

- Figure 1 shows a coordinate system used to indicate movements;
- Figure 2 shows a stair lift drive according to the present invention in an exploded view;
- Figure 3 shows a stair lift drive as in figure 2 in use;  
- Figure 4 shows the levelling system schematically;  
- Figure 5 shows the embodiment of figure 4 in an exploded view; and  
- Figure 6 shows the scale located on the mounting part;  
- Figure 7 shows alternative embodiments of a stair lift drive according to the present invention; and  
- Figures 8 shows an alternative embodiment of the stair lift drive according to the present invention; and  
- Figures 9 shows alternative embodiment of the stair lift drive according to the present invention.

Figure 1 shows the coordinate system as generally used to indicate movements. In order to designate the orientation of a drive with respect to a rail, a system of coordinates is used. The x-axis is the local tangent to the centerline of the rail. For the rotation around the x, y and z axes the navigational and/or aviational terms pitch, yaw and roll are used respectively. Note that the drive moves in the direction of the x-axis, respectively to the left or right, unlike vessels and planes, which move in the direction of the z-axis. In other words, the drive moves sideways.

In the figure, the reference numbers indicate the following:

101 Right  
102 Pitch  
103 Yaw  
104 Longitudinal  
105 Roll  
106 Vertical  
107 Lateral Left

Figure 2 shows a stair lift drive according to the present invention in an exploded view, comprising a first frame part 2, provided with at least one pair of wheels (A and B) engaging the (non shown) rail 1, a second frame part 3, provided with at least one pair of wheels (C and D) engaging the (non shown) rail, a propulsion 4, 5, 6, 7, for driving at least one of the wheels, a mounting part 8, for mounting a seat for a user of the stair lift, wherein the mounting part is connectable to the first frame part; and wherein the
mounting part is freely rotatably connected to the second frame part about two axes (E and F) which are perpendicular to each other and perpendicular to the tangential direction of the track; and wherein the mounting part is rotatably connected to the second frame part about the tangential direction of the track.

In the embodiment of figure 2 the two frame parts are connected to the mounting part by a gimbal bracket 9 and 10, which allows each frame part to rotate freely around their y- and the z-axis of the frame bracket. The rotation of both parts around the centreline of the rail is determined by the rail shape cross part.

Figure 3 shows a stair lift drive, comprising a rail 1, extending along a track, a first frame part 2, provided with at least one pair of wheels (A and B) engaging the rail, a second frame part 3, provided with at least one pair of wheels (C and D) engaging the rail, a propulsion 4, 5, 6, 7, for driving at least one of the wheels, a mounting part 8, for mounting a seat for a user of the stair lift, wherein the mounting part is connected to the first frame part; and wherein the mounting part is freely rotatably connected to the second frame part about two axes (E and F) which are perpendicular to each other and perpendicular to the tangential direction G of the track; and wherein the mounting part is rotatably connected to the second frame part about the tangential direction of the track.

Figure 4 shows a mounting part 8 carrying the weight of the user wherein its front plane 11 needs to be kept vertically. On both sides of this mounting part a levelling body 12, 13 is placed; the mounting part rests on both bodies by means of an scale 14, which divides the weight over both levelling bodies. Both levelling bodies are equipped with a levelling motor 15, 16. Each levelling motor propels against a circular rack body 17, 18, which is connected to a frame part (not shown here) via a gimbal bracket 9, 10. Thus, the circular rack bodies follow the orientation of the frame parts and the levelling bodies need to be levelled. The levelling bodies are connected to the mounting part by means of circular guiding profiles 19, 20. Each circular rack body is also equipped with a circular guiding profile 21, 22, which moves among rollers 23 which are connected to the corresponding levelling body.

Figure 5 shows the embodiment of figure 4 in an exploded view.
Figure 6 shows the central part of the levelling system. In case the drive is positioned on a straight rail part, both circular rack bodies have the mean orientation. As soon as twist occurs in the rail, one of the levelling bodies 12, 13 will rotate a little bit with respect to the x-axis of the levelling system. As a result, the scale rotates slightly as well and the front face of the mounting part rotates around the x-axis with half the amount as the rotated levelling body. In order to correct this error, the levelling motors of the rotated levelling bodies need to adjust the orientation of the levelling bodies until the front face of the mounting part reaches its vertical orientation again. In order to get the scale perpendicular to the levelling bodies the levelling motors have to drive the levelling bodies in opposite direction until the scale is levelled perpendicular. Besides, also both levelling bodies need to be rotated until the front face of the mounting part is oriented vertically. This all happens during the ride, so in case of ongoing changes of twist, the levelling motors need to react continuously. This could be achieved by measuring the rotation of the scale 14. When this element does not have a skew orientation, the front plane 11 of the mounting part 8 is vertically oriented. Another approach is to measure the orientation of the levelling bodies. When the top edges of the both levelling bodies are horizontal, as a result the front body of the mounting part will be vertically oriented. Independent of the orientation of the scale, the weight on the mounting part is always transferred to both levelling bodies equally.

