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DESCRIPTION

Escalator Apparatus

[Technical Field]

The present invention relates to an escalator system installable on existing stairs in stations, hospitals, schools, residences and the like.

[Background Art]

In recent years, escalators have been installed in stations, department stores and so on, but only in limited locations. Thus, existing stairs have to be used more often than not. Further, it is desirable to install escalators at homes of the elderly or physically handicapped.

With the above in view, escalators may only be added to existing stairs. When installing an escalator on existing stairs at a station or the like, the stairs formed of concrete are cut first, and then concrete is poured again to integrate the escalator into the existing stairs. This construction work entails the problems of being large scale and involving a high remodeling cost.

A method is conceivable in which an escalator system is installed as resting on existing stairs, without performing large-scale construction work. However, conventional escalator system have the problem of being large in thickness,

and leaving only small ceiling spaces when placed on stairs.

An object of the present invention, therefore, is to provide an escalator system small in thickness and easy to install on existing stairs.

[Disclosure of Invention]

An escalator system set forth in claim 1 comprises a plurality of steps each having a riding surface for carrying users, and circulating along a series of circulating paths with an upper circulating region and a lower circulating region extending between a lower position and an upper position and continuous with each other through an upward transitional region and a downward transitional region; and

driving means for driving the plurality of steps to travel in a predetermined traveling direction along the circulating paths;

wherein the upper circulating region has a transport region for transporting the users on the riding surfaces in horizontal posture, and the respective steps travel with the riding surfaces constantly facing upward in all the regions including the transport region.

According to the invention, the steps travel through the upper circulating region in a predetermined traveling direction from the lower position toward the upper position, for example, to act as an ascending escalator. In the transport region included in the upper circulating region, the users may be

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transported, as riding on the riding surfaces in horizontal posture, from the lower position to the upper position. The steps of such escalator system travel with the riding surfaces constantly facing upward. In the downward transitional region from the upper circulating region to the lower circulating region, the steps do not turn over as is the case with a conventional escalator system. Thus, the thickness of the escalator system may be minimized in the downward transitional region. Similarly, in the upward transitional region from the lower circulating region to the upper circulating region, the steps move with the riding surfaces facing upward, without turning over. Thus, the thickness of the escalator may be minimized in the upward transitional region also. As a result, the escalator may be made thin.

The escalator system set forth in claim 2 comprises kick-in boards disposed at ends of the steps opposed to the lower position, placed in a closing position for closing a gap between adjacent ones of the steps in the transport region, and placed in a retracted position retracted from the closing position in the lower circulating region.

According to the invention, each step has a kick-in board. The kick-in board closes a gap between adjacent steps in the transport region. This avoids an incidence of riding users having the tips of feet or the like pinched between the steps. Such a kick-in board is placed in a retracted position retracted

from a closing position in the lower circulating region. As a result, the thickness of the escalator system is reduced, and the escalator system may be made thin.

The escalator system set forth in claim 3 is characterized in that each kick-in board has a proximal end connected for angular displacement to one end of the step to extend downward to assume the closing position in the transport region,

folding means for causing the kick-in board in the closing position to make an angular displacement to the retracted position substantially parallel to the step immediately before reaching the downward transitional region where the step moves from the upper circulating region to the lower circulating region.

According to the invention, the kick-in board is connected for angular displacement to one end of the step, and is placed in the closing position depending therefrom in the transport region. Immediately before reaching the downward transitional region, the kick-in board is angularly displaced and folded by the folding means to the retracted position substantially parallel to the step. Where the kick-in board is folded while moving downward, the free end of the kick-in board in the downwardly extending state could interfere with the step in the lower circulating region. To avoid such an interference, the thickness of the escalator system must be increased. By contrast, the kick-in board is folded immediately before

reaching the downward transitional region according to the present invention. Consequently, the kick-in board moving downward is prevented from interfering with the step in the lower circulating region, and the escalator system may be made thin.

The escalator system set forth in claim 4 is characterized in that the folding means includes angular displacement means provided for each step, for causing an angular displacement of the kick-in board from the closing position toward the retracted position by pressing a press portion upstream in the traveling direction, and a pressing member disposed in a predetermined fixed position and protruding into a passage of the press portion for pressing the press portion.

According to the invention, when each step travels and reaches the pressing member disposed in the predetermined fixed position, the press portion of the angular displacement means is pressed upstream in the traveling direction by the pressing member. As a result, the kick-in board makes an angular displacement to be folded from the closing position to the retracted position. In this way, the kick-in board may be folded reliably by the simple construction, without requiring a drive source such as a motor for each step.

The escalator system set forth in claim 5 comprises downward kick-in board guide means for guiding the kick-in board, as maintained in the retracted position, in the downward transitional region from the upper circulating region to the

lower circulating region.

According to the invention, the kick-in board placed in the retracted position immediately before moving to the downward transitional region moves from the upper circulating region to the lower circulating region, while being maintained in the retracted position by the downward kick-in board guide means. In the downward transitional region, the kick-in board is constantly maintained in the retracted position. In this way, the kick-in board is prevented from hanging down during the downward movement to collide with the step in the lower circulating region.

The escalator system set forth in claim 6 is characterized in that the downward kick-in board guide means includes a rotation guide member disposed in a space between the upper circulating region and the lower circulating region of the steps to be rotatable with the steps moving through the downward transitional region, while supporting a free end of the kick-in board placed the retracted position.

According to the invention, the kick-in board, during a downward transition, moves downward in the folded state with the free end thereof supported by the rotation guide member. The rotation guide member having such a simple construction may reliably maintain the kick-in board in the retracted position during the downward transition.

The escalator system set forth in claim 7 comprises upward

kick-in board guide means for guiding the kick-in board, as maintained in the retracted position, in the upward transitional region from the lower circulating region to the upper circulating region.

According to the invention, the kick-in board moves, as maintained in the retracted position, in the upward transitional region from the lower circulating region to the upper circulating region. After reaching the upper circulating region, the kick-in board makes an angular displacement from the retracted position to the closing position. In this way, the kick-in board is maintained in the retracted position during a transition. The kick-in board is prevented from hanging down to have the free end thereof collide with the step in the lower circulating region.

The escalator system set forth in claim 8 comprises simplified mounting means for attachable and detachable installation on existing stairs extending between the upper position and the lower position.

According to the invention, the escalator system is attachably and detachably installed on existing stairs by the simplified mounting means. Thus, the existing stairs may easily be used as the escalator system without performing large-scale construction work. Moreover, since the escalator system of the present invention is the thin type as noted hereinbefore, a sufficient ceiling space may be secured even

when placed on the stairs. It may also be detached as necessary.

The escalator system set forth in claim 9 is characterized in that the simplified mounting means has a plurality of engaging members vertically insertable and removable for restricting a horizontal displacement relative to the existing stairs.

According to the invention, the simplified mounting means is restricted with respect to horizontal displacement by the vertically insertable and removable engaging members, thereby avoiding a horizontal displacement occurring, for example, when pushed by users. Further, the simplified mounting means is engaged by the vertically insertable and removable engaging members. When dismantling the escalator system, the escalator system may be detached from the stairs easily by removing the engaging members.

[Brief Description of Drawings]

Fig. 1 is a sectional view showing a construction of an escalator system 11 in one embodiment of the present invention.

Fig. 2 is a sectional view seen from cutting plane line II-II of Fig. 1.

Fig. 3 is a sectional view showing the vicinity of a lower end of the escalator system 11.

Fig. 4 is a sectional view showing the vicinity of an upper end of the escalator system 11.

Fig. 5(A) is a front view showing an attached state of a simplified mounting means 51, and Fig. 5(B) is a perspective

view of simplified mounting means 51.

Fig. 6(A) is a front view showing an attached state of simplified mounting means 55, and Fig. 6(B) is a perspective view of the simplified mounting means 55.

Fig. 7 is a view in vertical section of an escalator system 130 in another embodiment of the invention.

Fig. 8 is a cross section of escalator system 130.

Fig. 9 is a cross section showing, in enlargement, the vicinity of steps 137 in Fig. 8.

Fig. 10 is a side view showing a kick-in board 138 in a closing position.

Fig. 11 is a side view showing the kick-in board 138 in a retracted position.

