

DESCRIPTION

SAFETY SYSTEM FOR PASSENGER CONVEYOR,
PASSENGER CONVEYOR, AND
METHOD OF OPERATING PASSENGER CONVEYOR

FIELD

[0001]

The present embodiment relates to a safety system for a passenger conveyor, a passenger conveyor, and a method of operating a passenger conveyor.

BACKGROUND

[0002]

A passenger with a long object having a long length may get on a passenger conveyor. When the passenger stands still on one of steps and places the long object upright on the step, an upper end of the long object may interfere with a ceiling of a building. When the long object is caught between the step and the ceiling, the step may be restrained. When the step in this condition is further subjected to a driving force, the step may be damaged.

SUMMARY

[0002a]

According to a first aspect, there is provided a safety system for a passenger conveyor including: a long-object determination unit that determines whether a passenger who is going to get on the passenger conveyor holds a long object having a length equal to or more than a reference length; a rise-rate acquisition unit that acquires, when the long-object determination unit determines that the passenger holds the long object, a motor-current rise rate of a drive motor that moves steps in circulation; a rise-rate determination unit that determines, when a motor current value of the drive motor has reached a predetermined overload current value, whether the motor-current rise rate, which was acquired by the rise-rate acquisition unit at a time moment when the

1a

motor current value had reached the overload current value, is equal to or more than a reference rise rate; and a brake control unit that actuates, when the rise-rate determination unit determines that the motor-current rise rate is equal to or more than the reference rise rate, a brake to stop the circulation movement of the steps.

[0002b]

According to a second aspect, there is provided a passenger conveyor including the above safety system for a passenger conveyor.

[0002c]

According to a third aspect, there is provided a method of operating a passenger conveyor including: a step of determining whether a passenger who is going to get on a passenger conveyor holds a long object having a length equal to or more than a reference length; a step of acquiring, when the passenger is determined to hold the long object, a motor-current rise rate of a drive motor that moves steps in circulation; a step of determining, when a motor current value of the drive motor has reached a predetermined overload current value, whether the motor-current rise rate, which was acquired at a time point when the motor current value had reached the overload current value, is equal to or more than a reference rise rate; and a step of actuating, when the motor-current rise rate is determined to be equal to or more than the reference rise rate, a brake to stop the circulation movement of the steps.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003]

Fig. 1 is a view showing an overall schematic structure of a passenger conveyor according to the present embodiment.

Fig. 2 is a view showing a safety system for a passenger conveyor according to the present embodiment.

Fig. 3 is a view for describing an entrance length-

information acquisition unit shown in Fig. 2.

Fig. 4 is a view for describing an exit length-information acquisition unit shown in Fig. 2.

Fig. 5 is a view showing how a motor current value varies
5 as the number of passengers gradually increases.

Fig. 6 is a view showing that a long object held by a passenger is caught between one of steps and a ceiling.

Fig. 7 is a view showing how a motor current value varies
when the long object held by the passenger is caught between
10 the step and the ceiling.

Fig. 8 is a view showing a flowchart in a method of operating a passenger conveyor according to the present embodiment.

15 DETAILED DESCRIPTION

[0004]

A safety system for a passenger conveyor according to the present embodiment comprises a long-object determination unit, a rise-rate acquisition unit, a rise-rate determination unit, and a
20 brake control unit. The long-object determination unit determines whether a passenger who is going to get on the passenger conveyor holds a long object having a length equal to or more than a reference length. The rise-rate acquisition unit acquires, when the long-object determination unit determines
25 that the passenger holds the long object, a motor-current rise rate of a drive motor that moves steps in circulation. The rise-rate determination unit determines, when a motor current value of the drive motor has reached a predetermined overload current value, whether the motor-current rise rate, which was acquired
30 by the rise-rate acquisition unit at a time moment when the motor

current value had reached the overload current value, is equal to or more than a reference rise rate. The brake control unit that actuates, when the rise-rate determination unit determines that the motor-current rise rate is equal to or more than the reference
5 rise rate, a brake to stop the circulation movement of the steps.

