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- (73) Patenthaver: **Hawle Treppenlifte GmbH, Am Bacherbusch 1, 53809 Ruppichterorth, Tyskland**
- (72) Opfinder: **HERBECK, Michael, Lohen 2a, 83395 Freilassing, Tyskland**
- (74) Fuldmægtig i Danmark: **Awapatent A/S, Strandgade 56, 1401 København K, Danmark**
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Simulation-based stair lift construction

The invention relates to a computer-based method for the construction and production of a stairlift, in particular the support structure of a stairlift. The invention further relates to a corresponding computer construction program, a corresponding computer program storage medium and a corresponding computer having this storage medium. The invention also relates to a stairlift support structure constructed and produced by means of the method according to the invention.

Stairlifts are known from prior art, in particular from EP 1 700 812 B1, WO 2016/028146 A1 or WO 2013/137733 A1, among others those whose transport unit comprising an occupant seat is guided along on two rails which lie one above the other and are designed as tubes. The spatial course of these guide tubes relative to each other over the distance travelled is thus firstly specified by the transport unit or its predefined geometric design. Furthermore, the spatial course of the support structure must also be adapted to the geometric specifications of the later operating site. In order to guarantee a satisfactory function, the support structures of such stairlifts are manually produced on an assembly stand. For adapting the two tubes to the geometric specifications of the later operating site and additionally to the geometric design of the transport unit, the spatial course of the two tubes must be manually adjusted to one another in numerous, partially iterative steps. For this purpose, both tubes are composed of several portions, whose orientation to one another must often be changed several times. This not only requires a lot of technical expertise and experience but also necessarily involves a very high manual production cost.

The object of the present invention is to reduce this production cost. This object is solved by the subject matter of the coordinate claims 1, 7 and 8. Here, the dependent claims define preferred embodiments of the present invention.

The computer-implemented method according to the invention for the construction of the support structure of a stairlift having a first rail, a second rail and a transport unit guided thereon thus comprises the following steps:

- establishing a spatial course of the first rail corresponding to the general conditions specified by the installation of the support structure;

- establishing a spatial axis corresponding to the general conditions specified by the installation of the support structure;
- establishing a geometric design of the transport unit;
- determining a spatial course of the second rail which is necessary for guiding the transport unit, which is oriented with respect to the spatial axis, on the first and the second rail.

In other words, firstly, the spatial course of the first support structure rail is established, corresponding to the geometric specifications of the later installation or operating site of the stair lift. In this context, it is conceivable that the spatial course of the first rail is adapted to a virtual model of the later operating site using a construction programme. It is, however, also conceivable that the spatial course of the first rail was already established by the production thereof, following which this course only needs to be digitized for the further construction method. The rails which have already been produced can thus be measured and the data obtained for the further computer-implemented construction method can be supplied to the corresponding computer for further processing.

Furthermore, in the method according to the invention, a spatial axis, i.e., an axis in three-dimensional space relative to the course of the first rail, is established. The transport unit of the stair lift is finally oriented on this axis. In other words, the spatial axis thus establishes the orientation of the transport unit relative to the first rail.

Finally, the geometric design of the transport unit still has to be known, said design finally specifying the relative position of the two rails which is necessary for guiding the transport unit on and along the two rails.

The above data thus defines the general conditions for the spatial course of the second rail of the support structure, within which the transport unit can be satisfactorily guided on and along the two rails at the operating site.

According to the present invention, for determining the spatial course of the second rail, the spatial positional course of the transport unit which is guided on and along the first rail and oriented on the spatial axis is simulated by means of a three-dimensional model simulation. In other words, a virtual model of the transport unit can be guided along on a virtual model of

the first rail with a spatial course which has already been established, wherein the transport unit is, moreover, oriented on the spatial axis which has also already been established. For the orientation of the transport unit, it should be said that the transport unit is preferably oriented on the spatial axis in such a way that the vertical axis of the transport unit, which can be perpendicular to the seating surface of the transport unit, runs in parallel to the predefined spatial axis. With the simulation of the transport unit which is oriented on the spatial axis and guided along on the first rail, the spatial course of the second rail is established by the transport unit itself, or is properly recorded in three-dimensional space in an output table.

According to a further embodiment of the present invention, the simulation of the spatial positional course of the transport unit comprises the simulation of the spatial position of at least one, in particular all rollers of the transport unit that engage at least the first or second rail. The points at which the individual running rollers of the transport unit abut on the rails can thus be taken into account by means of simulation. As the running rollers are more or less strongly bonded to one other in their spatial location by their coupling to the transport unit, the contact points of the individual rollers form further general conditions for the course of the second rail.