Fig. 12 is a side view of escalator system 130 showing the vicinity of an upper floor 132.

Fig. 13 is a side view showing a step 137 immediately before reaching a downward transitional region S3.

Fig. 14 is a side view showing upper sprocket wheels 134 having rotated by an angle $\alpha=144^\circ$ from a reference.

Fig. 15 is a side view showing the escalator system 130 in the vicinity of a lower floor 131.

Fig. 16 is a side view showing a guide roller 155 guided to move on an inclined upper rear end 190 of a lower kick-in board guide rail 157.

Fig. 17 is a side view showing a guide roller 155 riding

on a support piece 197 of a first kick-in board guide rail 191.

Fig. 18 is a side view showing an escalator system 200 in a further embodiment of the invention.

Fig. 19 is a side view showing an escalator system 205 in the vicinity of upper floor 132 in a still further embodiment of the invention.

Fig. 20 is a side view showing the vicinity of an upper sprocket wheel 134 of an escalator system 305.

Fig. 21 is a sectional view showing simplified mounting means 300.

Fig. 22 is a sectional view seen from cutting plane line XXII-XXII of Fig. 21.

Fig. 23 is a sectional view showing simplified mounting means 321.

Fig. 24 is a sectional view seen from cutting plane line XXIV-XXIV of Fig. 23.

Fig. 25 is a sectional view showing simplified mounting means 331.

Fig. 26 is a sectional view seen from cutting plane line XXVI-XXVI of Fig. 25.

Fig. 27 is a fragmentary perspective view showing a frame 141.

Fig. 28 is a sectional view seen from cutting plane line XXVIII-XXVIII of Fig. 27.

[Best Mode for Carrying Out the Invention]

Fig. 1 is a sectional view showing a construction of an escalator system 11 in one embodiment of the present invention. Fig. 2 is a sectional view seen from cutting plane line II-II of Fig. 1. The escalator system 11 is installed on existing stairs 17 extending between an upper floor 15 which is an upper position and a lower floor 16 which is a lower position, and comprises a plurality of steps 12 for circulating along predetermined circulating paths S1-S4, with riding surfaces 22 constantly facing upward to carry users, and driving means 13 for driving the steps 12 to travel in a predetermined traveling direction through an upper circulating region. Each step 12 travels with the riding surface 22 maintained substantially horizontal in a transport region S5 for carrying the users. This escalator system 11 is detachably fixed to the existing stairs 17 by simplified mounting means 35 provided for a support frame unit 30.

The driving means 13 includes upper sprocket wheels 18 disposed on the upper floor 15, lower sprocket wheels 19 disposed on the lower floor 16, endless, annular driving chains 20 extending between the sprocket wheels 18 and 19, a motor 21 for rotating the upper sprocket wheels 18, and the support frame unit 30 for containing and supporting these components. The upper sprocket wheels 18 form a pair arranged in the direction of width (i.e. in a direction perpendicular to the plane of Fig. 1). The upper sprocket wheels 18 are supported coaxially with

each other by the support frame unit 30. Similarly, the lower sprocket wheels 19 form a pair spaced in the direction of width, and rotatably supported by the support frame unit 30 to have an axis of rotation parallel to the axis of rotation of upper sprockets 18. The driving chains 20 also form a pair extending from the upper sprocket wheels 18 to the lower sprocket wheels 19, respectively.

An upper run of the driving chain 20 is defined as an upper circulating region S1 of steps 12, and a lower run is defined as a lower circulating region S2 of steps 12. A chain winding portion of the upper sprocket wheel 18 is defined as a downward transitional region S3, and a chain winding portion of the lower sprocket wheel 19 is defined as an upward transitional region S4. These regions S1-S4 provide the circulating path. Part of the upper circulating region S1 provides the transport region S5.

By driving the motor 21 of the driving means 13, the steps 12 travel through the upper circulating region S1, in a traveling direction A indicated by an arrow in Fig. 1, i.e. from the lower floor 16 toward the upper floor 15, to act as an ascending escalator. By reversing the motor 21, the steps 12 move through the upper circulating region S1, in the direction opposite to the traveling direction A for use as a descending escalator.

The support frame unit 30 includes a bottom wall frame 32 placed on the stairs 17, a pair of side wall frames 31

upstanding vertically at opposite sides in the direction of width of the bottom wall frame 32, an upper cover 33 placed on the upper floor 15, and a lower cover 34 placed on the lower floor 16. The region extending from the lower cover 34 to the upper cover 33 provides the transport region S5.

Each step 12 has, at one end 12A thereof opposed to the lower floor 16, a pair of horizontal transition rollers 24 spaced apart in the direction of width and rotatable about a horizontal axis of rotation. The other end 12B of each step 12 has the pair of driving chains 20 connected for angular displacement to the opposite sides in the direction of width. The horizontal transition rollers 24 ride on a pair of horizontal transition rails 25 disposed in the side wall frames 31 to extend along the circulating paths, respectively. When the other ends 12B of steps 12 are driven by the driving chains 20 to travel in the traveling direction A through the upper circulating region, the horizontal transition rollers 24 are guided along the horizontal transition rails 25, whereby the steps 12 travel with the riding surfaces 22 placed substantially horizontal in the transport region S5. In the lower circulating region S2, the horizontal transition rollers 24 are guided by a pair of lower guide rails 26 fixed to the side wall frames 31 and extending along the circulating paths, respectively.

The support frame unit 30 of the escalator system 11 is detachably and attachably fixed to the stairs 17 by a plurality

of, e.g. three in this embodiment, simplified mounting means 35. As shown in Fig. 2, each simplified mounting means 35 has a base 45 detachably fixed to a stair 17 such as by anchor bolts 47, and a pair of stair engaging legs 46 in the form of triangular plates disposed at opposite sides in the direction of the width of the base 45. The stair engaging legs 46 are fixed to the bottom wall frames 32 of the support frame unit 30 such as by bolts 48. Such simplified mounting means 35 reliably fix the escalator system 11 to the stairs 17. The escalator system 11 may be removed from the stairs 17 easily by removing the anchor bolts 47 from stud anchors.

Such simplified mounting means 35 are not limited to the construction described above. The anchor bolts may be replaced with concrete bolts. In place of the stair engaging leg 46 in the form of a triangular plate fixed to the base 45, the stair engaging leg 46 may be attached to the base 45 for angular displacement to suit an angle of inclination of the stairs.

In addition, the base 45 of the simplified mounting means 35, instead of being fixed to the stairs 17, may be placed just to rest on the stairs. This further facilitates attachment and detachment to provide convenience especially for temporary use. In this case, the base 45 are not limited to the plate form, but may be in the form of a rod connected to the leg 46. The simplified mounting means 35 may be adapted foldably or detachably attached to the support frame unit 30. This

facilitates storage, with no protruding part in time of storage.

Fig. 3 is a sectional view showing the vicinity of a lower end of the escalator system 11. The horizontal transition rollers 24 attached to each step 12 have a large roller 28 having a large diameter and a small roller 27 having a small diameter, which are rotatably supported by an engaging piece 29, respectively. This engaging piece 29 is connected for angular displacement to the step 12 through a support axis 49, at the opposite sides in the direction of width at one side 12A of step 12. Supported by the two rollers 27 and 28 as noted above, the step 12 is guided steadily and without wobbling, along the horizontal transition rails 25. Stability is improved further since the step 12 is disposed below the horizontal transition rails 25 through the engaging pieces 29.

In the vicinity of the lower sprocket wheel 19, a lower portion guide rail 50 extends from a rear end 25A (rightward in Fig. 3) of the horizontal transition rails 25 to a rear end 26A of the lower guide rail 26. The lower portion guide rail 50 is inclined to extend downward and rearward, with the upper end thereof connected to each of the pair of side wall frames 31 through a hinge 51 for angular displacement about a horizontal axis. Each lower portion guide rail 50 has a rear end 52 thereof curved rearwardly, the rear end 52 in a natural state resting on the lower guide rail 26 to be smoothly continuous with the lower guide rail 26. When the step 12 moves rearward, as shown

in Fig. 3(A), the large roller 27, having a large diameter and disposed rearwardly, of the horizontal transition roller 24 push up the rear end 52 of the lower portion guide rail 50. As the horizontal transition roller 24 move further rearward and past the rear end 52 of the lower portion guide rail 50, the rear end 52 falls and rests on the lower guide rails 26. When the step 12 moves forward, as shown in Fig. 3(B), the horizontal transition roller 24 ride on the lower end 52 of the lower portion guide rail 50 to be guided upward along the lower portion guide rail 50. As the step 12 moves further forward, the horizontal transition roller 24 transfers from the upper end of the lower portion guide rail 50 to the rear end 25A of the horizontal transition rail 25 to be guided along the horizontal transition rail 25. In this way, when turned from the lower circulating region to the upper circulating region, the steps 12 are not rotated or turned over but the riding surfaces 22 constantly face upward. This avoids the construction being enlarged vertically at the turning point, thereby allowing the escalator system 11 to be made thin.