[0005]

A passenger conveyor according to the present embodiment comprises the aforementioned safety system for a passenger conveyor.

10 [0006]

A method of operating a passenger conveyor according to the present embodiment comprises: a step of determining whether a passenger who is going to get on a passenger conveyor holds a long object having a length equal to or more than a
15 reference length; a step of acquiring, when the passenger is determined to hold the long object, a motor-current rise rate of a drive motor that moves steps in circulation; a step of determining, when a motor current value of the drive motor has reached a predetermined overload current value, whether the
20 motor-current rise rate, which was acquired at a time point when the motor current value had reached the overload current value, is equal to or more than a reference rise rate; and a step of actuating, when the motor-current rise rate is determined to be equal to or more than the reference rise rate, a brake to stop the
25 circulation movement of the steps.

[0007]

A safety system for a passenger conveyor, a passenger conveyor, and a method of operating a passenger conveyor according to the present embodiment are described herebelow
30 with reference to the drawings.

[0008]

A passenger conveyor 1 according to the present embodiment is described with reference to Fig. 1. Here, an escalator is taken as an example of the passenger conveyor 1.

5 However, the passenger conveyor 1 according to the present embodiment may also be a moving walkway.

[0009]

As shown in Fig. 1, the passenger conveyor 1 comprises a plurality of steps 2, a drive device 3, a pair of parapets 4, a pair of skirts 5, a pair of handrail decks 6, and a pair of handrail belts 7.

[0010]

The steps 2 are coupled by an endless step chain 8. Each step 2 is guided by guide rails 9 to move in circulation between an entrance 10 of a lower floor and an exit 11 of an upper floor. In the present embodiment, an example in which the steps 2 are moved to convey a passenger from the entrance 10 of the lower floor to the exit 11 of the upper floor is described.

[0011]

20 The drive device 3 moves the steps 2 in circulation together with the handrail belts 7. The drive device 3 may include a drive motor 12 and a decelerator 13. The drive device 3 is provided with a brake 14. The brake 14 is configured to be capable of stopping rotation of the drive motor 12 and maintaining the stopped state.

[0012]

A structure for moving the steps 2 in circulation is more specifically described. As shown in Fig. 1, a truss 15 is installed under the floor of a building. An upper machine room 16 is provided on the upper floor side of the truss 15. The drive device

3 and a drive sprocket 17 are housed in the upper machine room 16. Rotation of the drive device 3 is transmitted to the drive sprocket 17 by a drive chain 18. A lower machine room 19 is provided on the lower floor side of the truss 15. A driven sprocket 20 is housed in the lower machine room 19. The aforementioned step chain 8 is wound around the drive sprocket 17 and the driven sprocket 20. When the drive motor 12 of the drive device 3 is driven, the drive sprocket 17 is rotated to move the step chain 8 in circulation. In this manner, the steps 2 are moved in circulation between the entrance 10 and the exit 11 to convey a passenger.

[0013]

The parapets 4 are provided upright on both right and left sides of the steps 2. Each parapet 4 is formed of a transparent member, for example, a glass member. The parapet 4 extends from the entrance 10 of the lower floor up to the exit 11 of the upper floor. The skirt 5 covers a lower part of the corresponding parapet 4. Similarly to the parapet 4, the skirt 5 extends from the entrance 10 toward the exit 11. The handrail deck 6 extends along an outer periphery of the parapet 4. The handrail deck 6 is sometimes referred to as a handrail. The handrail belt 7 is moved while being guided by the handrail deck 6. The handrail belt 7 is moved in a movement direction D in synch with the steps 2. The handrail belt 7 is wound around a handrail belt sheave 21 provided in the truss 15. The handrail belt sheave 21 is configured to rotate in synch with the drive sprocket 17. The handrail belt 7 is moved in circulation by rotation of the handrail belt sheave 21.

[0014]

The handrail deck 6 is provided with a lighting device 22.