Figure 7 shows an embodiment of the stairlift drive according to the invention, comprising a rail 1’ wherein brackets 24 and 25 are visible, comparable with brackets 9 and 10 from figure 2. However, a mounting part 8' is now coupled by a differential to circular rack bodies 26 and 27, comparable with circular rack bodies 17 and 18 from figure 4, so that the mounting part is rotatable about the tangent to the centreline of the rail, 28, that is, when the stair lift drive is on a straight track of the rail. The mounting part can be rotated with respect to the first frame part, 29, and second frame part, 30, by means of driveable shaft 31, driven by motor 32 and connected by rack and pinion with gear wheel 33, which is rotatable around axis 34. The first frame part is freely rotatable with respect to the second frame part by rotating gearwheel 35 over axis 34, causing gearwheel 36 to rotate in opposite direction. To level the front face of the mounting part, 37 to a vertical orientation, axes, 31 will be rotated, driven by motor 32, causing the gearwheel 33 to rotate around axis 34, enforcing the gearwheels 35 and 36 to rotate
in the same direction and so lift or lower the mounting part, resulting in a new and/or corrected to original vertical orientation of the front face of the mounting part, 37. The cog of the seat and user, 38, will be at a certain horizontal distance from the centreline of the rail so that the moment, it’s causing around the centreline of the rail, will be substantially equally transferred by the differential to both the first and second frame part.

Figure 8 shows an embodiment of the stair lift drive according to the invention, comprising a rail 1’, extending along a track, a first frame part 39, provided with at least one pair of wheels 40 engaging the rail, a second frame part 41, provided with at least one pair of wheels 42 engaging the rail 1’, a propulsion, 43, for driving at least one of the wheels, a mounting part 44, for mounting a carrier for a load such as a seat for a user of the stair lift, wherein the mounting part 44 is freely rotatably connected to the first frame part 45 and wherein the mounting part is via the first frame part 39 freely rotatably connected to the second frame part 46 about axes 47, 48 and/or 49, 50 which are perpendicular to each other and perpendicular to the tangential direction of the track and wherein the mounting part is freely rotatably connected to the first frame part and rigidly connected to the second frame part about an axis 51 parallel to the tangential direction 52 of the track. Wherein the mounting part 44 is coupled to a first bracket 53 which respect to which it can rotate about an axis 51, and also about the axis 47, and wherein the mounting part 44 is coupled to a second bracket 54 which respect to which it can rotate about an axis 51, and also about the axis 49, which is parallel to an axial direction 52 of the rail 1’, that is, when the stair lift drive is on a straight track of the rail. The first bracket 39 is coupled to the second bracket 41 to which respect it can rotate about the axis 51. The mounting bracket may either be driven rotatably connected to first bracket 39 or second bracket 41. By placing the centre of gravity (cog) of the user plus seat substantially close and/or vertically above the axis 51, the total amount of forces of user weight and seat will be transmitted through both frame parts on to the rail. In case of a moment caused by a horizontal distance between the cog and the axis 28 and/or change in orientation of front surface, 55, caused by change in orientation of the rail, the driven X-levelling around axis 51 will orient the front face of the mounting bracket to vertical and this torsional moment will be taken by either first bracket 39 or second bracket 41, depending to which bracket the mountain bracket is driven rotatably
connected. Again, the definitions of the axis are to be considered in a situation where
the stair lift drive is at a straight part of the track.

Figure 9 shows relevant parts of an exploded view of an embodiment of the stair lift
drive according to the invention. Brackets 56 and 57 are visible, comparable with
brackets 9 and 10 from figure 2. However, a mounting part 8' is now rotatably coupled
about axes of rotation 58 and 59, by means of a differential 60, with respect to which
the mounting part can be rotated by means of a driveable shaft. Axes 58 and 59 are
parallel and vertically above but not coincidental with the axial of the rail, that is, when
the stair lift drive is on a straight track of the rail. The cog of the seat and user, 61, will
be at a certain horizontal distance, 62, from 58 and 59 so that the moment, it's causing
around the centreline of the rail, will be substantially equally transferred by the
differential to both the first and second frame part and on to the rail by the wheels
engaging the rail.

The first frame part is freely rotatable with respect to the second frame part. In order to
correct the orientation of the front face, 63, of the mounting part, the differential needs
to be driven, so that it can rotate around the axis 58 and 59 simultaneously.