Fig. 4 is a sectional view showing the vicinity of an upper end of escalator system 11. Between the upper sprockets 18 and the motor 21 of the driving means 13 is an intermediate shaft 55 having an axis of rotation parallel to the axis of rotation of upper sprockets 18 for distributing drive of the motor. The motor 21 rotates this intermediate shaft 55. This intermediate

shaft 55 has pulleys 56 mounted on opposite ends in the direction of width thereof, respectively. The pulleys 56 rotate, through belts 58, a pair of pulleys 57 disposed coaxially with the pair of upper sprocket wheels 18, respectively. The upper sprocket wheels 18 are rotated by these pulleys 57.

As shown in Fig. 4, the horizontal transition rollers 24 guided along the horizontal transition rail 25 are arranged inwardly with respect to the pair of driving chains 20, respectively, and stop short of the upper sprocket wheels 18. Below these horizontal transition rails 25 are the lower guide rails 26 extending forwardly (upward in Fig. 4) of forward ends 25B of the horizontal transition rails 25. Thus, when the horizontal transition rollers 24 of steps 12 guided forward through the upper circulating region reach the forward ends 25B of the horizontal transition rails 25, the horizontal transition rollers 24 fall from the horizontal transition rails 25 to rear ends 26A of the lower guide rails 26. As shown in Fig. 1, the rear ends 26A of the lower guide rails 26 are inclined from adjacent the forward ends 25B of the horizontal transition rails 25 to the bottom wall frame 32 for smoothly guiding one end 12B of each step 12. Thus, the steps 12 are turned back without being turned over by the upper sprockets 18, with the riding surfaces 22 facing upward. As a result, the escalator system 11 is made thin.

In this embodiment, the endless, annular driving chains

are constructed to maintain the steps 12 in the circulating paths extending through the upper circulating region S1 and the lower circulating region S2. However, a chain take-up device may be installed at the upper end or lower end of the escalator system 11 for taking up the driving chains to drive the step. This will realize a still thinner construction.

Fig. 5 is a front view showing simplified mounting means 51 which is another form of simplified mounting means for installing an escalator system 21. As shown in Fig. 5(B), the simplified mounting means 51 has a bracket 52 with a lower end bent substantially vertically to define a base 47. An upper portion of this bracket 52 is inclined at a predetermined angle β to the base 47, and defines a mount 53 bent substantially vertically from the bracket 52. The base 47 defines two bolt receiving bores 49. Concrete bolts 48 are passed through the bolt receiving bores 49, respectively, to fix the bracket 52 to the existing stairs 17 as shown in Fig. 5(A).

Since the mount 53 is inclined at the predetermined angle β corresponding to an angle of inclination of the simplified escalator 21 to be installed, the escalator system may be supported stably from below by attaching the bottom wall frame 32 of the circulation driving means 13 in face-to-face contact with the mount 53. Further, the mount 53 defines two slots 54 extending longitudinally of the escalator system 21. Through these slots 54, the mount 53 is fixed to the bottom wall frame

32 of the driving means 13 by bolts and nuts. Since the slots 54 are formed in the mount 53 as noted above, the bottom wall frame 32 of the driving means 13 of the escalator system 21 may be supported and fixed to be adjustable in longitudinal directions. The escalator system 21 may simply be installed at the predetermined angle β regardless of an angle of inclination of the stairs 17.

Such simplified mounting means 51 is arranged adjacent an upper end, a lower end and a middle position of the existing stairs 17. As a result, the escalator system 21 is installed stably on the stairs. Since the bottom wall frame 32 is placed by the simplified mounting means 51 out of contact with edges of the existing stairs 17 as shown in Fig. 5(A), the bottom wall frame 32 is free from damage. The escalator system 21 may be detached from the stairs 17 easily by removing the concrete bolts 48 from the stairs 17. The concrete bolt 48 may be replaced with anchor bolts.

Fig. 6 is a front view showing simplified mounting means 55 which is a different form of simplified mounting means. The simplified mounting means 55 is similar to the simplified mounting means 51, but, as a point to be noted, is divided into a bracket 52 having a base 47 and a mounting bracket 57 having a mount 53. A bracket 56 defines a pair of slots 59 extending in the direction of height, while the mounting bracket 57 defines a pair of slots 58 extending in the direction of height and

corresponding to the slots 59, respectively. Thus, the escalator system 21 may be installed at a desired height by engaging and tightening bolts with the slots 58 and 59 extending longitudinally of the bracket 56 and the mounting bracket 57. Similarly, the mount 53 defines slots 54 extending longitudinally of escalator system 21. Thus, the escalator system 21 may be attached to be adjustable in longitudinal directions.

Fig. 7 is a simplified view in vertical section of an escalator system 130 in another embodiment of the invention. Fig. 8 is a cross section of the escalator system 130. The escalator system 130 is installed on stairs 133 extending from a lower floor 131 which is a lower position to an upper floor 132 which is an upper position. This escalator system 130 has a frame 141 placed to extend from the lower floor 131 to the upper floor 132. The frame 141, on the upper floor 132, includes a pair of upper sprocket wheels 134 spaced apart in the direction of width (perpendicular to the plane of Fig. 7) and rotatable about an axis of rotation extending in the direction of width. Similarly, the frame 141 includes, on the lower floor 132, a pair of rotatable lower sprocket wheels 135 spaced apart in the direction of width. A pair of endless chains 136 such as roller chains extend between and wound on the upper and the lower sprocket wheels 134 and 135, respectively. A plurality of steps 137 are connected between the pair of chains 136. Each step

136 has one end thereof connected to the chains 136 for angular displacement about an axis of angular displacement parallel to the direction of width. A proximal end of a kick-in board 138 is connected to the other end of each step 137 for angular displacement about an axis of angular displacement parallel to the direction of width.

The frame 141 includes a rotational drive source 139 such as a motor disposed on the upper floor 132. Rotational drive of the rotational drive source 139 is transmitted to an intermediate shaft 147, and to the upper sprocket wheels 134 through gears fixed to opposite ends of the intermediate shaft 147 and meshed with gears fixed to the upper sprocket wheels 134. Thus, the rotational drive source 139 drives the chains 136 to circulate the steps 137 from the lower floor 131 toward the upper floor 132 through an upper circulating region S1 which is an upper extending region of chains 136. The steps 137 travel along a series of circulating paths with the upper circulating region S1 and a lower circulating region S2 continuous through an upward transitional region and a downward transitional region. The traveling direction of steps 137 in the upper circulating region S1 will be referred to hereinafter as traveling direction A1, and the traveling direction of steps 137 in the lower circulating region S2 as traveling direction B1.

Rotational drive is transmitted to the upper sprocket

wheels 134, respectively, through the intermediate shaft 147. Thus, no rotary shaft is disposed to extend between the pair of upper sprocket wheels 134. The steps 137 and kick-in boards 138 pass between the upper sprocket wheels 134. The lower sprocket wheels 135 have a rotary shaft 140 mounted coaxially therewith. The kick-in boards 138 move upward as placed in retracted positions to be clear of the rotary shaft 140 as described hereinafter.

The frame 141 includes a lower plate 144 disposed on the lower floor 131 and facing upward for users to walk on. The frame 141 includes a similar, upper plate 143 disposed on the upper floor 133. The steps 137 in circulation travel horizontally under the lower plate 144 on the lower floor 131, emerge from the lower plate 144, move upward along the stairs 133, travel horizontally along the upper floor 132, and move under the upper plate 143. Thus, a region from the lower plate 144 to the upper plate 143, where the steps 137 are exposed, in the upper circulating region S1 of chains 136, is defined as a transport region S5. Each step 137 is maintained, in this transport region S5, such that the riding surface 148 for carrying a user is in horizontal posture, and each kick-in board 138, in the transport region S5, hangs down to assume a closing position for closing a vertical gap formed above an immediately succeeding step 137.