The lighting device 22 is formed along the handrail deck 6. The skirt 5 is provided with speakers 23. The speakers 23 are respectively located on the lower floor and the upper floor.

[0015]

- 5 A pair of entrance poles 24 are provided at the entrance
10. A pair of poles 25 are provided at the exit 11.

[0016]

- The passenger conveyor 1 according to the present
embodiment further comprises a safety system for a passenger
10 conveyor 30. The safety system for a passenger conveyor 30
according to the present embodiment is described.

[0017]

- As shown in Fig. 2, the safety system for a passenger
conveyor 30 may comprise an entrance length-information
15 acquisition unit 31, an exit length-information acquisition unit 32,
and a safety device 40.

[0018]

- The entrance length-information acquisition unit 31
acquires length information of a baggage held by a passenger
20 who is going to get on the passenger conveyor 1. As shown in
Fig. 3, the entrance length-information acquisition unit 31 may
include an entrance pole camera 33 and an entrance ceiling
camera 34.

[0019]

- 25 The entrance pole camera 33 is an example of a first
image-capturing unit, and may be provided on one of the
entrance poles 24. The entrance pole camera 33 may be located
above the entrance pole 24. The entrance pole camera 33
images the baggage in a first direction and creates an image.
30 For example, the entrance pole camera 33 images the baggage

from a diagonally front side in the horizontal direction. The front side means a front side of a travel direction of the passenger. The created image includes the baggage. The image of the baggage includes the length information of the baggage.

5 [0020]

The entrance ceiling camera 34 is an example of a second image-capturing unit, and may be provided on a ceiling 26 of the entrance 10. The entrance ceiling camera 34 images the baggage in a second direction which is different from the first
10 direction, and creates an image. For example, the entrance ceiling camera 34 images the baggage vertically from above. The image of the baggage includes the length information of the baggage.

[0021]

15 The exit length-information acquisition unit 32 acquires length information of the baggage held by the passenger who has got out the passenger conveyor 1. As shown in Fig. 4, the exit length-information acquisition unit 32 may include an exit pole camera 35 and an exit ceiling camera 36.

20 [0022]

The exit pole camera 35 is an example of a third image-capturing unit, and may be provided on one of the exit poles 25. The exit pole camera 35 may be located above the exit pole 25. The exit pole camera 35 images the baggage in a third direction
25 and creates an image. For example, the exit pole camera 35 images the baggage from a diagonally rear side in the horizontal direction. The rear side means a rear side of the travel direction of the passenger. The created image includes the baggage. The image of the baggage includes the length information of the
30 baggage.

[0023]

The exit ceiling camera 36 is an example of a fourth image-capturing unit, and may be provided on a ceiling 26 of the exit 11. The exit ceiling camera 36 images the baggage in a fourth direction
5 which is different from the third direction, and creates an image. For example, the exit ceiling camera 36 images the baggage vertically from above. The image of the baggage includes the length information of the baggage.

[0024]

10 Next, the safety device 40 is described. The safety device 40 may include a long-object determination unit 41, a getting-off determination unit 42, a current measurement unit 43, a current determination unit 44, a rise-rate acquisition unit 45, a rise-rate determination unit 46, a brake control unit 47, and a notification
15 unit 49. The safety device 40 may be incorporated in a not-shown control device of the passenger conveyor 1.

[0025]

As shown in Fig. 2, the long-object determination unit 41 determines whether a passenger who is going to get on the
20 passenger conveyor 1 holds a long object 60 having a length equal to or more than a reference length. For example, the long-object determination unit 41 may determine whether a baggage is a long object 60 based on the length information of the baggage, which was acquired by the entrance length-information
25 acquisition unit 31. As described above, the long object 60 is a baggage having a length equal to or more than the reference length.

[0026]

The long-object determination unit 41 according to the
30 present embodiment may calculate a length of the baggage from

an image created by the entrance pole camera 33 and an image created by the entrance ceiling camera 34. For example, from the lengths of the baggage on the respective images, the long-object determination unit 41 may calculate an actual length of the baggage by means of the Pythagorean theorem.

