

[DESCRIPTION]

[Title of Invention] MOVING HANDRAIL FLAW DETECTION APPARATUS FOR PASSENGER CONVEYOR

[Technical Field]

[0001]

The present invention relates to a moving handrail flaw detection apparatus for a passenger conveyor. Particularly, it relates to a flaw detection apparatus which is used for diagnosing internal deterioration in a moving handrail provided in a passenger conveyor such as an escalator or a moving walkway.

[Background Art]

[0002]

For example, an invention described in JP-A-2011-225333 (Patent Literature 1) has been known as this type technique. According to this invention, there is provided a moving handrail flaw detection apparatus for a passenger conveyor, including a roller which is attached to a state detection unit and disposed to come into contact with a moving handrail so as to rotate in accordance with movement or relative movement of the moving handrail, an optical detection unit which is attached to the state detection unit so as to detect an amount of rotational displacement in the roller, and a checking unit which checks a result of a state detected by the

state detection unit against a result of a state detected by the optical detection unit and carries out processing for continuously join the result of the state detected by the state detection unit and selected by this checking. With this configuration, the invention can reduce a measuring error of a position or a velocity in each part of the moving handrail even when time-related deterioration occurs in the surface of the moving handrail.

[Citation List]

[Patent Literature]

[0003]

[Patent Literature 1] JP-A-2011-225333

[Summary of Invention]

[Technical Problem]

[0004]

In the aforementioned invention described in Patent Literature 1, a worker manually moves the moving handrail flaw detection apparatus. It is therefore difficult to move the moving handrail flaw detection apparatus at a constant velocity. Therefore, when the moving handrail is scanned at a constant time interval and radiographic images acquired thus are checked against each other, there is a variation in moving distance, so that an accurate image for each distance cannot be created. As a result, it is difficult to perform

flaw detection with high accuracy.

[0005]

On the other hand, in order to perform flaw detection with high accuracy, configuration may be made in such a manner that a motor is mounted in the flaw detection apparatus so that the rotation of the motor can be controlled to move the moving handrail flaw detection apparatus at a constant velocity. However, such a configuration makes the apparatus so huge as to deteriorate the workability and increase the cost.

[0006]

Therefore, an object of the invention is to make it possible to perform flaw detection with high accuracy in a simple apparatus and to improve the workability.

[Solution to Problem]

[0007]

In order to attain the foregoing object, the invention provides a moving handrail flaw detection apparatus for a passenger conveyor, including: a flaw detection unit; and a movement amount measuring unit which measures a movement amount of the flaw detection unit; wherein: the movement amount measuring unit includes a moving mechanism which moves the flaw detection unit at a constant velocity and along a longitudinal direction of the moving handrail.

[Advantageous Effects of Invention]

[0008]

According to the invention, flaw detection can be performed with high accuracy in a simple apparatus, and the workability can be also improved.

[Brief Description of Drawings]

[0009]

[Fig. 1] A main portion perspective view showing the configuration of an escalator as a general passenger conveyor.

[Fig. 2] A view showing a state when flaw detection work is carried out using a moving handrail flaw detection apparatus according to an embodiment of the invention.

[Fig. 3] A front view of a moving distance measuring device according to the embodiment of the invention, which is mounted on a moving handrail.

[Fig. 4] A sectional view taken on line A-A in Fig. 3.

[Fig. 5] A plan view of Fig. 3.

[Fig. 6] An explanatory view showing an image processing process according to the background art.

[Fig. 7] An explanatory view showing an image processing process according to the invention.

[Description of Embodiments]

[0010]

An embodiment of the invention will be described below with reference to the drawings.

[0011]

Fig. 1 is a main portion perspective view showing the configuration of an escalator as a general passenger conveyor. Besides the escalator, a moving walkway may be another example of the passenger conveyor. This embodiment will be described while the escalator is used as an example.

[0012]

In Fig. 1, an escalator 100 has steps 1 on which passengers stand, and moving handrails 2 moving in the same direction as the travelling direction of the steps 1. The moving handrails 2 are provided on opposite, left and right sides of the steps 1 with respect to the travelling direction of the steps 1.

[0013]

Each moving handrail 2 is arranged to be endless so that the moving handrail 2 can circulate along a balustrade 3 provided on corresponding one of the opposite sides of the steps 1 and in parallel with the movement direction of the steps 1. That is, the moving handrail 2 moves in the same direction as the travelling direction of the steps 1 when the moving handrail 2 is on an upper side of

the balustrade 3. Once the moving handrail 2 reaches an end portion of the balustrade 3, the moving handrail 2 moves downwards while drawing an arc. The moving handrail 2 which has been turned upside down thus is pulled into a deck 1a provided with a skirt guard and so on. Then, the moving handrail 2 passing through the inside of the deck 1a reaches an opposite end portion of the balustrade 3. The moving handrail 2 which has been turned upside down gets out of the deck 1a, moves upwards while drawing an arc, and returns to the upper side of the balustrade 3. