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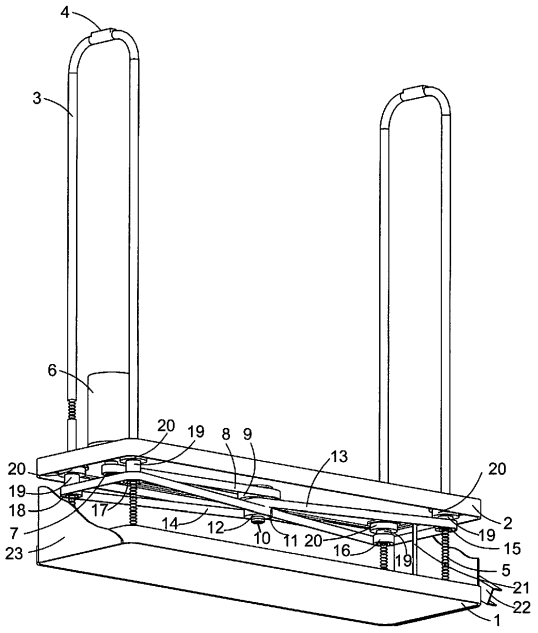
Amended claims in accordance with Rule 137(2) EPC.

(54) Staircase elevator device

(57) A Staircase Elevator Device for ascenting/descending any given number of steps of a staircase is proposed comprising an equal to the staircase steps number of modular step elevators, each individual modular step elevator being associated with one step of the staircase and connected with the step in a non-destructive way, each modular step elevator comprising a base (1) firmly arranged on the horizontal surface of the staircase step the modular step elevator is associated with and shaped according to the shape of the horizontal surface of the staircase step and a movable platform (2) having the same shape as the base and beeing able to be moved up or down between the base (1) of the modular step elevator and the level of the lower position of the movable platform (2) of the modular step elevator associated with the next higher staircase step by means of an electric, pneumatic or hydraulic actuator, the movable platform (2) having at least one handhold (3) beeing arranged on one side of the movable platform (2), whereby the electric, pneumatic or hydraulic actuator is controllable by a user by means of control means (4) provided on at least one handhold (3) of the movable platform (2), whereby the bases (1) of the modular step elevators associated with one staircase between two floors are firmly connected to each other by means of at least one stable profile (22) running along and parallel to the inclination of the staircase from the lower floor to the higher floor and serving also as a guide channel for the cables and/or tubing needed for the operation of the actuators of the movable platforms (2).

Figure 1



EP 2 913 290 A1

Description

[0001] The present invention relates to a Staircase Elevator Device universally suitable for ascenting/descending from a few steps up to any given number of steps of a staircase according to Claim 1.

[0002] The present invention relates generally to powered devices for ascending and descending staircases between floors. Persons, especially elderly or disabled, ascending or descending stairs often need powered mechanical asistance. To this end the following kinds of devices are currently in use.

(a) Elevators (or lifts), which move vertically people or goods between floors next to a staircase.

(b) Escalators (or moving staircases), which are conveyor transport devices for carrying large numbers of people between floors of a building. These devices consist of a motor-driven chain of individual, linked steps that move up or down on tracks, allowing the step treads to remain horizontal and are mainly used to move pedestrian traffic in places where elevators would be impractical. Principal areas of usage include department stores, shopping malls, airports, transit systems, convention centers, hotels, arenas, stadiums and public buildings.

(c) Stair lifts (or chair lifts, stair gliders) namely mechanical devices for lifting people and wheelchairs up and down stairs. For sufficiently wide stairs, a rail is mounted to the treads of the stairs or on the wall beside the stairs. A chair or lifting platform is attached to the rail and a person on the chair or platform is lifted as the chair or platform moves along the rail.

(d) Step lifts (powerstep lifts, lowrisers, combination of stairway and lift) for short/medium rise up to a maximum of ~8 steps (1,4 meters) from the ground. They comprise a plurality of steps, able to be converted into a lift platform for a wheelchair user.

(e) Stair-climbing devices, which operate on stairs by means of special wheels or crawler tracks. They may be independent units to which an existing manual wheelchair can be attached or they may be an integral part of the wheelchair and function as a powered wheelchair. They are controlled by experienced assistants.

(f) Stair-climbing robots, having a series of articulating wheel sets extending below a platform. All of the wheel sets are vertically adjustable to negotiate stairways and similar changes of elevation. They use sensors to detect the presence of the stair risers and their height, the control of the assembly being accomplished by a control circuit on board the stair-climbing robot. The wheel sets are raised and lowered independently by special mechanisms.

(g) Suspending systems with a seat suspended by a rail secured to the roof or by crane or by winch.

[0003] Each of the above powered devices has various restrictions regarding installation and use:

(a) Elevators: they require a suitable building space or a modification of the existing building structure to accept lifts for their vertical movement next to the staircase.

(b) Escalators: they also need an extra space in a bulding besides the conventional staircase; they are conveyor transport devices, sutable for carrying large numbers of people between floors and, therefore, are mainly used to move pedestrians in places with traffic.

(c) Stair lifts (or chair lifts, stair gliders): they need suitable staircase space and shape; in narrow staircases they can not be applied; for their installation intervention on the building structure is required.

(d) Step lifts (powerstep lifts, lowrisers, combination stairway and lift): they can not be used between floors, since they are only for short/medium rise up to a maximum of ~1,4 meter (~ 8 steps) from the ground.

(e) Stair-climbing devices: their control needs experienced assistants.

(f) Stair-climbing robots: they are complicated devices, needing for their movements trained operators; they may be more suitable to carry or lift goods and cargo than single human beings.

(g) Suspending systems: they require suitable building space or modification of the existing building structure to accept suspending systems and offer little flexibility.

[0004] It is the task of this invention to provide a Staircase Elevator Device suitable for ascenting/desending any given number of steps of a staircase which avoids the above mentioned drawbacks and restrictions of the prior art powered devices for ascending and descending between floors.

[0005] This task is solved by the features of Patent Claim 1. Additional configurations and advantages derive from the Dependent Claims.

[0006] Accordingly, a Staircase Elevator Device suitable for ascenting/desending any given number of steps of a staircase is proposed comprising an equal to the staircase steps number of modular step elevators firmly combined by one or two long metal profiles in a stable,

united and all-integrated Device, each individual modular step elevator beeing associated with one step of the staircase and connected with the step in a non-destructive way, e.g. by means of a double-sided adhesive tape, each modular step elevator comprising a base which is firmly arranged on the horizontal surface of the staircase step the modular step elevator is associated with and shaped according to the shape of the horizontal surface of the staircase step and a movable platform having the same shape as the base and being able to be moved up or down between the base of the modular step elevator and the level of the lower position of the movable platform of the modular step elevator associated with the next higher staircase step by means of an electric, pneumatic or hydraulic actuator, the movable platform having at least one handhold beeing arranged on one side of the movable platform preferrably essentialy verticaly to the riser and to the movable platform, whereby the electric, pneumatic or hydraulic actuator is controllable by the user by means of control means provided on at least one handhold of the movable platform.

