

## PASSENGER CONVEYOR SYSTEM

### FIELD

Embodiments described herein relate generally to a passenger conveyor system.

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### BACKGROUND

Generally, passenger conveyors (for example, escalators, moving walkways and the like) have a structure that can be used as stairs or walkways even when they are not in operation, and therefore even when the passenger conveyor is not in operation, it does not necessarily mean that there are no passengers (users) on the passenger conveyor. If the passenger conveyor is started while there are passengers on it, and the passenger conveyor begins to operate, there is a possibility that accidents such as falls may occur. For this reason, when starting or stopping a passenger conveyor, the facility manager (hereafter referred to as the facility manager) of the facility where the passenger conveyor is installed must visually check that there are no passengers on the passenger conveyor and then start or stop the passenger conveyor.

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Note here that in elevators, information (operation information) which indicates the status of the various devices that constituting the elevator is collected through automatic diagnostic operation. However, as described above, the presence of the facility manager is required when starting and stopping the passenger conveyor, it is difficult in practice to perform automatic diagnostic operation in a way similar to that for elevators.

### SUMMARY

According to one embodiment, a passenger conveyor system diagnoses the status of a passenger conveyor.

The passenger conveyor system comprises a control device and a detection device. The control device controls operation of the passenger conveyor. The detection device is installed near an entrance and exit section of the passenger conveyor and detects a passenger on the passenger conveyor. The control device comprises a storage unit, a determination unit and an information processing unit. The storage unit stores time information indicating a start time at which the passenger conveyor is to be started. The determination unit continuously determines whether or not there is a passenger on the passenger conveyor based on a detection result from the detection device at or after the start time indicated by the time information. The information processing unit starts the passenger conveyor, operates the passenger conveyor in a first operation mode, and diagnoses the status of the passenger conveyor when a result of determination made by the determination unit at the start time indicates that there is no passenger on the passenger conveyor.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram schematically showing an example of a structure of a passenger conveyor system according to one embodiment.

FIG. 2 is a block diagram showing an example a functional structure of some of the elements included in the passenger conveyor system of the embodiment.

FIG. 3 is a flowchart showing an example of the operation of the passenger conveyor system of the embodiment.

#### DETAILED DESCRIPTION

Embodiments will now be described with reference

to the accompanying drawings.

Note that the disclosure is merely an example, and proper changes within the spirit of the invention, which are easily conceivable by a skilled person, are included in the scope of the invention as a matter of course. In addition, in some cases, in order to make the description clearer, the widths, thicknesses, shapes, etc., of the respective parts are schematically illustrated in the drawings, compared to the actual modes. Further, in the specification and drawings, corresponding elements are denoted by like reference numerals, and a detailed description thereof may be omitted unless otherwise necessary.

Further, in the following descriptions, such a case will be provided that the passenger conveyor included in the passenger conveyor system is an "escalator".

FIG. 1 is a diagram an example schematically showing of a structure of a passenger conveyor system according to this embodiment. The passenger conveyor system is a system that includes an escalator 10 and can diagnose the status of various devices that constitute the escalator 10 (a system that can collect operational information on various devices that constitute the escalator 10). As shown in FIG. 1, the escalator 10 is installed at an angle between a lower floor and an upper floor of a building, for example. Note that in the example shown in FIG. 1, it is assumed that the lower floor side is the entrance to the escalator 10 and the upper floor side is the exit.

The escalator 10 shown in FIG. 1 is configured to transport passengers (users) who board steps 11 by circularly moving a plurality of steps 11, which are

coupled to each other without any gaps, between a lower machine chamber 12 (entrance) and an upper machine chamber 13 (exit).

5           The multiple steps 11 are coupled with each other by an endless connecting chain 14 and arranged within a truss 15 installed under the floor of the building. In the truss 15, a lower sprocket 16 and an upper sprocket 17 are arranged and the connecting chain 14 is wound therebetween.