All features of the present invention can be combined with the features disclosed in the
same dated Dutch patent applications "Stair lift drive" and "Stair lift drive system for a
smooth dented rail" by the applicant which are incorporated by reference.
Claims

1. Stair lift drive, comprising
   • a rail extending along a track,
   • a first frame part, provided with at least one pair of wheels engaging the rail,
   • a second frame part, provided with at least one pair of wheels engaging the rail,
   • a propulsion, to drive at least one of the wheels,
   • a mounting part, for mounting a carrier for a load such as a seat for a user of the stair lift,

wherein
   • the mounting part is connected to the first frame part; and
   • wherein the mounting part is freely rotatably connected to the second frame part about two axes which are perpendicular to each other and perpendicular to the tangential direction of the track; and
   • wherein the mounting part is rotatably connected to the second frame part about or rotatable about an axis parallel to the tangential direction of the track.

2. Stair lift drive according to claim 1, wherein
   • mounting part is freely rotatably connected to the first frame part about two axes which are perpendicular to each other and perpendicular to the tangential direction of the track;
   • and the mounting part is rotatably connected to the first frame part about or rotatable about an axis parallel to the tangential direction of the track.

3. Stair lift drive according to claim 2, wherein
   • the mounting part is connected to the first frame part by a first bracket, wherein the connection between the mounting part and the first bracket comprises a first of two rotation axes, and the connection between the first bracket and the first frame part comprises a second of two rotation axes; and
• wherein the mounting part is connected to the second frame part by a second bracket, wherein the connection between the mounting part and the second bracket comprises a first of two rotation axes, and the connection between the second bracket and the second frame part comprises a second of two rotation axes.

4. Stair lift drive according to claim 3, wherein
• the connection between the first bracket and the mounting part comprises a first levelling body, with respect to which the first bracket and the mounting part are moveable and in particular rotatable about the tangential direction of the track; and
• the connection between the second bracket and the mounting part comprises a second levelling body, with respect to which the second bracket and the mounting part are moveable and in particular rotatable about the tangential direction of the track.

5. Stair lift drive according to claim 4, wherein
• one of the rotations of the first bracket or the movement or in particular the rotation of the mounting part with respect to the first levelling body is controllably drivable, and wherein the other rotation is limited; and
• wherein one of the rotations of the second bracket or the movement or in particular the rotation of the mounting part with respect to the second levelling body is controllably drivable, and wherein the other rotation is limited.

6. Stair lift drive according to claim 4 or 5, comprising a scale, by which the mounting part is suspended between the first and the second levelling body.

7. Stair lift drive according to claim 6, wherein the scale comprises a sensor, to measure the difference of twist in the track, and to release a sensor signal representing the difference of twist.
8. Stair lift drive according to one of the preceding claims, comprising
   • a first gear, connected to the levelling body and controllably driveable, 
     engaging on a first rack that is connected to the first bracket; and
   • a second gear, connected to the levelling body and controllably 
     driveable, engaging on a second rack that is connected to the second 
     bracket.

9. Stair lift drive according to any of the preceding claims, wherein the mounting part 
   orientation is measured by a sensor configured for generating a signal representing the 
   amount of inclination of the mounting part with respect to the horizontal.

10. Stair lift drive according to claim 6 to 9, configured to control the gears based on the 
    signal from the sensor.

11. Stair lift according to any of claims 5-9 wherein the levelling bodies are configured 
    to divide at last a weight component of the stair lift and a weight component exerted on 
    the mounting part by a load over two frame parts substantially even over the wheels that 
    engage the rail.

12. Stair lift drive according to one of the preceding claims, wherein
    • the rail is provided with at least one recess, extending along the 
      tangential direction of the track; and wherein
    • the first and second frame part are each provided with at least a pair of 
      wheels, of which at least one engages the rail in the at least one recess, 
      wherein
    • the wheels are each rotatable along an axis which extends substantially 
      both perpendicular to the width of the rail and perpendicular to the 
      tangential direction of the rail, wherein
    • the running surfaces of the wheels engage on at least a part of the recess; 
      and
    • the cross part of the rail has a substantially smooth shape.
13. Stair lift drive according to claim 12, wherein the cross section of the rail has one or more dents, wherein at least one of the wheels engages the rail in a dent.

14. Stair lift drive according to claim 13, wherein the wheel engaging the rail in the dent locks the angular orientation of the stair lift drive to the rail.
### A. CLASSIFICATION OF SUBJECT MATTER

**INV.** B66B9/08

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):

- B66B

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 practicable, search terms used):

- EPO-Internal, WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer:

Oosterom, Marcel
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