[0007] The control means can be control buttons or a control stick and can also comprise an alarm button. In case the movable platform has two handholds they are arranged at opposite sides of the movable platform verticaly to the riser and to the movable platform.

[0008] The first step according to the invention is an area of the floor level of the lower floor and the last step an area of the floor level of the higher floor, the last step beeing not associated with a modular step elevator, whereby the movable platform of the modular step elevator associated with the second last step is able to be moved up or down between the base and the level of the floor level of the higher floor.

[0009] The bases of the modular step elevators associated with one staircase between two floors are firmly connected to each other by means of at least one, preferably one or two stable profiles in a stable, united and all-integrated Device. The profile is running along and parallel to the inclination of the staircase from the lower floor to the higher floor and can serve also as a guide channel for the cables and/or tubing needed for the operation of the actuators of the movable platforms. Within another embodiment groups of successive arranged modular step elevators are firmly connected to each other by means of at least one stable profile.

[0010] The operation of the Staircase Elevator Device according to the present invention for ascending is as follows: The user holds the handholds of the lowest 'first' modular staircase elevator and stands on its movable platform. By pressing an "up" button on the handhold or by suitably operating a control stick the 'first' platform ascents to the level of the next, 'second' movable platform of the modular staircase elevator associated with the next higher staircase step, which is in the lower position, namely on the base thereof.

[0011] The two movable platforms are at this stage at the same level and the user holds the handholds of the second movable platform and moves from the 'first' on the 'second' movable platform and stands on it. By pressing the "up" push button on the handhold the 'second' movable platform he ascents to the level of the next 'third' movable platform and so on and so forth until the higher floor is reached.The same procedure as for ascenting applies for descending the stairs of the staircase by pressing the "down" button or by suitably operating a control stick of the respective handholds.

[0012] The process of ascending and descending can also be automated, whereby the movable platforms are moved sequentially up or down according to the operation mode at predefined, adjustable time intervals. In case the time intervals are too short or problems arise the user can operate an alarm button arranged on the handholds stopping the movement.

[0013] Within another embodiment the handholds of each movable platform comprise also a touch sensor, whereby the movement of the movable platform comprising the handhold starts when the touch sensor is dampened for a predefined time.

[0014] The Staircase Elevator Device according to the present invention successfully encounters the restrictions and drawbacks of various powered devices for ascending and descending between floors known from the prior art as explained below:

(a) Compared to Elevators the Staircase Elevator Device does not require a suitable building space or any modification of the existing building structure.

(b) Compared to Escalators: the Staircase Elevator Device is affixed on the already existing staircase and is intended to carry one to two persons at a time.

(c) Compared to Stair lifts (or chair lifts, stair gliders) the Staircase Elevator Device needs practically no modification of or intervention on the building structure; it is flexible and easily adaptable to any shape, size or pitch of stair and can be easily removed any time, since it is fixed on the staircase in a non-duestructive way, securing a stable operation. The Staircase Elevator Device according to the invention is especially suitable for narrow staircases, where chair lifts with the seating person can not be accommodated.

(d) Compared to Step Lifts (powerstep lifts, lowrisers, combination stairway and lift) the Staircase Elevator Device is universally suitable for ascenting/desending between a few steps up to unlimited number of steps and not restriced for short/medium rise only.

(e) Compared to Stair-climbing devices the Staircase Elevator Device is controlled by the user himself on the step, needing no experienced assistance.

(f) Compared to Stair-climbing robots the Staircase

Elevator Device is a simple device and its operation is easily controlled by the user himself, needing no trained operators.

(g) Compared to Suspending systems the Staircase Elevator Device does not use such suspending systems which are rather inappropriate for elderly people, having to travel suspended from the roof or by a crane or by a winch.

[0015] Moreover the Staircase Elevator Device according to the invention does not interfere with normal use of the stairs, when it is not in use. The use of the Staircase Elevator Device according to the invention results in a reduction in tooling costs and in the costs of ongoing maintenance, because of its flexibility and simplicity in installation and use. Moreover the Staircase Elevator Device can be adapted to enable ascenting and descenting from a few steps, e.g. 2-3 steps up to unlimited number of steps depending on the number of steps of the staircase.

[0016] In the following, the invention will be described in greater detail using the enclosed Figures, which show:

Figure 1: A schematic perspective view of a first prefered embodiment of a modular step elevator based on the invention;

Figure 2: A schematic perspective view of a second prefered embodiment of a modular step elevator based on the invention;

Figure 3: A schematic perspective view of a third prefered embodiment of a modular step elevator based on the invention;

Figure 4: A schematic overall view of a Staircase Elevator Device according to the invention, installed on the steps of a staircase at a non-operational stage/modus; and

Figure 5: An illustration of the way a user ascends by using the Staircase Elevator Device from level 1 to level 2.

[0017] Per the invention and with reference to Figure 1 a modular step elevator of a Staircase Elevator Device suitable for ascenting/descending any given number of steps of a staircase comprises a base 1 firmly arranged in a non-destructive way on the horizontal surface of the staircase step the modular step elevator is associated with and shaped according to the shape of the horizontal surface of the staircase step and a movable platform 2 having the same shape as the base 1 and beeing able to be moved up or down between the base 1 of the modular step elevator and the level of the lower position of the movable platform of the modular step elevator associated with the next higher staircase step by means of an electric, pneumatic or hydraulic actuator. The base can be metallic and/or wooden and has the shape of the horizontal surface of the staircase step, to which it is assigned.

[0018] The movable platform 2 shown in Figure 1 has two handholds 3 beeing arranged at opposite sides of the movable platform 2 verticaly to the riser and to the movable platform 2, whereby the actuator of the is modular step elevator is controllable by a user by means of control means 4 provided on at least one handhold 3 of the movable platform 2.

[0019] According to the embodiment shown in Figure 1 the movable platform 2 is electrically driven by means of an electric motor 6 and preferably trapezoidal screws 5 fixed vertically near the corners of the base 1 and passing through holes of the movable platform 2. In the embodiment shown in figure 1 the motor is a 12V motor with a housing vertically fixed on top of the the movable platform 2. At least one suitable, recharchable battery for providing the electric energy for the motor 6 of the modular step elevators of the Staircase Elevator Device is provided (not shown).