Winding regions of the chains 136 wound on the upper

sprocket wheels 134 are defined as a downward transitional region S3. In this downward transitional region S3, each step 137 moves from the upper circulating region S1 to the lower circulating region S2, with the riding surface 148 facing upward. Similarly, chain winding regions of the lower sprocket wheels 135 are defined as an upward transitional region S4. In the upward transitional region S4, each step 137 moves from the lower circulating region S2 to the upper circulating region S1, with the riding surface 148 facing upward.

Above the frame 141 are a pair of endless, circulating handrails 145 spaced apart in the direction of width, which receive drive from the rotational drive source 139 to run at an equal speed with the chains 136. Thus, the users having walked from the lower floor 131 to the lower plate 144 step onto the riding surfaces 148 of the steps 137 while holding the handrails 145, to be transported to the upper floor 132.

The frame 141 is fixed to the lower floor 131, the upper floor 132 and the stairs 133 by simplified mounting means 146. The simplified mounting means 146 has a concrete bolt or the like for detachable fixation. Loose fit holes may be formed in the lower floor 131, the upper floor 132 and the stairs 133 for loosely receiving the bolts of the simplified mounting means 146. Then, the escalator system 130 may be installed simply by loose fitting the bolts of the simplified mounting means 146 into the loose fit holes. With this installation mode, there

is no need to tighten the concrete bolts when installing or dismantling the escalator system 130 on/from the stairs. Thus, the escalator system 130 may be installed and dismantled with ease.

The frame 141 is divided into a plurality of parts as described hereinafter. The length of the frame is selected to be less than 5m at most. Thus, the escalator system 130 may be transported, assembled and dismantled with ease.

Fig. 9 is a sectional view showing, in enlargement, the vicinity of the steps 137 in the cross section of Fig. 8. Fig. 10 is a side view showing the kick-in board 138 in the closing position. Fig. 11 is a side view showing the kick-in board 138 in the retracted position. The steps 137 and kick-in boards 138 are in the form of comb plates. In the transport region S5, the kick-in board 138 and the steps 137 adjacent the kick-in boards 138 have comb teeth meshed with one another.

Each step 137 has a chain support shaft 158 disposed at one end thereof and extending in the direction of width. Front guide rollers 159 are mounted on opposite end portions of the chain support shaft 158 to be rotatable about the axis of the chain support shaft 158. The chains 136 are connected to opposite extremities of the chain support shaft 159 for angular displacement about the axis of the chain support shaft 158. The frame 141 has, attached to side walls 142 thereof, upper step guide rails 160 extending along the upper circulating region

S1, and lower step guide rails 169 extending along the lower circulating region S2. When the steps 137 travel along the upper circulating region S1, the front guide rollers 159 are guided along the upper step guide rails 160. Similarly, when the steps 137 travel along the lower circulating region S2, the front guide rollers 159 are guided along the lower step guide rails 169. Further, upper chain guide rails 170 extend along the upper circulating region S1. The chains 136 in the upper circulating region S1 are guided along the chain guide rails 170. Similarly, lower chain guide rails 171 extend along the lower circulating region S2. The chains 136 in the lower circulating region S2 are guided along the chain guide rails 171.

Each step 137 has an angular displacement shaft 164 disposed adjacent the other end thereof and extending in the direction of width to be capable of angular displacement. The kick-in board 138 is fixed at a proximal end thereof to this angular displacement shaft 164. The kick-in board 138 has a pair of guide rollers 155 disposed at opposite ends in the direction of width of the free end thereof and having an axis of rotation parallel to the direction of width. Small rollers 161 having a smaller diameter than the guide rollers 155 are disposed adjacent the guide rollers 155 and inwardly of the guide rollers 155 in the direction of width.

The step 137 has the other end thereof defining an engaging

end 163 bent to extend downward. When the kick-in board 138 is in the closing position, an upper end surface 162 of kick-in board 138 contacts the engaging end 163 for support. In a natural state, the kick-in board 138 is suspended to assume the closing position.

The angular displacement shaft 164 at the proximal end of the kick-in board 138 has gears 165 fixed to opposite ends thereof, respectively. These gears 165 are meshed with sector gears 166 disposed adjacent thereto. The sector gears 166 have levers 149 fixed thereto and extending toward the other end of step 137. These levers 149 act as press portions, and incline downward toward the other end of step 137 when the kick-in board 138 is in the closing position. The frame 141 includes, in fixed positions adjacent the upper floor 132, guide rollers 168 acting as pressing members protruding into passages of the levers 149 of the sector gears 166. When the step 137 having reached the upper floor 132 moves horizontally rightward in Fig. 10 (i.e. downstream in the upper traveling direction A1), the guide rollers 168 contact the levers 149 of the sector gears 166. As the step 137 moves further rightward, the sector gears 166 are pushed leftward, i.e. upstream in the upper traveling direction A1, thereby making an angular displacement clockwise in Fig. 11. As a result, the gears 165 meshed with the sector gears 166 and the kick-in board 138 fixed to these gears 165 make an angular displacement counterclockwise in Fig. 11. The kick-in

board 138 thereby assumes the retracted position substantially parallel to the step 137. In this way, the kick-in board 138 is placed in the retracted position immediately before reaching the downward transitional region S3.

The frame 141 includes upper kick-in board guide rails 156 vertically spaced from the upper step guide rails 160, and similarly lower kick-in board guide rails 157 below the lower step guide rails 169 and adjacent the lower step guide rails 169. When the step 137 travels through the transport region S5, the guide rollers 155 are guided along the upper kick-in board guide rails 156, with the kick-in board 138 placed in the closing position. When the step 137 travels through the lower circulating region S2, the guide rollers 155 are guided by the lower kick-in board guide rails 157, whereby the kick-in board 138 is placed in the retracted position. Thus, the kick-in board 138 is maintained in the closing position at least in the transport region S5 of the upper circulating region S1. In the lower circulating region S2, the kick-in board 138 travels as placed in the retracted position. It is therefore possible to reduce the spacing between the upper circulating region S1 and lower circulating region S2, thereby making the escalator system 130 thin. Such escalator system 130 has a thickness W not exceeding 40cm, for example.

When the kick-in board 138 travels through the transport region S5 as placed in the closing position, the small rollers

161 contact, from below, small roller guide rails 150 extending parallel to the upper kick-in board guide rails 156.

Consequently, the kick-in board 138 is prevented from making an angular displacement toward the retracted position while traveling through the transport region S5. The riding surface 148 of the step 137 may be maintained stably in horizontal posture.

Fig. 12 is a side view showing the escalator system 130, with a side wall 142 detached, in the vicinity of the upper floor 132. Downward kick-in board guide means 174 is disposed adjacent the upper sprocket wheels 134 and in a space between the upper circulating region S1 and lower circulating region S2. The downward kick-in board guide means 174 has a pair of kick-in board rotation guide members 175 spaced apart in the direction of width. The kick-in board rotation guide members 175 are rotatably supported on a rotary shaft 176 having an axis of rotation L1 disposed parallel to and upstream in the upper traveling direction A1 (leftward in Fig. 12) of the axis of rotation of the upper sprocket wheels 134. The kick-in board rotation guide members 175 have sprocket wheels 151 disposed coaxially therewith. Chains 152 extend from these sprocket wheels 151 to sprocket wheels 153 disposed coaxially with the upper sprocket wheels 134. Consequently, the kick-in board rotation guide members 175 are rotatable at the same speed and in the same direction as the upper sprocket wheels 134. Each

kick-in board rotation guide member 175 has a pair of receiving portions 177 and 178 symmetrical about the axis of rotation L1. When the step 137 moves along the downward transitional region S3 from the upper circulating region S1 to the lower circulating region S2, the receiving portions 177 and 178 support the guide rollers 155 disposed at the free end of kick-in board 138. Thus, with the kick-in board 138 maintained in the retracted position, the step 137 is guided from the upper circulating region S1 to the lower circulating region S2.

