(12) UK Patent (19) GB (11) 2 259 068 (13) B

(54) Title of Invention

Escalator apparatus and method of operation

(51) INT CL[5]; **B66B 31/00 23/12**

(21) Application No
9216501.8

(22) Date of filing
03.08.1992

(30) Priority Data

(31) **03195224**

(32) **05.08.1991**

(33) **JP**

(43) Application published
03.03.1993

(45) Patent published
16.11.1994

(52) Domestic classification
(Edition M)
B8A ALA AR15 AW7
E2A AAK ACT A139 A162 A190
U1S S1287 S1827 S2409

(56) Documents cited
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US4557369 A

(58) Field of search

As for published application 2259068 A *viz:*
UK CL(Edition K) **B8A ALA ALB ALC ALD**
INT CL[5] **B66B**
Online **databases : WPI**
updated as appropriate

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FIG. 1

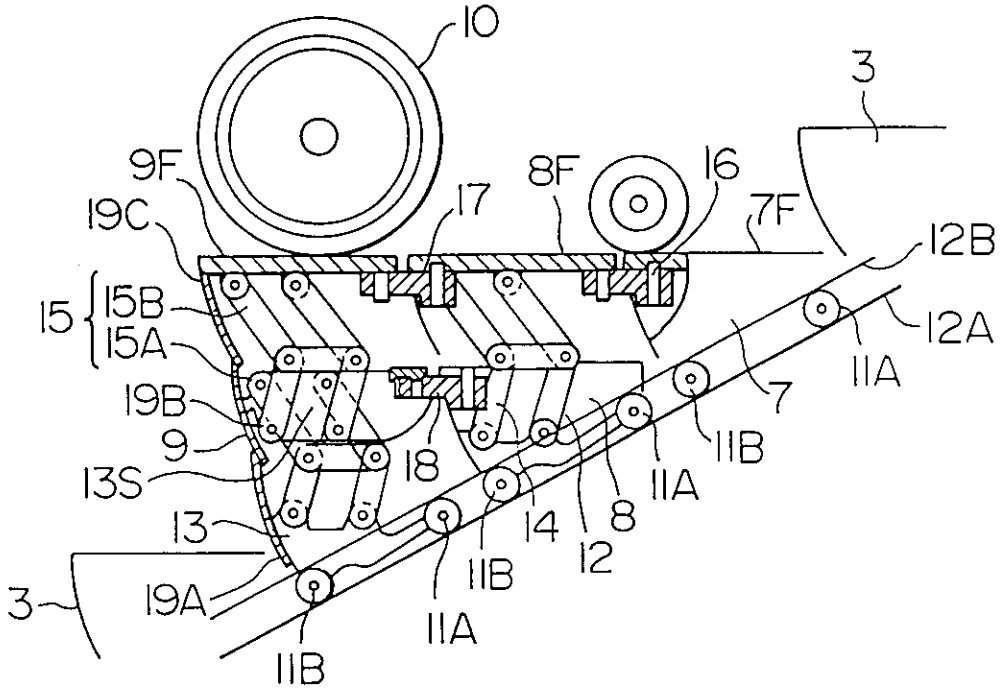


FIG. 2

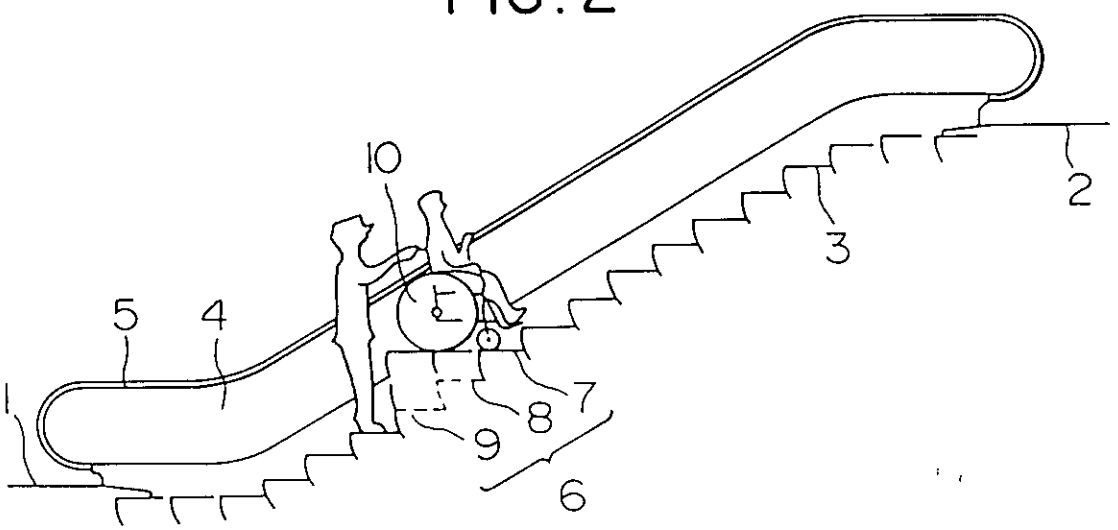


FIG. 3

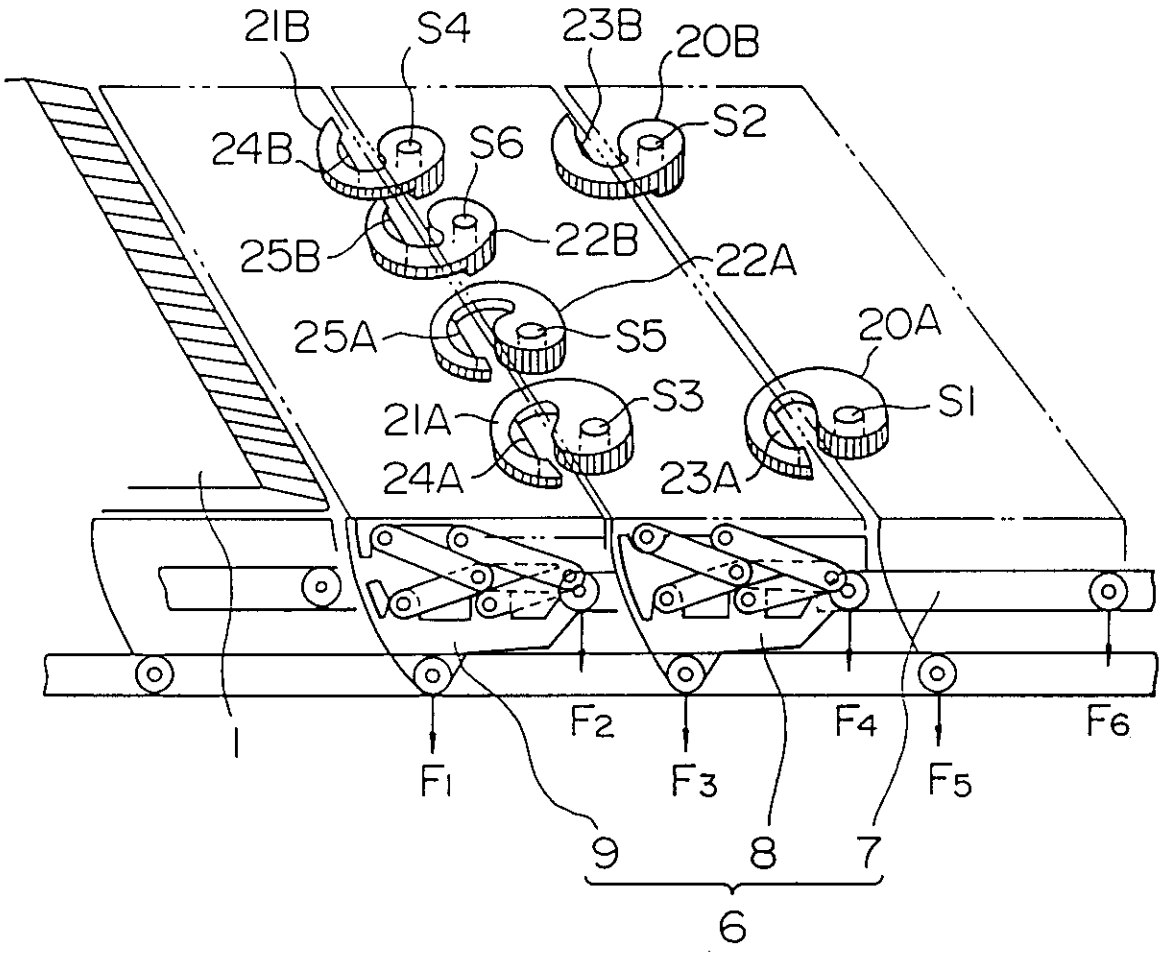