10           In the example shown in FIG. 1, a drive device 18 including a motor, a speed reducer and the like is coupled to the upper sprocket 17. With the drive device 18, the lower sprocket 16 and the upper sprocket 17, which are wound by and connected to the connecting  
15 chain 14 are rotated, and the multiple steps 11 are circularly moved between the lower machine chamber 12 and the upper machine chamber 13 while being guided by a guide rail (not shown) via the connecting chain 14. Note here in FIG. 1, the drive device 18 is connected  
20 to the upper sprocket 17, but the drive device 18 may as well be connected to the lower sprocket 16.

          Further, a pair of skirt guards (not shown in the figure) are installed on an upper part of the truss 15, so as to oppose respective side surfaces of each step  
25 11, along the direction of movement of the steps 11. A parapet 19 is provided to stand on the upper part of each of this pair of skirt guards. In other words, the parapet 19 is provided to stand on each side of each step 11. A belt-like handrail 20 is attached around  
30 the parapet 19. The handrail 20 is a handrail that passengers boarding on the step 11 can hold on to, and for example, it rotates in synchronization with the movement of the steps 11, for example, as the driving

force of the drive device 18 is transmitted thereto.

The entrance and exit of the escalator 10 are located at the top of the lower machine chamber 12 and upper machine chamber 13, and entrance and exit boards 22 and 23 are respectively installed removably in the entrance and exit. The entrance and exit boards 22 and 23 correspond to respective ceilings of the lower machine chamber 12 and upper machine chamber 13. Passengers pass over on the entrance and exit board 22 when boarding the escalator 10 (steps 11), and pass over the entrance and exit board 23 when getting off from the escalator 10 (steps 11).

In the upper machine chamber 13, a control device 21 is installed in addition to the drive device 18. The control device 21 controls the operations of various devices installed in the escalator 10 (for example, the operation of the drive device 18) in order to control the operation of the escalator 10.

A detection device 24 is provided, which is an infrared beam sensor that includes, for example, a light projector 24a and a light receiver 24b, and the light projector 24a and the light receiver 24b are installed in the vicinity of the entrance and exit section so as to oppose each other. For example, the projector 24a is installed on the deck cover near the entrance such that the aperture that emits infrared beam opposes the exit side (towards the light receiver 24b), whereas the receiver 24b is installed on the deck cover near the exit such that the surface thereof that receives the infrared beam opposes the entrance side (towards the projector 24a).

In the vicinity of the control device 21, a remote monitoring device 25 is installed and is connected to

the control device 21 by a cable. Further, the remote monitoring device 25 is connected to a monitoring center (not shown in the figure) in a way that allows communications therebetween.

5           The remote monitoring device 25 transmits to the monitoring center, information indicating the status of the various devices that constitutes the escalator 10 (information on diagnostic results, the details of which will be described later) and information  
10           indicating the operating status of the escalator 10, which are obtained from the control device 21. Further, the remote monitoring device 25 receives various instructions (for example, diagnostic  
15           instructions) from the monitoring center and outputs the received various instructions to the control device 21.

FIG. 2 is a block diagram showing an example of the functional structure of some of the elements included in the passenger conveyor system of this  
20           embodiment. As shown in FIG. 2, the control device 21 is connected to both the detection device 24 and the remote monitoring device 25.

As shown in FIG. 2, the control device 21 comprises a storage unit 21a, a passenger  
25           presence/absence determination unit 21b, an information processing unit 21c, and a drive control unit 21d.

The storage unit 21a stores start time information indicating the start time (the time of start of operation) of the escalator 10. Note that the storage  
30           unit 21a may also store stop time information indicating the stop time (the time of end of operation) of the escalator 10. Further, the storage unit 21a may as well store operation schedule information including

the start time information and stop time information.

The passenger presence/absence determination unit 21b continuously (repeatedly) determines whether or not there is a passenger on the escalator 10 based on the detection results acquired from the detection device 24 after the start time of the escalator 10 indicated by the start time information stored in the storage unit 21a. Note here, for example, at the start time of the escalator 10, the detection device 24 switches the power supply of the detection device 24 from off to on, and starts to irradiate the infrared beam from the projector 24a towards the receiver 24b. Note that the operation is not limited to this, but the detection device 24 may irradiate the infrared beam from the projector 24a towards the receiver 24b at all times. Further, the power of the detection device 24 may be switched from on to off when the series of processes shown in FIG. 3, which will be described later, are completed.

