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(54) **Apparatus for transporting a load from a first to a second level, in particular a stairlift**

Vorrichtung zum Transportieren einer Last von einer ersten zu einer zweiten Ebene, speziell ein Treppenlift

Appareil pour le transport d'une charge d'un premier à un deuxième niveau, en particulier un monte-escalier

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EP 2 216 284 B1

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Description

[0001] The invention relates to an apparatus for transporting a load from a first to a second level, in particular a stairlift, in accordance with the preamble of claim 1.

[0002] Such an apparatus is described in WO 99/46198 and GB-A-2 358 389. In GB-A-2 358 389 a gyroscope mounted on the frame measures the rate of tilt of the frame and generates an equal and opposite tilt on the seat, so keeping the seat level. To improve accuracy and to maintain long-term horizontality a pendulum (accelerometer) is fixed to the seat, in order to give an absolute measure of the angular position of the seat. However, the pendulum fixed to the seat is not only sensitive to rotation of the carrier, but also to linear movement of the carriage. In order to decrease the reactivity of the system to the linear movement of the carriage, the sensitivity of the control unit to the pendulum signal is set low.

[0003] The invention has for its object to provide a transporting apparatus of the above described type that is more accurate and/or responsive and/or efficient and/or stable.

[0004] According to the invention this is achieved by the apparatus of claim 1. A gyroscope is to be interpreted as any device that is arranged to sense angular velocity, and an accelerometer as any device that is arranged to measure an angle.

[0005] The control system is arranged to derive the amount of deviation of the load carrier from the gravity acceleration from the signal of the accelerometer and to use said amount to maintain the load carrier in the predetermined position, wherein the control system is arranged to combine the signal of the accelerometer with the signal of the gyroscope, in such a manner that a second amount of deviation of the load carrier from the gravity acceleration is calculated. The control system is further arranged to use said second amount of deviation of the load carrier from the gravity acceleration for controlling the adjusting motor. An advantage of such an arrangement of the control system is that said second amount of deviation of the load carrier from the gravity acceleration is a more accurate and/or stable signal than the amount derived from the signal of the accelerometer alone.

[0006] Preferably, the control system further comprises an amplifier that is arranged to amplify the signal of the gyroscope before it is combined with the signal of the accelerometer, wherein preferably, the amplifier has a gain in a range of 5 - 15, more preferably in a range of 8 - 12, and even more preferably in a range of 9.5 - 10.5.

[0007] Preferably, the control system further comprises a Low Pass filter that is arranged to filter the combined signal of the gyroscope and the accelerometer, wherein preferably, the Low Pass filter has a cutoff frequency in a range of 0.01 - 0.03 Hz, more preferably in a range of 0.013 - 0.02 Hz, and even more preferably in a range of 0.015 - 0.017 Hz.

[0008] Preferably, the control system further comprises

a High Pass filter that is arranged to filter the filtered combined signal of the gyroscope and the accelerometer, wherein preferably, the High Pass filter has a cutoff frequency a range of 0.01 - 0.03 Hz, more preferably in a range of 0.013 - 0.02 Hz, and even more preferably in a range of 0.015 - 0.017 Hz.

[0009] Preferably, the control system further comprises a second Low Pass filter that is arranged to filter the signal of the accelerometer, wherein preferably, the second Low Pass filter filters frequencies in a range of 0.01 - 0.03 Hz, more preferably in a range of 0.013 - 0.02 Hz, and even more preferably in a range of 0.015 - 0.017 Hz. An advantage of said second Low Pass filter is that high frequency signals due to linear acceleration (for example due to shocks) are reduced.

[0010] Preferably, the control system is arranged to combine the doubly filtered combined signal of the gyroscope and the accelerometer and the filtered signal of the accelerometer, wherein preferably, the control system is further arranged to subtract this combined signal from a predetermined amount of deviation of the load carrier from the gravity acceleration, and wherein preferably, the control system further comprises a PI controller that is arranged to determine the correctional rotation needed in order to reach the predetermined amount of deviation of the load carrier from the gravity acceleration.

[0011] Preferably, said sensors further comprise a second gyroscope mounted on the frame, wherein preferably, the control system is arranged to use the signal of the second gyroscope for controlling the adjusting motor so that a correctional rotation occurs. An advantage of said second gyroscope is that the control system is arranged such that as soon as said second gyroscope senses an angular velocity of rotation the adjusting motor will start a correctional counter-rotation at the same angular velocity.

[0012] The invention is now elucidated on the basis of two embodiments, wherein reference is made to the annexed drawing in which corresponding components are designated with reference numerals increased by 100, and in which:

Fig. 1 shows a perspective front view of a stairlift installation according to a first embodiment of the invention,

Fig. 2 shows a partly broken-away, perspective rear view of a part of the stairlift installation of fig. 1,

Fig. 3 shows a side view according to arrow III in fig. 2,

Fig. 4 is a partly broken-away, perspective rear view of the stairlift installation of fig. 1 in a bend of the rail, Fig. 5 is a partly broken-away, perspective rear view of an alternative embodiment of the stairlift installation,

Fig. 6 is a perspective front view of the stairlift installation of fig. 1-4 with a number of sensors for determining the position of the load carrier, and

Fig. 7 shows a block diagram of a system for main-

taining the position of the load carrier.

Figs. 8 a, b, c, d show a block diagram of the electronic control system for processing the sensor inputs and controlling the adjusting motor.

[0013] An installation 1 for transporting a load from a first to a second level (fig. 1), in the shown embodiment a stairlift installation, comprises a rail 3 which is placed along a staircase 2 and which encloses an angle α with the horizontal H, and an apparatus 4 movable along rail 3 for transporting the load between the different levels, here therefore a stairlift. Rail 3, which in the shown embodiment has a round cross-section, is supported by a number of posts 5 which are arranged distributed along staircase 2 and which are fixed to a protruding part 6 extending along rail 3 (fig. 2). The function of this protruding part 6 is elucidated hereinbelow. Rail 3 is further provided with a propelling part, here in the form of a gear rack 8, which has a round cross-section.

[0014] Stairlift 4 comprises a frame 9 which is displaceable along rail 3 and on which a load carrier 10 is mounted, here in the form of a chair with a seat 11, back rest 12, armrests 13 and a footrest 14. Chair 10 is connected to frame 9 for pivoting on a horizontal shaft 45 (fig. 3), and arranged in frame 9 and carrier 10 is a maintaining mechanism 70 to be elucidated further hereinbelow and consisting of, among other parts, of an adjusting motor 71 connected to shaft 45 so that the position of chair 10 can be kept constant at all times irrespective of the inclination of rail 3.

[0015] Frame 9 of stairlift 4 is further provided with support and guide means 15 which engage round a part of the periphery of rail 3. For this purpose the frame 9 is given a substantially L-shaped form with an upright back 38 and two feet 26 engaging under rail 3. The support and guide means 15 are adapted to absorb moments directed transversely of the direction of displacement of stairlift 4. To this end the support and guide means 15 comprise a number of guide rollers 17 which are arranged with interspacing in the direction of displacement and which engage on rail 3. In the shown embodiment there are even a plurality of pairs of guide rollers 17, which are moreover arranged distributed in peripheral direction of rail 3. By making use of a large number of guide rollers 17, they can each be given a relatively small form, thereby achieving a compact construction. The loads of stairlift 4 are moreover thus spread uniformly over rail 3 and the resistance is minimized. Guide rollers 17 are each rotatable on a shaft 18 and received per pair in a recess in a roller carrier 20. The outer recesses are covered with a closing plate 19.

[0016] In the shown embodiment roller carrier 20 takes the form of a ring segment open to one side and having a spherical outer surface 21. The open side serves to allow the ring segment to engage round the protruding part 6 of rail 3. In the shown embodiment there are two roller carriers 20 present, in each of which three pairs of roller 17 are arranged with a mutual spacing of 120° in

peripheral direction. Each roller carrier 20 is mounted at two diametrically opposite points in bowl-shaped dishes 24 connected to frame 9 such that it is in principle movable in all directions. Dishes 24 are fixed with a number of screws 25 to the foot 26 protruding under rail 3 and to a part 27 of frame 9 engaging over rail 3. An imaginary line connecting the roller carriers 20 encloses a small angle β with the vertical V.

[0017] In order to limit the mobility of roller carrier 20 to two mutually perpendicular directions transversely of the direction of displacement of the stairlift, thus a tilting movement transversely of rail 3, there are formed in the outer surface 21 thereof two grooves 22 which run practically in the direction of displacement and in which a pin 23 engages in each case. This pin 23 protrudes out the bowl-shaped dish 24 in the middle. Through sliding of pins 23 in grooves 22 a rotating movement of roller carrier 20 about a practically horizontal axis is thus allowed, while a rotation of roller carrier 20 on pins 23 is also possible. On the other hand, the pins 23 prevent a tilting movement on the longitudinal axis of rail 3. In this manner bends in staircase 2, and thus also in rail 3, which generally cause rotations in both the horizontal and vertical plane (fig. 4), can be followed extremely well.