[0027]

In addition, the long-object determination unit 41 may determine whether the length of the baggage is equal to or more than the reference length, by comparing the calculated length of the baggage and the reference length. When the length of the baggage is equal to or more than the reference length, the long-object determination unit 41 may determine that the passenger who is going to get on the passenger conveyor 1 holds the long object 60. The reference length may be a minimum distance between each step 2 of the passenger conveyor 1 and the ceiling 26. The minimum distance may be a distance perpendicular to each step 2. The reference length may be a value including a margin to the minimum length.

[0028]

The getting-off determination unit 42 determines whether a passenger who has just got off the passenger conveyor 1 holds the long object 60. For example, the getting-off determination unit 42 may determine whether a baggage is the long object 60 based on the length information of the baggage, which was acquired by the exit length-information acquisition unit 32.

[0029]

The getting-off determination unit 42 may calculate a length of the baggage from an image created by the exit pole camera 35 and an image created by the exit ceiling camera 36. For example, from the lengths of the baggage on the respective

images, the getting-off determination unit 42 may calculate an actual length of the baggage by means of the Pythagorean theorem.

[0030]

5 In addition, the getting-off determination unit 42 may determine whether the length of the baggage is equal to or more than the reference length, by comparing the calculated length of the baggage and the reference length. When the length of the baggage is equal to or more than the reference length, the
10 getting-off determination unit 42 may determine that the passenger who has got off the passenger conveyor 1 holds the long object 60. From this, the getting-off determination unit 42 may determine that the passenger who holds the long object 60, which was determined by the long-object determination unit 41,
15 has got off the passenger conveyor 1. The reference length may be equal to the reference length used by the long-object determination unit 41.

[0031]

 Alternatively, the getting-off determination unit 42 may
20 determine whether the long object 60 held by the passenger who has got off the passenger conveyor 1 is the same as the long object 60 which was determined by the long-object determination unit 41, by comparing the calculated length of the baggage and the length of the long object 60 which was calculated by the
25 aforementioned long-object determination unit 41. From this, the getting-off determination unit 42 may determine that the passenger who holds the long object 60, which was determined by the long-object determination unit 41, has got off the passenger conveyor 1.

30 [0032]

The current measurement unit 43 measures a value of a motor current (motor current value) flowing through the drive motor 12 that moves the steps 2 in circulation. The current measurement unit 43 may continuously measure the motor current value before the long-object determination unit 41 determines that the passenger who is going to get on the passenger conveyor 1 holds the long object 60. In addition, the current measurement unit 43 may also continuously measure the motor current value after the getting-off determination unit 42 has determined that the passenger who has got off the passenger conveyor 1 holds the long object 60.

[0033]

The current determination unit 44 determines whether the motor current value measured by the current measurement unit 43 has reached a predetermined overload current value. The overload current value may be set as a current value which flows through the drive motor 12 when the number of passengers reaches the capacity, or as a current value at which the drive motor 12 and a system which supplies the drive motor 12 with a current can be protected.

[0034]

When the long-object determination unit 41 determines that a passenger holds the long object 60, the rise-rate acquisition unit 45 may acquire a rise rate of a motor current (motor-current rise rate) flowing through the drive motor 12 which moves the steps 2 in circulation. For example, the rise-rate acquisition unit 45 may calculate the motor-current rise rate from the motor current value of the drive motor 12 which was measured by the aforementioned current measurement unit 43. The motor-current rise rate may be calculated as a change rate

of the motor current value during a predetermined time interval.

[0035]

When the aforementioned getting-off determination unit 42 determines that a passenger who has got off the passenger conveyor 1 holds the long object 60, the rise-rate acquisition unit 45 may stop acquiring the motor-current rise rate.