Fig. 13 is a side view showing, in enlargement, the vicinity of the kick-in board rotation guide members 175 immediately before the step 137 reaches the downward transitional region S3. The kick-in board 175 has a pair of receiving portions 177 and 178 projecting substantially radially outward. The receiving portions 177 and 178 have support surfaces 179, respectively. The support surfaces 179 are inclined with respect to a virtual plane 173 linking the axis of rotation L1 and extreme ends 182 of the receiving portions 177 and 178, by angle $\theta 1$ about the extreme ends 182 in a direction opposite to a direction of rotation C (clockwise in Fig. 13) of the kick-in board rotation guide member 175. Angle $\theta 1$ is selected to be in a range $0^\circ < \theta 1 < 30^\circ$. Outside this range, it would be difficult to maintain the kick-in board 138 in the retracted position reliably until the step 137 reaches the downward transitional region S3.

When guiding the kick-in board 138 from the upper circulating region S1 to the lower circulating region S2, contact positions on the support surfaces 179 contacted by the guide rollers 155 of the kick-in board 138 describe circular moving paths as shown in a phantom line 183, which have a diameter D1 substantially equal to a diameter D2 of upper sprocket wheels 134. Consequently, the kick-in board 138 is guided, as maintained in the retracted position, from the upper circulating region S1 to the lower circulating region S2.

Forward ends 157A adjacent the upper floor 132 of the lower kick-in board guide rails 157 for guiding the guide rollers 155 of the kick-in board 138 in the lower circulating region S2 are curved upward through an angle $\theta 2$ about the axis of rotation L1 of the kick-in board rotation guide members 175. Angle $\theta 2$ is selected to be in a range $30^\circ < \theta 2 < 90^\circ$, and preferably is 52° . Where angle $\theta 2$ is less than 30° , the guide rollers 155 of the kick-in board 138 could collide hard with the lower kick-in board guide rails 157 when the step 137 moves to the lower circulating region S2. This would pose a problem of producing noise. Where angle $\theta 2$ exceeds 90° , the forward ends 157A of the lower kick-in board guide rails 157 would be elongated, and hence a problem of failing to secure sufficient strength.

The forward ends 157A of the lower kick-in board guide rails 157, the kick-in board rotation guide members 75, the

sprocket wheels 151 and 153, and the chains 152, as described above, constitute the kick-in board guide means 174.

A distance E1 between the axis of rotation L1 of the kick-in board rotation guide members 175 and the axis of rotation L2 of the upper sprocket wheels 134 is selected to be equal to a distance E2 between the axis of the chain support shaft 158 of the step 137 and the axis of rotation of the guide rollers 155 of the kick-in board 138 placed in the retracted position.

When the chain support shaft 158 of the step 137 reaches the downward transitional region S3, the kick-in board 138 is placed in the retracted position by the sector gears 166. The kick-in board rotation guide members 175 are positioned such that, at this time, each guide roller 155 of the kick-in board 138 placed in the retracted position contacts the support surface 179 of one receiving portion 177 of the kick-in board rotation guide member 175. Consequently, the guide rollers 168 are disengaged from the guide surfaces 167 from the levers 149 fixed to the sector gears 166. Even when the kick-in board 138 is about to make an angular displacement toward the closing position, the support surfaces 179 of the receiving portions 177 contacting from below prevent the kick-in board 138 from making the angular displacement toward the closing position.

Fig. 14 is a side view showing the upper sprocket wheels 134 having rotated by an angle $\alpha=144^\circ$ from a reference set to the time when one end of the step 137 reaches the upper end of

the downward transitional region S3. In this state, the guide rollers 155 are guided along the lower kick-in board guide rails 157, with the support surfaces 179 of the other receiving portions 178 in line symmetry across the axis of rotation L1 being opposed to the guide rollers 155 of the succeeding step 137 from below. Thus, with a further rotation of the upper sprocket wheels 134, the other receiving portions 178 support the guide rollers 155 of the succeeding step 137 to exhibit the state shown in Fig. 13 described above. In this way, the kick-in board rotation guide members 175, by rotating at an equal speed with the upper sprocket wheels 134, sequentially guide the kick-in boards 138 of the succeeding steps 137 to the lower circulating region S2.

The forward ends 157A of the lower kick-in board guide rails 157, formed arcuate about the axis of rotation L1 of the kick-in board rotation guide members 175, can smoothly guide the guide rollers 155 guided arcuately about the axis of rotation L1 by the kick-in board rotation guide members 175. With the kick-in boards 138 smoothly guided in this way, noise may be prevented and the steps 137 circulated smoothly.

Fig. 15 is a side view showing the escalator system 130, with a side wall 142 removed, in the vicinity of the lower floor 131. Upward kick-in board guide means 189 is disposed in the vicinity of the lower floor 131 for guiding the kick-in boards 138, as maintained in the retracted position, from the lower

circulating region S1 to the upper circulating region S2. The upward kick-in board guide means 189 includes kick-in board guide members 195 and first kick-in board guide rails 191.

The ends in the lower traveling direction B1 of the lower kick-in board guide rails 157 define inclined rear ends 190 extending upward and downstream in the lower traveling direction B1. Kick-in board guide rollers 194 are disposed below the inclined rear ends 190 of the lower kick-in board guide rails 157. The kick-in board guide rollers 194 form a pair spaced apart in the direction of width and arranged between the inclined rear ends 190 of the lower kick-in board guide rails 157 spaced apart in the direction of width, to be rotatable about an axis of rotation extending in the direction of width, and have outer peripheral surfaces opposed, from below, to the kick-in boards 138 guided along the inclined rear ends 190.

These inclined rear ends 190 of the lower kick-in board guide rails 157 and kick-in board guide rollers 194 constitute kick-in board guide members 195.

Above the inclined rear ends 190 of the lower kick-in board guide rails 157 are first kick-in board guide rails 191 extending upward and downstream in the upper traveling direction A1. The first kick-in board guide rails 191 are disposed, in the sideways direction in Fig. 15, between the inclined rear ends 190 of the lower kick-in board guide rails 157 and horizontal guide rails 192 which guide the kick-in board 138 maintained in the retracted

position, horizontally in the upper circulating region S1, and include support pieces 197 disposed in a region outwardly (leftward in Fig. 15) of the chains 136, connecting guide rails 198 disposed in a region inwardly of the chains 136 for connection to the horizontal guide rails 192, and switchable guide members 196 supported by the support pieces 197 for angular displacement and disposed between the support pieces 197 and connecting guide rails 198.

The switchable guide members 198, which traverse the moving path of the chain support shaft 158 disposed at one end of each step 137, are made switchable not to obstruct movement of the chain support shaft 158 when the step 137 moves from the lower circulating region S2 to the upper circulating region S1. That is, the switchable guide members 196 have proximal ends supported by upper ends of the support pieces 157 for angular displacement about an axis of angular displacement extending in the direction of width, and free ends engaged with rear ends (leftward in Fig. 15) of the connecting guide rails 198. When the chain support shaft 158 of step 137 passes, the switchable guide members 196 are pushed up and opened by the chain support shaft 158. The chain support shaft 158 passes between the switchable guide members 196 and connecting guide rails 198. The switchable guide members 196 close after passage of the chain support shaft 158. The switchable guide members 196 are formed of a synthetic resin such as acrylic resin, to avoid noise being

produced each time they collide with the connecting guide rails 198 which are formed of metal.

Upper surfaces of the support pieces 197, switchable guide member 196 and connecting guide rails 198 of the first guide rails 191 are aligned to present smoothly continuing surfaces for smoothly guiding the guide rollers 155 of the kick-in boards 138 to the horizontal guide rails 192. Lower ends (leftward ends in Fig. 16) 197A of the support pieces 197 of the first kick-in board guide rails 191 are disposed downstream of the kick-in board guide rollers 194 with respect to the upper traveling direction A1, and form a spacing F1 with the inclined rear ends 190 of the lower kick-in board guide rails 157, which spacing is selected to be slightly larger than an outside diameter D3 of the guide rollers 155. Consequently, the guide rollers 155 can pass under the first kick-in board guide rails 191 and, with the direction of movement reversed after the passage, can easily ride on the support pieces 197.

