



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.05.2012 Bulletin 2012/20

(51) Int Cl.:
B66B 9/08 (2006.01)

(21) Application number: **10190711.1**

(22) Date of filing: **10.11.2010**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
 GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
 PL PT RO RS SE SI SK SM TR**
 Designated Extension States:
BA ME

(72) Inventor: **The designation of the inventor has not yet been filed**

(74) Representative: **BOVARD AG
 Optingenstrasse 16
 3000 Bern 25 (CH)**

(71) Applicant: **Micro-Motor AG
 4106 Therwil (CH)**

(54) **Rail follower apparatus for stair lift**

(57) Rail follower apparatus for a stair lift having a single rail. Two rail followers (1, 2) are connected to each other by a linkage (6), each rail follower (1, 2) being connected to the linkage (6) by a joint having multiple degrees of freedom. The rotational axis (31, 32) of each of

the rotational degrees of freedom intersects with or passes close to the traction zone (52) where the drive wheel (23) contacts the toothed track (4). The turning moments required to keep the followers aligned with the rail are thereby reduced to a minimum.

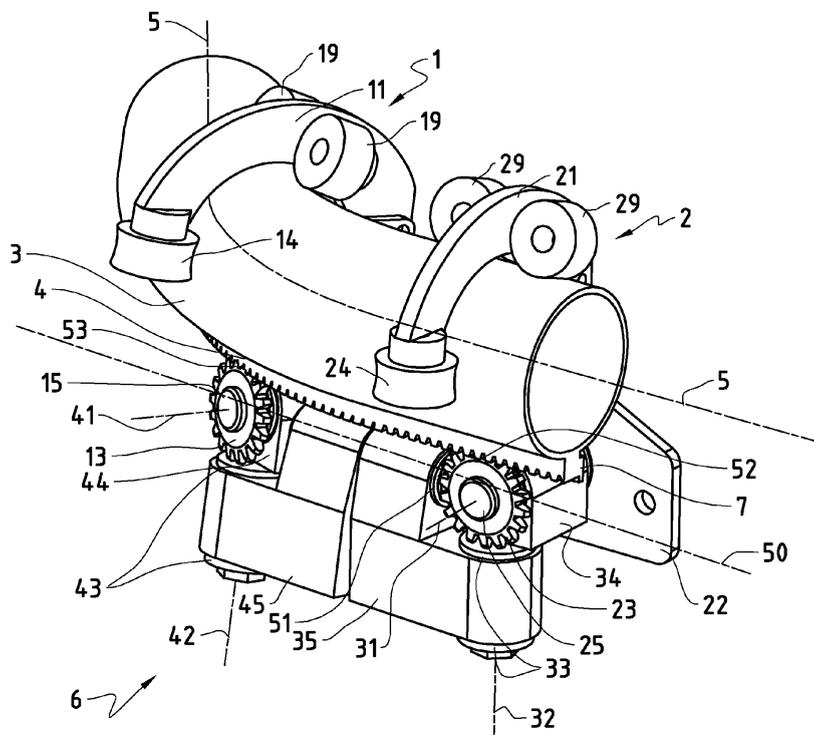


FIG. 1

Description

[0001] The present invention relates to the field of drive mechanisms and rail followers which are capable of load-bearing displacement along curved rails. In particular, but not exclusively, it relates to the field of drive apparatuses which are capable of travelling along rails having a three-dimensional curvature, such as are used, for example, in stair lifts

[0002] Stair lifts, such as are installed for the use of people unable to climb stairs unaided, typically comprise one or more rails or tracks fixed, for example, to a vertical wall at the side of a pre-existing staircase. A seat or platform, propelled along the rail, must travel smoothly and evenly up and down the staircase and remain level as it proceeds. The rails must be installed so that they do not significantly reduce the usability of the stairs for people climbing the stairs. It is therefore important that the rails are mounted close to one side of the staircase, and that they do not protrude significantly over the surface of the stair treads. Single rail systems are generally preferred, since they are less costly and less intrusive to install. In this description, we use the example of a single-rail system.

[0003] The load to be raised on the seat or platform must be supported on the rail, guided along the rail and propelled (or braked) as it ascends (or descends) the stairs. Propulsion is commonly by frictional or kinematic engagement with a part of the rail, usually a rack and pinion arrangement. A longitudinal toothed track is commonly welded or otherwise fixed to the rail along its length, or at least along the length of the rail over which traction is required. In this description, the terms propulsion and drive should be understood to refer to a controlled application of a motive or resisting (braking) force to a load in the direction of travel along the rail.

[0004] The three functions of propulsion, guiding and support are commonly provided by a drive apparatus mounted on the rail or rails. Since the rail is mounted to the side of the stairs, but the load to be lifted (usually a person sitting on a seat) has a centre of gravity at or near the centreline of the stairs, the drive apparatus must be capable of supporting the rotational moment of the load about the longitudinal axis of the rail. How this is achieved depends on the sectional profile of the rail. For tubular rails having a circular cross-section, for example, a longitudinal guide track may be welded or otherwise fixed at a particular position on the cross-section of the tube. Alternatively, this guiding function may also be provided by a second rail, installed with a predetermined geometrical relationship to the first rail. The two-rail solution has the disadvantage that its geometry is difficult to calculate and install.

[0005] In order to reduce manufacturing costs, the guide track and the propulsion track may be constructed as one. In this case, for example, the track may have a toothed surface for propulsion for engagement by a pinion, and a smooth running surface against which and

along which load-bearing wheels can run, the load-bearing wheels and the running surface acting to prevent rotation of the drive apparatus about the longitudinal axis of the rail in the rotational direction of the moment of the load. A second running surface and corresponding wheel (s) may also be provided for preventing rotation in the opposite rotational direction.