[0018] Stairlift 4 is also provided with drive means 16 which co-act with the propelling part 8 of rail 3. These drive means 16 are accommodated in a sub-frame 28 which here has a reverse L-shape and which is formed between the feet 26 of frame 9. A roller 29 is mounted in sub-frame 28 for rotation on a shaft 30, whereby sub-frame 28 supports on rail 3. Drive means 16 comprise a motor 31 with an output shaft 32 on which a rotatable drive member 33 is arranged which engages on the propelling part 8 of rail 3. For power supply to motor 31 in the shown embodiment, two batteries 34 are arranged at the top of sub-frame 28 in the shown embodiment.

[0019] As stated, in the shown embodiment the propelling part 8 is a gear rack and drive member 33 is thus embodied as a toothed wheel. Since gear rack 8 is arranged on the side of the rail 3 remote from frame 9, an output shaft 32 driven by motor 31 extends transversely of the direction of displacement under rail 3.

[0020] In the shown embodiment the output shaft 32 even extends beyond gear rack 8 and toothed wheel 33 as far as the protruding part 6 of rail 3. Mounted on the protruding part of shaft 32 is a support wheel 35 which engages on the protruding part or strip 6 of rail 3. A moment directed round rail 3, which is the result of the weight of load carrier 10 and the load carried thereby, can hereby be absorbed by drive means 16.

[0021] In order to ensure an optimal engagement of toothed wheel 33 in gear rack 8, a further closing roller 36 is mounted rotatably on a shaft 37 opposite support wheel 35. The reverse L-shaped sub-frame 28 with the closing roller 36 mounted therein and the protruding shaft 32 with support wheel 35 thus form a unit almost wholly enclosing rail 3.

[0022] Because the support and guide means 15 and

drive means 16 are offset as seen in the direction of displacement of stairlift 4 and because the propelling part 8 does not coincide with rail 3, guide rollers 17 and toothed wheel 33 will not display the same displacement when rail 3 goes through a bend. There is therefore the danger of the toothed wheel 30 moving out of engagement with propelling part 8 of rail 3, whereby stairlift 4 could come to a stop or at least move in jolting manner. Such differences would also disrupt the electronic control of the position-maintaining means 70. The invention therefore provides that drive means 16 are received in frame 9 for movement relative to support and guide means 15.

[0023] In the shown embodiment the sub-frame 28 with drive means 16 therein is movable relative to frame 9 substantially transversely of the direction of displacement of stairlift 4, whereby differences in distance from the centre line of rail 3 can be compensated in inside and outside bends. Sub-frame 28 is connected for this purpose to the back 38 of frame 9 via a member 39 which has a pivot shaft 40 respectively 41 on either side. The pivot shafts 40, 41 are herein oriented substantially in the direction of displacement of stairlift 4. Making use of two parallel pivot shafts 40, 41 achieves that sub-frame 28 is movable transversely of rail 3 in two mutually perpendicular directions.

[0024] In order to enable transmission to frame 9 of stairlift 4 of the drive forces generated by engagement of toothed wheel 30 in gear rack 8, force-transmitting means 42 are arranged in the shown embodiment between the sub-frame 28 of drive means 16 and the frame 9. These force-transmitting means 42 must be movable to be able to follow the movements between sub-frame 28 and frame 9. In the shown embodiment the force-transmitting means 42 comprise for this purpose two co-acting pushing members or slide bearings 43, 44, one on sub-frame 28 and one on frame 9, which are freely movable transversely of the direction of displacement of stairlift 4. During a relative movement of frame 9 and sub-frame 28 these pushing members 43, 44 slide along each other, roughly in the manner of buffer stops on mutually coupled railway carriages. The drive forces can thus be transmitted at all times from rail 3 to stairlift 4, irrespective of the relative position of sub-frame 28 and frame 9.

[0025] In an alternative embodiment of the stairlift 104 (fig. 5), the sub-frame 128 in which drive means 116 are arranged is movable relative to frame 109 by means of two linkages 150 on either side thereof. Each linkage 150 comprises a substantially vertically directed bar 139 which is pivotally connected at the top and bottom via shafts 140, 141 to in each case two pivoting bars 151, 152 directed toward and away from rail 103 and oriented obliquely upward. The bars 151 directed toward rail 3 are herein pivotally connected at their other end to sub-frame 128 via a shaft 153, while the bars 152 directed away from rail 103 are connected to frame 109 via a pivot shaft 154. Achieved once again in this manner is that relative to frame 109 the sub-frame 128 is movable transversely of rail 3 in two mutually perpendicular directions.

[0026] In order to transmit the drive forces from drive means 116 to frame 109, use is made in this embodiment of force-transmitting means 142 in the form of two pull and push rods or Panhard rods 155, an end 156 of which is connected to sub-frame 128 via for instance a hinge 157, while the other end 158 can likewise be connected via a hinge 159 to a spacer bar 160 of frame 109.

[0027] In this embodiment the support and guide means 115 otherwise comprise two relatively large guide rollers 117 on either side of rail 103 which are mounted directly in frame 109.

[0028] As stated above, stairlift 4, 104 comprises a position-maintaining means 70, 170 which consists of an adjusting motor 71, 171 which is connected drivingly to pivot shaft 45, 145 of carrier 10. The construction and operation of this mechanism 70 is elucidated on the basis of the first embodiment of stairlift 4 and with reference to figs. 6, 7 and 8 a, b, c, d. The operation of adjusting motor 71 is controlled by an electronic control system 78 which receives signals from three sensors 73, 74, 75. Sensor 73 is a first gyroscope mounted on the frame 9 close to the rail 3. Sensor 74 is a second gyroscope mounted on the lower part of the carrier 10 approximately at the level of the rail 3. Sensor 75 is an accelerometer which is also mounted on the lower part of the carrier 10 approximately at the level of the rail 3. Accelerometer 75 is arranged such to measure the two components of gravitation g_x and g_y (fig. 8 b) in the vertical plane of the direction of movement of the frame, which are perpendicular to each other and to the rotation axis of the carrier 10, i.e. to shaft 45. From said components the angle of carrier 10 with the horizontal plane (φ_{xy}) can be calculated with use of the formula $\varphi_{xy} = -\arctan(g_y/g_x)$, possibly corrected with a constant angle. The gyroscopes 73 and 74 are arranged to sense the angular velocity of the rotation of frame 9 (ω_{frame}) and carrier 10 (ω_{carrier}) respectively, around said rotation axis. Modern accelerometers and vibrating structure gyroscopes, belonging to the group of micro electro-mechanical systems (MEMS), are very small and cost effective devices and thereby very suitable for the current apparatus.

[0029] The three signals are processed in control system 78 and on the basis thereof a control signal 80 is generated to adjusting motor 71. The rotation of this adjusting motor 71 is transmitted to shaft 45 by a transmission 72 which is preferably self-locking, such as for instance a worm wheel transmission.

[0030] The gyroscope 73 on the frame 9 provides information on the angular velocity of rotation of the frame 9 around the rotation axis of carrier 10. The control system is arranged such that during movement of the frame 9 along the rail 3, as soon as the signal of gyroscope 73 on the frame 9 indicates an angular velocity of rotation, the adjusting motor 71 will start a correctional counter-rotation at the same angular velocity.

[0031] The precise, and final, amount of counter-rotation is determined by the angle of chair 10 with the horizontal plane (φ_{xy}), calculated from the signal of accel-

ometer 75 on the carrier 10, such that the carrier 10 is maintained horizontal. A method of this kind is described in more detail in GB-A-2 358 389, which is incorporated herein by reference.

[0032] However, the signal of accelerometer 75 is not only influenced by a change in gravitational acceleration due to rotation of the carrier 10 relative to the horizontal plane, but also by linear acceleration of the carrier. This problem is also described in GB-A-2 358 389, and that document proposes to set the sensitivity of the control unit to the accelerometer signal low. According to the invention however an error correction is provided, by using the fact that a linear acceleration will cause an acceleration signal from the accelerometer 75 on the carrier 10, which will alter the calculated angle of carrier 10 with the horizontal plane (φ_{xy}), but will not cause a simultaneous angular velocity signal of gyroscope 74 on the carrier 10 ($\omega_{carrier}$) because gyroscope 74 is not sensitive to linear acceleration. Therefore, the control system 78 is arranged such that by use of block 82 (see also figs. 8 c, d) a second, more accurate and/or more stable angle of the carrier 10 with the horizontal plane ($\varphi_{carrier}$) based on the angle calculated from the signal of accelerometer 75 (φ_{xy}) and the angular velocity signal of gyroscope 74 ($\omega_{carrier}$) is calculated. The difference (φ_{error}) between the second calculated angle of the carrier 10 and the horizontal plane ($\varphi_{carrier}$) and the predetermined angle ($\varphi_{predetermined}$) is determined by a subtractor 83 and subsequently used by a PI controller 84 to determine the correctional rotation needed (ω_{corr}) in order to reach the predetermined angle of the carrier 10 and the horizontal plane. The predetermined angle of the carrier 10 and the horizontal plane can for example be 0 degrees, which corresponds to a predetermined position of the load carrier in which the seat 11 of the carrier 10 is horizontal. Said correctional rotation (ω_{corr}) is added by a summer 85 to the correctional rotation based on the angular velocity signal of the gyroscope 73 on the frame 9 (ω_{frame}), so that a correctional rotation is started by the adjusting motor 71 (ω_{motor}) such that the predetermined angle of the carrier 10 and the horizontal plane is reached.