Forward ends (rightward ends in Fig. 16) 198A of the connecting guide rails 198 of the first kick-in board guide rails 191, when each step 137 is guided horizontally along the upper circulating region S1 on the lower floor 131, are smoothly connected to the horizontal guide rails 91 for guiding the kick-in board 138 placed in the retracted position. The forward ends 198A of the connecting guide rails 198 are disposed downstream (rightward in Fig. 16) of the rotary shaft 140 of

the lower sprocket wheels 135 with respect to the upper traveling direction A1.

Forward ends (rightward ends in Fig. 16) 192A of the horizontal guide rails 192 are smoothly continuous with second kick-in board guide rails 193. The second kick-in board guide rails 193 are inclined downward as they extend downstream in the upper traveling direction A1 to guide the guide rollers 155 disposed at the free ends of kick-in boards 138, as the steps 137 travel in the upper traveling direction A1, to place the kick-in boards 138 in the closing position immediately before reaching the transport region S5. Further, small roller guide rails 199 are disposed parallel and opposed to the second kick-in board guide rails 193. The small rollers 161 are guided by these small roller guide rails 199 to guide the kick-in boards 138 in the retracted position reliably to the closing position.

Next, the motion of each kick-in board 138 occurring when the step 137 moves from the lower circulating region S2 to the upper circulating region S1 will be described with reference to Figs. 15-17. As the step 137 traveling horizontally in the lower traveling direction B1 through the lower circulating region S2 on the lower floor 131 reaches a position adjacent the upward transitional region S4 and moves upward along the lower sprocket wheels 135, the guide rollers 155 disposed on the kick-in board 138 are guided by the inclined rear ends 190 of the lower kick-in board guide rails 157, whereby the kick-in

board 138 also is displaced upward. As a result, the kick-in board 138 is guided upward while being maintained in the retracted position. With the guide rollers 155 guided by the inclined rear ends 190 as described above, the lower sprocket wheels 135 rotate and the step 137 is guided in the lower traveling direction B1. Then, the guide rollers 155 pass under the support pieces 197 of the first kick-in board guide rails 191. With a further rotation of the lower sprocket wheels 135, one surface 138A of the kick-in board 138 facing outward contacts the outer peripheral surfaces of the kick-in board guide rollers 194, whereby the guide rollers 155 separate upward from the inclined rear ends 190 of the lower kick-in board guide rails 157.

As the lower sprocket wheels 135 rotate further in this state and one end of the step 137 reaches a middle position in the upward transitional region S4, the traveling direction of the step 137 is reversed from the lower traveling direction B1 to the upper traveling direction A1. The guide rollers 155 mount the support pieces 197 of the first kick-in board guide rails 191 as shown in Fig. 17. The step 137 travels in the upper traveling direction A1. The guide rollers 155 of the kick-in board 138 are guided on the surfaces of the switchable guide members 196 and connecting guide rails 198.

Angle $\theta 3$ formed between a line linking the axis of rotation of the guide rollers 155 and the axis of angular

displacement shaft 164 of the step 137, and the surfaces of the support pieces 197 when the guide rollers 155 mount the support pieces 197 of the first kick-in board guide rails 191, is selected to be in a range $0^\circ < \theta 3 < 90^\circ$. Angle $\theta 4$ formed between a line linking the axis of angular displacement of the kick-in board 138 and the axis of rotation of the guide rollers 155, and the step 137, is selected to be in a range $0^\circ < \theta 4 < 90^\circ$. By selecting $\theta 3$ and $\theta 4$ to occur in time of the guide rollers 155 contacting the support pieces 197 of the first kick-in board guide rails 191 as noted above, when one end of the step 137 moves from the middle position in the upward transitional region S4 toward the upper circulating region S1, with the guide rollers 155 mounting the support pieces 197, the kick-in board 138, while being placed in the retracted position reliably, may be guided upward along the support pieces 197 of the first kick-in board guide rails 191.

In this way, the guide rollers 155 are guided along the first kick-in board guide rails 191, above the rotary shaft 140 of the lower sprocket wheels 135, and to a downstream position in the upper traveling direction A, with the kick-in board 138 placed in the retracted position. Consequently, the kick-in board 138 is prevented from interfering with the rotary shaft 140 of the lower sprocket wheels 135.

As the step 137 travels further in the upper circulating region S1 along the upper traveling direction A1, the guide

rollers 155 are guided along the horizontal guide rails 192. When the guide rollers 155 reach the second kick-in board guide rails 193, the guide rollers 155 contact these second kick-in board guide rails 193 from below, and the small rollers 161 contact the small roller guide rails 199. The guide rollers 155 are guided such that the kick-in board 138 is smoothly placed in the retracted position as the step 137 travels in the upper traveling direction A1. Such guiding action avoids the kick-in board 138 being moved rapidly from the retracted position to the closing position, with the upper end surface 162 of kick-in board colliding with the engaging end 163 of the kick-in board 138, the impact of the collision impairing a smooth running of each step 137. Thus, the kick-in board 138 is placed in the closing position immediately short of the transport region S5 by the second kick-in board guide rails 193.

In this embodiment, the escalator has been described as used for ascending, where each step 137 travels through the upper circulating region S1 from the lower floor 131 toward the upper floor 132. The same effects as of the present invention may be produced when used conversely as a descending escalator.

Fig. 18 is a side view showing an escalator system 200 in a further embodiment of the invention. Like reference signs will be used to identify like elements in the escalator system 130 shown in Figs. 7-17. Stairs 233 where the escalator system 200 is installed have a horizontal landing 201 between a lower

floor 231 and an upper floor 232. The chains 136 extend along the stairs 233 having such landing 201, and the frame 141 is likewise installed along such stairs 233. That is, the escalator system 200 becomes horizontal on the landing 201. In such escalator system 200 also, the steps 137 can circulate along the chains 136 to transport users from the lower floor 131 to the upper floor 132.

Fig. 19 is a side view showing an escalator system 205 in the vicinity of the upper floor 132 in a still further embodiment of the invention. Like reference signs will be used to identify like elements in the escalator system 130 shown in Figs. 7-17. The escalator system 205 has downward kick-in board guide means 206 disposed adjacent the upper sprocket wheels 134 for guiding the guide rollers 155 disposed at the free end of each kick-in board 138 to guide the kick-in board 138, as placed in the retracted position, from the upper circulating region S1 to the lower circulating region S2 when the step 137 moves through the downward transitional region S3 from the upper circulating region S1 to the lower circulating region S2.

Fig. 20 is a side view showing, in enlargement, the vicinity of the downward kick-in board guide means 206. In Fig. 20, the moving path of the chain support shaft 158 of each step 137 is depicted in the form of chain support shafts 158A-158K in phantom lines, in a sequence based on the passage of time. The guide rollers 155 corresponding thereto are depicted in the

form of guide rollers 155A-155K in phantom lines.

Retraction guide members 209 are provided which are inclined upward and as they extend downstream in the upper traveling direction A1 from the forward ends (rightward ends in Fig. 20) of the upper kick-in board guide rails 156 which guide the guide rollers 155 with the kick-in board 138 placed in the closing position while in the upper circulating region S1. When traveling in the upper traveling direction A1 through the extension region S1, the kick-in board 138 is placed in the retracted position by the guide rollers 168 immediately before reaching the downward transitional region S3. At this time, the retraction guide members 209 guide the guide rollers 155 by way of assistance, and prevent the kick-in board 138 from making an angular displacement toward the closing position when the sector gears 166 disengage from the guide rollers 168.

The kick-in board guide means 206 has upper guide members 207 and lower guide members 208. The upper guide members 207 are disposed inwardly of the moving paths of the guide rollers 155 of the kick-in board 138, and have upper guide surfaces 207A for contacting and supporting the guide rollers 155 from below when the chain support shaft 158 disposed at one end of the step 137 moves from the upper end to a middle position of the downward transitional region S3, whereby the kick-in board 138 is placed in the retracted position, and the step 137 is guided in a substantially horizontal state.