[0020] As can be taken from Figure 1 the motor 6 drives a first motor pulley 7 which is connected by means of a first timing belt 8 with a central reduction pulley 9 which is arranged on a shaft 10 on which a second and a third pulley 11, 12 serving as distribution pulleys are arranged. The first, second and third pulley 9, 11, 12 are rotating with the shaft 10. The second and third pulley 11, 12 transfer momentum by means of second and third belts 13, 14 to peripheral pulleys 15, 16, 17, 18, whereby each peripheral pulley 15, 16, 17, 18 drives a nut 19 on each trapezoidal screw 5, screwing or unscrewing them along the trapezoidal screws 5, thus converting the rotational movement into an up or down movement and driving the inner rings of the ball bearings 20 to ascent or descent, whereby the outer rings of the ball bearings 20 are fixed to the movable platform 2. The inner rings of the bearings 20 are revolved by the trapezoidal nuts 19. A can be taken by Figure 1, the trapezoidal screws 5 are partialy guided (the upper part thereof depending on the movement of the movable platform 2) through the handholds 3, which are configured as hollow bodies. In order to show this feature a part of the left part of the left handhold 3 is not shown so that the upper part of the screw 5 guided through the handhold can bee seen.

[0021] Moreover the modular step elevator comprises a height adjustment screw 21 which is preadjusted to stop the movement of the movable platform 2 at the level of the lower position of the movable platform of the modular step elevator associated with the next higher staircase step.

[0022] As Figure 1 shows the bases 1 of the modular step elevators associated with one staircase between two floors are firmly connected to each other by means of at least one stable profile 22 in a stable, united and all-integrated Device, whereby the at least one profile 22 is running along and parallel to the inclination of the stair-

case from the lower floor to the higher floor and can serve also as a guide channel for the cables needed for the operation of the actuators of the movable platforms 2. In addition side vertical plates 23 can be provided which are fixed at one or both sides of the base 1, on which the at least one profile 22 is affixed.

[0023] The Staircase Elevator Device also comprises limit-switches and relays used to activate the motors of the modular step elevators in order to be controllable by the user for up or down movement either separately for each modular step elevator or sequentially for all modular step elevators on the staircase steps.

[0024] The embodiment shown in Figure 2 differs from the embodiment shown in Figure 1 in that the the movable platform 2 is electrically driven by means of an electric motor 6 and toothed racks 28 fixed vertically near the corners of the base 1, passing through proper holes of the movable platform 2 and partialy guided (the upper part thereof depending on the movement of the movable platform 2) through the handholds 3, which are configured as hollow bodies.

[0025] As shown in Figure 2 the motor 6 is coupled to a gear box 24 for speed reduction, whereby the momentum is transferred from the gear box 24 by sprockets 25 and chains 26 to peripheral gears 27 arranged on axles 29 according to the principle of a chain drive, which are movable up or down along the racks 28, thus carrying upwards or downwards the movable platform 2, at which the ends of the axles 29 are rotatably fixed. The peripheral gears 27, engaged to the racks 28 provide synchronous and parallel movement of the movable platform 2 by elevating it at the preadjusted height by a height adjustment screw shown in Figure 1 at the level of the lower position of the movable platform of the modular step elevator associated with the next higher staircase step. In addition roller means 30 assigned to each rack 28 arranged on axles can be provided to avoid friction between the racks 28 and to ensure a smooth movement of the movable platform 2.

[0026] The embodiment shown in Figure 3 differs from the embodiment shown in figure 1 in that the the movable platform 2 is pneumatically or hydraulically driven by means of pneumatic or hydraulic cylinders 31 and toothed racks 32, fixed vertically near the corners of the base 1, passing through proper holes of the movable platform 2 and partialy guided (the upper part thereof depending on the movement of the movable platform 2) through the handholds 3, which are configured as hollow bodies.

[0027] The cylinders 31 are fixed vertically at both sides on the top of the movable platform 2 and have piston rods 33 fixed on the base 1, initiating the up or down movement of the movable platform 2. The compressed air or oil moves the pistons rods 33 depending on the operation mode up or down, thus changing the distance between the base 1 and the movable platform 2.

[0028] The compressed air or oil of an air compressor or oil pump moves through a tubing and corresponding air or oil valves the piston rods 33 vertically and in synchronous mode, which are movable the platform 2 at a height preadjusted by a height adjustment screw (not shown).

[0029] The movement of the movable platform 2 can be supported by peripheral gears 34, engaged to the racks 32, providing synchronous up or down movement of the movable platform 2. Within this context a chain 37, sprockets 35 and axles 36 are provided, transferring synchronous rotation to peripheral gears 34 engaged to the racks 32, whereby for each side of the modular step elevator an axle 36 is provided, on which a sprocket 35 and gears 34 assigned to the racks 32 are firmly arranged. The sprockets 35 of both sides are connected to reach other by means of a revolving chain 37 for synchronization. In addition roller means 30 assigned to each rack 32 arranged on axles can be provided to avoid friction between the racks 32 and to ensure a smooth movement of the movable platform 2.

[0030] An air-Compressor or oil-pump is installed separately and close to the staircase, providing compressed air or oil to the cylinders 31. The Staircase Elevator Device also comprises flow controls for regulating the upwards or downwards speed of the movable platform 2, either separately for each movable platform 2 or sequentially for all movable platforms 2 on the staircase steps.

[0031] The bases 1 of the modular step elevators associated with one staircase between two associated with one staircase between two floors are firmly connected to each other by means of at least one stable profilen in a stable, united and all-integrated Device, whereby the profile is running along and parallel to the inclination of the staircase from the lower floor to the higher floor and can serve as a guide channel for the cables and the tubing needed for the operation of the pneumatic or hydraulic cylinders of the movable platforms 2.

[0032] Figure 4 shows a Staircase Elevator Device according to the invention comprising 18 modular step elevators installed on a staircase having 18 steps. The bases of the modular step elevators associated with the staircase are firmly connected to each other by means of a stable profile 22 running along and parallel to the inclination of the staircase from the lower floor to the higher floor.

[0033] According to the invention and with reference to Figure 5 the operation of the Staircase Elevator Device for ascending is as follows: The user holds the handholds of the lowest 'first' modular staircase elevator and stands on its movable platform (figure 5a). By pressing an "up" button on the handhold or by suitably operating a control stick the 'first' platform ascents to the level of the next, 'second' movable platform of the modular staircase elevator associated with the next higher staircase step, which is in the lower position (Figure 5b).

[0034] The two movable platforms are at this stage at the same level and the user holds the handholds 3 of the second movable platform and moves from the 'first' on the 'second' movable platform and stands on it (Figure

5b). By pressing the "up" push button or by suitably operating a control stick on the handhold the 'second' movable platform he ascents to the level of the next 'third' movable platform (Figure 5c, Figure 5d) and so on and so forth until the 17th step (Figure 5e) and the higher floor is reached (Figure 5f). The same procedure as for ascenting applies for descending the stairs of the staircase by pressing the "down" button or by suitably operating a control stick of the respective handholds 3.

[0035] While the operation has been described above as being a series of finite, sequential steps, the various operations can be actuated in a fairly rapid and fluid sequence, allowing the user to move smoothly and reasonably rapidly from the lower to the highetr floor or vice versa.