[0036]

When the motor current value of the drive motor 12 has reached the overload current value, the rise-rate determination unit 46 determines whether the motor-current rise rate, which was acquired by the rise-rate acquisition unit 45 at a time point when the motor current value had reached the overload current value, is equal to or more than a reference rise rate. In other words, at a time point when the motor current value has reached the overload current value, the rise-rate determination unit 46 determines whether the motor-current rise rate, which was calculated immediately before (or which was calculated for the last time) is equal to or more than the reference rise rate. When the current determination unit 44 determines that the motor current value has reached the overload current value, the rise-rate determination unit 46 performs the determination of the motor-current rise rate.

[0037]

The motor-current rise rate is more specifically described with reference to Figs. 5 to 7. Fig. 5 shows how the motor current value varies when the number of passengers on the passenger conveyor 1 gradually increases. Fig. 6 is a view showing that the long object 60 held by a passenger is caught between one of the steps 2 and the ceiling 26. Fig. 7 is a view showing how the motor current value varies when the long object

60 is caught between the step 2 and the ceiling 26.

[0038]

As shown in Fig. 5, when the number of passengers on the passenger conveyor 1 gradually increases, the motor current value gradually and slowly increases and finally reaches the overload current value. In this case, at a time point when the motor current value has reached the overload current value, the motor-current rise rate is relatively small.

[0039]

On the other hand, when the long object 60 is caught between the step 2 and the ceiling 26, the motor-current rise rate is relatively large. More specifically, as shown in Fig. 6, suppose that a passenger standing still on one of the steps 2 places the long object 60 upright on the step 2. When the long object 60 has a length equal to or more than the reference length, an upper end of the long object 60 gradually comes close to the horizontal ceiling 26 as the steps 2 move, and finally comes into contact with the ceiling 26. In this case, the long object 60 may be caught between the step 2 and the ceiling 26. At this time, as shown in Fig. 7, the motor current value sharply increases in a short period of time to reach the overload current value.

[0040]

Although the motor current value reaches the overload current value in both cases, how the motor current value rises differs between the case shown in Fig. 7 and the case shown in Fig. 5. The safety system 30 in the present embodiment utilizes the difference between the rise rates of the motor current values. Thus, whether the long object 60 is caught between the step 2 and the ceiling 26 can be determined by determining whether the motor-current rise rate, which was acquired at a time point when

the motor current value reached the overload current value, is equal to or more than a reference rise rate.

[0041]

As shown in Fig. 2, when the rise-rate determination unit
 5 46 determines that the motor-current rise rate is equal to or more
 than the reference rise rate, the brake control unit 47 actuates
 the brake 14 to stop the circulation movement of the steps 2. In
 this case, the brake 14 stops the rotation of the drive motor 12
 to stop the circulation movement of the steps 2. Actuation of
 10 the brake 14 can more quickly stop the steps 2 than interruption
 of the motor current.

[0042]

When the rise-rate determination unit 46 determines that
 the motor-current rise rate is less than the reference rise rate,
 15 the current control unit 48 stops supplying the motor current to
 the drive motor 12. For example, the current control unit 48
 may actuate a breaker, not shown, to interrupt the motor current.
 This stops the rotation of the drive motor 12. Also when the
 motor-current rise rate is determined to be equal to or more than
 20 the reference rise rate, the current control unit 48 may interrupt
 the motor current to the drive motor 12.

[0043]

When the aforementioned long-object determination unit
 41 determines that a passenger holds the long object 60, the
 25 notification unit 49 may provide the passenger with a warning
 notice to carefully handle the long object 60. For example, the
 notification unit 49 may issue an announcement to carefully
 handle the long object 60 from the aforementioned speakers 23.

[0044]

30 When the aforementioned getting-off determination unit

42 determines that a passenger who has got off the passenger conveyor 1 holds the long object 60, the notification unit 49 may stop the aforementioned warning notice.

[0045]

5 The safety device 40 according to the present embodiment may further include a speed control unit 50. When the long-object determination unit 41 determines that a passenger holds the long object 60, the speed control unit 50 may decrease a movement speed of the steps 2. This allows the passenger
10 holding the long object 60 to safely get on the passenger conveyor 1. The speed control unit 50 may decrease the movement speed of the steps 2 by controlling the drive motor 12 of the aforementioned drive device 3. The speed control unit 50 may decrease the movement speed of the steps 2 at the same
15 time point when the start of the warning notice by the aforementioned notification unit 49 and the stop of the same.