The lower guide members 208 are disposed outwardly of the moving paths of the guide rollers 155 of the kick-in board for contacting the guide rollers 155 from below when the chain support shaft 158 disposed at one end of the step 137 moves from the middle position of the downward transitional region S3 to the lower circulating region S2, whereby the kick-in board 138 is placed in the retracted position, and the step 137 is guided in the substantially horizontal state. These lower guide members 208 have arcuate guide rails 213, and lower end guide members 210 inclined from lower ends of the guide rails 213 toward the lower kick-in board guide rails 157 and angularly displaceable about an axis of angular displacement extending in the direction of width in a position rearwardly of the guide rails 213 (rightward in Fig. 20). Inner peripheral surfaces 213A, facing upward, of the guide rails 213 and surfaces 210A, facing upward, of lower end guide members 210 constitute lower guide surfaces of the lower guide members 208. Upward displacement inhibiting members 212 are disposed opposite the lower guide members 208 for inhibiting an upward displacement of the guide rollers 155 guided along the lower guide members 208.

Further, the lower kick-in board guide rails 157 for guiding the guide rollers 155 of the kick-in board 138 in the lower circulating region S2 have forward ends (rightward ends in Fig. 20) 211 thereof inclined upward toward the lower ends

of the guide members 210.

Next, the motion of the kick-in board 138 occurring when the step 137 moves downward through the downward transitional region S3 will be described. With rotation of the upper sprocket wheels 104, the step 137 travels horizontally in the upper traveling direction A1 on the upper floor 131.

Immediately before the chain support shaft 158 reaches the downward transitional region S3, the kick-in board 138 is placed in the retracted position by the guide rollers 168. The positions of the guide rollers 155 at this time are indicated by the guide roller 155C in Fig. 20. When, with a further rotation of the upper sprocket wheels 134 from this state, the chain support shaft 158 of the step 137 is guided arcuately along the downward transitional region S3 to the middle position of the downward transitional region S3, the guide rollers 155 are guided along the arcuate guide surfaces 207A of the upper guide members 207, and the step 137 moves in a substantially horizontal state with the kick-in board 138 placed in the retracted position. As the upper sprocket wheels 134 rotate further, the guide rollers 155 transfer from the upper guide members 207 to the guide rails 213 of the lower guide members 208. The positions of the guide rollers 155 at this time are indicated by the guide roller 155F in a phantom line.

In this way, as the chain support shaft 158 moves from the middle position of the downward transitional region S3

toward the lower circulating region S2, the guide rollers 155 are guided arcuately along the guide rails 213. At this time also, the step 137 is guided in the substantially horizontal state with the kick-in board 138 placed in the retracted position.

The guide rollers 155 guided to the lower ends of the guide rails 213 as noted above transfer to the lower end guide members 210 of the lower guide members 208, and then from these lower end guide members 210 to the forward ends 211 of the lower kick-in board guide rails 157. Since the lower end guide members 210 are capable of angular displacement as noted hereinbefore, an angular adjustment may be made for the guide rails 155 to be guided smoothly from the lower ends of the guide rails 213 toward the forward ends 211 of the lower kick-in board guide rails 157. When shifting from the upper circulating region S1 to the lower circulating region S2, the kick-in board is smoothly guided by the kick-in board guide means 206 while being placed in the retracted position. Consequently, the guide rollers disposed at the free end of the kick-in board are prevented from colliding hard when moving to the lower circulating region S2, as occurs in the prior art, thereby producing noise or impairing a smooth running of each step.

The embodiments of the present invention have been described in relation to the escalator system installed on existing stairs, but they may be installed on a sloping ground,

for example.

Next, simplified mounting means 300, 321 and 331 which are modified forms of the simplified mounting means 146 of the escalator system 130 will be described. Fig. 21 is a sectional view showing the simplified mounting means 300. Fig. 22 is a sectional view seen from cutting plane line XXII-XXII of Fig. 21. The simplified mounting means 300 is used to install the frame 141 of the escalator system 130 in a predetermined position of the stairs 133. By this simplified mounting means 300, the frame 141 is restricted with respect to horizontal displacement, and vertically detachably attached to the stairs 133.

The simplified mounting means 300 has mounting members 305 with upper and lower mounting members 303 and 304. The upper mounting members 303 are bent substantially at right angles at upper ends thereof to define contact pieces 306 for contacting ribs 302 bent substantially at right angles from lower ends of frame 141. The contact pieces 306 of the upper mounting members 303 are inclined to match an inclination of the stairs 133. The ribs 302 of the frame 141 and the contact pieces 306 of the upper mounting members 303 are fixed to each other by bolts 313 and nuts 314.

The lower mounting members 304 are bent substantially at right angles at lower ends thereof to define support pieces 307 for contacting a stair 133 for support.

Main bodies 303A of the upper mounting members 303 and

main bodies 304A of the lower mounting members 304 contacting each other define a pair of slots 310 extending vertically. Through these slots 310, the upper mounting members 303 and the lower mounting members 304 are vertically adjustably fixed to each other by bolts 311 and nuts 312. As a result, the height of mounting members 305 may be adjusted to the stair.

The support pieces 307 of the lower mounting members may be fixedly attached to the stair 133 such as by concrete bolts. However, in this embodiment, recessed grooves 308 are formed in the stair 133 for loosely fitting the shanks of bolts 309, and the shanks of bolts 309 are inserted into these recessed grooves 308 through bolt receiving bores 315 formed in the support pieces 307 and corresponding to the recessed grooves 308, respectively. The bolts 309 and the recessed grooves 308 are provided two each for each support piece 307.

In this way, the mounting members 305 are attached to the stair 133 by the bolts 309 acting as engaging members inserted into the recessed grooves 308. The support pieces 307 are engaged by the bolts 309 having projecting upper portions, whereby the frame 141 of the escalator system 130 is attached with horizontal displacement inhibited. Even when the escalator system 130, during use, is pushed horizontally by users, for example, such displacement is reliably inhibited. Since the bolts 309 are loosely fitted in the recessed grooves 308, the trouble of tightening the bolts 309 is omitted in time

of attachment, whereby the escalator system 130 may be installed conveniently for the stairs. When dismantling the escalator system 130, since the bolts 309 are vertically removably inserted, the escalator system 130 may be removed from the stairs 130 easily only by upwardly pulling out the bolts.

In order to avoid instability of the escalator system 130 in use, gravel, sand, granulated rubber or the like may be filled into the recessed grooves 308 to prevent rattling of the bolts 309 loosely fitted therein. The construction involving filling of the recessed grooves 308 with gravel, sand, granulated rubber or the like is equally applicable to the simplified mounting means 321 and 331 to be described hereinafter. The bolts 309 may be replaced with pins for loosely fitting in the recessed grooves 308, to produce the same effect as the bolts 309.

Further, in attaching the frame 141 to the upper floor 132 and the lower floor 131, upper mounting members with contact pieces 306 extending substantially parallel to the support pieces 307 are used in place of the above-noted upper mounting members 303 with the contact pieces 306 inclined according to the inclination of the stairs.

Fig. 23 is a sectional view showing the simplified mounting means 321. Fig. 24 is a sectional view seen from cutting plane line XXIV-XXIV of Fig. 23. The simplified mounting means 321 is similar to the foregoing simplified

mounting means 300, and the same reference signs are used to identify the corresponding elements.

Support pieces 322 of the lower mounting members 304 for contacting the stair 133 define cutouts 323 extending in a direction parallel to the transverse direction of the escalator system 130. The stair 133 defines a recessed groove 326 extending transversely of the escalator system. This recessed groove 326 receives an engaging plate 324 acting as an engaging member. The engaging plate 324 is a rectangular plate having a pair of upward projections 327 extending in one direction of width at longitudinally opposite ends thereof. The distal ends of these upward projections 327 are bent at right angles to define engaging portions 325.

Such engaging plate 324 is loosely fitted in the recessed groove 326. In this state, the upward projections 327 project upward from the recessed groove 326. The support pieces 322 of the lower mounting members 304 have, with the upward projections 327 of the engaging plate 324 fitted in the cutouts 323, the engaging portions 325 of engaging plate 324 supported on the support pieces 322 of the lower mounting members 304.

Since the simplified mounting means 321 has the mounting members 305 engaged by the engaging plate 324, the frame 141 is reliably inhibited from making a horizontal displacement. When installing the escalator system 130, the escalator system may be lowered to fit the engaging plate 324 into the recessed

groove 326, with the engaging plate 324 engaging the lower mounting members 304 of mounting members 305. Alternatively, with the upper mounting members 303 and lower mounting members 304 separated beforehand, the engaging plate 324 and lower mounting members 304 may be attached to the stair 133 first, and thereafter the upper mounting members 303 fixed to the frame 141 and the lower mounting members 304 may be fixed together.