Claims

1. Staircase Elevator Device for ascenting/descending any given number of steps of a staircase comprising an equal to the staircase steps number of modular step elevators firmly combined by one or two long metal profiles in a stable, united and all-integrated Device, each individual modular step elevator being associated with one step of the staircase and connected with the step in a non-destructive way, each modular step elevator comprising a base (1) firmly arranged on the horizontal surface of the staircase step the modular step elevator is associated with and shaped according to the shape of the horizontal surface of the staircase step and a movable platform (2) having the same shape as the base and beeing able to be moved up or down between the base (1) of the modular step elevator and the level of the lower position of the movable platform (2) of the modular step elevator associated with the next higher staircase step by means of an electric, pneumatic or hydraulic actuator, the movable platform (2) having at least one handhold (3) beeing arranged on one side of the movable platform (2) essentialy verticaly to the riser and to the movable platform (2), whereby the electric, pneumatic or hydraulic actuator is controllable by a user by means of control means (4) provided on at least one handhold (3) of the movable platform, whereby the bases (1) of the modular step elevators associated with one staircase between two floors are firmly connected to each other by means of at least one stable profile (22) running along and parallel to the inclination of the staircase from the lower floor to the higher floor and serving also as a guide channel for the cables and/or tubing needed for the operation of the actuators of the movable platforms (2), whereby the first step is an area of the floor level of the lower floor and the last step an area of the floor level of the higher floor, the last step beeing not associated with a modular step elevator, whereby the movable platform (2) of the modular step elevator associated with the second last step is able to be moved up or down between the base (1) and the level of the floor level of the higher floor.

2. Staircase Elevator Device according to claim 1, **characterized in that** the movable platform (2) is electrically driven by means of an electric motor (6) and trapezoidal screws (5) fixed vertically near the corners of the base (1) and passing through holes of the movable platform (2), the motor (6) driving a first motor pulley (7) which is connected by means of a first timing belt (8) with a central reduction pulley (9) which is arranged on a shaft (10) on which a second and a third pulley (11, 12) are arranged, whereby the first, second and third pulley are rotating with the shaft (10) and the second and third pulley (11, 12) transfer momentum by means of second and third belts (13, 14) to peripheral pulleys (15, 16, 17, 18), each peripheral pulley (15, 16, 17, 18) driving a nut (19) on each trapezoidal screw (5), screwing or unscrewing them along the trapezoidal screws (5), thus converting the rotational movement into an up or down movement and driving the inner rings of ball bearings (20) to ascent or descent, whereby the outer rings of the ball bearings (20) are fixed to the movable platform (2) and the inner rings of the bearings (20) are revolved by the trapezoidal nuts (19).

3. Staircase Elevator Device according to claim 1, **characterized in that** the movable platform (2) is electrically driven by means of an electric motor (6) and toothed racks (28) fixed vertically near the corners of the base (1) and passing through proper holes of the movable platform (2) the motor (6) being coupled to a gear box (24) for speed reduction, whereby the momentum is transferred from the gear box (24) by sprockets (25) and chains (26) to peripheral gears (27) arranged on axles (29), which are movable up or down along the racks (28), thus carrying upwards or downwards the movable platform (2), at which the ends of the axles (29) are fixed, whereby the peripheral gears (27), engaged to the racks (28) provide synchronous and parallel movement of the movable platform (2).

4. Staircase Elevator Device according to claim 1, **characterized in that** the movable platform (2) is pneumatically or hydraulically driven by means of pneumatic or hydraulic cylinders (31) and toothed racks (32), fixed vertically near the corners of the base (1) and passing through proper holes of the movable platform (2), the cylinders (31) being fixed vertically at both sides on the top of the movable platform (2) and having piston rods (33) fixed on the base (1), initiating the up or down movement of the movable platform (2), whereby the compressed air or oil moves the pistons rods (33) vertically and in synchronous mode up or down, thus changing the

distance between the base (1) and the movable platform (2).

5. Staircase Elevator Device according to claim 4, **characterized in that** the movement of the movable platform (2) is supported by peripheral gears (34), engaged to the racks (32), providing synchronous up or down movement of the movable platform (2), whereby a chain (37), axles (36) and sprockets (35) are provided, transferring synchronous rotation to the peripheral gears (34), whereby for each side of the modular step elevator an axle (36) is provided, on which a sprocket (35) and gears (34) assigned to the racks (32) are firmly arranged, the sprockets (35) of both sides being connected to eachother by means of a revolving chain (37) for synchronization.

6. Staircase Elevator Device according to claim 2, 3, 4 or 5, **characterized in that** each modular step elevator comprises a height adjustment screw (21) which is preadjusted to stop the movement of the movable platform (2) at the level of the lower position of the movable platform (2) of the modular step elevator associated with the next higher staircase step.

7. Staircase Elevator Device according to claim 1, 2, 3, 4, 5 or 6, **characterized in that** the control means (4) are control buttons or a control stick.

8. Method for operating a Staircase Elevator Device according to any of the prededing claims **characterized in that** a user holds the handholds (3) of the lowest 'first' modular staircase elevator and stands on its movable platform whereby by pressing an "up" button on the handhold or by suitably operating a control stick the 'first' movable platform (2) ascents to the level of the next, 'second' movable platform (2) of the modular staircase elevator associated with the next higher staircase step, which is in the lower position, thus the two movable platforms (2) being at the same level, whereby in a next step the user holds the handholds of the "second" movable platform and moves from the 'first' on the 'second' movable platform (2) and stands on it, whereby by pressing the "up" push button or by suitably operating a control stick on the handhold (3) the 'second' movable platform (2) he ascents to the level of the next 'third' movable platform (2) and so on and so forth until the higher floor is reached, whereby the same procedure as for ascenting applies for descending the stairs of the staircase by pressing the "down" button or by suitably operating a control stick of the respective handholds (3).

9. Method for operating a Staircase Elevator Device according to claim 8, **characterized in that** the handholds (3) of each movable platform (2) comprise a touch sensor, whereby the movement of a movable platform (2) starts when the touch sensor is dampened for a predefined time.

10. Method for operating a Staircase Elevator Device according to any of the prededing claims 1-7, **characterized in that** the process of ascending and descending is automated, whereby the movable platforms (2) are moved sequentially up or down according to the operation mode at predefined, adjustable time intervals, whereby in case the time intervals are too short or problems arise the user can operate an alarm button arranged on the handholds (3) stopping the movement.

Amended claims in accordance with Rule 137(2) EPC.