[0033] Fig. 8 c shows an arrangement of block 82 to calculate the second angle of the carrier 10 and the horizontal plane ($\varphi_{carrier}$) based on the angle calculated from the signal of accelerometer 75 (φ_{xy}) and the angular velocity signal of gyroscope 74 ($\omega_{carrier}$). The angular velocity signal of gyroscope 74 ($\omega_{carrier}$) is integrated by an integrator 87 in order to obtain a gyroscopic angle signal (φ_{gyro}). Time constant τ_1 in integrator 87 for example has a value equal to 1 s. Due to integration an integration constant is present in the gyroscopic angle signal (φ_{gyro}). The offset present in the angular velocity signal of gyroscope 74 ($\omega_{carrier}$) is also integrated by integrator 87 and this integrated offset is therefore also present in the gyroscopic angle signal (φ_{gyro}). In order to remove the integration constant the gyroscopic angle signal (φ_{gyro}) is filtered by a High Pass filter 88. The offset of the gyro-

scope 74 remains in the signal as a more or less constant signal. The angle signal from the accelerometer 75 (φ_{xy}) is filtered by a Low Pass filter 89, which will reduce high frequency signals due to linear acceleration (for example due to shocks), and subsequently added by a summer 90 to the integrated and filtered gyroscopic angular velocity signal. This combined signal is already a more accurate signal for the angle of the carrier 10 and the horizontal plane but still contains the offset of the gyroscope 74. This combined signal is therefore filtered by a High Pass filter 91 in order to remove the offset of the gyroscope 74. This signal is added by a summer 93 to the by a Low Pass filter 92 filtered angle signal from the accelerometer 75, which results in a signal for the second angle of the carrier 10 and the horizontal plane ($\varphi_{carrier}$) that combines the best qualities of both sensors 74 and 75 in respectively their high and low frequency areas. This signal is therefore an accurate signal for the angle of the carrier 10 and the horizontal plane ($\varphi_{carrier}$).

[0034] Fig. 8 d shows a practical arrangement of block 82 to calculate the second angle of the carrier 10 and the horizontal plane ($\varphi_{carrier}$) based on the angle calculated from the signal of accelerometer 75 (φ_{xy}) and the angular velocity signal of gyroscope 74 ($\omega_{carrier}$). The angular velocity signal of gyroscope 74 ($\omega_{carrier}$) is practically first filtered by a High Pass filter and subsequently integrated in order to prevent the integrator to obtain an unlimited value. This is done by amplifying the angular velocity signal of gyroscope 74 ($\omega_{carrier}$) by an amplifier 94, subsequently adding this signal to the the signal of accelerometer 75 (φ_{xy}) by a summer 95 and then by filtering this combined signal by a Low Pass filter 96. In order to remove the offset of gyroscope 74 this combined signal is filtered by a High Pass filter 97 and added by a summer 99 to the by a Low Pass filter 98 filtered angle signal from the accelerometer 75, which results in a signal for the second angle of the carrier 10 and the horizontal plane ($\varphi_{carrier}$) that combines the best qualities of both sensors 74 and 75 in respectively their high and low frequency areas. This signal is therefore an accurate signal for the angle of the carrier 10 and the horizontal plane ($\varphi_{carrier}$). It is noted here that the control arrangements shown in figs. 8 c, d of block 82 are substantially the same as to function.

[0035] Practical values for time constants τ_2 and τ_3 in figs. 8 c), d) are for example $\tau_2 = \tau_3 = 10$ s. Cutoff frequencies of Low Pass filters 89, 91, 96, 98 and High Pass filters 88, 91, 97 are preferably in a range of 0.01 - 0.03 Hz, more preferably in a range of 0.013 - 0.02 Hz, and even more preferably in a range of 0.015 - 0.017 Hz. Gain of amplifier 94 is preferably in a range of 5 - 15, more preferably in a range of 8 - 12, and even more preferably in a range of 9.5 - 10.5.

[0036] In described control system the angular velocity signal of gyroscope 74 ($\omega_{carrier}$) can be used to control the adjusting motor 71 such that the carrier 10 is maintained horizontal. At stand-still gyroscope 73 will not produce a rotation signal, but gyroscope 74 may, due to the

weight of a person, and also in that situation the carrier 10 is maintained horizontal by the above arrangement. This may for instance occur if the person on the carrier moves its centre of gravity on the seat 11.

[0037] Although the invention is described above on the basis of a number of embodiments, it will be apparent that the invention is not limited thereto. Instead of being pivotable, the drive means could therefore also be slidable, for instance along two guides enclosing a mutual angle. There could also be provided only one sub-frame with at least two guide rollers, whereby a more compact but more heavily loaded construction is obtained. The guide rollers could also be mounted in the frame in a different way, for instance by means of a cardan suspension or a linkage, while the force-transmitting means could also take another form. It is possible here to envisage balls or flexible elements rotatable in all directions, such as pulling cables, springs and the like. It would even be possible to dispense with the use of separate force-transmitting means if the connection between the drive means and the support and guide means is rigid enough. The form and location of the drive could of course also be varied, for instance by applying a straight gear rack or a worm wheel. Nor does the support wheel have to be combined with the drive, but it could be mounted separately on the frame or sub-frame. In addition, there could also be a different choice in the distribution of the loads over the support and guide means on the one hand and the drive means on the other. The position-maintaining mechanism could also be embodied differently. More or fewer sensors could be used, and the sensors used could also be of electromechanical nature, for instance in the form of encoders which convert a mechanical movement into an electric signal. Time constants, cutoff frequencies and gains of integrators, Low and High Pass filters and Amplifiers can be in a different range. Finally, the position-maintaining mechanism as described here could also be applied in combination with another type of stairlift.

[0038] The scope of the invention is therefore defined solely by the appended claims.

Claims

1. Apparatus (1) for transporting a load from a first to a second level, in particular a stairlift, comprising:

a frame (9) which is displaceable along a rail (3) and which is provided with support and guide means (15) and drive means (16) arranged to engage the rail (3),
a load carrier (10) mounted on said frame (9), and
means (70) for maintaining the load carrier (10) in a predetermined position relative to the direction of gravity, which position-maintaining means comprise at least one adjusting motor (71) arranged to move the load carrier (10) rel-

ative to the frame (9), a control system (78) for controlling the adjusting motor (71) so that a correctional rotation occurs, and sensors (73, 74, 75) connected therewith arranged to generate signals to the control system (78),

characterized in that said sensors (73, 74, 75) comprise an accelerometer (75) mounted on the load carrier (10) and a gyroscope (74) mounted on the load carrier (10), and the control system (78) is arranged to derive the amount of deviation of the load carrier (10) from the gravity acceleration from the signal of the accelerometer (75) and to use said amount to maintain the load carrier (10) in the predetermined position, wherein the control system (78) is arranged to combine the signal of the accelerometer (75) with the signal of the gyroscope (74), in such a manner that a second amount of deviation of the load carrier (10) from the gravity acceleration is calculated, wherein the control system (78) is further arranged to use said second amount of deviation of the load carrier (10) from the gravity acceleration for controlling the adjusting motor (71).

2. Apparatus according to claim 1, **characterized in that** the control system (78) further comprises an amplifier (94) that is arranged to amplify the signal of the gyroscope (74) before it is combined with the signal of the accelerometer (75).
3. Apparatus according to claim 2, **characterized in that** said amplifier (94) has a gain in a range of 5 - 15, preferably in a range of 8 - 12, more preferably in a range of 9.5 - 10.5.
4. Apparatus according to claim 2 or 3, **characterized in that** the control system (78) further comprises a Low Pass filter (96) that is arranged to filter the combined signal of the gyroscope (74) and the accelerometer (75).
5. Apparatus according to claim 4, **characterized in that** said Low Pass filter (96) has a cutoff frequency in a range of 0.01 - 0.03 Hz, preferably in a range of 0.013 - 0.02 Hz, more preferably in a range of 0.015 - 0.017 Hz.
6. Apparatus according to claim 4 or 5, **characterized in that** the control system (78) further comprises a High Pass filter (97) that is arranged to filter the filtered combined signal of the gyroscope (74) and the accelerometer (75).
7. Apparatus according to claim 6, **characterized in that** said High Pass filter (97) has a cutoff frequency in a range of 0.01 - 0.03 Hz, preferably in a range of 0.013 - 0.02 Hz, more preferably in a range of 0.015

- 0.017 Hz.