[0046]

 The safety device 40 according to the present embodiment may further include a lighting control unit 51. When the long-
20 object determination unit 41 determines that a passenger holds the long object 60, the lighting control unit 51 may change a lighting mode of the passenger conveyor 1. The lighting control unit 51 may change the lighting mode by controlling the aforementioned lighting device (see Fig. 1). For example, the
25 lighting control unit 51 may change a lighting color of the lighting device 22, or may change the lighting mode of the lighting device 22 from an illumination mode into a blinking mode. The lighting control unit 51 may change the lighting mode of the passenger conveyor 1 at the same time point when the start of the warning
30 notice by the aforementioned notification unit 49 and the stop of

the same. Changing the lighting mode of the passenger conveyor 1 can alert a passenger holding the long object 60 and prevent the long object 60 from interfering with the ceiling 26. This can effectively alert a hearing-impaired.

5 [0047]

Next, a method of operating the passenger conveyor according to the present embodiment as structured above is described. Herein, an operating method shown in a flowchart of Fig. 8 is described by way of example.

10 [0048]

As shown in Fig. 8, after the passenger conveyor 1 has begun the operation, a step S1 is performed in which the entrance length-information acquisition unit 31 acquires length information of a baggage held by a passenger who is going to get on the passenger conveyor 1. For example, images are captured by the entrance pole camera 33 and the entrance ceiling camera 34. The respective captured images are transmitted to the safety device 40.

[0049]

20 After the step S1, a step S2 is performed in which the long-object determination unit 41 determines whether the passenger who is going to get on the passenger conveyor 1 holds a long object 60 having a length equal to or more than a reference length. For example, the length of the baggage is calculated from the respective images, and is compared with the reference length. The length of the baggage, which is determined as the long object 60, may be stored in a storage unit, not shown. When the passenger is determined not to hold a long object 60, the method returns to the aforementioned step S1.

30 [0050]

When the step S2 determines that the passenger holds the long object 60, a step S3 is performed in which the rise-rate acquisition unit 45 acquires a motor-current rise rate flowing through the drive motor 12 which moves the steps 2 in circulation.

5 For example, the motor-current rise rate is calculated from a motor current value of the drive motor 12, which was measured by the aforementioned current measurement unit 43. The calculated motor-current rise rate may be stored in the storage unit, not shown.

10 [0051]

In addition, in the step S3, the notification unit 49 provides the passenger with a warning notice to carefully handle the long object 60. For example, the notification unit 49 issues the announcement to carefully handle the long object 60 from the
15 respective speakers 23 provided on the skirts 5.

[0052]

After the step S3, a step S4 is performed in which the exit length-information acquisition unit 32 acquires length information of a baggage held by a passenger who has got off the
20 passenger conveyor 1. For example, images are captured by the exit pole camera 35 and the exit ceiling camera 36. The respective captured images are transmitted to the safety device 40.

[0053]

25 After the step S4, a step S5 is performed in which the getting-off determination unit 42 determines whether a passenger who has got off the passenger conveyor 1 holds the long object 60. For example, the length of the baggage is calculated from the respective images, and is compared with the
30 reference length.

[0054]

When the step S5 determines that a passenger who has got off the passenger conveyor 1 holds the long object 60, a step S6 is performed in which the rise-rate acquisition unit 45 stops
5 acquiring the motor-current rise rate. When the passenger who has got off the passenger conveyor 1 is determined to hold the long object 60, it can be considered that the passenger who was determined by the step S2 to hold the long object 60 has got off the passenger conveyor 1. Thus, it can be considered that there
10 is no passenger holding the long object 60 on the passenger conveyor 1. In addition, in the step S6, the notification unit 49 stops issuing the announcement to carefully handle the long object 60.