1. Staircase Elevator Device for ascenting/descending any given number of steps of a staircase comprising an equal to the staircase steps number of modular step elevators, each individual modular step elevator being associated with one step of the staircase, each modular step elevator comprising a base (1) firmly arranged on the horizontal surface of the staircase step the modular step elevator is associated with and shaped according to the shape of the horizontal surface of the staircase step and a movable platform (2) having the same shape as the base and beeing able to be moved up or down between the base (1) of the modular step elevator and the level of the lower position of the movable platform (2) of the modular step elevator associated with the next higher staircase step by means of an electric, pneumatic or hydraulic actuator, the movable platform (2) having at least one handhold (3) beeing arranged on one side of the movable platform (2) essentialy verticaly to the riser and to the movable platform (2), whereby the electric, pneumatic or hydraulic actuator is controllable by a user by means of control means (4) provided on at least one handhold (3) of the movable platform, whereby the first step is an area of the floor level of the lower floor and the last step an area of the floor level of the higher floor, the last step beeing not associated with a modular step elevator, whereby the movable platform (2) of the modular step elevator associated with the second last step is able to be moved up or down between the base (1) and the level of the floor level of the higher floor, **characterized in that** each individual modular step elevator associated with one step of the staircase is connected with the step in a non-destructive way, **in that** the modular step elevators are firmly combined by one or two long metal profiles in a stable, united and all-integrated Device and **in that** the bases (1) of the modular step elevators associated with one staircase between two floors are firmly connected to each other by means of at least one stable profile

(22) running along and parallel to the inclination of the staircase from the lower floor to the higher floor and serving also as a guide channel for the cables and/or tubing needed for the operation of the actuators of the movable platforms (2).

2. Staircase Elevator Device according to claim 1, **characterized in that** the movable platform (2) is electrically driven by means of an electric motor (6) and trapezoidal screws (5) fixed vertically near the corners of the base (1) and passing through holes of the movable platform (2), the motor (6) driving a first motor pulley (7) which is connected by means of a first timing belt (8) with a central reduction pulley (9) which is arranged on a shaft (10) on which a second and a third pulley (11, 12) are arranged, whereby the first, second and third pulley are rotating with the shaft (10) and the second and third pulley (11, 12) transfer momentum by means of second and third belts (13, 14) to peripheral pulleys (15, 16, 17, 18), each peripheral pulley (15, 16, 17, 18) driving a nut (19) on each trapezoidal screw (5), screwing or unscrewing them along the trapezoidal screws (5), thus converting the rotational movement into an up or down movement and driving the inner rings of ball bearings (20) to ascent or descent, whereby the outer rings of the ball bearings (20) are fixed to the movable platform (2) and the inner rings of the bearings (20) are revolved by the trapezoidal nuts (19).

3. Staircase Elevator Device according to claim 1, **characterized in that** the movable platform (2) is electrically driven by means of an electric motor (6) and toothed racks (28) fixed vertically near the corners of the base (1) and passing through proper holes of the movable platform (2) the motor (6) being coupled to a gear box (24) for speed reduction, whereby the momentum is transferred from the gear box (24) by sprockets (25) and chains (26) to peripheral gears (27) arranged on axles (29), which are movable up or down along the racks (28), thus carrying upwards or downwards the movable platform (2), at which the ends of the axles (29) are fixed, whereby the peripheral gears (27), engaged to the racks (28) provide synchronous and parallel movement of the movable platform (2).

4. Staircase Elevator Device according to claim 1, **characterized in that** the movable platform (2) is pneumatically or hydraulically driven by means of pneumatic or hydraulic cylinders (31) and toothed racks (32), fixed vertically near the corners of the base (1) and passing through proper holes of the movable platform (2), the cylinders (31) being fixed vertically at both sides on the top of the movable platform (2) and having piston rods (33) fixed on the base (1), initiating the up or down movement of the movable platform (2), whereby the compressed air or oil moves the pistons rods (33) vertically and in synchronous mode up or down, thus changing the distance between the base (1) and the movable platform (2).

5. Staircase Elevator Device according to claim 4, **characterized in that** the movement of the movable platform (2) is supported by peripheral gears (34), engaged to the racks (32), providing synchronous up or down movement of the movable platform (2), whereby a chain (37), axles (36) and sprockets (35) are provided, transferring synchronous rotation to the peripheral gears (34), whereby for each side of the modular step elevator an axle (36) is provided, on which a sprocket (35) and gears (34) assigned to the racks (32) are firmly arranged, the sprockets (35) of both sides being connected to eachother by means of a revolving chain (37) for synchronization.

6. Staircase Elevator Device according to claim 2, 3, 4 or 5, **characterized in that** each modular step elevator comprises a height adjustment screw (21) which is preadjusted to stop the movement of the movable platform (2) at the level of the lower position of the movable platform (2) of the modular step elevator associated with the next higher staircase step.

7. Staircase Elevator Device according to claim 1, 2, 3, 4, 5 or 6, **characterized in that** the control means (4) are control buttons or a control stick.

8. Method for operating a Staircase Elevator Device according to any of the preceding claims **characterized in that** a user holds the handholds (3) of the lowest 'first' modular staircase elevator and stands on its movable platform whereby by pressing an "up" button on the handhold or by suitably operating a control stick the 'first' movable platform (2) ascents to the level of the next, 'second' movable platform (2) of the modular staircase elevator associated with the next higher staircase step, which is in the lower position, thus the two movable platforms (2) being at the same level, whereby in a next step the user holds the handholds of the "second" movable platform and moves from the 'first' on the 'second' movable platform (2) and stands on it, whereby by pressing the "up" push button or by suitably operating a control stick on the handhold (3) the 'second' movable platform (2) he ascents to the level of the next 'third' movable platform (2) and so on and so forth until the higher floor is reached, whereby the same procedure as for ascenting applies for descending the stairs of the staircase by pressing the "down" button or by suitably operating a control stick of the respective handholds (3).

9. Method for operating a Staircase Elevator Device according to claim 8, **characterized in that** the

handholds (3) of each movable platform (2) comprise a touch sensor, whereby the movement of a movable platform (2) starts when the touch sensor is dampened for a predefined time.

10. Method for operating a Staircase Elevator Device according to any of the prededing claims 1-7, **characterized in that** the process of ascending and descending is automated, whereby the movable platforms (2) are moved sequentially up or down according to the operation mode at predefined, adjustable time intervals, whereby in case the time intervals are too short or problems arise the user can operate an alarm button arranged on the handholds (3) stopping the movement.