8. Apparatus according to claim 6 or 7, **characterized in that** the control system (78) further comprises a second Low Pass filter (98) that is arranged to filter the signal of the accelerometer (75). 5
9. Apparatus according to claim 8, **characterized in that** said second Low Pass filter (98) has a cutoff frequency in a range of 0.01 - 0.03 Hz, preferably in a range of 0.013 - 0.02 Hz, more preferably in a range of 0.015 - 0.017 Hz. 10
10. Apparatus according to claim 8 or 9, **characterized in that** the control system (78) is arranged to combine the doubly filtered combined signal of the gyroscope (74) and the accelerometer (75) and the filtered signal of the accelerometer (75), wherein the control system (78) is further arranged to subtract this combined signal from a predetermined amount of deviation of the load carrier (10) from the gravity acceleration, and wherein the control system (78) further comprises a PI controller (84) that is arranged to determine the correctional rotation needed in order to reach the predetermined amount of deviation of the load carrier (10) from the gravity acceleration. 15 20 25
11. Apparatus according to any of the preceding claims 1 - 10, **characterized in that** said sensors (73, 74, 75) further comprise a second gyroscope (73) mounted on the frame. 30
12. Apparatus according to claim 11, **characterized in that** the control system (78) is arranged to use the signal of the second gyroscope (73) for controlling the adjusting motor (71) so that a correctional rotation occurs. 35

Patentansprüche 40

1. Vorrichtung (1) zum Transportieren einer Last von einer ersten Ebene zu einer zweiten Ebene, insbesondere ein Treppenlift, umfassend:

einen Rahmen (9), der entlang einer Schiene (3) verlagert werden kann und der mit Trag- und Führungsmitteln (15) und Antriebsmitteln (16) versehen ist, die angeordnet sind, um mit der Schiene (3) zusammenzuwirken, 50
einen Lastträger (10), der an dem Rahmen (9) angebracht ist, und Mittel (70) zum Halten des Lastträgers (10) in einer vorbestimmten Position relativ zur Richtung der Schwerkraft, wobei die positionshaltenden Mittel zumindest einen Einstellmotor (71) aufweisen, der angeordnet ist, um den Lastträger (10) relativ zu dem Rahmen (9) zu bewegen, ein Steuersystem (78) zum 55

Steuern des Einstellmotors (71), so dass eine Korrekturdrehung erfolgt und damit verbundene Sensoren (73, 74, 75), die angeordnet sind, um Signale für das Steuersystem (78) zu erzeugen,

dadurch gekennzeichnet, dass die genannten Sensoren (73, 74, 75) einen Beschleunigungsmesser (75) umfassen, der an dem Lastträger (10) angebracht ist, und ein Gyroskop (74), das an dem Lastträger (10) angebracht ist, wobei das Steuersystem (78) so eingerichtet ist, dass es den Betrag der Abweichung des Lastträgers (10) von der Schwerebeschleunigung aus dem Signal des Beschleunigungsmessers (75) ableitet und den genannten Betrag dazu verwendet, um den Lastträger (10) in der vorbestimmten Position zu halten, wobei das Steuersystem (78) eingerichtet ist, um das Signal des Beschleunigungsmessers (75) mit dem Signal des Gyroskops (74) zu kombinieren, auf eine solche Weise, das ein zweiter Betrag an Abweichung des Lastträgers (10) von der Schwerebeschleunigung berechnet wird, wobei das Steuersystem (78) weiterhin eingerichtet ist, um den genannten zweiten Betrag an Abweichung des Lastträgers (10) von der Schwerebeschleunigung zur Steuerung des Einstellmotors (71) zu verwenden.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** das Steuersystem (78) weiterhin einen Verstärker (94) umfasst, der eingerichtet ist, um das Signal des Gyroskops (74) zu verstärken, bevor es mit dem Signal des Beschleunigungsmessers (75) kombiniert wird.
3. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der genannte Verstärker (94) einen Verstärkungsfaktor in einem Bereich von 5 bis 15 aufweist, vorzugsweise in einem Bereich von 8 bis 12 und weiter bevorzugt in einem Bereich von 9,5 bis 10,5.
4. Vorrichtung nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** das Steuersystem (78) weiterhin ein Tiefpassfilter (96) aufweist, das angeordnet ist, um das kombinierte Signal des Gyroskops (74) und des Beschleunigungsmessers (75) zu filtern.
5. Vorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** das genannte Tiefpassfilter (96) eine Abschnidefrequenz in einem Bereich von 0,01 bis 0,03 Hz aufweist, vorzugsweise in einem Bereich von 0,013 bis 0,02 Hz und weiter bevorzugt in einem Bereich von 0,015 bis 0,017 Hz.
6. Vorrichtung nach Anspruch 4 oder 5, **dadurch gekennzeichnet, dass** das Steuersystem (78) weiterhin ein Hochpassfilter (97) aufweist, das eingerichtet ist, um das gefilterte kombinierte Signal des Gyro-

skops (74) und des Beschleunigungsmessers (75) zu filtern.

7. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** das genannte Hochpassfilter (97) eine Abschnidefrequenz in einem Bereich von 0,01 bis 0,03 Hz aufweist, vorzugsweise in einem Bereich von 0,013 bis 0,02 Hz und weiter bevorzugt in einem Bereich von 0,015 bis 0,017 Hz. 5
8. Vorrichtung nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** das Steuersystem (78) weiterhin ein zweites Tiefpassfilter (98) aufweist, das eingerichtet ist, um das Signal des Beschleunigungsmessers (75) zu filtern. 10
9. Vorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** das genannte zweite Tiefpassfilter (98) eine Abschnidefrequenz in einem Bereich von 0,01 bis 0,03 Hz aufweist, vorzugsweise in einem Bereich von 0,013 bis 0,02 Hz und weiter bevorzugt in einem Bereich von 0,015 bis 0,017 Hz. 15
10. Vorrichtung nach Anspruch 8 oder 9, **dadurch gekennzeichnet, dass** das Steuersystem (78) eingerichtet ist, um das doppelt gefilterte kombinierte Signal des Gyroskops (74) und des Beschleunigungsmessers (75) und das gefilterte Signal des Beschleunigungsmessers (75) zu kombinieren, wobei das Steuersystem (78) weiterhin eingerichtet ist, um dieses kombinierte Signal von einem vorbestimmten Betrag an Abweichung des Lastträgers (10) von der Schwerebeschleunigung zu subtrahieren, und wobei das Steuersystem (78) weiterhin einen PI-Regler (84) aufweist, der eingerichtet ist, um die Korrekturdrehung zu bestimmen, die notwendig ist, um den vorbestimmten Betrag an Abweichung des Lastträgers (10) von der Schwerebeschleunigung zu erreichen. 20
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30
35
11. Vorrichtung nach einem der vorangehenden Ansprüche 1 bis 10, **dadurch gekennzeichnet, dass** die genannten Sensoren (73, 74, 75) weiterhin ein zweites Gyroskop (73) aufweisen, das auf dem Rahmen angebracht ist. 40
12. Vorrichtung nach Anspruch 11, **dadurch gekennzeichnet, dass** das Steuersystem (78) eingerichtet ist, um das Signal des zweiten Gyroskops (73) zum Steuern des Einstellmotors (71) zu verwenden, so dass eine Korrekturdrehung erfolgt. 45
50

Revendications

1. Appareil (1) pour transporter une charge d'un premier niveau vers un second niveau, en particulier un monte-escalier, ledit appareil comprenant :

un châssis (9) qui est déplaçable le long d'un rail (3) et qui est doté de moyens de guidage et de support (15) et de moyens d'entraînement (16) prévus pour s'engager avec le rail (3), un porte-charge (10) monté sur ledit châssis (9), et

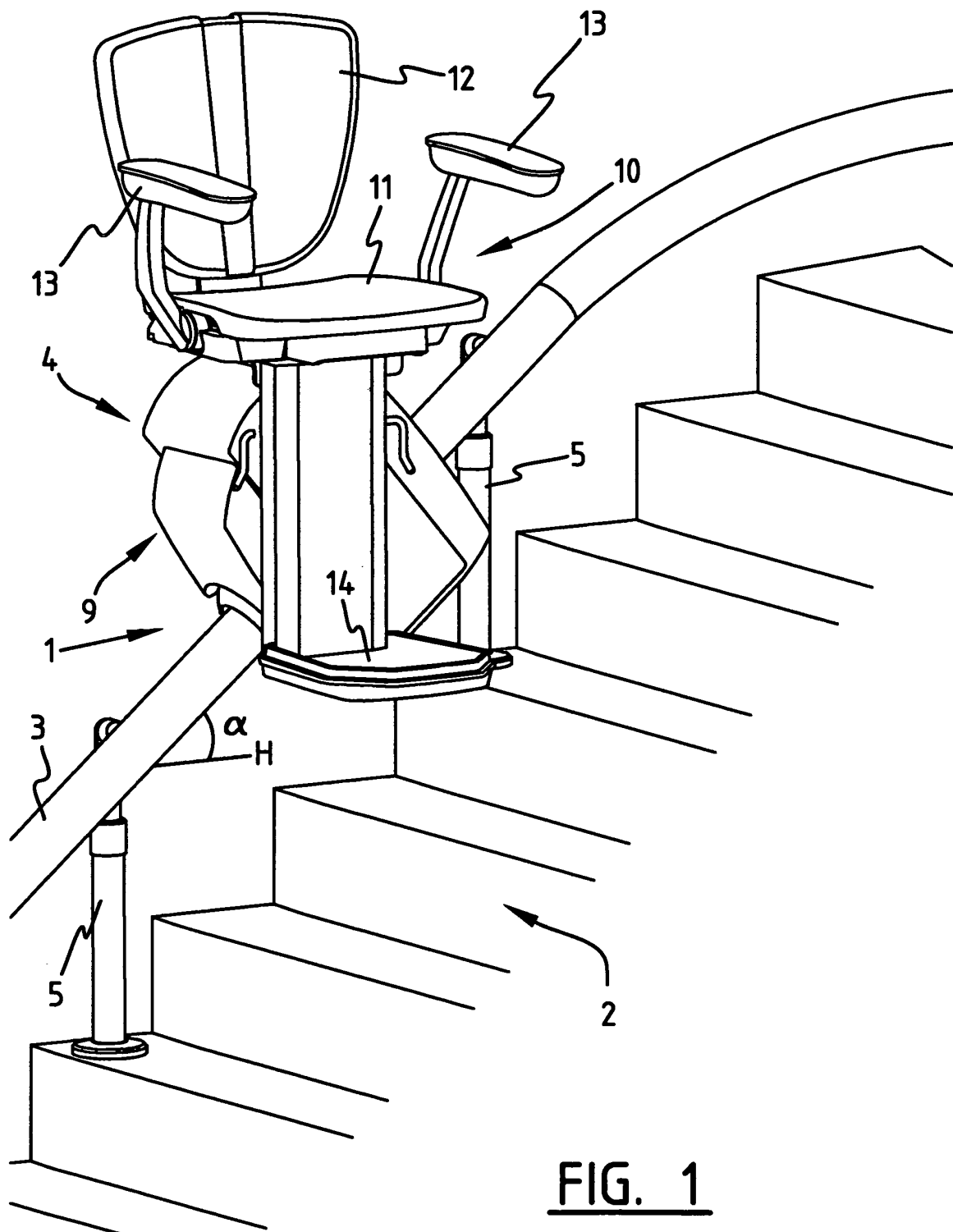
des moyens (70) destinés à maintenir le porte-charge (10) dans une position prédéterminée par rapport à la direction de la pesanteur, lesquels moyens de maintien de position comprennent au moins un moteur de réglage (71) prévu pour déplacer le porte-charge (10) par rapport au châssis (9), un système de commande (78) destiné à commander le moteur de réglage (71) de façon à ce qu'une rotation de correction soit effectuée, et des capteurs (73, 74, 75) raccordés audit moteur et prévus pour générer des signaux à destination du système de commande (78), **caractérisé en ce que** lesdits capteurs (73, 74, 75) comprennent un accéléromètre (75) monté sur le porte-charge (10) et un gyroscope (74) monté sur le porte-charge (10), et le système de commande (78) est prévu pour déduire l'écart du porte-charge (10) par rapport à l'accélération de la pesanteur à partir du signal de l'accéléromètre (75) et d'utiliser ledit écart pour maintenir le porte-charge (10) dans la position prédéterminée, dans lequel le système de commande (78) étant prévu pour combiner le signal de l'accéléromètre (75) au signal du gyroscope (74), de manière à calculer un second écart du porte-charge (10) par rapport à l'accélération de la pesanteur, dans lequel le système de commande (78) étant en outre prévu pour utiliser ledit second écart du porte-charge (10) par rapport à l'accélération de la pesanteur pour commander le moteur de réglage (71).