21B
S4
23B
20B
S2
24B
S6
25B
22B
22A
25A
S5
20A
S3
S1
21A
24A
23A
1
F1
F2
F3
F4
F5
F6
9
8
7
6

FIG. 4

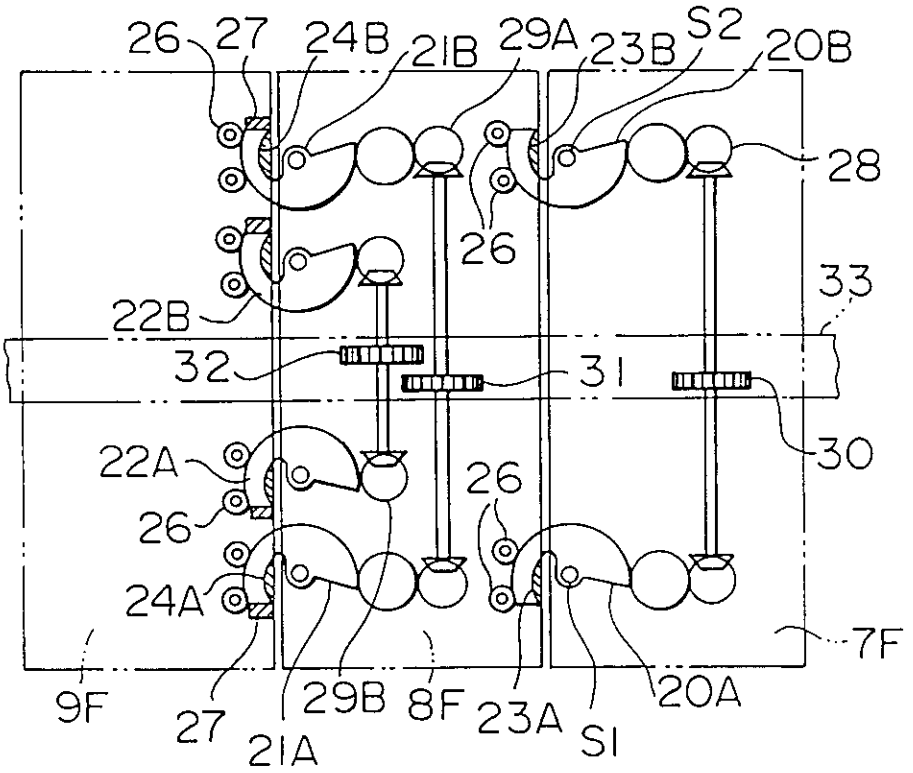

26
27
24B
21B
29A
23B
S2
20B
28
26
33
22B
32
31
30
22A
26
26
24A
7F
9F
27
29B
8F
23A
S1
20A
21A

FIG. 5

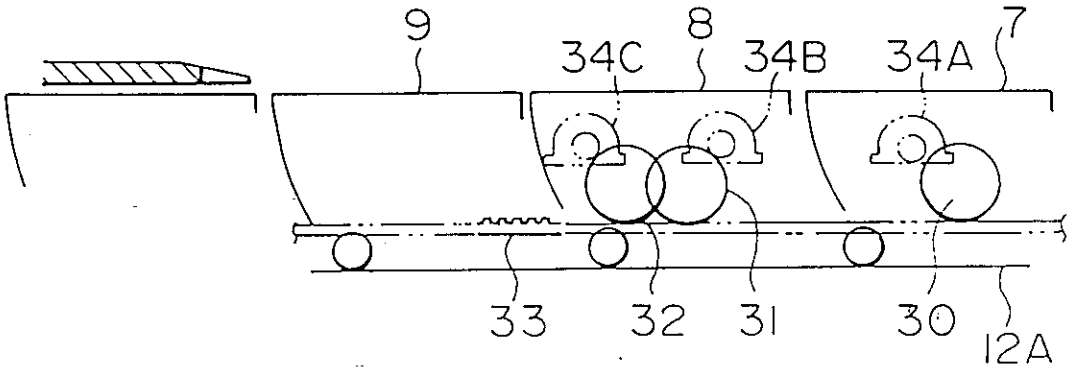

9
34C
8
34B
34A
7
33
32
31
30
12A

FIG. 6

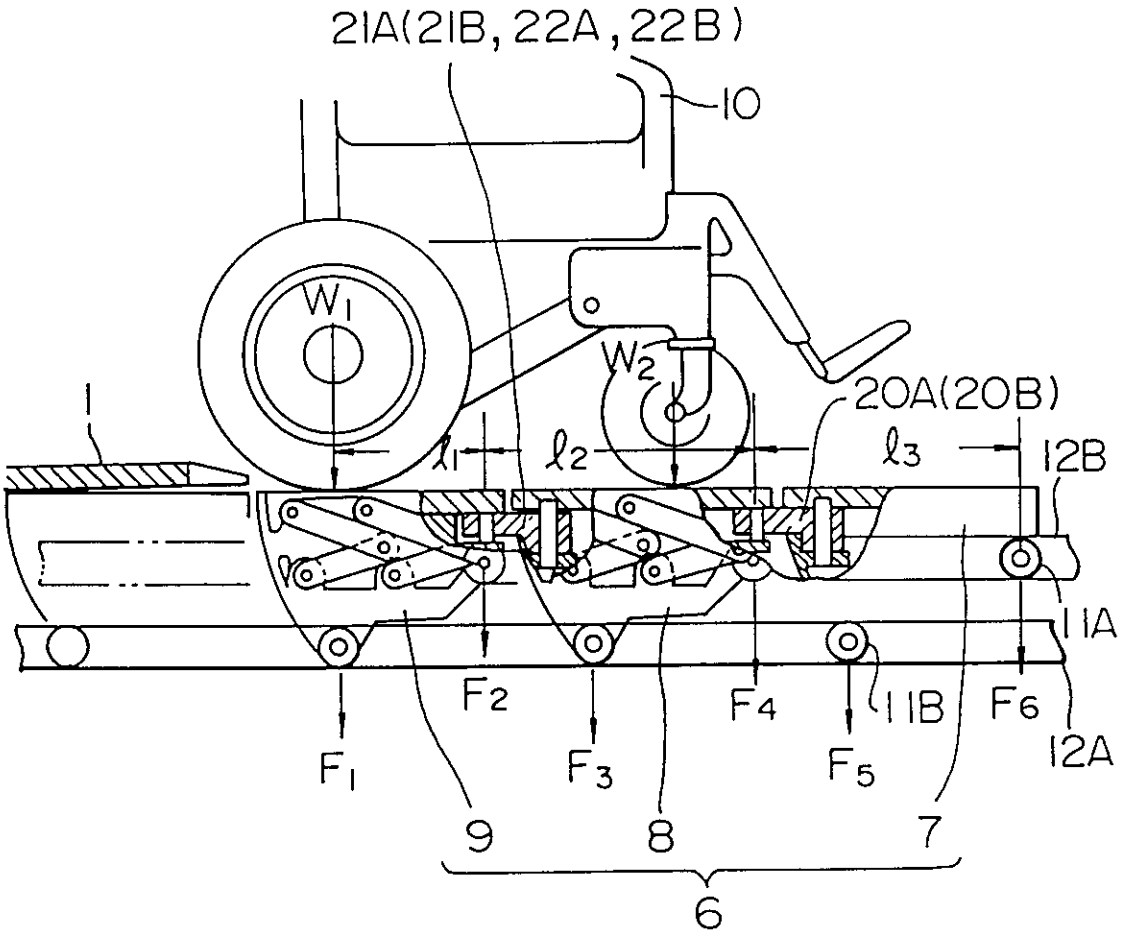

21A(21B, 22A, 22B)
10
W1
W2
1
l1
l2
l3
20A(20B)
12B
11A
11B
12A
F1
F2
F3
F4
F5
F6
9
8
7
6

FIG. 7

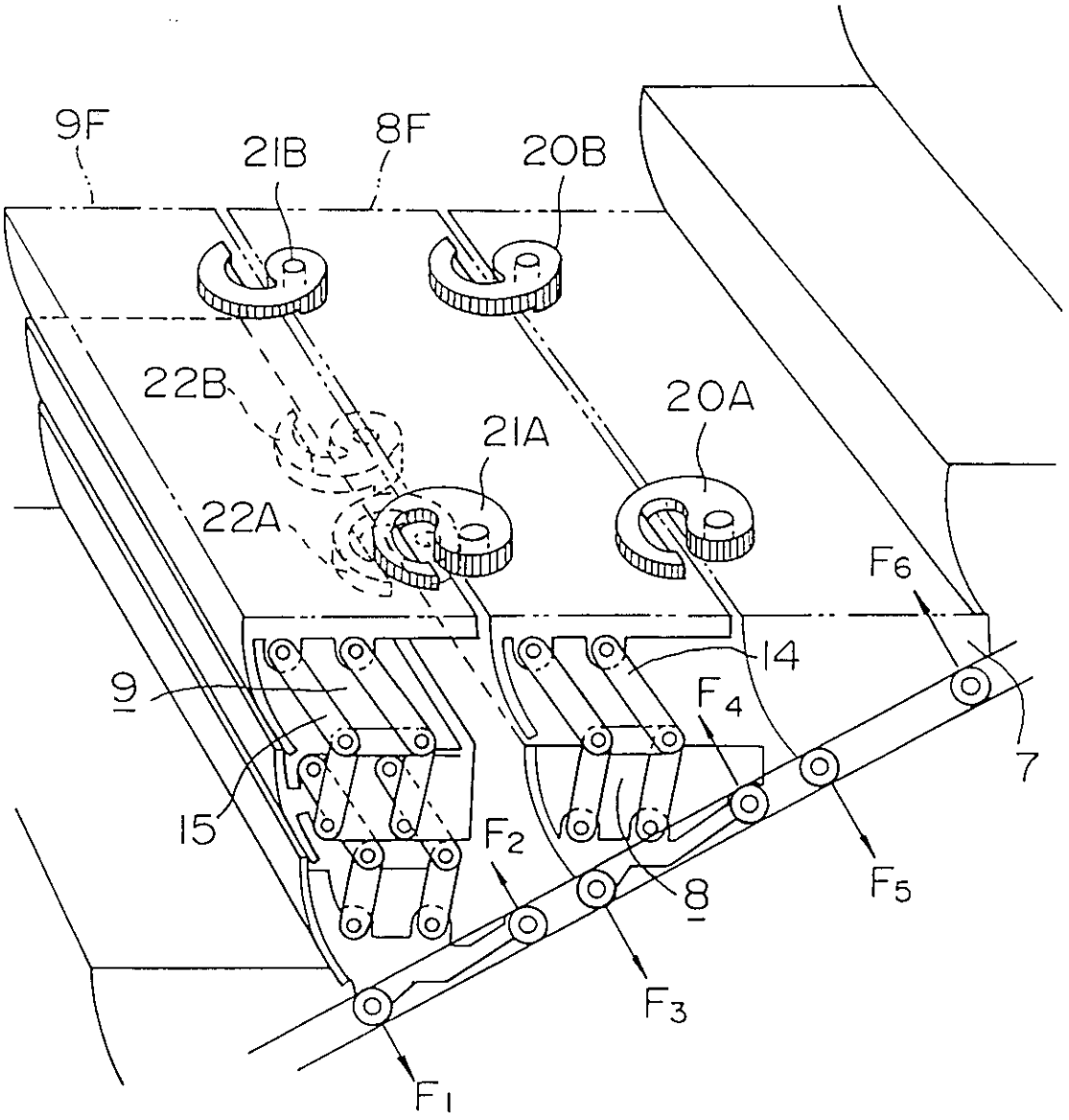


FIG. 8

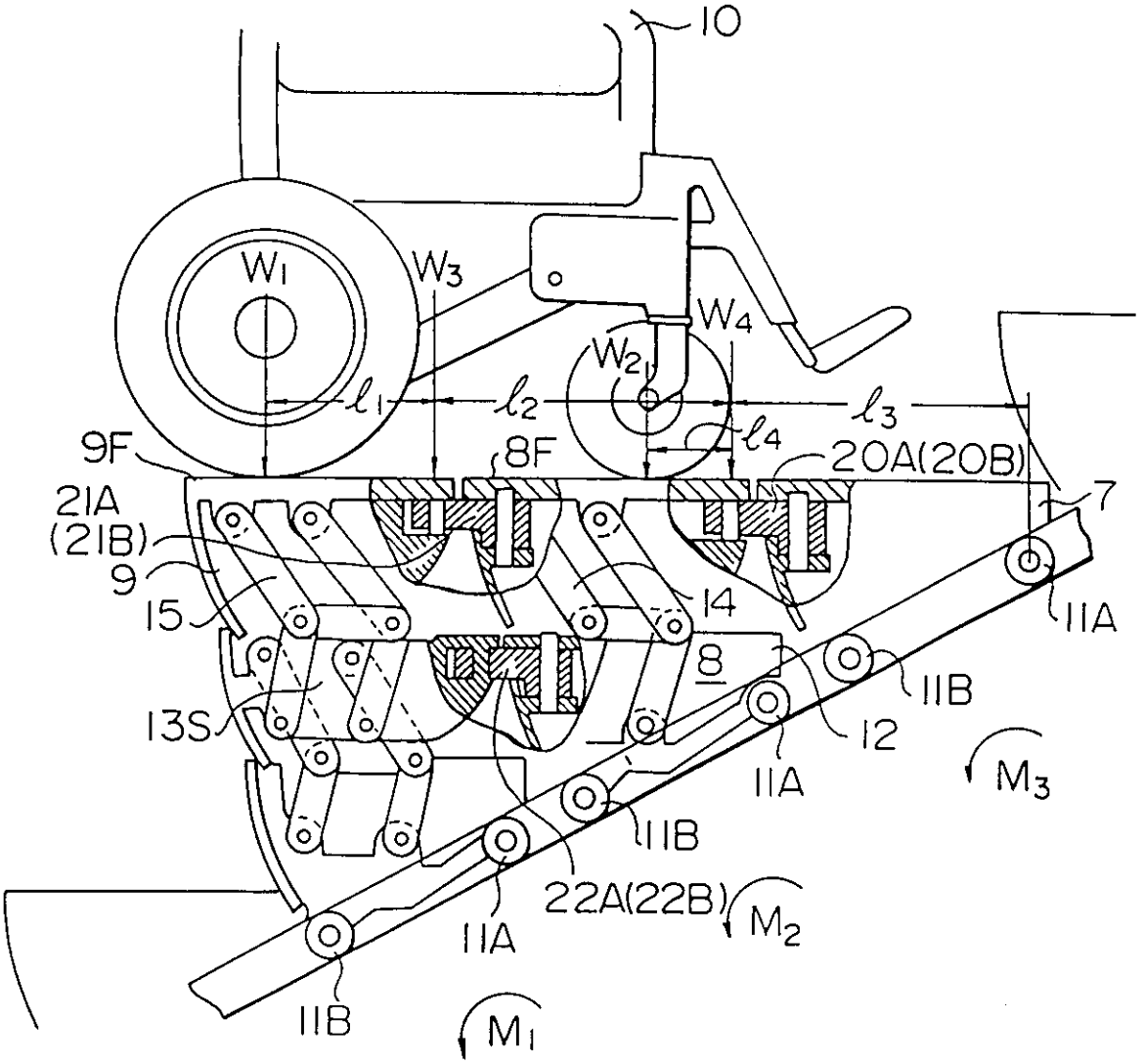

10
W1
W3
W4
W2
ℓ1
ℓ2
ℓ3
ℓ4
9F
8F
20A(20B)
7
21A
(21B)
9
15
14
11A
8
11B
13S
12
11A
M3
11B
22A(22B)
M2
11A
11B
M1

FIG. 9

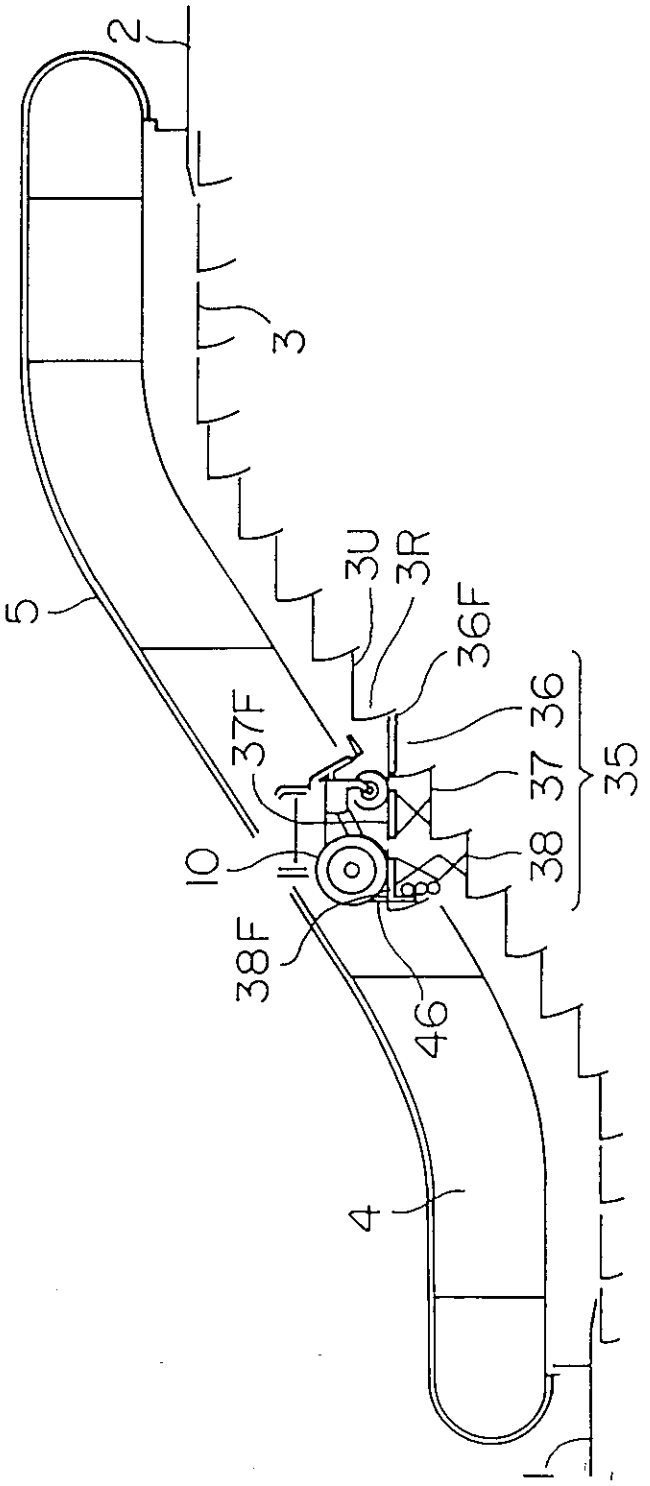


FIG. 10

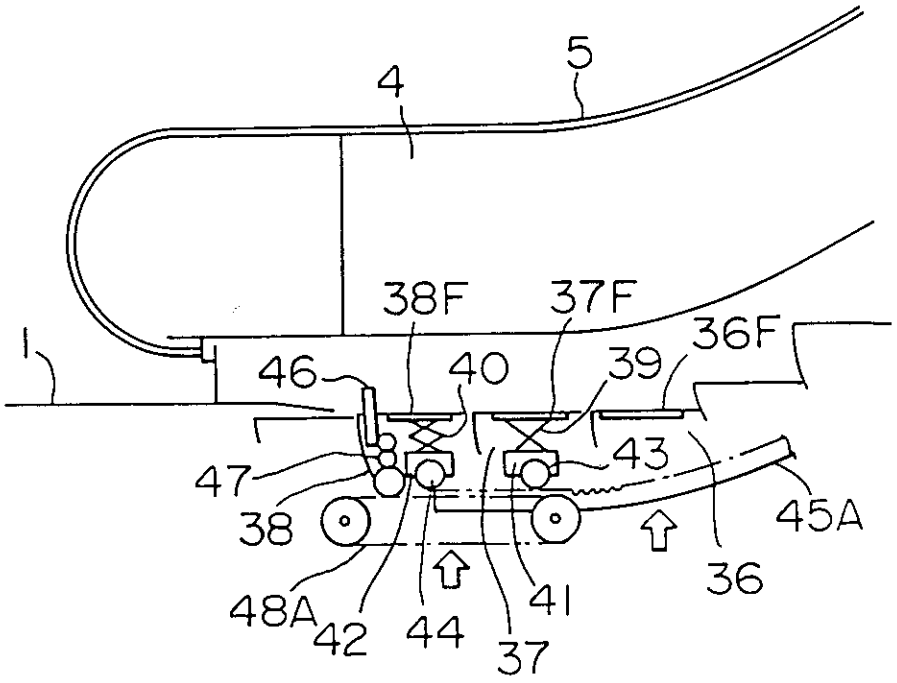

4
5
38F
37F
36F
1
46
40
39
47
43
38
45A
36
48A
42
44
41
37

FIG. 11

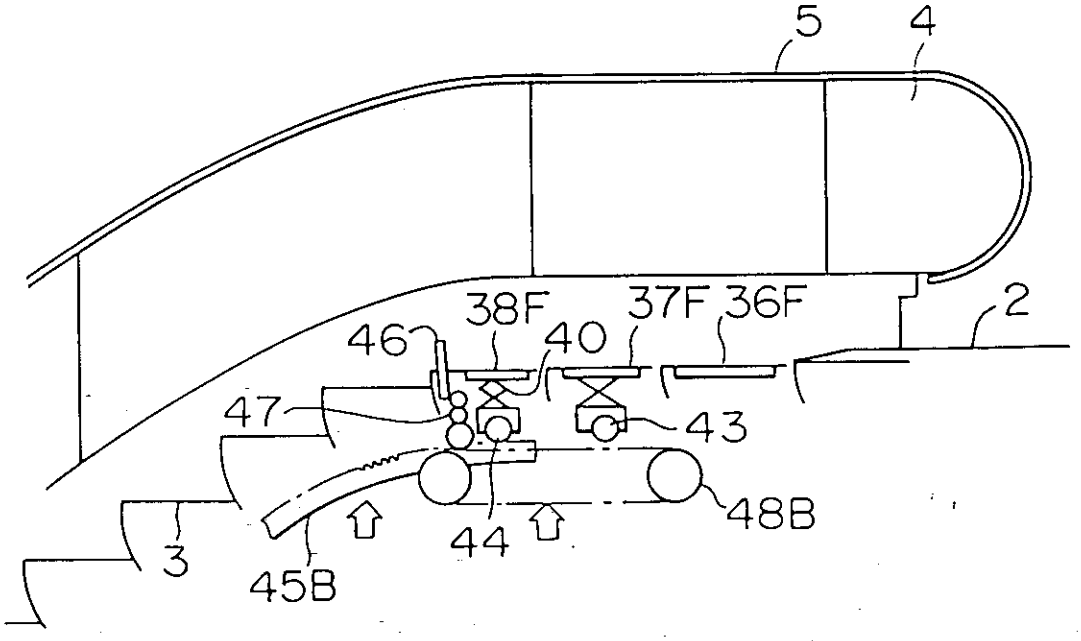
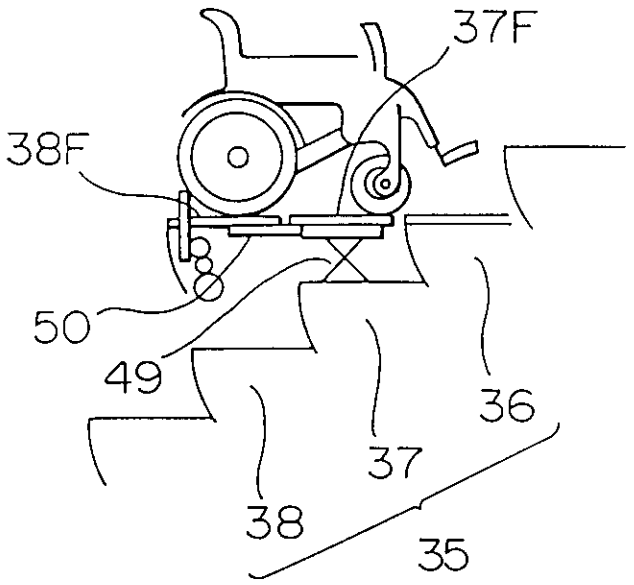

5
4
38F