Figure 1

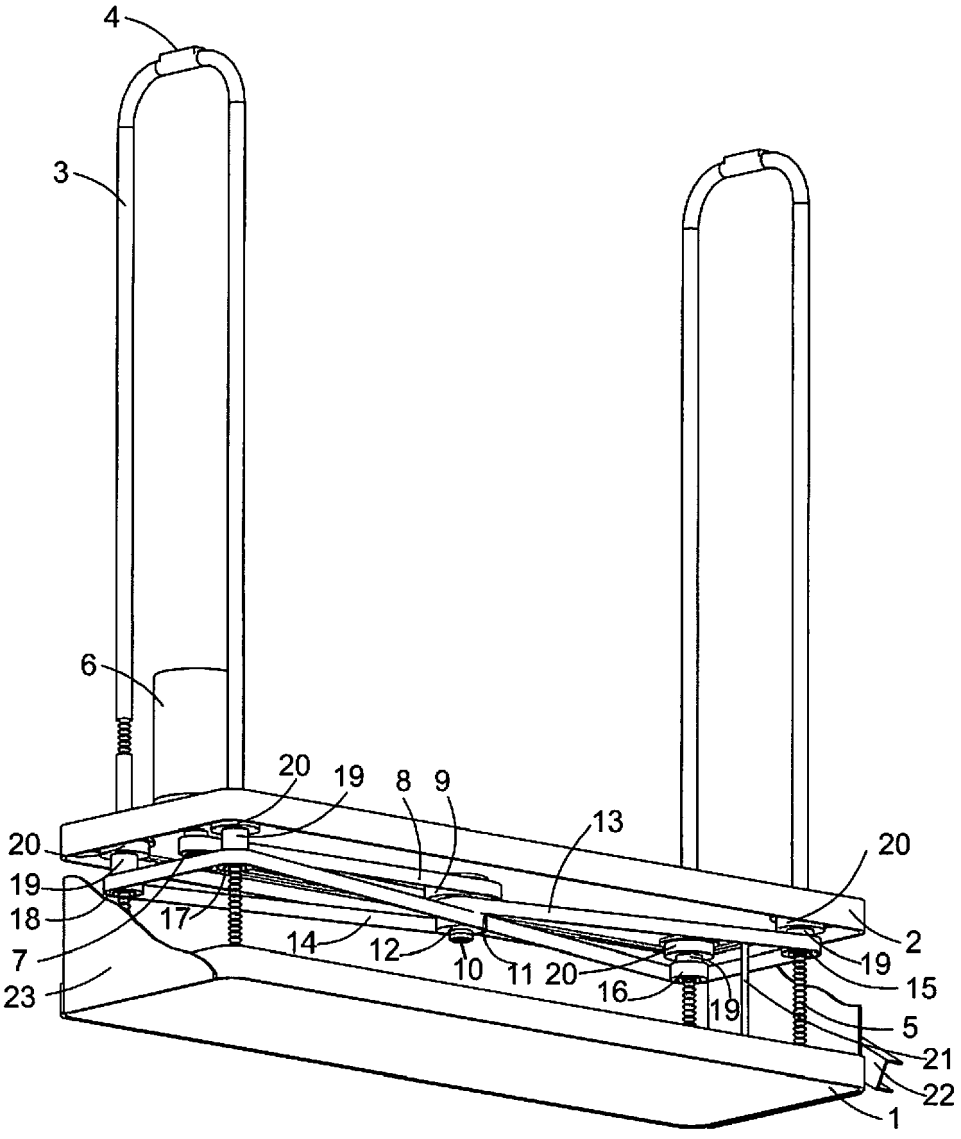


Figure 2

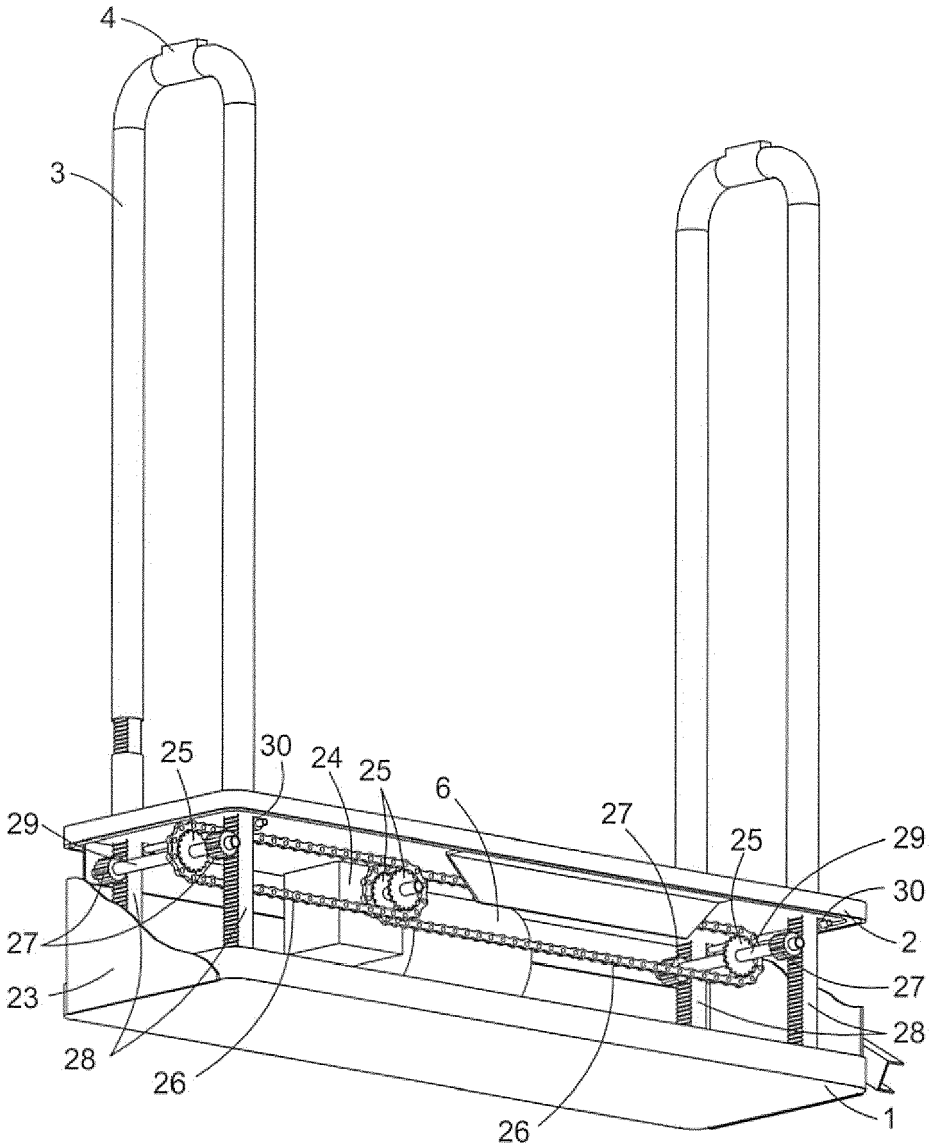


Figure 3

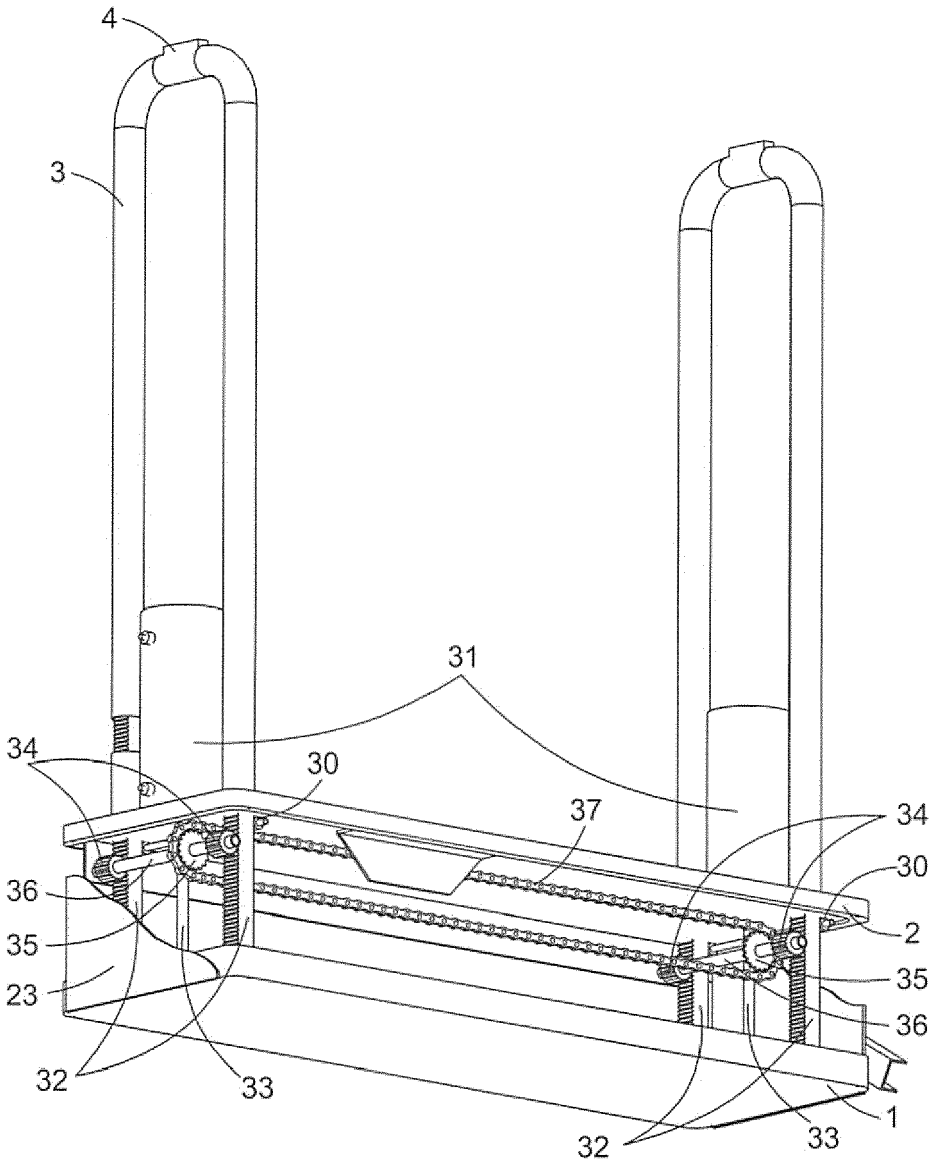


Figure 4