2. Appareil selon la revendication 1, **caractérisé en ce que** le système de commande (78) comprend en outre un amplificateur (94) qui est prévu pour amplifier le signal du gyroscope (74) avant qu'il ne soit combiné au signal de l'accéléromètre (75). 55
3. Appareil selon la revendication 2, **caractérisé en ce que** ledit amplificateur (94) a un gain dans une gamme de 5 à 15, de préférence dans une gamme de 8 à 12, plus préférablement dans une gamme de 9,5 à 10,5.
4. Appareil selon la revendication 2 ou 3, **caractérisé en ce que** le système de commande (78) comprend en outre un filtre passe-bas (96) qui est prévu pour filtrer le signal combiné du gyroscope (74) et de l'accéléromètre (75).
5. Appareil selon la revendication 4, **caractérisé en ce que** ledit filtre passe-bas (96) a une fréquence de

coupure dans une gamme de 0,01 à 0,03 Hz, de préférence dans une gamme de 0,013 à 0,02 Hz, plus préférablement dans une gamme de 0,015 à 0,017 Hz.

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6. Appareil selon la revendication 4 ou 5, **caractérisé en ce que** le système de commande (78) comprend en outre un filtre passe-haut (97) qui est prévu pour filtrer le signal combiné filtré du gyroscope (74) et de l'accéléromètre (75). 10
7. Appareil selon la revendication 6, **caractérisé en ce que** ledit filtre passe-haut (97) a une fréquence de coupure dans une gamme de 0,01 à 0,03 Hz, de préférence dans une gamme de 0,013 à 0,02 Hz, plus préférablement dans une gamme de 0,015 à 0,017 Hz. 15
8. Appareil selon la revendication 6 ou 7, **caractérisé en ce que** le système de commande (78) comprend en outre un second filtre passe-bas (98) qui est prévu pour filtrer le signal de l'accéléromètre (75). 20
9. Appareil selon la revendication 8, **caractérisé en ce que** ledit second filtre passe-bas (98) a une fréquence de coupure dans une gamme de 0,01 à 0,03 Hz, de préférence dans une gamme de 0,013 à 0,02 Hz, plus préférablement dans une gamme de 0,015 à 0,017 Hz. 25
10. Appareil selon la revendication 8 ou 9, **caractérisé en ce que** le système de commande (78) est prévu pour combiner le signal combiné doublement filtré du gyroscope (74) et de l'accéléromètre (75) et le signal filtré de l'accéléromètre (75), le système de commande (78) étant en outre prévu pour soustraire ce signal combiné d'un écart prédéterminé du porte-charge (10) par rapport à l'accélération de la pesanteur, et le système de commande (78) comprenant en outre un contrôleur PI (84) qui est prévu pour déterminer la rotation de correction nécessaire pour atteindre l'écart prédéterminé du porte-charge (10) par rapport à l'accélération de la pesanteur. 30 35 40
11. Appareil selon l'une quelconque des revendications précédentes 1 à 10, **caractérisé en ce que** lesdits capteurs (73, 74, 75) comprennent en outre un second gyroscope (73) monté sur le châssis. 45
12. Appareil selon la revendication 11, **caractérisé en ce que** le système de commande (78) est prévu pour utiliser le signal du second gyroscope (73) pour commander le moteur de réglage (71) de sorte qu'une rotation de correction soit effectuée. 50 55