[0006] Staircases may include corners, curves or horizontal sections, as well as straight flights of steps. A stair lift system should be capable of being installed in all such instances, with the rail following as closely as possible any bends or transitions in the geometry of the staircase. For this reason, it is highly advantageous for the drive apparatus to be able to travel around many different geometries of bend, including three-dimensional curves (ie curvature not in a single plane) and bends having a small radius of curvature.

[0007] The above problems have been partially addressed by known stair lift systems. For example, the international patent application WO97/12830 describes a running gear in which the load is mounted on two sets of guide wheels (followers, or follower assemblies using the terminology of the present application) using two cardan-type suspension joints. The two followers are connected by a linkage giving multiple angular degrees of freedom with respect to the longitudinal axis of the rail, and which constrains the relative motion of the followers relative to each other and relative to the rail such that any angular motion of one follower with respect to the longitudinal axis of the rail always results in a mirrored angular motion of the other follower. The running gear of WO97/12830 also has a drive wheel with its axis of rotation in the plane of symmetry of the motion-mirroring mentioned above. The running gear of WO97/12830 has the disadvantage that it is only efficient when the rail is curved in an appropriate way, with curvature obeying the same symmetry constraints as those of the running gear's guide wheels. A further disadvantage of the running gear is that it comprises two sets of relatively complicated joint mechanisms: a first joint mechanism to link the two sets of guide wheels in the symmetrically-constrained fashion, and a second joint mechanism for mounting the load to the running gear and for holding the drive wheel in its correct orientation with its axis of rotation in the plane of symmetry. Both joint mechanisms must be robustly constructed in order to bear the forces arising from the weight of the load being transported, and the forces resulting from propulsion or braking.

[0008] An alternative running gear geometry was proposed in EP1449801, in which each of two follower assemblies is implemented with a spherical outer surface which can each rotate independently of each other with three degrees of freedom within corresponding spherical bearings mounted in a rigid frame. The centres of rotation for all three degrees of freedom are at the centre of the sphere of the spherical bearings, which also coincides with the central axis of the tubular rail. The running gear of EP1449801 has a drive wheel mounted, as with the

running gear of WO97/12830, centrally between the two follower assemblies.

[0009] International patent application W02007/046690 disclosed a running gear geometry which also uses two follower assemblies, each constructed as a part-sphere held in two bearing plates of spherical form. In the system of W02007/046690, each follower comprises a drive wheel, a load-bearing wheel and a set of guide wheels. The load bearing wheel is positioned so that it runs along a guide profile which is in effect one side surface of the toothed track welded to the underside of the rail. Almost all of the static weight of the load being transported is transferred, as a rotational moment, by the load bearing wheel to the lateral surface of the track. As long as the curvature of the portion of the rail being travelled remains constant, the spherical body of each follower remains stationary within the spherical bearing plates. In this condition, the follower can be driven along the rail by its drive wheel, while the only forces experienced by the guide wheels are the forces due to a component of the weight of the load, and the tractive force of the driving wheel. The magnitude and direction of these forces will be dependent on the particular angle of tilt of the rail at the point being travelled by the follower.

[0010] As soon as one of the followers encounters a section of the rail where the rail's curvature changes, however, the spherical body of the follower will be required to rotate in its spherical bearing surfaces. This rotation is forced by the combined forces of the traction of the drive wheel on one hand, and the force exerted by the surface of the rail on one or two of the leading guide wheels. Because the rollers and the traction point of the drive wheel are offset from all the rotational axes of the spherical follower body, the forces result in a rotation of the spherical body within the spherical bearing.

[0011] In order to permit smooth rotation of the spherical follower body in the spherical bearing plates, the surfaces of the spherical bearing must have very low friction. However, the weight of the load is constantly exerting a rotational force on both bearing plates around the rail's axis, and this persistent lateral force on the bearing geometry acts to increase the friction at both bearing interfaces. Furthermore, the separation distance between the force vectors which must induce rotation of the spherical body (ie the forces on the drive wheel and the guide wheel or wheels) is small when compared with the separation distances of the opposing force vectors of the spherical bearing surfaces (which act at a tangent to the surface of the spherical follower body). In order to overcome these opposing moments, therefore, the running gear arrangement of W02007/046690 requires a much more powerful motor to drive the drive wheel than would be required simply to displace the load in the absence of such large moments. The structure of the spherical follower bodies and their enclosing frame must also be highly robust in order to accommodate the forces being exerted on the spherical bearings.

[0012] In addition, the guide wheels of W02007/

046690 must be placed relatively far apart in order to produce enough rotational moment to turn the spherical follower body in its bearings. This far-apart spacing of the guide wheels significantly increases the minimum rail curvature which the followers can negotiate.

[0013] The object of the present invention is to overcome the above and other disadvantages of the prior art. In particular, it aims to provide a rail follower arrangement which is simpler, which is easier to construct than the prior art followers, which offers less resistance when negotiating curves in the rail, and which is capable of negotiating curves of significantly smaller radius.

[0014] In order to achieve the above object, therefore, the invention envisages a drive apparatus for propelling a load, in particular the chair or platform of a stair-lift, along a curved rail by driven engagement with a traction part of the rail, the traction part being hereafter referred to as the track, the drive apparatus comprising: a first rail follower assembly and a second rail follower assembly mechanically connected to each other by a linkage such that the first and second rail follower assemblies travel together along the rail, one behind the other, a load mount arrangement for supporting the load on the drive apparatus during its travel along the rail, the first rail follower assembly being connected to the linkage by a first articulation joint having at least first and second rotational degrees of freedom about first and second rotation axes respectively, the second rail follower assembly being connected to the linkage by a second articulation joint having at least third and fourth rotational degrees of freedom about third and fourth rotation axes respectively, the first rail follower assembly comprising a first drive-wheel for driven engagement with the track, the first drive-wheel being rotatable about a first drive-wheel axis and engageable with the track in a first traction engagement zone, the first articulation joint being arranged such that both the first and the second rotation axes pass through or near the traction engagement zone.