[0055]

15 The method returns to the aforementioned step S1 after the step S6.

[0056]

When the step S5 determines that a passenger who has got off the passenger conveyor 1 does not hold the long object
20 60, a step S7 is performed in which the current determination unit 44 determines whether a motor current value has reached an overload current value. When a passenger who has got off the passenger conveyor 1 is determined not to hold the long object 60, it can be considered that the passenger holding the
25 long object 60 is still on the passenger conveyor 1. When the step S7 determines that the motor current value does not reach the overload current value, the method returns to the step S4.

[0057]

When the step S7 determines that the motor current value
30 has reached the overload current value, a step S8 is performed

in which the rise-rate determination unit 46 determines whether the motor-current rise rate, which was acquired at a time point when the motor current value had reached the predetermined overload current value, is equal to or more than a reference rise
 5 rate.

[0058]

When the step S8 determines that the motor-current rise rate is equal to or more than the reference rise rate, a step S9 is performed in which the brake control unit 47 actuates the brake
 10 14 to stop the circulation movement of the steps 2. When the motor-current rise rate is equal to or more than the reference rise rate, which is shown in Fig. 7, it can be considered that the long object 60 held by the passenger on one of the steps 2 is caught between the step 2 and the ceiling 26 so that the step 2 is
 15 restrained, which is shown in Fig. 6. Thus, the brake 14 is actuated to quickly stop the steps 2. This stops the operation of the passenger conveyor 1.

[0059]

On the other hand, when the step S8 determines that the
 20 motor-current rise rate is less than the reference rise rate, a step S10 is performed in which the current control unit 48 stops supplying a motor current to the drive motor 12. For example, the current control unit 48 may actuate a breaker, not shown, to interrupt the motor current. This stops the rotation of the drive
 25 motor 12 to stop the operation of the passenger conveyor 1. When the motor-current rise rate is less than the reference rise rate, it cannot be considered that the step 2 is restrained by the long object 60 but can be considered that the number of passengers of the passenger conveyor 1 reaches the capacity.
 30 In this case, the brake 14 need not be actuated.

[0060]

According to the present embodiment, when a passenger holding a long object 60 has got on the passenger conveyor 1 and a motor current value has reached a predetermined overload
5 current value, whether a motor-current rise rate, which was acquired at a time point when the motor current value had reached the overload current value, is equal to or more than the reference rise rate is determined. When the motor current increase rate is equal to the more than the reference rise rate,
10 the brake 14 is actuated to stop the circulation movement of the steps 2. In this case, it can be considered that the long object 60 is caught between one of the steps 2 and the ceiling 26 of a building in which the passenger conveyor 1 is installed so that the step 2 is restrained. Thus, the circulation movement of the
15 steps 2 can be quickly stopped by actuating the brake 14, so that the step 2 can be prevented from being damaged.

[0061]

In addition, according to the present embodiment, length information of a baggage held by a passenger who is going to get
20 on the passenger conveyor 1 is acquired, and whether the baggage is the long object 60 or not is determined based on the length information. Thus, whether the passenger who is going to get on the passenger conveyor 1 holds the long object 60 can be determined.

25 [0062]

In addition, according to the present embodiment, the entrance length-information acquisition unit 31 includes the entrance pole camera 33 and the entrance ceiling camera 34 which capture images of the baggage in directions different from
30 each other. This allows the length of the baggage to be precisely

acquired.

[0063]

In addition, according to the present embodiment, whether the passenger holding the long object 60 has got off the passenger conveyor 1 can be determined. When a passenger
5 holding the long object 60 is determined to have got off, the acquisition of the motor-current rise rate of the drive motor 12 is stopped. This allows the operation of the passenger conveyor 1 to return to the original operating state.

10 [0064]

In addition, according to the present embodiment, when a passenger who is going to get on the passenger conveyor 1 is determined to hold the long object 60, the passenger is provided with an announcement to carefully handle the long object 60.
15 This can alert the passenger holding the long object 60 and prevent the long object 60 from interfering with the ceiling 26. This can prevent the long object 60 from being caught between one of the steps 2 and the ceiling 26.