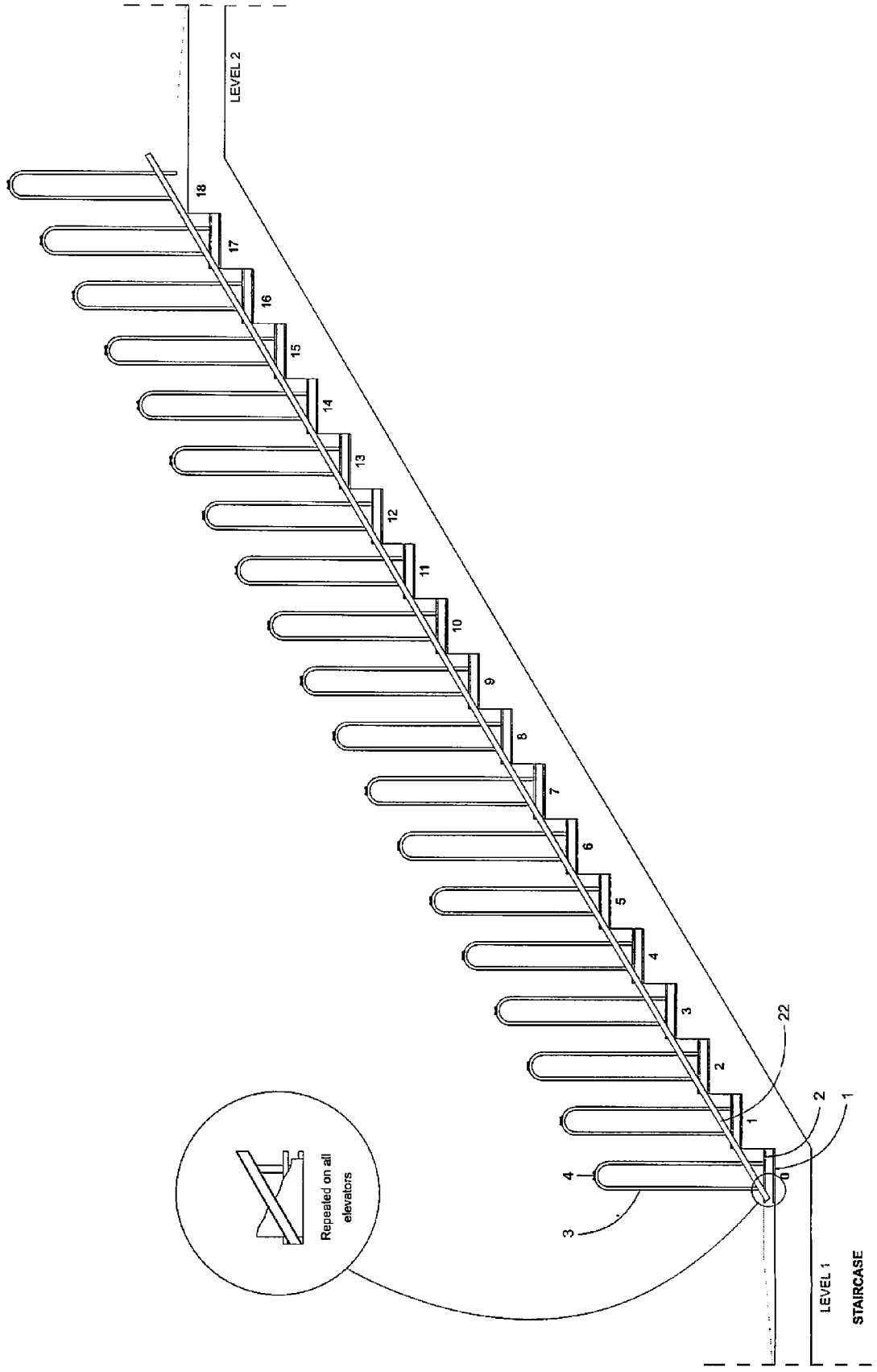

LEVEL 2
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
22
2
1
4
3
Repealed on all elevators
LEVEL 1
STAIRCASE