[0015] By arranging the rotation axes as close as possible to the traction point (and thereby outside the outer limits of the rail profile), the rotation moments which are required in order to provide angular guidance of the first follower so that it remains at a constant attitude with respect to the rail become greatly reduced. The turning moments required to keep the followers aligned with the rail are reduced to a minimum. This reduction in the required forces means that the follower can be made smaller and simpler. The guiding elements, usually pairs of rollers or wheels, which act to keep the follower in line with the rail, can also be placed closer together, since they are no longer required to generate large steering moments. By using rollers which are closer together, it is possible to guide the follower around tighter curves in the rail.

[0016] According to a variant of the drive apparatus of the invention, the second rail follower assembly comprises a second drive-wheel for driven engagement with the track, the second drive-wheel being rotatable about a

second drive-wheel axis and engagable with the track in a second traction engagement zone, whereby the third and fourth rotation axes each pass through or close to the second traction engagement zone. As with the first follower, by arranging the rotation axes to pass as close as possible to the traction region, the follower construction can be reduced and simplified, and the guide rollers positioned closer together. By using two such driven follower assemblies in the drive apparatus, the drive apparatus can be made significantly more agile and able to cope with two or three-dimensional curves of even small radius.

[0017] According to a further variant of the drive apparatus of the invention, the first rotation axis is implemented as a first swivel joint substantially parallel to the first drive-wheel axis, the second rotation axis is implemented as a second swivel joint substantially orthogonal to the first rotation axis, and the linkage comprises a fifth rotation axis implemented as a third swivel joint substantially orthogonal to the first rotation axis and to the second rotation axis. By positioning the rotation axes on the outside of the rail, it is possible to use a joint comprising simple swivel bearings, which are strong and long-lasting and offer very low operational friction. The fifth rotation axis permits the first and second followers to rotate relative to each other around the longitudinal axis of the rail, which is required if the drive apparatus is to be able to negotiate three-dimensional curves (curves not confined to on plane).

[0018] According to another variant of the drive apparatus of the invention, the fifth rotation axis passes through or close to the first traction engagement zone and/or the first rotation axis. As with the first to fourth axes, by positioning the fifth rotation axis so that it passes near to the traction region, the torque required to rotate the first follower with respect to the second can be greatly reduced compared with the prior art systems.

[0019] According to another variant of the drive apparatus of the invention, the rotation axes of the first and second articulation joints are arranged such that the fifth rotation axis, and thereby the third swivel joint, remain substantially parallel to a tangent of the longitudinal axis of the rail at a point between the first and second rail follower assemblies during travel of the drive apparatus along the rail. As will be explained below, by keeping the linkage parallel to the rail, it is possible to ensure that the load (seat, for example) mounted on the drive apparatus, also remains parallel to the rail.

[0020] According to another variant of the drive apparatus of the invention, the load is mounted on the linkage and/or on one or both of said first and second articulation joints. As will be described below, it is possible to arrange the linkage such that an element of one of the articulation joints, for example, remains at a constant attitude to the rail axis. By mounting the load on such an existing element, one can dispense with the need for a separate set of articulations for supporting the load, as seen for example in WO97/12830.

[0021] According to another variant of the drive apparatus of the invention, the first articulation joint comprises a first joint element rotatable on the first drive-wheel axis, a second joint element connected to the first joint element by means of the second swivel joint, the second joint element also being connected to the second articulation joint by means of the third swivel joint. The drive-wheel axis is in many cases sufficiently close to the traction engagement zone to achieve the moment-reducing effect described earlier, and one can further reduce the complexity of the design by using the existing drive-wheel axis as the rotational bearing for the first rotational axis.

[0022] According to another variant of the drive apparatus of the invention, the load is mounted on the second joint element. This element can be arranged to remain at a constant attitude to the rail (eg it remains vertical), with the result that, if the load is mounted to the second element, only a simple rotational correction must be performed between the load and the second element to keep the load level as it travels up the stairs.

[0023] According to another variant of the drive apparatus of the invention, the first rail follower assembly comprises a first guide frame having first guide means for maintaining the first drive-wheel in aligned engagement with the track.

[0024] According to another variant of the drive apparatus of the invention, the first guide means comprise a pair of load bearing wheels for running against a longitudinal guide surface of the rail adjacent to the track. By combining the functions of load-bearing and guiding, the construction of the first follower is further simplified. In addition, because a significant load is borne by two wheels running against the guide surface, the two wheels act as a strong force for keeping the follower aligned relative to the guide surface. Having such a strong force means that the two load-bearing wheels can be positioned closer together, and thereby negotiate curves having a smaller radius.

[0025] According to another variant of the drive apparatus of the invention, the first rail follower assembly comprises motor means for driving the first drive-wheel, the motor means being mounted on the first guide frame.

[0026] According to another variant of the drive apparatus of the invention, the second rail follower assembly comprises second guide frame having second guide means for maintaining the second drive-wheel in aligned engagement with the track.

[0027] According to another variant of the drive apparatus of the invention, the second rail follower assembly comprises motor means for driving the second drive-wheel, the motor means being mounted on the second guide frame.

[0028] According to another variant of the drive apparatus of the invention, the load is supported on the rail, via the first and/or second articulation joints, by the first and/or second guide frames, the rail comprises a longitudinal load-bearing surface, adjacent to the track or formed as part of the track, for resisting rotation of the

first and/or second guide frames about the longitudinal axis of the rail.