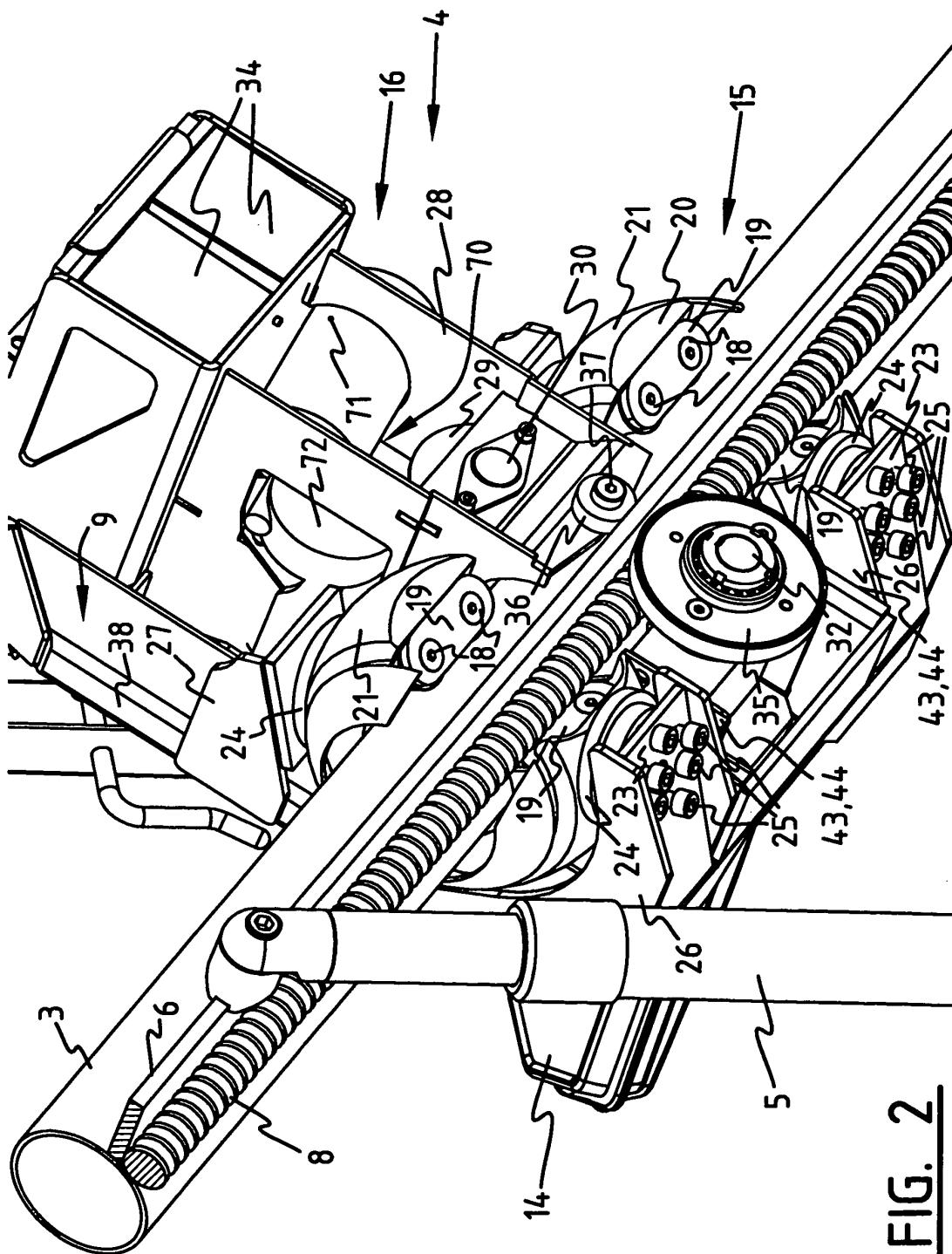
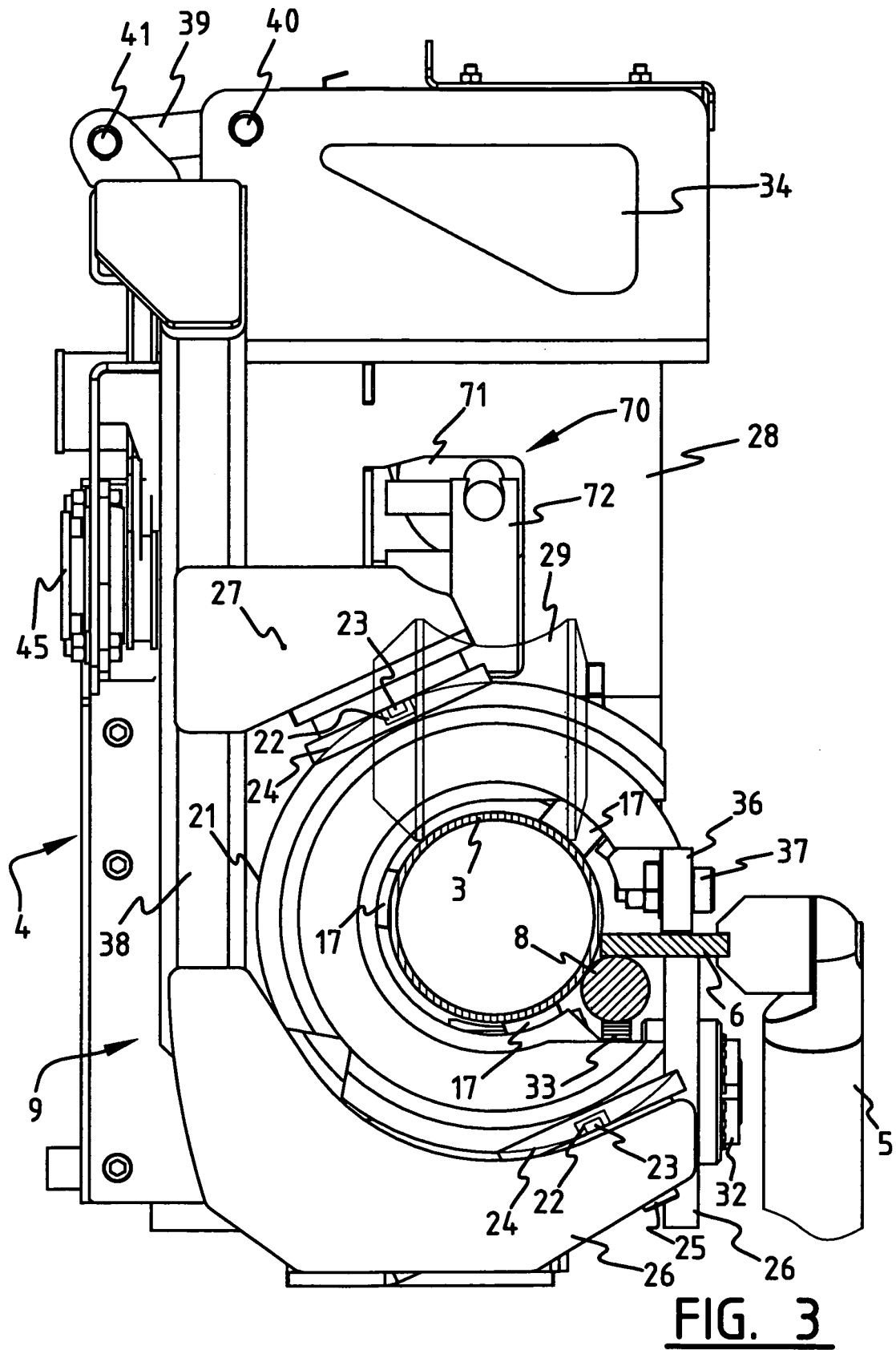