Fig. 25 is a sectional view showing the simplified mounting means 331. Fig. 26 is a sectional view seen from cutting plane line XXVI-XXVI of Fig. 25. The simplified mounting means 131 is similar to the foregoing simplified mounting means 300 and 321, and the same reference signs are used to identify the corresponding elements.

The stair 133 defines a pair of recessed grooves 337 extending in the ascending and descending direction of stairs 133 (sideways in Fig. 25) and spaced apart transversely of the escalator system. Support pieces 332 of the lower mounting members 304 define receiving bores 333 corresponding to the recessed grooves 337 and disposed adjacent the main bodies 304A of the lower mounting members 304. With support pieces 332 placed in contact with the stair 133, plates 338 acting as engaging members are inserted through the receiving bores 333 formed in the support pieces 332 and into the recessed grooves 337 formed in the stair 133. The ends of plates 338 exposed upward when the plates 338 are inserted define bolt receiving

bores 339. The main bodies 304A of the lower mounting members 304 define bolt receiving bores 340 corresponding to these bolt receiving bores 339.

Thus, the mounting members 305 are fixed to the stair 133 by passing the bolt shank of a long bolt 335 from the bolt receiving bore 340 of the lower mounting member 304 and the bolt receiving bore 339 of the plate 338 at one side, and through the receiving bore 340 of the lower mounting member 304 and the bolt receiving bore 339 of the plate 338 at the other side, and tightening a nut 336 from outside. The mounting members 305 may be attached to the stair 133 reliably and steadily by holding the mounting members 305 between the pair of recessed grooves 337 by means of the long bolt 335 and nut 306. When installing the escalator system 130 on the stairs 133, the frame 141 with the mounting members fixed thereto is placed on the stairs 133, and thereafter the plates 338 are inserted through the receiving bores 333 of the lower mounting members 304 into the recessed grooves 337 and clamped and fixed by the long bolt 335 and nut 336. When removing the escalator system 130 from the stairs 133, the escalator system 130 may be dismantled from the stairs 133 easily by removing the long bolt 335 and nut 336 and pulling out the plates 338.

Fig. 27 is a fragmentary perspective view showing the frame 141 of the escalator system 130. The frame 141 is longitudinally divided into a plurality of divisional frames

341. The escalator system 130 is assembled by interconnecting the divisional frames 341 with connecting plates 342. The length of the division frames 341 is selected to be approximately 5m, which facilitates transportation, assembly and disassembly of the escalator system 130.

Fig. 28 is a sectional view seen from cutting plane line XXVIII-XXVIII of Fig. 27. The divisional frames 341 and the connecting plates 342 are connected by a plurality of bolts 343 and nuts 344. The bolts 343, e.g. stud bolts, are screwed into the divisional frames 341, and then fixed to the divisional frames 341 by welding. The connecting plates 342 define bolt receiving bores corresponding to the bolts 343.

Thus, when installing the escalator system 130 on the stairs 133, the frame 141 is assembled by first attaching the divisional frames 341 in divided state to the stairs 133, thereafter fitting the connecting plates 342 on the bolt 343 fixed to the divisional frames 341, and tightening the nuts 344 from outside. The assembling operation is simplified by dividing the frame 341, as noted above, which is the largest structure. The escalator system 130 is assembled by attaching the chains 136, the steps 137, the handrails 145 and so on after the frame 141 is assembled.

[Industrial Utility]

According to the present invention, the steps of an escalator system travel with the riding surfaces constantly

facing upward, which allows the escalator system to be made thin.

According to the invention, each step has a kick-in board. The kick-in board closes a gap between adjacent steps in a transport region. This avoids an incidence of riding users having the tips of feet or the like pinched between the steps. Such a kick-in board is placed in a retracted position retracted from a closing position in a lower circulating region. As a result, the thickness of the escalator system is reduced, and the escalator system may be made still thinner.

According to the invention, the kick-in board is folded immediately before reaching a downward transitional region. Consequently, the kick-in board moving downward is prevented from interfering with the step in the lower circulating region, and the escalator system may be made thin.

According to the invention, the press portion of angular displacement means provided for each step is pressed by a pressing member disposed in a fixed position. Thus, the kick-in board may be folded reliably by the simple construction, without requiring a drive source such as a motor for each step.

According to the invention, the kick-in board is constantly maintained in the retracted position while in the downward transitional region. Thus, the kick-in board is prevented from hanging down during the downward movement to collide with the step in the lower circulating region.

According to the invention, the kick-in board, during a

downward transition, moves downward in the folded state with the free end thereof supported by a rotation guide member. The rotation guide member having such a simple construction may reliably maintain the kick-in board in the retracted position during the downward transition.

According to the invention, the kick-in board is maintained in the retracted position during an upward transition. The kick-in board is prevented from hanging down to have the free end thereof collide with the step in the lower circulating region.

According to the invention, the escalator system is attachably and detachably installed on existing stairs by simplified mounting means. Thus, the existing stairs may easily be used as the escalator system without performing large-scale construction work. Moreover, since the escalator system of the present invention is the thin type as noted hereinbefore, a sufficient ceiling space may be secured even when placed on the stairs. It may also be detached as necessary.

According to the invention, the simplified mounting means is restricted with respect to horizontal displacement by the vertically insertable and removable engaging members, thereby avoiding a horizontal displacement occurring, for example, when pushed by users. Further, the simplified mounting means is engaged by the vertically insertable and removable engaging members. When dismantling the escalator system, the escalator

system may be detached from the stairs easily by removing the engaging members.



This Sheet Has Been Replaced



WHAT IS CLAIMED IS:

1. An escalator system comprising:

a plurality of steps each having a riding surface for carrying users, and circulating along a series of circulating paths with an upper circulating region and a lower circulating region extending between a lower position and an upper position and continuous with each other through an upward transitional region and a downward transitional region; and

driving means for driving the plurality of steps to travel in a predetermined traveling direction along the circulating paths;

wherein the upper circulating region has a transport region for transporting the users on the riding surfaces in horizontal posture, and the respective steps travel with the riding surfaces constantly facing upward in all the regions including the transport region.

2. The escalator system of claim 1, comprising:

kick-in boards disposed at ends of the steps opposed to the lower position, placed in a closing position for closing a gap between adjacent ones of the steps in the transport region, and placed in a retracted position retracted from the closing position in the lower circulating region.

3. The escalator system of claim 2, wherein the kick-in board



has a proximal end connected for angular displacement to one end of the step to extend downward to assume the closing position in the transport region, the escalator system comprising:

folding means for causing the kick-in board in the closing position to make an angular displacement to the retracted position substantially parallel to the step immediately before reaching the downward transitional region where the step moves from the upper circulating region to the lower circulating region.

4. The escalator system of claim 3, wherein the folding means includes angular displacement means provided for each step, for causing an angular displacement of the kick-in board from the closing position toward the retracted position by pressing a press portion upstream in the traveling direction, and a pressing member disposed in a predetermined fixed position and protruding into a passage of the press portion for pressing the press portion.

5. The escalator system of claim 4, comprising:

downward kick-in board guide means for guiding the kick-in board, as maintained in the retracted position, in the downward transitional region from the upper circulating region to the lower circulating region.



6. The escalator system of claim 5, wherein the downward kick-in board guide means includes a rotation guide member disposed in a space between the upper circulating region and the lower circulating region of the steps to be rotatable with the steps moving through the downward transitional region, while supporting a free end of the kick-in board placed the retracted position.

7. The escalator system of any one of claims 2 to 6, comprising:

upward kick-in board guide means for guiding the kick-in board, as maintained in the retracted position, in the upward transitional region from the lower circulating region to the upper circulating region.

8. The escalator system of any one of claims 1 to 7, comprising:

simplified mounting means for attachable and detachable installation on existing stairs extending between the upper position and the lower position.

9. The escalator system of claim 8, wherein the simplified mounting means has a plurality of engaging members vertically insertable and removable for restricting a horizontal displacement relative to the existing stairs.