[0029] According to another variant of the drive apparatus of the invention, the load is supported on the second joint element, and wherein the load-bearing surface and the first, second, third, fourth and fifth axes are arranged such that the second joint element, and thereby the load maintains a constant attitude at a tangent of the longitudinal axis of the rail during the travel.

[0030] The invention will be described in more detail with reference to the accompanying figures, in which

Figure 1 illustrates an example embodiment of the drive apparatus of the invention,

Figure 2 shows a detail of the embodiment of figure 1.

Figure 3 shows a schematic sectional view of a follower used in the drive apparatus.

Figures 4 and 5 show schematic elevation and plan views of one of the followers of figure 1.

[0031] It should be noted that the figures are used to aid in understanding the invention, and that they are in no way intended to limit the scope of protection sought. The same reference signs used in different figures are intended to refer to the same or corresponding elements.

[0032] Figure 1 shows an example of a drive apparatus according to the invention. The drive apparatus consists of two rail follower assemblies 1 and 2, connected by a linkage 6. The followers 1 and 2 are supported on a tubular rail 3 having a longitudinal axis 5. On the underside of the rail (in this example) is attached a toothed track 4. The follower 2 comprises a frame 21 with guide rollers 24 and 29. A pair of further guide rollers 26, 27, which are not visible in figure 1, run along guide surface 7, which is arranged along the side of the track 4. Follower 1 also comprises a drive wheel 23, which rotates about drive wheel axis 31, and motor mount plate 22, which is rigidly connected to the frame 21 and which supports the axis 31 so that the drive wheel 23 can rotate relative to the motor mount 22 and the frame 21.

[0033] The follower 1 is shown as being the same, or rather a mirror image, of the follower 2, with labelled with corresponding reference numbers.

[0034] Linkage 6 of the example drive apparatus consists of two joint assemblies, each with two rotational degrees of freedom, linked by a swivel bearing 52, which gives the linkage 6 a further rotational degree of freedom. The first swivel joint assembly, which connects the frame 21 of first follower 2 to the linkage swivel joint 51, comprises two orthogonal swivel bearings. The first of these is formed by joint element 34, which is rotatable around the drive wheel axis 31, and the second is formed by element 35 rotating around axis 32, orthogonal to axis 31. It should be noted that the apparatus shown in figure 1 is just one of many possible configurations of joint el-

ements which could achieve the aim of the invention, namely to arrange the rotation axes 31, 32 and 51 of the first follower (2) as close as possible to the region where the drive-wheel engages with the track 4.

[0035] The frame 21 of the first follower 2 has two functions: firstly it keeps the drive wheel 23 correctly aligned to the track, and secondly it supports at least part of the load on the guide surface 7 of the rail 3. As will be described below, the load (seat or platform) can be supported on joint element 35, for example. The weight of the load is therefore supported on the rail 3 mainly via axis 31 and frame 21. Guide wheels 29 support the vertical weight of the load, while load-bearing wheels 26 (not shown in figure 1) support the rotational moment of the load against guide surface 7. Guide wheel 24 holds the frame in position on the rail. Since both pairs of guide wheels 29 and 26, 27 of the first follower 2 are both held against their respective guiding surfaces by the significant force of the weight of the load, both these pairs of wheels exert a strong guiding moment on the frame. These guiding moments act around the rotational axes 1 and 2 respectively, and are effectively opposed by the tractive moment of the driving wheel 23 pushing the follower along the curved rail 3. However, because the axes of rotation 31, 32 lie close to the traction zone 52, the moment of this opposing force is small, and particularly small compared with the guiding moments described above.

[0036] The first joint assembly 33, 34, 35 is implemented as discrete bearings to give the required degrees of freedom. However, other types of joint could be used, such as a ball-and-socket joint, or a ball and socket joint of which only one degree of freedom has been disabled.

[0037] The first follower 2 has been described in some detail, and it will be understood that the second follower 1 may be of the same design as the first follower 2. Alternatively, the first follower can be arranged as shown in figure 1, linked to a simpler second follower by the linkage 6. If most of the weight of the load is supported on joint element 35, then the second follower is not required to bear so much weight and can be of significantly simpler construction.

[0038] Figure 2 shows in more detail the pair of load-bearing rollers 26, 27 referred to above. The view is a perspective view from the underside of the rail. The wheels 26, 27 are shown bearing against the side face of the toothed track 4, although it would often be preferable for the track to be protected by a guide surface 7 as indicated in figure 1.

[0039] A further guide wheel 28 is also shown with dotted lines in figure 2. Wheel 28 can be used to provide extra guidance for the frame 21 and to ensure the safety of the drive apparatus by preventing the follower from rotating in the other direction around the rail axis 5

[0040] In the example illustrated, the track 4 is shown on the underside of a tubular rail 3, but it will be appreciated that the track 4 could be at any point on the surface of the rail 3. Similarly, it should be understood that the

rail 3 need not be tubular, and could be of any cross-section around which the frame 21 would fit.

[0041] Figure 3 shows a schematic sectional view of a follower like those illustrated in figures 1 and 2. In particular, figure 3 shows how the first and second rotation axes lie very close to the traction engagement zone of the drive wheel. Swivel bearing part 33 has an axis of rotation which passes through the drive wheel 23 and through the engagement zone between the drive wheel 23 and the track 4. The other axis of rotation is formed by the element 34, which is free to rotate about the drive wheel axis 31. This axis does not pass directly through the traction engagement zone (which is where, in the case of a toothed engagement, the teeth of the drive wheel 23 mesh with the teeth of the track 4). It would be difficult, if not impossible, to construct the follower such that these two axes of rotation both pass through the traction engagement zone. It is sufficient that the element 34 rotates about an axis 31 at a close distance (somewhat less than the radius of the drive wheel 23) from the traction engagement zone. None of the rotation axes should be further from the traction engagement zone than one diameter of the drive wheel.