FIG. 2



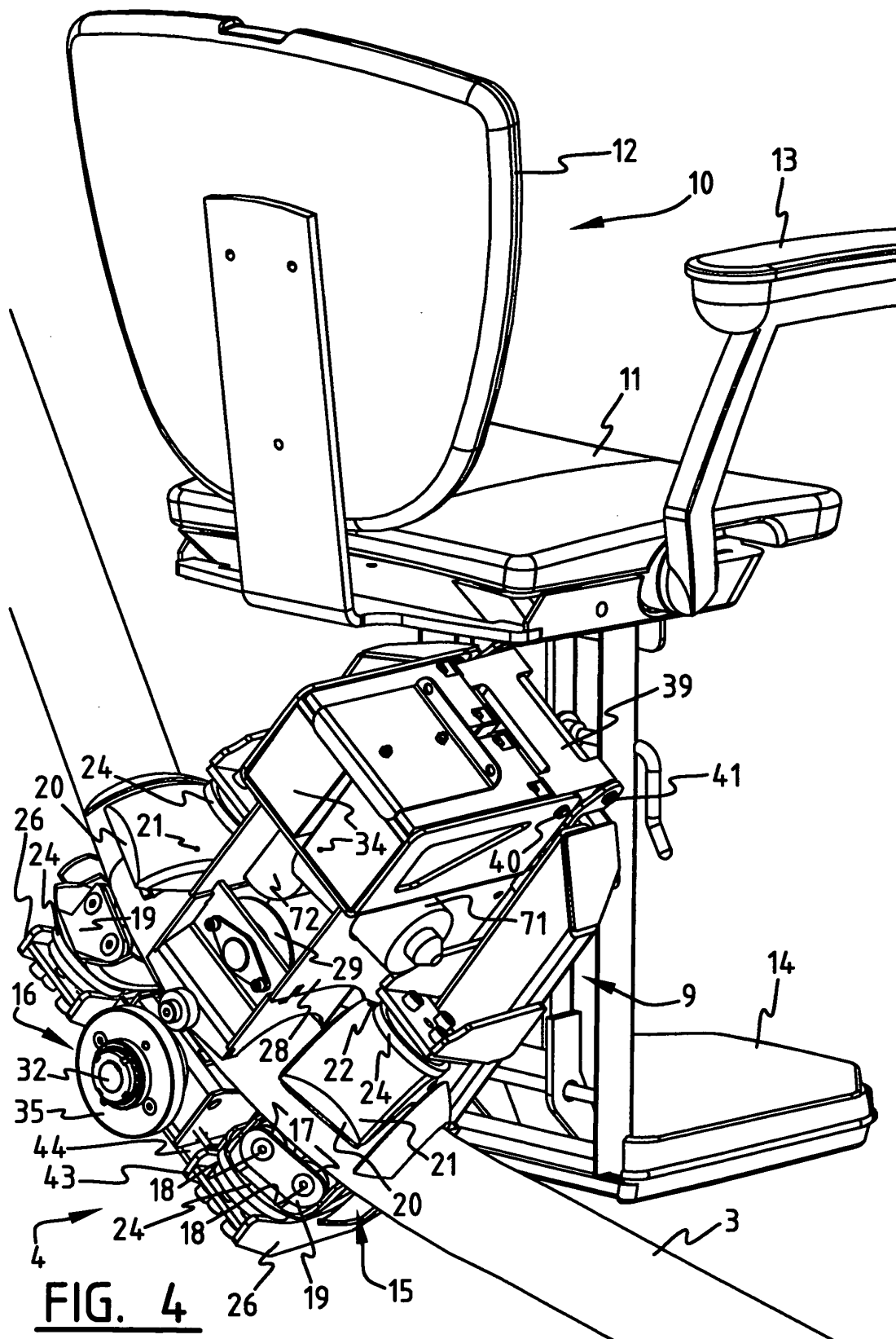
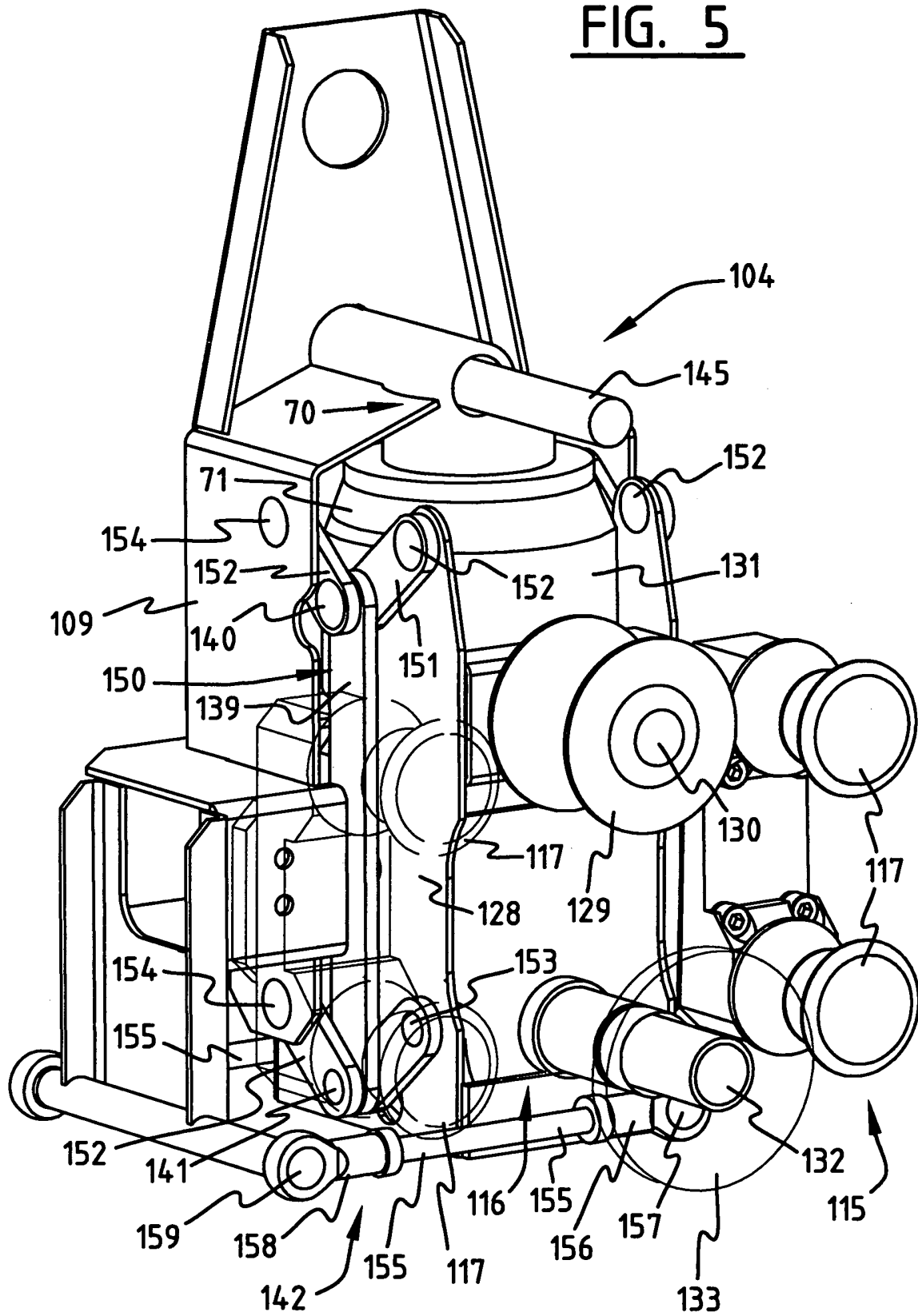
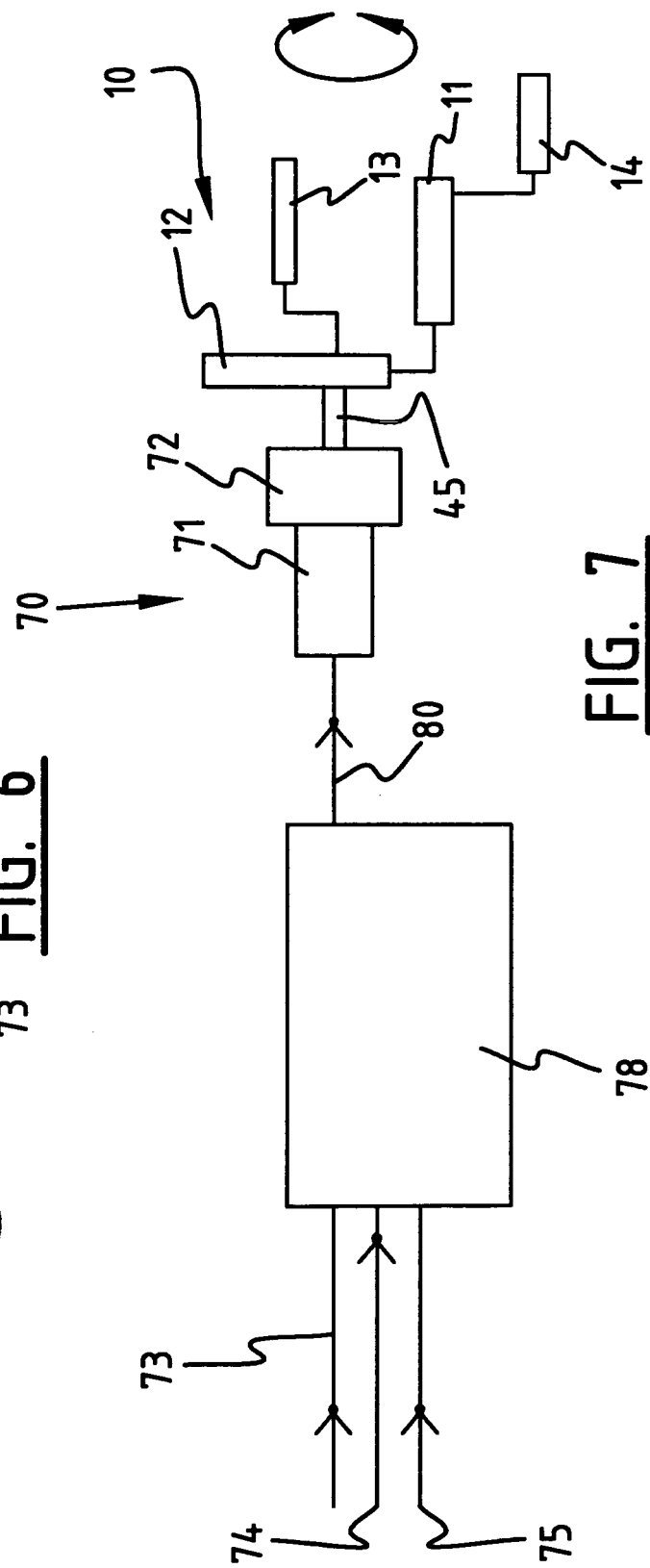
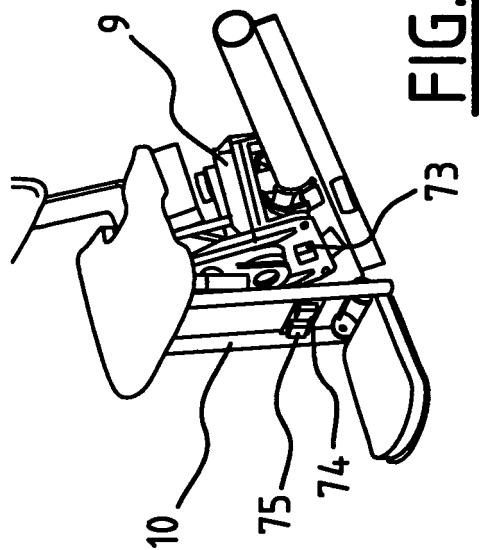