[0065]

20 The above embodiment is described as an example in which the entrance length-information acquisition unit 31 includes the entrance pole camera 33 and the entrance ceiling camera 34. However, the present embodiment is not limited thereto. The positions and the image-capturing directions of the
25 two cameras are optional as long as images of a baggage of a passenger can be captured in two directions different from each other. The same applies to the exit length-information acquisition unit 32.

[0066]

30 The aforementioned embodiment can prevent the step

from being damaged, even when a long object held by a passenger is caught between one of the steps and the ceiling.

[0067]

While some embodiments of the present invention have
5 been described, these embodiments have been presented as
examples, and are not intended to limit the scope of the invention.
These novel embodiments can be implemented in various other
forms, and various omissions, replacements, and alterations can
be made without departing from the gist of the invention. These
10 embodiments and modifications thereof are included in the scope
and gist of the invention, and are included in the invention
described in the claims and the equivalent scope thereof.

CLAIMS

1. A safety system for a passenger conveyor comprising:
 - a long-object determination unit that determines whether a passenger who is going to get on the passenger conveyor holds a long object having a length equal to or more than a reference length;
 - a rise-rate acquisition unit that acquires, when the long-object determination unit determines that the passenger holds the long object, a motor-current rise rate of a drive motor that moves steps in circulation;
 - a rise-rate determination unit that determines, when a motor current value of the drive motor has reached a predetermined overload current value, whether the motor-current rise rate, which was acquired by the rise-rate acquisition unit at a time moment when the motor current value had reached the overload current value, is equal to or more than a reference rise rate; and
 - a brake control unit that actuates, when the rise-rate determination unit determines that the motor-current rise rate is equal to or more than the reference rise rate, a brake to stop the circulation movement of the steps.
2. The safety system of a passenger conveyor according to claim 1, further comprising an entrance length-information acquisition unit that acquires length information of a baggage held by a passenger who is going to get on the conveyor,
 - wherein the long-object determination unit determines whether the baggage is the long object based on the length information acquired by the entrance length-information

acquisition unit.

3. The safety system for a passenger conveyor according to claim 2, wherein

the entrance length-information acquisition unit includes a first image-capturing unit that captures an image of the baggage, and a second image-capturing unit that captures an image of the baggage in a direction different from that of the first image-capturing unit.

4. The safety system for a passenger conveyor according to claim 1, further comprising a getting-off determination unit that determines whether a passenger who has got off the passenger conveyor holds the long object,

wherein, when the getting-off determination unit determines that the passenger holds the long object, the rise-rate acquisition unit stops acquiring the motor-current rise rate.

5. The safety system for a passenger conveyor according to claim 1, further comprising a notification unit that provides, when the long-object determination unit determines that the passenger holds the long object, the passenger with a warning notice to carefully handle the long object.

6. The safety system for a passenger conveyor according to claim 1, further comprising a speed control unit that decreases, when the long-object determination unit determines that the passenger holds the long object, a movement speed of the steps.

7. The safety system for a passenger conveyor according to

claim 1, further comprising a lighting control unit that changes, when the long-object determination unit determines that the passenger holds the long object, a lighting mode of the passenger conveyor.

8. A passenger conveyor comprising the safety system for a passenger conveyor according to any one of claims 1 to 7.

9. A method of operating a passenger conveyor comprising:
a step of determining whether a passenger who is going to get on a passenger conveyor holds a long object having a length equal to or more than a reference length;
a step of acquiring, when the passenger is determined to hold the long object, a motor-current rise rate of a drive motor that moves steps in circulation;
a step of determining, when a motor current value of the drive motor has reached a predetermined overload current value, whether the motor-current rise rate, which was acquired at a time point when the motor current value had reached the overload current value, is equal to or more than a reference rise rate; and
a step of actuating, when the motor-current rise rate is determined to be equal to or more than the reference rise rate, a brake to stop the circulation movement of the steps.