37F
36F
2
46
40
47
43
48B
3
44
45B

FIG.12



ESCALATOR APPARATUS AND METHOD OF OPERATION

The present invention relates to escalator apparatus which may be used not only by general passengers but also by a person on a wheelchair or by a handcart.

Escalator apparatus adapted to carry a wheelchair in addition to general passengers are disclosed in Japanese Utility Model Publication No. 1-9828, Japanese Unexamined Patent Publication No. 2-8190 and US Patent No. 4,681,207.

The escalator apparatus disclosed in the Japanese Utility Model Publication No. 1-9828 must be of an increased height along its entire length for a special truck to horizontally maintain a plurality of steps and for a rail exclusively used to run such a truck. Thus, there has been a problem that it is impossible to modify an existing escalator apparatus to carry a wheelchair.

The escalator apparatus disclosed in the Japanese Unexamined Patent Publication No. 2-8190 has a plurality of steps horizontally arranged from the outset. Thus, in the case where the sloping angle of the escalator apparatus is relatively gentle and the

apparatus is to be installed for the same height, its installation size becomes relatively large.

Furthermore, in the escalator apparatus disclosed in US Patent No: 4,681,207, a wheelchair carrying surface is formed by two steps. It is thus difficult for this escalator to carry a large size wheelchair or handcart.

According to the present invention there is provided an escalator apparatus including steps having bases movable on a guide rail and movable step boards which are supported by said bases and can be raised to provide a surface for carrying a wheelchair, wherein said movable step boards are those of at least two adjacent steps and are arranged to be movable upwardly and/or downwardly together with a further step board of an upper step adjacent to said at least two adjacent steps, and an inclination suppressing means is provided between said bases and said movable step boards for suppressing inclination of said movable step boards when the latter step boards are in their raised positions.

In this way, the present invention can permit an escalator apparatus to carry a large size wheelchair or a handcart.

The present invention may permit an escalator apparatus to carry a wheelchair without changing the conventional installation size thereof.

With the construction as described above, it is

possible to secure a large horizontal surface for carrying a wheelchair. As a result, it is easy to carry a large size wheelchair or a handcart. At the same time, since ascent and descent of the step boards is performed by the raising/lowering mechanism provided in

the steps, it is not necessary to increase the installation size of the escalator apparatus compared with the conventional size.