FIG. 5





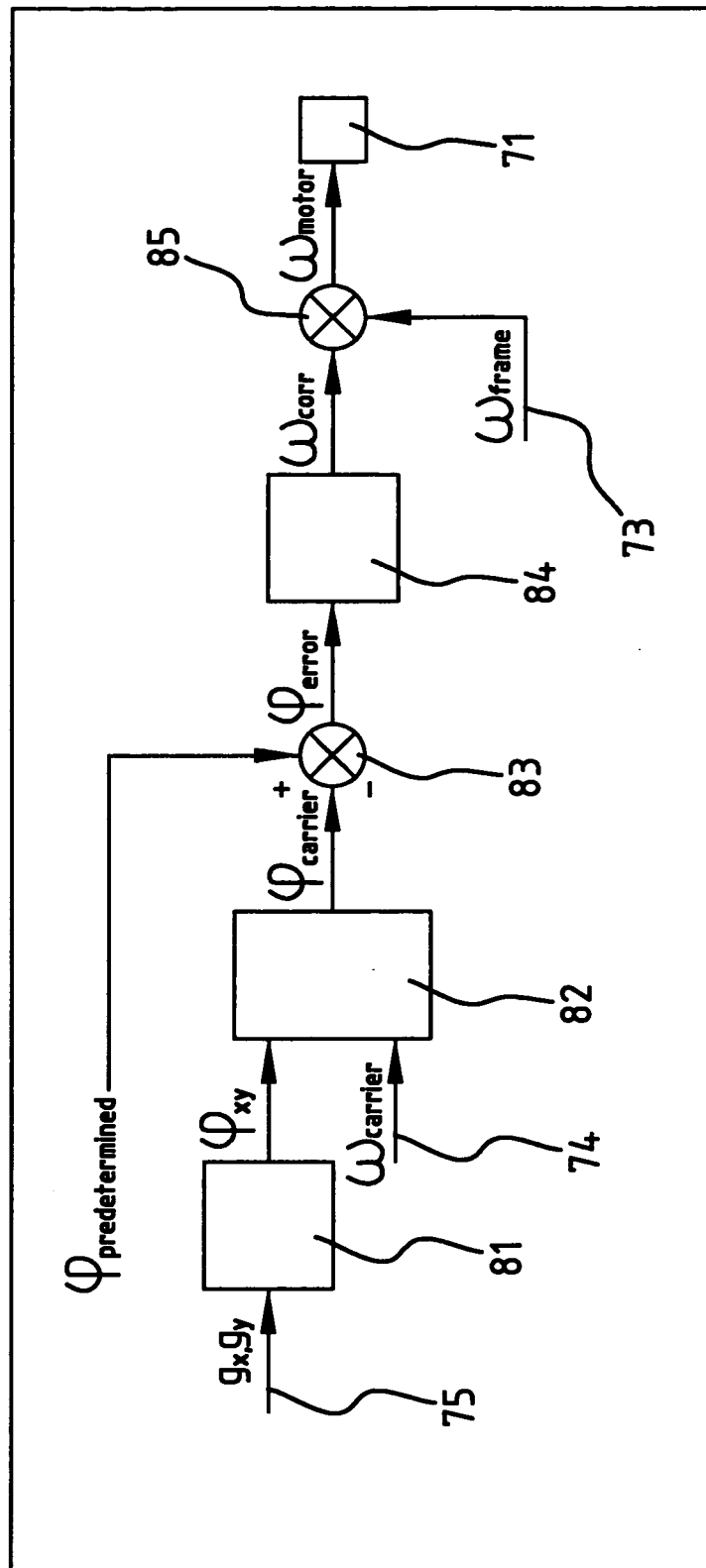


FIG. 8A

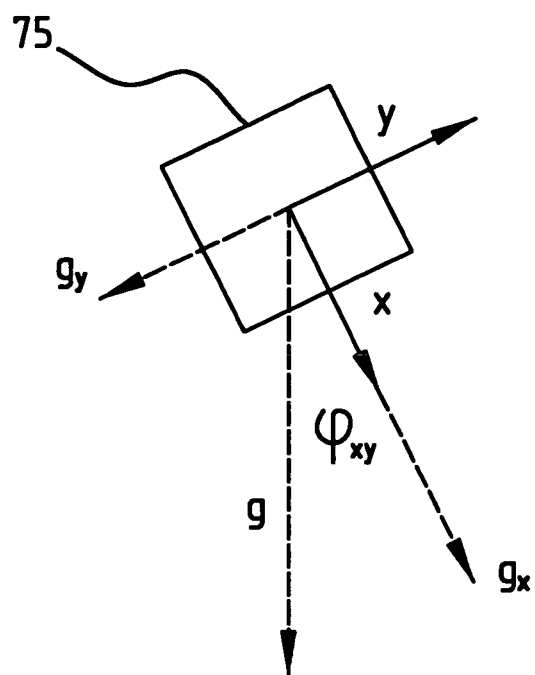
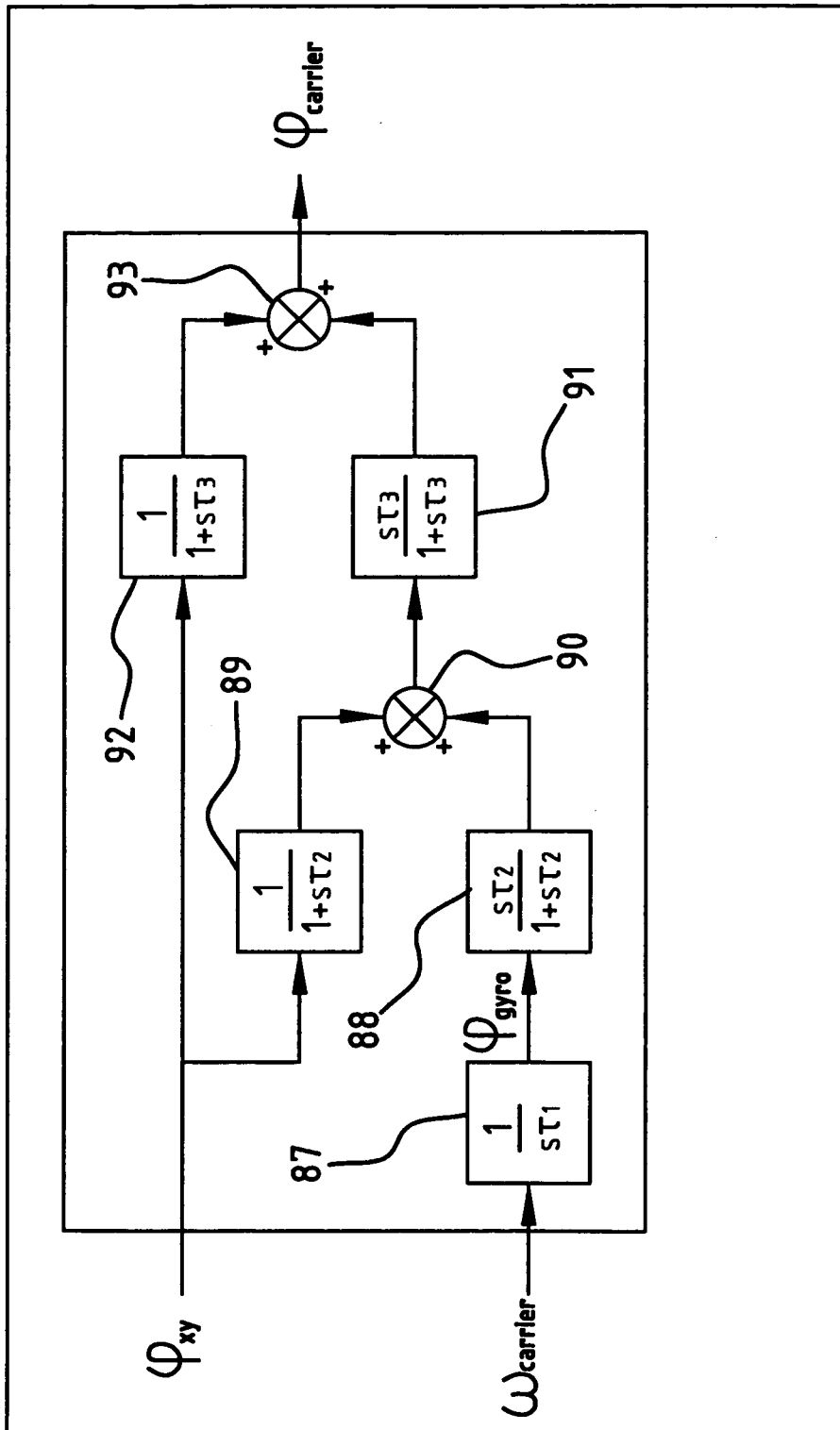


FIG. 8B

FIG. 8C

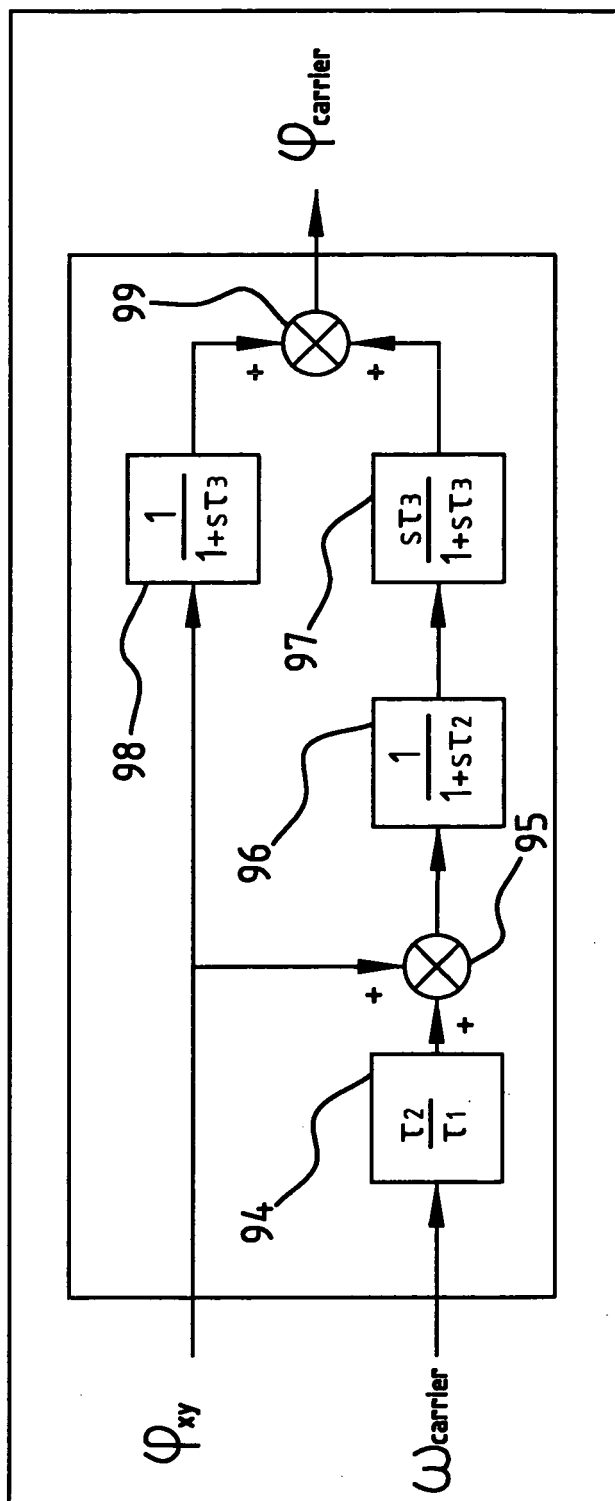


FIG. 8D

REFERENCES CITED IN THE DESCRIPTION

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