When the result of the determination made by the passenger presence/absence determination unit 21b at the start time indicates that there is no passenger on the escalator 10, the information processing unit 21c starts the escalator 10 and outputs instructions to the operation control unit 21d to set the operation mode of the escalator 10 to a low-speed operation mode (the first operation mode). When the operation control unit 21d receives an instruction from the information processing unit 21c to set the operation mode of the escalator 10 to the low-speed operation mode, it controls the operation of the drive device 18 so as to make the escalator 10 operate at low speed. Note here that the low-energy operation mode is an operation mode

in which the escalator 10 is operated at a moving speed of 10 m/min, for example.

When the result of the determination made by the passenger presence/absence determination unit 21b when low-speed operation is started indicates that there is no passenger on the escalator 10, the information processing unit 21c carries out diagnosis of the various devices that constitute the escalator 10 while operating the escalator 10 in low-speed operation mode.

Further, when the result of the determination made by the passenger presence/absence determination unit 21b when the diagnosis in the low-speed operation mode is completed indicates that there is no passenger on the escalator 10, the information processing unit 21c outputs instructions to the operation control unit 21d to switch the operation mode of the escalator 10 from the low-speed operation mode to an energy-saving operation mode (the second operation mode). When the operation control unit 21d receives instructions from the information processing unit 21c to switch the operation mode of the escalator 10 from the low-speed operation mode to the energy-saving operation mode, it controls the operation of the drive device 18 so as to make the escalator 10 operate in the energy-saving operation mode. The energy-saving operation mode is an operation mode in which the escalator 10 is operated at a moving speed of 20 m/min, for example.

When the result of the determination made by the passenger presence/absence determination unit 21b when the energy-saving operation is started indicates that there is no passenger on the escalator 10, the information processing unit 21c carries out diagnosis of the various devices that constitute the escalator 10

while operating the escalator 10 in the energy-saving operation mode.

Further, when the result of the determination made by the passenger presence/absence determination unit 21b when the diagnosis in the energy-saving operation mode is completed indicates that there is no passenger on the escalator 10, the information processing unit 21c outputs instructions to the operation control unit 21d to switch the operation mode of the escalator 10 from the energy-saving operation mode to a normal operation mode (the third operation mode). When the operation control unit 21d receives an instruction from the information processing unit 21c to switch the escalator 10 from the energy-saving operation mode to the normal operation mode, it controls the operation of the drive device 18 so as to operate the escalator 10 in the normal operation mode. The normal operation mode is an operation mode in which the escalator 10 is operated at a moving speed of 30 m/min, for example.

When the result of the determination made by the passenger presence/absence determination unit 21b when the normal operation is started indicates that there is no passenger on the escalator 10, the information processing unit 21c carries out diagnosis of the various devices that constitute the escalator 10 while operating the escalator 10 in the normal operation mode.

The diagnostic result information indicating the results of the diagnosis performed in each of the low-speed operation mode, energy-saving operation mode, and normal operation mode is stored in the storage unit 21a and also transmitted to the monitoring center (not shown) via the remote monitoring device 25.

Note that when the result of the determination made by the passenger presence/absence determination unit 21b at the start time indicates that there is a passenger on the escalator 10, the information processing unit 21c does not start the escalator 10 because there is a possibility that the passenger will fall.

Further, in the case where the result of the determination made by the passenger presence determination unit 21b when the escalator 10 is started to operate in any of the operation modes or the diagnosis in any of the operation modes is completed, indicates that there is a passenger on the escalator 10, the information processing unit 21c outputs instructions to the operation control unit 21d to switch the operation mode of the escalator 10 to the normal operation mode. In this case, the information processing unit 21c transmits diagnostic result information indicating that the diagnosis of the various devices that constitute the escalator 10 has failed to the monitoring center via the remote monitoring device 25. Alternatively, the information processing unit 21c transmits diagnostic result information indicating the results of the diagnosis carried out before it is determined that there is a passenger on the escalator 10 out of those carried out in these operation modes, to the monitoring center via the remote monitoring device 25.