Figure 5

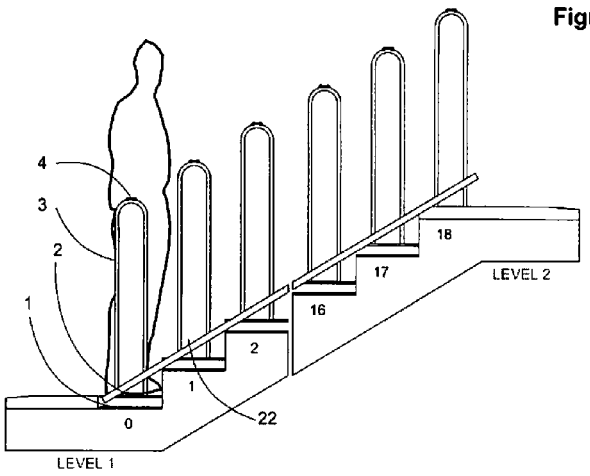


fig.5a

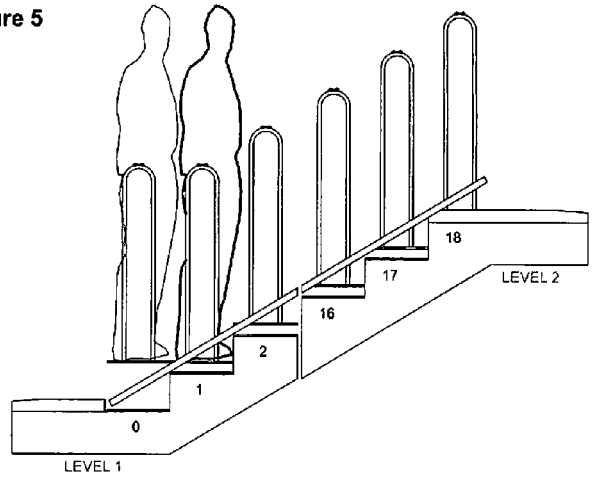


fig.5b

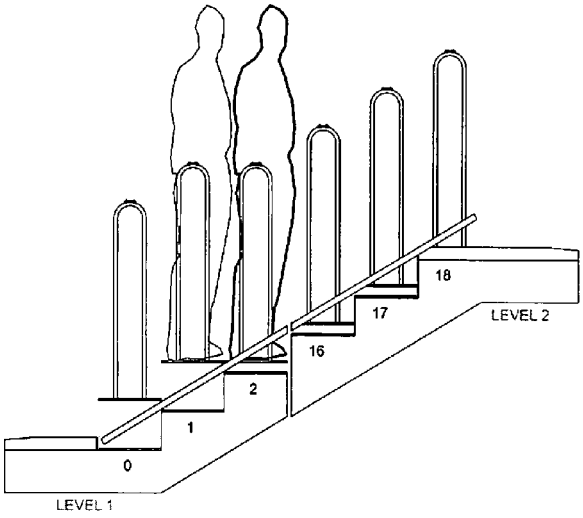


fig.5c

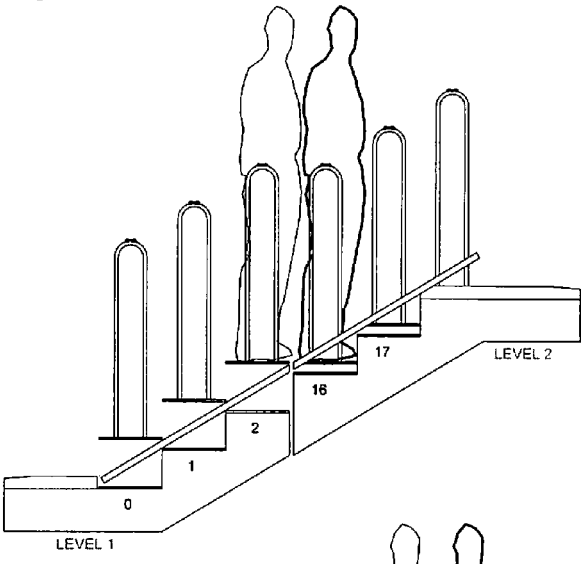


fig.5d

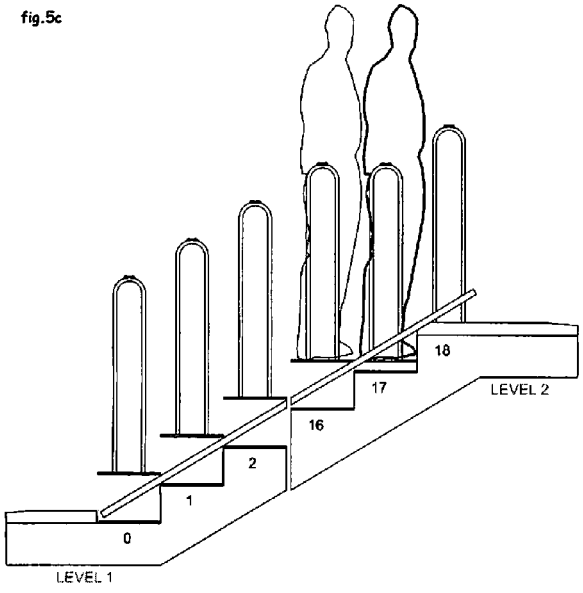


fig.5e

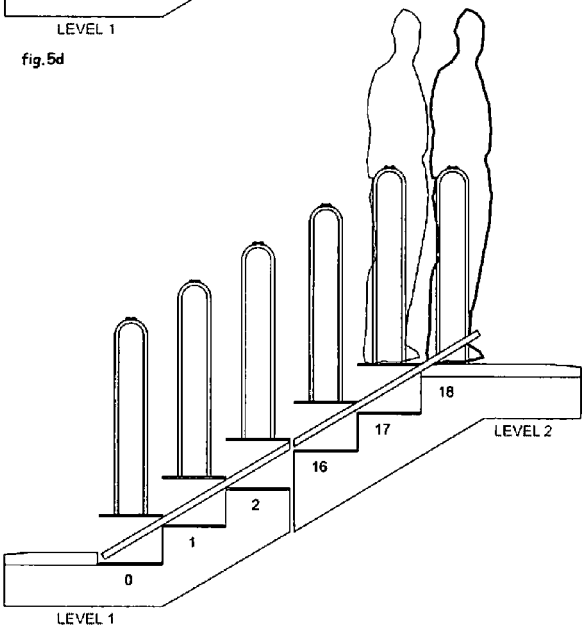


fig.5f

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EUROPEAN SEARCH REPORT

Application Number
EP 14 15 6811

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	NL 2 004 022 C (UNIV TWENTE [NL]) 9 September 2011 (2011-09-09) * page 13, line 6 - line 9; figures 3,11-13 * -----	1-10	INV. B66B9/08

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	30 June 2014	Fiorani, Giuseppe

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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30-06-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
NL 2004022 C	09-09-2011	NONE	

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