Within the context of the present invention it is possible to calculate all spatial coordinates for the individual points of the rail course in one working step in order to determine the spatial course of the second rail. However, it is also conceivable that the spatial coordinates of the individual points of the rail course can be calculated separately from one another, wherein it is conceivable, in particular, that the horizontal course is calculated separately from the vertical course of the second rail.

It is further possible to determine the course of the central axis of the second rail in order to determine the spatial course of the second rail, in particular to determine its horizontal course and its vertical course in turn separately from each other.

The direction of the spatial axis on which the transport unit is to be oriented can change, in principle, over the course of the first or the second rail. For example, one can imagine that the transport unit has a certain inclination along the entire route, for example is inclined forwards or backwards, transversely to the direction of travel. It can, however, also be provided that the spatial axis and thus the inclination of the transport unit differs in certain route sections,

for example in curves from their other orientation in the remaining route. Preferably, the direction of the spatial axis is nevertheless constant over the entire distance travelled, i.e., the entire course of the rails, such that the transport unit is oriented in a single direction over the entire distance travelled during later operation. The spatial axis can thus be oriented in parallel to the direction of gravity in the eventual installation location of the stairlift. In this way, the transport unit is always oriented relative to the gravity vector in the same way in later operation.

It is preferably the upper, for example tubular, rail of the support structure, whose spatial course is established first, on whose basis the spatial course of the lower support structure rail is then determined. Here, the terms “upper” and “lower” refer to the installation position at the operating site.

A further aspect of the present invention relates to a method for the production of the support system of a stairlift having a first rail, a second rail and a transport unit guided thereon, having the following steps:

- Producing, in particular installing, the first rail with an established spatial course;
- Carrying out a computer-implemented construction method as described above;
- Producing, in particular installing, the second rail with a spatial course determined by means of the construction method.

As already indicated above, a first, preferably upper rail can firstly be produced having a spatial course that is necessary for the later operating site of the stairlift. By means of the construction or simulation method as described above, the spatial course of the second, preferably lower rail of the support structure can be calculated after measuring this rail. It is however also conceivable that the spatial course of the support structure is calculated solely virtually. Thus, for example, the spatial course of the first rail can be established with the aid of a model of the later operating site, and the spatial course of the lower rail can also be determined immediately by means of the construction or simulation described above.

Using the present invention, the necessary spatial course of at least the second rail is already known precisely before its production, and thus no longer has to be changed and adapted in a

time-consuming manner during production, for example by separating a rail portion and its reattachment with a changed orientation, curvature and/or length.

Further aspects of the present invention consequently relate to a computer program storage medium or a data carrier having a program stored thereon, said program causing a computer to carry out a construction method described above. An additional aspect of the present invention relates to a computer which has a corresponding storage medium or a corresponding data carrier and/or on which a computer program as described above is loaded.

The invention will be described below in more detail with reference to the drawings of exemplary embodiments. The features described herein can be included individually and in any convenient combination of the present invention. Here are shown:

Figure 1 a stairlift having a support structure comprising two rails,

Figure 2 a transport unit designed for guiding on and along two rails,

Figure 3 a flowchart having the essential steps of the construction method according to the invention.

In Figure 1, a stairlift/stair lift is shown, whose transport unit 3 is guided on two tubular rails 1 and 2 lying one on top of the other in such a manner that this transport unit 3 is always oriented along the rails 1 and 2 towards the gravity vector G. The seat (not labelled in Figure 2) of the transport unit 3 thus occupies a “plumb” position at all times and consequently is only twisted around the vector G.

Figure 2 shows a corresponding transport unit 3, on the rear side of which several running rollers 4 and 5 which are at least partially positionally variably mounted relative to the transport unit 3, the transport unit 3 being coupled to both the course of the upper rail 1 and the course of the lower rail 2 by means of said running rollers 4 and 5. Furthermore, the central fibre or central axis 6 of the second, lower rail 2 can be seen in Figure 2, the spatial course of said lower rail 2 to the upper rail 1 being able to be calculated by means of the construction method according to the invention, such that the transport unit 3 maintains its plumb orientation along the rail course.

Figure 3 shows a flowchart having the essential steps of the construction method according to the invention. On the basis of data obtained regarding the spatial course of the first rail, the spatial axis and the geometric design of the transport unit, the necessary spatial course of the second rail can finally be calculated. This data can thus be obtained in any order or also be obtained simultaneously, such that the sequence of the first three essential steps of the method which can be seen in Figure 3 is not necessarily to be interpreted as a chronological sequence.