[0042] Motor unit 47, with gearing, is also shown in figure 3, mounted on the rail follower frame 21. The load mount 46 is also shown.

[0043] Figure 4 shows a schematic elevation view which indicates the arrangement in a vertical plane of the upper guide rollers 29, the drive wheel 23 and the rail 3 and the track 4. As can be seen from this figure, the distance from the guide wheels to the traction engagement zone is much larger than the distance from the rotational axis 31 to the traction engagement zone. This illustrates how the turning moment exerted by one of the guide wheels 29 will exceed the opposing turning moment of the drive wheel 23.

[0044] Figure 5 shows a schematic plan view which indicates the relative positions of the two load-bearing wheels 26, 27 and the drive wheel 23. Because the axis 31 runs through the drive wheel 23, the small distance between the guide wheels 26 and 27, and the traction engagement zone, can exert a virtually unopposed rotational moment on the guide frame 21 about axis 32 as the drive apparatus travels along the rail 3.

Claims

1. Drive apparatus for propelling a load, in particular the chair or platform of a stair-lift, along a curved rail (3) by driven engagement with a traction part (4) of the rail (3), the traction part (4) being hereafter referred to as the track, the drive apparatus comprising:

a first rail follower assembly (2) and a second rail follower assembly (2) mechanically connected to each other by a linkage (6) such that the

first (2) and second (1) rail follower assemblies travel together along the rail (3), one behind the other,

a load mount arrangement for supporting the load on the drive apparatus during its travel along the rail (3),

the first rail follower assembly (2) being connected to the linkage (6) by a first articulation joint (33, 34, 35) having at least first and second rotational degrees of freedom about first and second rotation axes (31, 32) respectively,

the second rail follower assembly (1) being connected to the linkage (6) by a second articulation joint (43, 44, 45) having at least third and fourth rotational degrees of freedom about third and fourth rotation axes (41, 42) respectively,

the first rail follower assembly (2) comprising a first drive-wheel (23) for driven engagement with the track (4), the first drive-wheel (23) being rotatable about a first drive-wheel axis (31) and engagable with the track (4) in a first traction engagement zone (52),

the first articulation joint (33, 34, 35) being arranged such that both the first and the second rotation axes (31, 32) pass through or near the traction engagement zone (52).

2. The drive apparatus of claim 1, wherein the second rail follower assembly (1) comprises a second drive-wheel (43) for driven engagement with the track (4), the second drive-wheel (43) being rotatable about a second drive-wheel axis (41) and engagable with the track (4) in a second traction engagement zone (53), whereby the third and fourth rotation axes (41, 42) each pass through or close to the second traction engagement zone (53).
3. Drive apparatus according to claim 1 or 2, wherein the first rotation axis (31) is implemented as a first swivel joint (25, 34) substantially parallel to the first drive-wheel axis (31), the second rotation axis (32) is implemented as a second swivel joint (33, 34) substantially orthogonal to the first rotation axis (31), and the linkage (6) comprises a fifth rotation axis (50) implemented as a third swivel joint (51, 35, 45) substantially orthogonal to the first rotation axis (31) and to the second rotation axis (32).
4. Drive apparatus according to claim 3, wherein the fifth rotation axis (50) passes through or close to the first traction engagement zone (52) and/or the first rotation axis (31).
5. Drive apparatus according to one of claims 3 and 4, wherein the rotation axes (31, 32, 41, 42, 50) of the first and second articulation joints are arranged such that the fifth rotation axis (50), and thereby the third

- swivel joint (51, 35, 45), remain substantially parallel to a tangent of the longitudinal axis (5) of the rail (3) at a point between the first and second rail follower assemblies (2, 1) during travel of the drive apparatus along the rail (3). 5
6. Drive apparatus according to one of the preceding claims, wherein the load is mounted on the linkage (6) and/or on one or both of said first and second articulation joints. 10
7. Drive apparatus according to one of claims 2 to 6, wherein the first articulation joint (33, 34, 35) comprises a first joint element (34) rotatable on the first drive-wheel axis (31), a second joint element (35) connected to the first joint element (34) by means of the second swivel joint (33), the second joint element (35) also being connected to the second articulation joint (44, 45) by means of the third swivel joint (51). 15
8. Drive apparatus according to claim 7, wherein the load is mounted on the second joint element (35). 20
9. Drive apparatus according to one of the preceding claims, wherein the first rail follower assembly (2) comprises a first guide frame (21) having first guide means (26, 27, 28) for maintaining the first drive-wheel (23) in aligned engagement with the track (4). 25
10. Drive apparatus according to claim 9, wherein the first guide means (26, 26, 28) comprise a pair of load bearing wheels (26, 27) for running against a longitudinal guide surface (7) of the rail (3) adjacent to the track (4). 30
11. Drive apparatus according to claim 9 or 10, wherein the first rail follower assembly (2) comprises motor means (47) for driving the first drive-wheel (23), the motor means (47) being mounted on the first guide frame (21). 35
12. Drive apparatus according to one of claims 2 to 11, wherein the second rail follower assembly (1) comprises second guide frame (11) having second guide means (16, 17, 18) for maintaining the second drive-wheel (43) in aligned engagement with the track. 40
13. Drive apparatus according to claim 12, wherein the second rail follower assembly (1) comprises motor means for driving the second drive-wheel (43), the motor means being mounted on the second guide frame (11). 45
14. Drive apparatus according to claim 13, wherein the load (46) is supported on the rail (3), via the first and/or second articulation joints, by the first and/or second guide frames (21, 11), the rail (3) comprises a longitudinal load-bearing sur- 50
- face (7), adjacent to the track (4) or formed as part of the track (4), for resisting rotation of the first and/or second guide frames (21, 11) about the longitudinal axis (5) of the rail (3). 55
15. Drive apparatus according to one of claims 7 to 14, wherein the load (46) is supported on the second joint element (35), and wherein the load-bearing surface (7) and the first (31), second (32), third (41), fourth (42) and fifth (50) axes are arranged such that the second joint element (35), and thereby the load (46) maintains a constant attitude at a tangent of the longitudinal axis (5) of the rail (3) during the travel. Linkage is mounted at a point as close as possible to the drive wheel. In the case where the rail is at the bottom of the rail, the load is supported from a point as close as possible to the drive wheel. Can advantageously mount the track a distance x away from the bottom centre line, so that the