As shown in FIG. 2, the remote monitoring device 25 comprises a communication unit 25a and a control unit 25b. The communication unit 25a is a communication interface for communicating with the control device 21 and the monitoring center. The

control unit 25b controls the operation of the remote monitoring device 25.

FIG. 3 is a flowchart showing an example of the operation of the passenger conveyor system of this embodiment.

When the start time indicated by the start time information stored in the storage unit 21a arrives (step S1), the passenger presence/absence determination unit 21b determines whether or not there is a passenger on the escalator 10 based on the detection results acquired from the detection device 24 at this timing (step S2).

When the determination in Step S2 determines that there is a passenger on the escalator 10 (Yes in Step S2), the information processing unit 21c does not start the escalator 10 and executes the processing in Step S2 once again.

On the other hand, when the determination in Step S2 determines that there is no passenger on the escalator 10 (No in Step S2), the information processing unit 21c starts the escalator 10 and outputs instructions to the operation control unit 21d to set the operation mode of the escalator 10 to the low-speed operation mode (the first operation mode). The operation control unit 21d controls the operation of the drive device 18 so as to operate the escalator 10 at low speed in accordance with the above-described instructions from the information processing unit 21c (Step S3).

When the escalator 10 is started to operate in the low-speed operation mode, the passenger presence/absence determination unit 21b determines whether or not there is a passenger on the escalator 10

based on the detection results acquired from the detection device 24 at this timing (Step S4).

When the determination in Step S4 determines that there is a passenger on the escalator 10 (Yes in Step S4), the information processing unit 21c outputs instructions to the operation control unit 21d to switch the escalator 10 to the normal operation mode. The operation control unit 21d controls the operation of the drive device 18 so as to operate the escalator 10 in the normal operation mode, in accordance with the above-described instructions from the information processing unit 21c (Step S5). After that, the information processing unit 21c transmits diagnostic result information indicating that the diagnosis of the various devices that constitute the escalator 10 has failed to the monitoring center via the remote monitoring device 25 (in other words, to notify the monitoring center that the diagnosis has failed) (Step S6), and terminates the series of operations here.

On the other hand, when the determination in Step S4 determines that there is no passenger on the escalator 10 (No in Step S4), the information processing unit 21c carries out diagnosis of the various devices that constitute the escalator 10 while operating the escalator 10 in the low-speed operation mode (Step S7).

When the diagnosis in the low-speed operation mode is completed, the passenger presence/absence determination unit 21b determines whether or not there is a passenger on the escalator 10 based on the detection results acquired from the detection device 24 at this timing (Step S8).

If the determination in Step S8 determines that

there is a passenger on the escalator 10 (Yes in Step S8), the processing in Steps S5 and S6 described above is executed in order.

5 On the other hand, when the determination in Step S8 determines that there is no passenger on the escalator 10 (No in Step S8), the information processing unit 21c outputs instructions to the operation control unit 21d to switch the operation mode of the escalator 10 from the low-speed operation mode to the energy-saving operation mode (the second operation mode). The operation control unit 21d controls the operation of the drive device 18 so as to operate the escalator 10 in the energy-saving mode in accordance with the above-described instructions from the information processing unit 21c (Step S9).

15 When the escalator 10 is started to operate in the energy-saving operation mode, the passenger presence/absence determination unit 21b determines whether or not there is a passenger on the escalator 10 based on the detection results acquired from the detection device 24 at this timing (Step S10).

20 When the determination in Step S10 determines that there is a passenger on the escalator 10 (Yes in Step S10), the processing in Steps S5 and S6 described above is executed in order.

25 On the other hand, when the determination in Step S10 determines that there is no passenger on the escalator 10 (No in Step S10), the information processing unit 21c carries out diagnosis of the various devices that constitute the escalator 10 while operating the escalator 10 in the energy-saving operation mode (Step S11).

30 When the diagnosis in the energy-saving operation

mode is completed, the passenger presence/absence determination unit 21b determines whether or not there is a passenger on the escalator 10 based on the detection results acquired from the detection device 24 at this timing (Step S12).