P A T E N T K R A V

1. Computerimplementeret fremgangsmåde til konstruktion af understøtningsstrukturen af en trappelift med en første og en anden skinne (1, 2) og en på disse ført transportenhed (3), hvor fremgangsmåden omfatter følgende trin:

- 5 - etablering af et rumligt forløb af den første skinne (1) svarende til de generelle betingelser, der er specificeret ved installationen af understøtningsstrukturen;
 - etablering af en rumlig akse (G) svarende til de generelle betingelser angivet ved installationen af understøtningsstrukturen;
 - etablering af et geometrisk design af transportenheden (3);
10 - bestemmelse af et rumligt forløb af den anden skinne (2), der er nødvendig til føring af den til den rumlige akse (G) orienterede transportenhed (3) på den første og den anden skinne (1,2);

 hvor transportenhedens (3) rumlige positionsforløb, som føres langs den første skinne (1) og orienteret langs den rumlige akse (G), simuleres ved hjælp af en tredimensionel
15 modelsimulering til bestemmelse af det rumlige løbet af den anden skinne (2).

2. Fremgangsmåde ifølge krav 1, hvor den tredimensionelle modelsimulering af det rumlige positionsforløb tager højde for simuleringen af den rumlige position af mindst én af transportenhedens ruller, især alle rulle(r) (4, 5), der i det mindste griber ind i den første
20 eller anden skinne (1, 2), især simuleringen af den rumlige position af mindst ét kontaktpunkt mellem mindst én rulle (4, 5) og mindst én skinne (1, 2).

3. Fremgangsmåde ifølge et hvilket som helst af kravene 1 eller 2, hvorved forløbet af den anden skinnes (2) centrale akse (6) bestemmes til bestemmelse af den anden skinnes (2) rumlige forløb, især hvor deres horisontale forløb og deres vertikale forløb bestemmes separat fra hinanden.
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4. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 3, hvor retningen af den rumlige akse (G) er konstant over den første skinnes (1) forløb og/eller er parallel med
30 retningen af tyngdekraften.

5. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 4, hvor den første skinne (1) er en øvre skinne, og den anden skinne (2) er en nedre skinne af understøtningsstrukturen.
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6. Fremgangsmåde til fremstilling af understøtningsstrukturen af understøtningsstrukturen af en trappelift med en første og en anden skinne (1, 2) og en på disse ført transportenhed (3), hvor fremgangsmåden omfatter følgende trin:

- fremstilling, især installation, af den første skinne (1);

- udførelse af den computerimplementerede konstruktionsfremgangsmåde ifølge et hvilket som helst af kravene 1 til 5;
- fremstilling af den anden skinne (2) svarende til det rumlige forløb af den anden skinne (2), som bestemmes ved hjælp af konstruktionsfremgangsmåden.

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7. Computerprogramlagringsmedium, der har et program gemt derpå, hvilket bevirker, at computeren udfører en fremgangsmåde ifølge et hvilket som helst af kravene 1 til 5, når det køres på en computerprocessor eller er lagret i computerens hukommelse.

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8. Computer med et lagringsmedium ifølge krav 7.