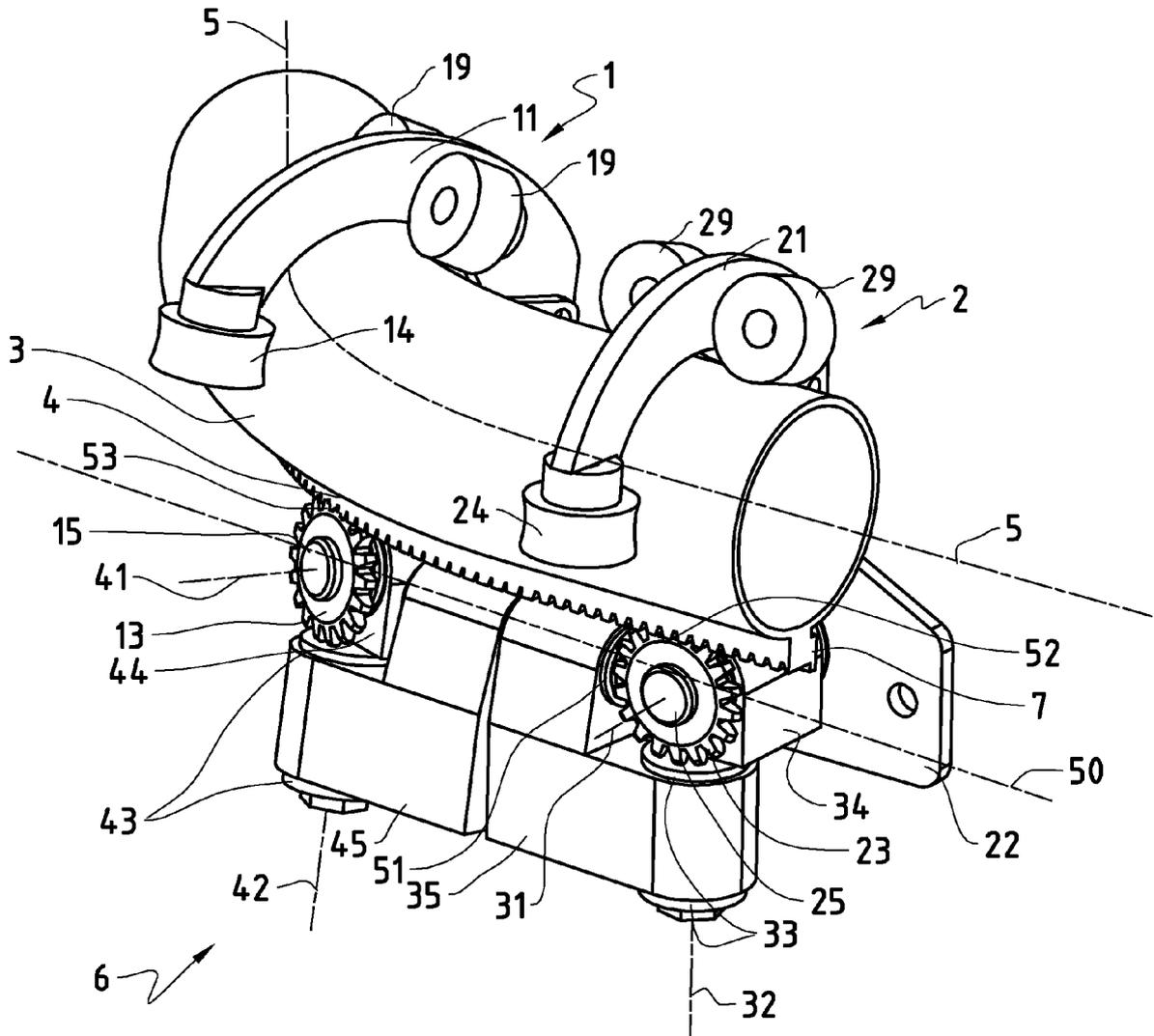


FIG. 1