In the drawings:

Fig. 1 is a partially sectional side view of a part of an escalator apparatus according to the present invention with the apparatus shown in operation;

Fig. 2 is a schematic side view of the escalator apparatus according to the present invention showing entire operative modes thereof;

Fig. 3 shows in perspective view a coupling mechanism for a special step group of the escalator apparatus according to the present invention;

Fig. 4 is a top plan view showing a power transmission mechanism for the special step group of the escalator apparatus according to the present invention;

Fig. 5 is a side view showing the power transmission mechanism of the special step group of the escalator apparatus according to the present invention;

Fig. 6 is a side view of a part of the escalator apparatus according to the present invention with a wheelchair on the special step group of the apparatus;

Fig. 7 is a perspective view showing respective mechanisms of the special step group at the sloping portion of the escalator apparatus according to the present invention;

Fig. 8 is a perspective view of the special step group and a wheelchair thereon at the sloping portion of the escalator apparatus according to the present invention;

Fig. 9 is a schematic side view showing the entire modes of operation of the escalator apparatus according to another embodiment of the present invention;

Fig. 10 is a schematic side view of a lower entrance/exit section of the apparatus according to the other embodiment of the present invention;

Fig. 11 is a schematic side view of an upper entrance/exit section of the escalator apparatus of the other embodiment of the present invention; and

Fig. 12 is a schematic side view of a wheelchair carried by the escalator apparatus of the other embodiment of the present invention.

An embodiment of the present invention will now be described with reference to Figs. 1 to 8. As shown in Fig. 2, the escalator apparatus according to the present invention has a plurality of steps 3 connected together to form an endless loop arranged to extend and driven to run between a lower entrance/exit 1 and an upper entrance/exit 2 which are provided on a lower floor and an upper floor, respectively, of a construction or building. A railing 4 is raised along each of the two sides of the path of travel of the steps

3. A handrail 5 which rotates in the same direction as the steps 3 is guided by the railing 4. Of the plurality of steps 3, specific three steps 7-9 located next to one another are selected to form a special step group 6. In the special step group 6, an upper step 7 is selected as a reference step. The respective step boards of a middle step 8 and a lower step 9 of the particular step group can be elevated so that a horizontal surface is provided by the special step group 6 to carry a wheelchair 10.

The actual construction and operation of the above described special step group will now be described with reference to Fig. 1 and Figs. 3 to 8. The upper step 7, middle step 8 and lower step 9 of the special step group 6 are respectively provided with a fixed step board 7F and vertically movable step boards 8F and 9F and have front wheels 11A and rear wheels 11B rotatable between and guided by guide rails 12A and 12B which are fixed to a frame body constituting the fixed structure of the escalator. Further, the step boards 8F and 9F are supported through parallel linkages 14 and 15 on bases 12 and 13 on which the front wheels 11A and rear the wheels 11B are mounted. Note that the parallel linkage 15 of the lower step 9 is formed by two sets of linkages, i.e., a first parallel linkage 15A and a second parallel linkage 15B with a middle base 13S interposed therebetween. Furthermore, coupling mechanisms 16 and 17 are provided between the step boards 7F,

8F and 9F to couple them together when a wheelchair is to be carried. A coupling mechanism 18 for coupling the base 12 of the middle step 8 and the middle base 13S of the lower step 9 is also provided. In addition, the lower step 9 is provided with a riser 19A attached to the base 13, a riser 19B attached to the middle base 13S and a riser 13C attached to the step board 9F, the three risers forming a triple superposed structure. On the other hand, the coupling mechanisms 16, 17 and 18 are constructed as shown in Figs. 3 to 5. That is, when the steps 7 to 9 are horizontally positioned, a rack rotating mechanism is rotated by a motor energized by a built-in battery within a step or an external power supply, or by a rack mechanism and driving means within the steps, as shown in Figs. 4 and 5. Fixing hooks 20A, 20B, 21A, 21B, 22A and 22B are thus rotated to fix the steps 7, 8 and 9 together against relative movements in vertical and forward-rearward directions.

When the steps 7, 8 and 9 are horizontally positioned at the lower portion or at the upper portion of the escalator, the vertical load from the wheelchair 10 does not act upon the fixing hooks 20A, 20B, 21A, 21B, 22A and 22B, so that it is easy to engage the fixing hooks. Further, the parallel linkages 14 and 15 which bear the moment generated by the load of the wheelchair 10 do not receive the load and are in their free state. Thus the load from the wheelchair 10 only acts upon the front wheels 11A and the rear wheels 11B

of the steps 7, 8 and 9 as downward loads F1-F6. The fixing hooks 20A are 20B are pivotally supported by shafts S1 and S2 on the lower surface of the step board 7F and are rotatable into engagement with noses 23A and 23B provided on the adjacent step board 8F. The fixing hooks 21A and 21B are rotatably supported by the shafts S3 and S4 on the lower surface of the step board 8F and are rotatable to engage noses 24A and 24B provided on the adjacent step board 9F. Furthermore, the fixing hooks 22A and 22B are supported by means of shafts S5 and S6 on the base 12 of the step 8 and are rotatable to engage noses 25A and 25B provided on the middle base 13S of the adjacent step 9. It should be noted that no jolting is caused after such engagement since the free ends of the fixing hooks 20A, 20B, 21A, 21B, 22A and 22B are engaged with the respective noses 23A, 23B, 24A, 24B, 25A and 25B while they are inserted into the respective spaces formed between these noses and rollers 26 disposed adjacent the noses. Further, the state of engagement may be constantly maintained by a stopper 27 provided at the position corresponding to the terminal end of each fixing hook in its engaged position.

The mechanism for rotating the fixing hooks are drivingly connected to pinions 30-32 beneath the steps 7-9 by a group of power transmission gears 28, 29A and 29B, respectively. These pinions 30-32 are adapted to mesh with racks 34 arranged in parallel to the guide rails 12A, 12B. The racks 34 are disposed in the upper

and lower horizontal portions of the escalator and raised into meshing engagement with the pinions 30-32 only when a wheelchair is to be carried. It should be noted that, instead of the racks 34, motors 34A-34C may be provided in the steps 7 and 8 to drive the pinions.

Fig. 6 shows the state of carrying the wheelchair 10 when the steps 7-9 are in their horizontal state at an entrance/exit. In this state, the fixing hooks 20A-20B of the coupling mechanism are already engaged and extend over adjacent pairs of steps 7 and 8 and 8 and 9. Since, at this time, loads W_1 and W_2 from the wheelchair 10 act directly upon the front wheels 11A and the rear wheels 11B, but not act upon the above-described fixing hooks.

A description will now be given with respect to a case where the special step group carrying the wheelchair 10 is moved to the sloping portion of the escalator. As shown in Figs. 7 and 8, the upper step 7 of the special step group receives loads W_1 and W_2 of the wheelchair 10 through the fixing hooks 20A-22B and the moment caused by said loads is born by the parallel linkages 14 and 15 to distribute the loads to the respective front wheels 11A and rear wheels 11B of the steps 7-9. Loads on the front wheels 11A and rear wheels 11B are thus lowered to an allowable level. Specifically, the lower step 9 is heavily loaded by the wheelchair 10 in the case where the wheelchair is a motor-operated one and is heavy and large in size.