When the determination in Step S12 determines that there is a passenger on the escalator 10 (Yes in Step S12), the processing in Steps S5 and S6 described above is executed in order.

On the other hand, when the determination in Step S12 determines that there is no passenger on the escalator 10 (No in Step S12), the information processing unit 21c outputs instructions to the operation control unit 21d to switch the operation mode of the escalator 10 from the energy-saving operation mode to the normal operation mode (the third operation mode). The operation control unit 21d controls the operation of the drive device 18 so as to operate the escalator 10 in the normal operation mode, in accordance with the above-described instructions from the information processing unit 21c (Step S13).

When the escalator 10 is started to operate in the normal operation mode, the passenger presence/absence determination unit 21b determines whether or not there is a passenger on the escalator 10 based on the detection results acquired from the detection device 24 at this timing (step S14).

When the determination in Step S14 determines that there is a passenger on the escalator 10 (Yes in Step S14), the processing in Steps S5 and S6 described above is executed in order.

On the other hand, when the determination in Step S14 determines that there is no passenger on the

escalator 10 (Step S14 No), the information processing unit 21c carries out diagnosis of the various devices that constitute the escalator 10 while operating the escalator 10 in the normal operation mode (Step S15).

5           After that, the information processing unit 21c transmits (notifies) the diagnostic result information indicating the results of the diagnosis carried out in these operation modes to the monitoring center via the remote monitoring device 25 (Step S16), and terminates  
10 the series of operations here.

          As described above, the passenger conveyor system of this embodiment determines, at a start time indicated by the start time information stored in advance in the storage unit 21a has arrives, whether or  
15 not there is a passenger on the escalator 10 based on detection results acquired from the detection device 24, and starts the escalator 10 when it is determined that there is no passenger. According to this, the escalator 10 can be started safely and automatically,  
20 and therefore there is no need for the facility manager to attend the site to start the escalator 10. Thus, the burden on the facility manager can be reduced.

          Further, the passenger conveyor system of this embodiment operates the escalator 10 when starting it,  
25 in the low-speed operation mode, energy-saving operation mode, and normal operation mode, which have different moving speeds, in order, and carries out diagnosis of the various devices that constitute the escalator 10. With this configuration, it is possible  
30 to perform automatic diagnosis of the escalator 10 each time the escalator 10 is started, and therefore abnormalities that may occur in the escalator 10 can be detected at an early stage. In addition, maintenance

staff can perform regular inspections based on the results of the automatic diagnosis performed each time the escalator 10 is started, and therefore it is further possible to expect a reduction in the number of operation steps required for regular periodical inspections (in other words, a reduction in the burden on maintenance staff during regular inspections).

Note that this embodiment is described in connection with the case where the escalator 10 is started safely and automatically, but it is also possible to stop the escalator 10 safely and automatically by performing processing similar to that of the time when starting the escalator 10 (that is, by executing the processing of steps S1 and S2 shown in FIG. 3). With this configuration, the burden on facility managers can be reduced not only when the escalator 10 is started, but also when the escalator 10 is stopped.

Further, this embodiment is described in connection the case where the diagnosis of the various devices that constitute the escalator 10 is carried out when the escalator 10 is started, but the embodiment is not limited to this case. Note that the diagnosis of the various devices that constitute the escalator 10 may be carried out, for example, when the escalator 10 is stopped. In this case, the information processing unit 21c can perform the diagnosis in each of the operation modes by, for example, sequentially shifting the operation mode of the escalator 10 through the normal operation mode, energy-saving operation mode, and low-speed operation mode.

Furthermore, the diagnosis of the various devices that constitute the escalator 10 may be carried out not

when the escalator 10 is started or stopped, but at the timing when the operation mode is switched during operation.

5       Note that this embodiment is described on an assumption case where the detection device 24 is an infrared beam sensor, but the embodiment is not limited to this case. Note that the detection device 24 can be any device that can detect whether there is a passenger on the escalator 10. For example, the detection device  
10       24 can be a camera attached to a sensor pole that can pick up images of the escalator 10.