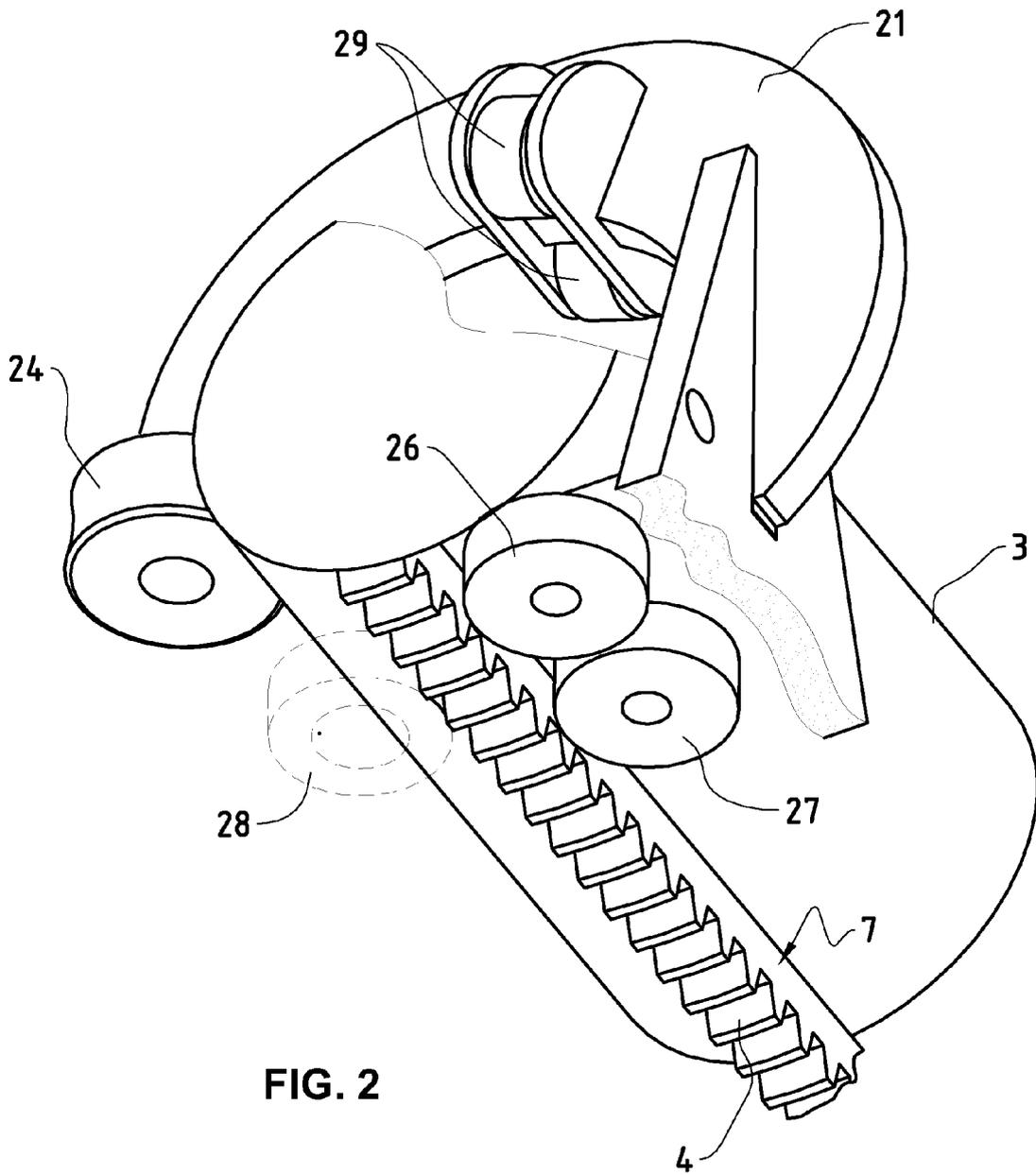
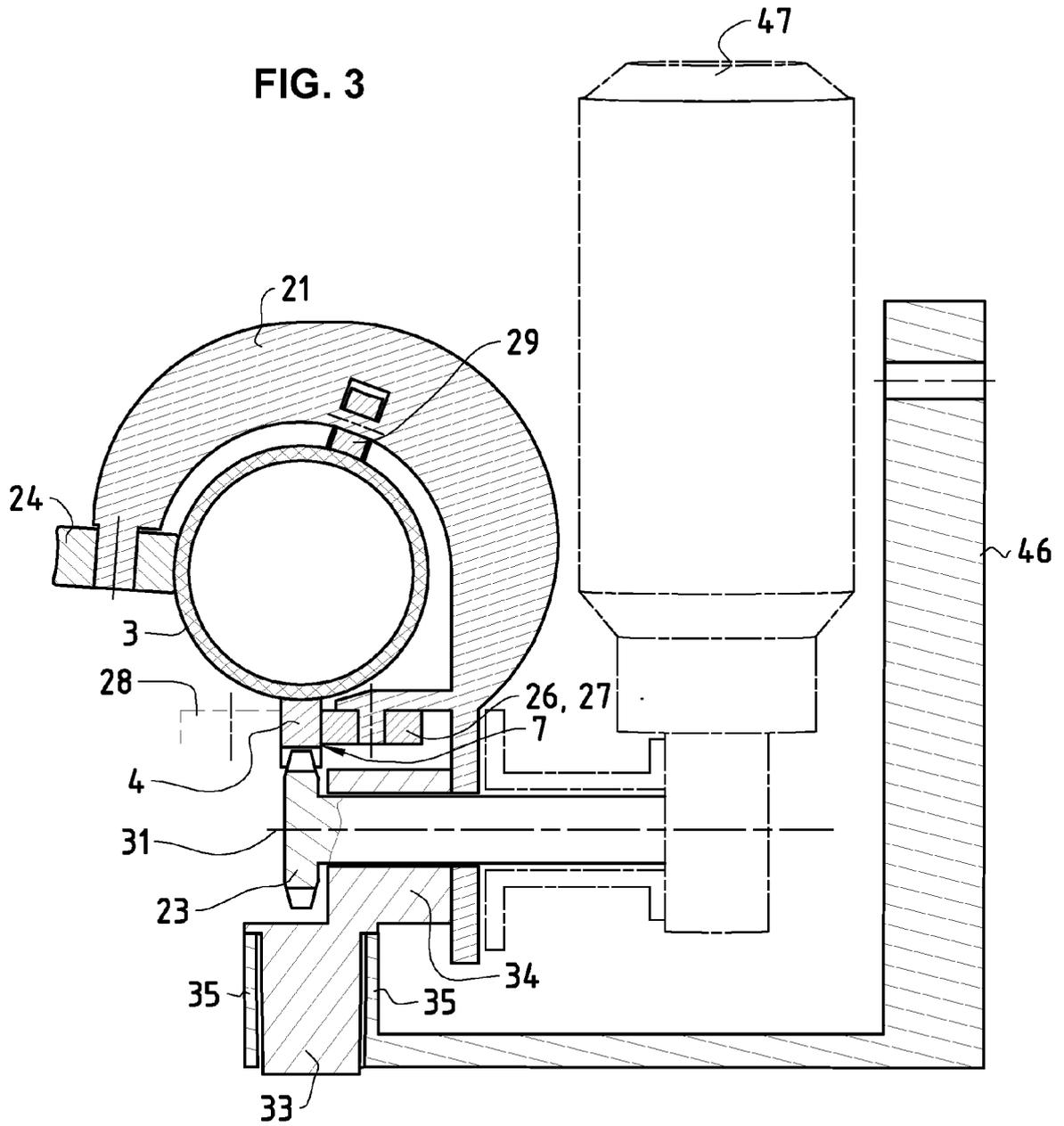