Thus, the upper step 7 and the step board 8F of the middle step 8 are connected in an interlocked manner by means of the fixing hooks 20A and 20B. Further, an interlocked connection is made respectively between the step board 8F and the step board 9F of the lower step 9 by fixing hooks 21A and 21B and between the base 12 and the middle base 12S by the fixing hooks 22A and 22B. In this state, when the upper step 7 is displaced upward as it is moved to the sloped portion of the escalator, the steps 8F and 9F connected to the upper step 7 by the fixing hooks 20A-22B are lifted. At this time, while the step boards 8F and 9F tend to be inclined about the fixing hooks 20A, 20B and 21A, 21B, the parallel linkages 14 and 15 are provided to prevent such inclination. That is, a moment $M_1=W_1 \times \ell_1$ is generated when the load W_1 by the wheelchair 10 acts upon the step board 9F of the lower step 9. Since this moment M_1 is transmitted to the parallel linkage 15, the moment is distributed to the front wheel 11A and the rear wheel 11B of the lower step 9. On the other hand, since the load W_1 is received by the fixing hooks 21A and 21B, the load W_1 acts as a load W_3 at the point of connection. Further, the load acting upon the step board 8F consists of the above-mentioned load W_3 and the load W_2 by the wheelchair 10. When these loads W_2 and W_3 act upon the step board 8F, a total moment M_2 consisting of a moment $W_3 \times \ell_2$ and a moment $W_2 \times \ell_4$ is generated. The moment M_2 is distributed to the front wheel 11A and the rear

wheel 11B of the middle step 8. Further, the loads W_2 and W_3 are received as a load W_4 by the fixing hooks 20A and 20B. The upper step 7 is subjected to the load W_4, the weight of itself and a moment M_3 consisting of W_4 x ℓ_3. At this time, the respective front wheels 11A and rear wheels 11B of the steps 7-9 are subjected to loads F_1-F_6 (Fig. 7).

The operation of the escalator constructed as described will now be described. If it is desired to place a wheelchair on an escalator which is being operated in its usual manner, it is necessary to call a person in charge or to push an operation button provided in the vicinity of an entrance/exit to switch the operation of the escalator to an wheelchair carrying mode. When it is switched to the wheelchair carrying mode, the special step group 6 is stopped in front of the lower entrance 1. At this time, the respective step boards 7F, 8F and 9F of the upper step 7, the middle step 8 and the lower step 9 are horizontally arranged so that the wheelchair 10 can be loaded thereon. Upon detecting that the above described special step group 6 has been stopped at the predetermined position, the rack 33 shown in Figs. 4 and 5 is raised and engaged with the pinions 30-32 incorporated into the steps 7 and 8.

Next, when the escalator is operated by pushing the operation button of the escalator, the pinions 30-32 meshed with the rack 33 are rotated as the steps 7 and 8 are moved. Such rotation is transmitted

by the power transmission gear group 28, 29A and 29B to the fixing hooks 20A-22B to cause them to rotate into locking engagement with the noses 23A-25B of the adjoining step boards 8F and 9F and the middle base 13S. When the steps 7-9 are further moved and enter the sloped portion of the escalator, the upper step 7 is moved upward. At this time, the step boards 8F and 9F of the middle step 8 and the lower step 9 which are coupled to the upper step 7 are concurrently raised upward so that the parallel linkages 14 and 15 are extended. The steps are further moved through the sloped portion while maintaining their horizontal positions (Fig. 1, Fig. 2, Fig. 7, Fig. 8).

In this sloped portion, the step board 9F of the lower step 9 is to be raised by the amount equal to two steps. If nothing is done, a large gap is formed between the step board 9F and the base 13. In the present embodiment, however, the risers 19A-19C constructed in three-fold are provided to prevent the occurrence of such gap.

When the above described special step group 6 reaches the horizontal portion at a higher entrance/exit, the steps 7-9 are brought into the same level, so that the parallel linkages 14 and 15 are contracted. Thus, no difference in level is caused between the step boards 7F-9F. Stopping the special step group 6 at a predetermined position, the wheelchair 10 is moved to the upper entrance/exit and then removed therefrom. It

should be noted that, after the special step group has arrived at the predetermined position, the rack is raised, in a similar manner as at the lower entrance/exit 1, into engagement with the pinions 30-32 and the escalator is again operated in normal mode. The fixing hooks 20A-22B are rotated and disengaged to release the interlocking. This rising of the upper rack may be performed simultaneously with the rising of the lower rack at the lower entrance/exit. After the above described interlocking is released, the rack is lowered to assure that the rack is disengaged from the pinions 30-32 during normal operation of the escalator.

Many movable components are incorporated in the steps 7-9 to raise and lower the step boards 8F and 9F. If, among such movable components, the fixing hooks 20A-22B for example are not securely moved to their predetermined positions, the step boards 8F and 9F are displaced at the time of carrying a wheelchair to receive an excessive stress. In order to detect that each of the fixing hooks is displaced to its predetermined position, it is thus desirable to provide a motion confirming member which is movable with each fixing hook. A sensor is provided for example on the frame of the escalator at a position corresponding to the displaced position of the motion confirming member to check the reliability of motion to perform safe operation.

Further, since the steps 8 and 9 provided with the movable step boards 8F and 9F are reversed in their high and low relationship on the returning side of the escalator. It is thus possible that the step boards 8F and 9F are separated from the bases 12 and 13 due to their own weight and are damaged upon their collision against the bottom of the frame body. Therefore, it is desirable to provide a holding mechanism which holds the step boards 8F and 9F at their predetermined positions during normal operation and releases them from the predetermined positions when a wheelchair is to be carried.

As has been described, according to the above embodiment, the three step boards 7F, 8F and 9F are maintained horizontally even at the sloped portion by the coupling mechanism for coupling the upper step 7 of the special step group 6 to the respective step boards 8F and 9F of the two remaining steps 8 and 9. It is thus possible to carry a large wheelchair without changing the construction of a conventional escalator.

Another embodiment of the present invention will now be described with reference to Figs. 9-11, wherein the reference numerals same as in Figs 1-8 indicate identical components and a repetitive description thereof will be omitted. This embodiment is similar to the foregoing embodiment in that the respective step boards 37F and 38F of middle and lower steps 37 and 38 of a special step group 35 are raised to the

same level as the step board of an upper step 36 when carrying a wheelchair to secure a surface for supporting the wheelchair and that the raising/lowering mechanisms for the step boards 37F and 38F are incorporated in the steps 37 and 38 to make it possible to transport a large size wheelchair or a handcart without changing the installation size of the escalator.

In the embodiment, the respective mechanisms for raising/lowering the step boards 37F and 38F are provided independently from each other in the steps 37 and 38. That is, the step boards 37F are 38F are provided on bases (not shown) equivalent to those in the foregoing embodiment and cross linkages 39 and 40 are so constructed as to be expanded/contracted by power from power transmission gear 41 and 42. The transmission gears 41 and 42 are to be driven by an external driving means. That is, when an instruction for wheelchair carrying operation is given, racks 45A and 45B located respectively at the upper and lower portions of the escalator between the sloped portion and the respective horizontal portions are raised in the direction of the arrows so that the rack 45A is engaged with the pinions 43 and 44 at the lower entrance/exit 1. If the escalator is operated in this state, since the rack 45A is not moved, the pinions 43 are 44 are rotated and the rotating force thereof causes the cross linkages 39 and 40 to be raised through the power transmission gears 41 and 42 so that the step boards 36F-38F of the steps

36-37 are placed in the same level. The steps 37 and 38 after being disengaged from the rack 45A are continued to be moved with the cross linkages 39 and 40 in their raised state. When the pinions 43 and 44 are engaged with the rack 45B at the upper portion, the cross linkages 39 and 40 are lowered as shown in Fig. 11. Before the normal operation is restored, the racks 45A and 45B are lowered to their regular positions.