      Further, note that this embodiment is described on an assumption case where the passenger conveyor included in the passenger conveyor system is an  
15       escalator 10, but the embodiment is not limited to this case. For example, the passenger conveyor included in the passenger conveyor system may as well be a moving walkway.

      According to the embodiment described above, it is  
20       possible to provide a passenger conveyor system that can start the passenger conveyor without the attendance of the facility manager and diagnose the status of the passenger conveyor.

      While certain embodiments have been described,  
25       these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and  
30       changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or

modifications as would fall within the scope and spirit of the inventions.

WHAT IS CLAIMED IS:

1. A passenger conveyor system for diagnosing a status of a passenger conveyor, the system comprising:

5 a control device which controls operation of the passenger conveyor;

a detection device installed near an entrance and exit section of the passenger conveyor, which detects a passenger on the passenger conveyor,

the control device comprising:

10 a storage unit which stores time information indicating a start time at which the passenger conveyor is to be started;

15 a determination unit that continuously determines whether or not there is a passenger on the passenger conveyor based on a detection result from the detection device at or after the start time indicated by the time information; and

20 an information processing unit which starts the passenger conveyor, operates the passenger conveyor in a first operation mode, and diagnoses the status of the passenger conveyor when a result of determination made by the determination unit at the start time indicates that there is no passenger on the passenger conveyor.

25 2. The passenger conveyor system of claim 1, wherein

30 the information processing unit operates, when a result of determination made by the determination unit when the diagnosis in the first operation mode is completed indicates that there is no passenger on the passenger conveyor, the passenger conveyor in a second operation mode, which has a faster moving speed than that of the first operation mode, and further diagnoses the status of the passenger conveyor, and

operates, when a result of determination made by the determination unit when the diagnosis in the second operation mode is completed indicates that there is no passenger on the passenger conveyor, the passenger conveyor in a third operation mode, which has a faster moving speed than that of the second operation mode, and further diagnoses the status of the passenger conveyor.

3. The passenger conveyor system of claim 2, wherein

the information processing unit transmits diagnostic result information indicating results of the diagnosis carried out in each of the respective operation modes to a monitoring center via a remote monitoring device connected to the control device.

4. The passenger conveyor system of claim 3, wherein

the information processing unit, when the result of the determination made by the determination unit at the start time indicates that there is a passenger on the passenger conveyor, does not start the passenger conveyor, and

transmits, when the result of the determination made by the determination unit when the diagnosis in the first operation mode is completed or when the result of the determination made by the determination unit when the diagnosis in the second operation mode is completed indicates that there is a passenger on the passenger conveyor, diagnosis result information indicating that the diagnosis has failed to the monitoring center.

5. The passenger conveyor system of claim 3, wherein

the information processing unit, when the result of the determination made by the determination unit at the start time indicates that there is a passenger on the passenger conveyor, does not start the passenger conveyor,

transmits, when the result of the determination made by the determination unit when the diagnosis in the first operation mode is completed indicates that there is a passenger on the passenger conveyor, diagnosis result information indicating the result of the diagnosis in the first operation mode to the monitoring center, and

transmits, when the result of the determination made by the determination unit when the diagnosis in the second operation mode is completed indicates that there is a passenger on the passenger conveyor, diagnosis result information indicating the result of the diagnosis carried out in each of the first operation mode and the second operation mode to the monitoring center.

6. The passenger conveyor system of claim 2, wherein

the first operation mode is a low-speed operation mode,

the second operation mode is an energy-saving operation mode, and

the third operation mode is a normal operation mode.

7. The passenger conveyor system of claim 1, wherein

the detection device is an infrared beam sensor which includes a light projector and a light receiver,

the projector is installed on a deck cover near an

entrance in such manner that an irradiation aperture  
for irradiating an infrared beam opposes an exit side,  
and

5       the receiver is installed on a deck cover near an  
exit in such manner that a light receiving surface for  
receiving an infrared beam opposes an entrance side.

8.   The passenger conveyor system of claim 1,  
wherein  
the detection device is a camera which can pick up  
10   images of the passenger conveyor.