FIG. 3



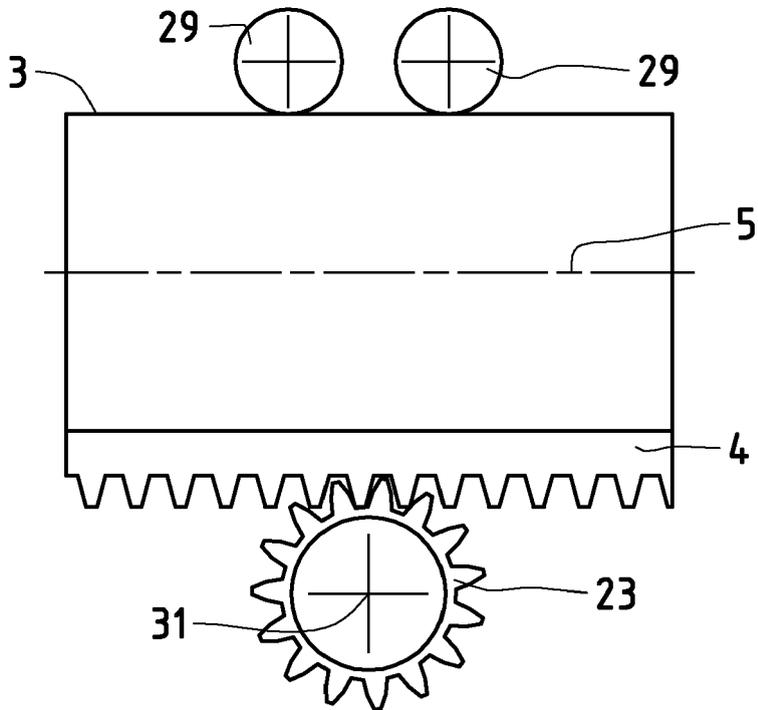


FIG. 4

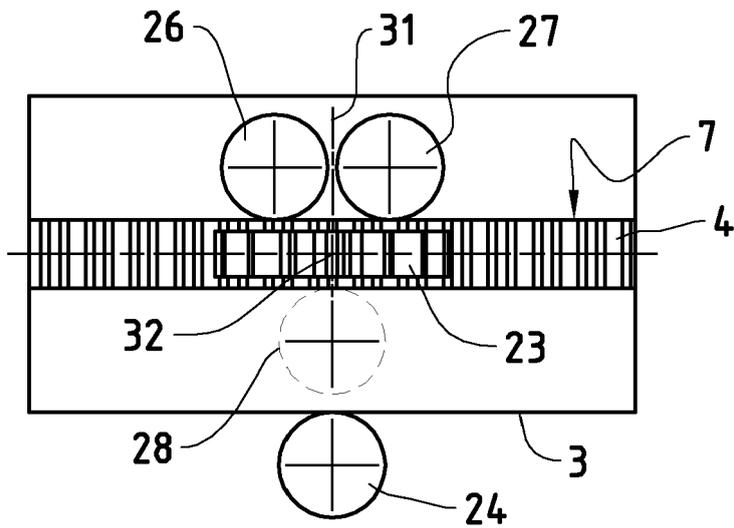


FIG. 5



EUROPEAN SEARCH REPORT

Application Number
EP 10 19 0711

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	EP 0 143 737 A1 (RIGERT CESAR) 5 June 1985 (1985-06-05)	1,2,6	INV. B66B9/08
Y	* page 2, paragraph 3; figures 1-4 *	3,5	
A	* page 5, paragraph 3 - page 6, paragraph 1 *	7-15	
Y	----- US 2010/101894 A1 (SZENTISTVANY ANDREAS CSABA [GB] ET AL) 29 April 2010 (2010-04-29) * paragraph [0044] - paragraph [0057]; figures 1-14 *	3,5	
A	----- EP 1 236 671 A1 (BC LIFT AS [DK]) 4 September 2002 (2002-09-04) * paragraph [0022]; figures 1-8 *	3	
			TECHNICAL FIELDS SEARCHED (IPC)
			B66B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		11 April 2011	Janssens, Gerd
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

1
EPO FORM 1503 03 82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 19 0711

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-04-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0143737 A1	05-06-1985	DE 3334476 A1	11-04-1985
US 2010101894 A1	29-04-2010	EP 2064143 A1 WO 2008047116 A1	03-06-2009 24-04-2008
EP 1236671 A1	04-09-2002	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 9712830 A [0007] [0008] [0020]
- EP 1449801 A [0008]
- WO 2007046690 A [0009] [0011] [0012]