It should be noted that a wheel stopper 46 projects from the step board 38F of the step 38 and is vertically movable by a power transmission gear 47 incorporated into the step 38. The lower portion of the power transmission gear 47 is engaged by a rack raised from its regular position or by driving chains 48A and 48B. At the side of the lower entrance/exit, therefore, after a wheelchair 10 is placed on the special step group, the wheel stopper 46 is caused to protrude by the operation of the power chain 48A and the escalator is operated in this state. On the other hand, at the upper entrance/exit 2, the power chain 48B is operated after the wheelchair 10 is removed from the escalator to lower the wheel stopper 46. Further, when a wheelchair 10 is to be loaded at the upper entrance/exit 2, the wheel stopper 46 is caused to protrude before the loading. During the movement of the escalator, a stopper is formed by the wheel stopper 46 and a riser 3R of an upper step 3U which is adjacent to the special step group 35. It is thus possible to safely carry the

wheelchair 10 by retaining it within the range of the special step group 35.

Further, since the steps 37 and 38 are independent from the step 36, the arrangement of the preceding embodiment may be incorporated into the present embodiment, if necessary, to assure a safe operation.

Fig. 12 shows another embodiment according to the present invention, in which only a middle step 37 of the special step group 35 is provided with a raising/lowering mechanism 49 for raising/lowering a step board 37F. A step board 38F of a lower step 38 is raised/lowered by a supporting rod 50 which projects from the step board 37F.

As has been described, the present invention provides an escalator apparatus which can carry a large size wheelchair of a handcart and which can be installed in a conventional installation size.

CLAIMS

1. An escalator apparatus including steps having bases movable on a guide rail and movable step boards which are supported by said bases and can be raised to provide a surface for carrying a wheelchair, wherein said movable step boards are those of at least two adjacent steps and are arranged to be movable upwardly and/or downwardly together with a further step board of an upper step adjacent to said at least two adjacent steps, and an inclination suppressing means is provided between said bases and said movable step boards for suppressing inclination of said movable step boards when the latter step boards are in their raised positions.

2. An escalator apparatus according to Claim 1, wherein the step boards of said at least two adjacent steps and said further step board are upwardly movable at the same speed.

3. An escalator apparatus according to Claim 1, wherein the step boards of said at least two adjacent steps are so constructed as to be raised following said further step board.

4. An escalator apparatus according to Claim 1, said steps having said movable step boards accommodate a raising/lowering mechanism for raising said movable step boards of said at least two adjacent steps together with said further step board.

5. An escalator apparatus according to Claim 1, further including coupling means for coupling together the step

boards of said at least two adjacent steps and coupling together said further step board and at least one of the step boards of said at least two adjacent steps to provide said wheelchair carrying surface.

6. An escalator apparatus according to Claim 1, wherein one of said at least two adjacent steps accommodates a raising/lowering mechanism for raising its step board, the movable step board or boards of the other step or steps of said at least two adjacent steps being structured to be raised and lowered by the raising/lowering force of said raising/lowering mechanism.

7. An escalator apparatus according to Claim 1, wherein, when the movable step boards of said at least two adjacent steps are moved to a sloped portion of the escalator apparatus, the loads acting upon said movable step boards are borne partly by upper adjacent step boards, respectively.

8. An escalator apparatus according to Claim 1, wherein said at least two acjacent steps and said upper step adjacent thereto cooperate together to form a special step group, a wheel stopping member is provided on and projects from the step board of the lowest step of said special step group, and said wheel stopping member cooperates with a still further step adjacent to said special step group at the upper side thereof to form means for preventing a wheelchair on said special step group from being moved in the forward and rearward directions of the movement of said escalator apparatus.

9. An escalator apparatus according to Claim 1, wherein

said at least two acjacent steps and said upper step adjacent thereto cooperate together to form a special step group, and said special step group accommodates a movable component element for actuating a sensor provided on a fixed member of said escalator apparatus for confirming motion of said escalator apparatus.

10. An escalator apparatus according to Claim 1, wherein one of said at least two adjacent steps comprises a first riser integral with the movable step board of said one step, a second riser movable upwardly following an upward movement of the last-memtioned movable step board, and a third riser attached to said base.

11. An escalator apparatus according to Claim 1, wherein one of said at least two adjacent steps comprises a middle base supported on the base of said one step through a first inclination suppressing means, and the movable step board of said one step is supported on said middle base through a second inclination suppressing means.

12. An escalator apparatus according to Claim 1, wherein one of said at least two adjacent steps has its movable step board supported on said base through an inclination suppressing means and held by a holding mechanism at a fixed position on said base.

13. An escalator apparatus according to Claim 1, wherein each of said at least two adjacent steps has a raising/lowering mechanism for independently raising/lowering the step board of the step.

14. An escalator apparatus according to Claim 1, wherein said at least two adjacent steps accommodate a

raising/lowering mechanism for raising the step boards of said at least two adjacent steps and said raising/lowering mechanism is actuated by a relative movement between said at least two adjacent steps and a fixed member of said escalator apparatus.

15. An escalator apparatus according to Claim 1, further including coupling means for coupling together the movable step boards of said at least two adjacent steps and for coupling together said further step board and adjacent one of the movable step boards of said at least two adjacent steps.

16. An escalator apparatus according to Claim 15, further including a coupling force imparting mechanism provided on a fixed part of said escalator apparatus for imparting a coupling force to each of said coupling means when the movable step boards of said at least two adjacent steps are at a predetermined position in an entrance of said escalator apparatus and a disengaging force imparting mechanism provided on another fixed part of said escalator apparatus for imparting an uncoupling force to each of said coupling means when the step boards of said at least two adjacent steps are at a predetermined position in an exit of said escalator apparatus.

REGISTER ENTRY FOR GB2259068

Form 1 Application No GB9216501.8 filing date 03.08.1992

Priority claimed:
05.08.1991 in Japan - doc: 03195224

Title ESCALATOR APPARATUS AND METHOD OF OPERATION

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Classified to
B8A E2A U1S
B66B

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Publication No GB2259068 dated 03.03.1993

Examination requested 03.08.1992

Patent Granted with effect from 16.11.1994 (Section 25(1)) with title
ESCALATOR APPARATUS AND METHOD OF OPERATION

09.04.1994 Notification of change of Address For Service address of
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dated 14.03.1994. Written notification filed on GB2270363
Entry Type 7.3 Staff ID. BH Auth ID. HEO

**** END OF REGISTER ENTRY ****

RENEWAL DETAILS

PUBLICATION NUMBER GB2259068

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DATE FILED 03.08.1992

DATE GRANTED 16.11.1994

DATE NEXT RENEWAL DUE 03.08.1996

DATE NOT IN FORCE

DATE OF LAST RENEWAL

YEAR OF LAST RENEWAL 00

STATUS PATENT IN FORCE

**** END OF REPORT ****