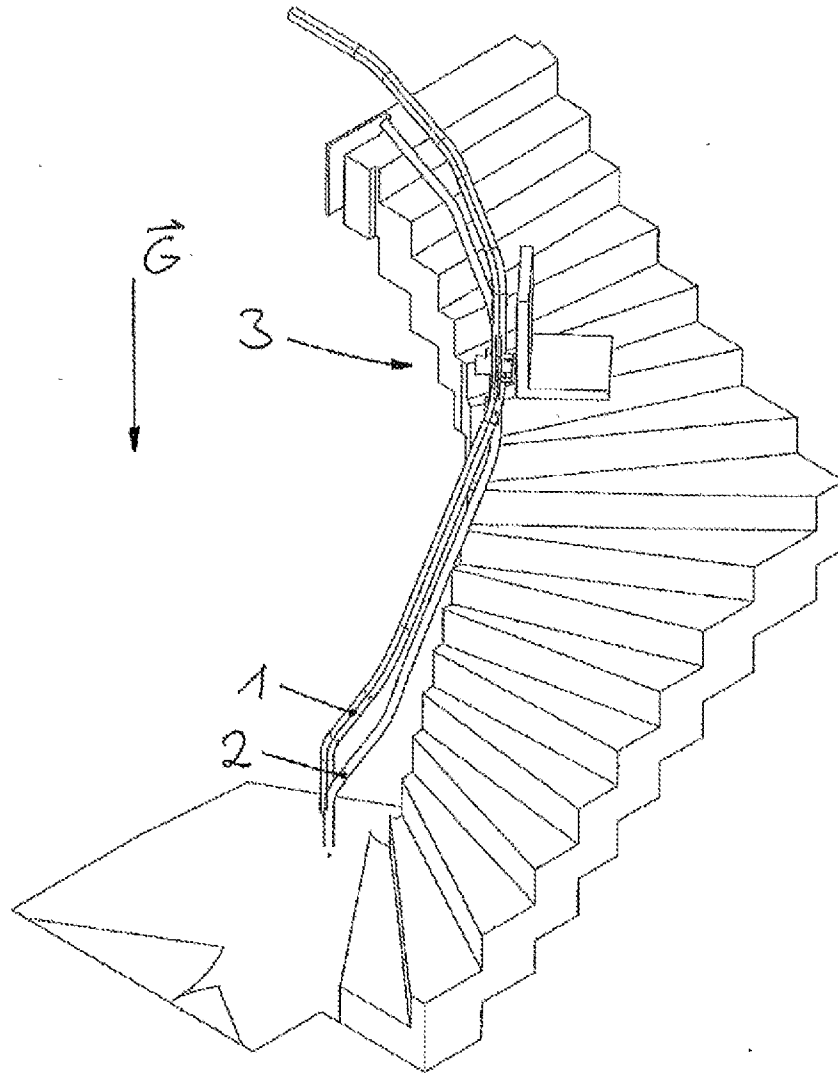


Fig. 1

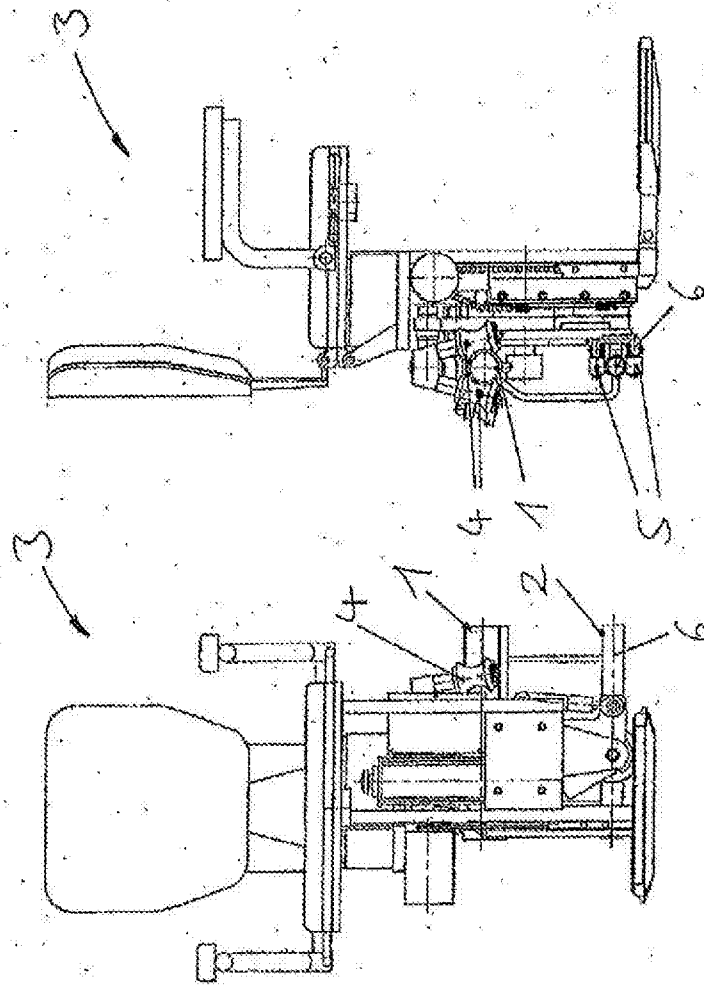


Fig. 2

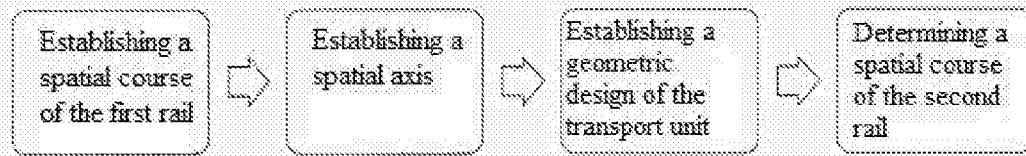


Fig. 2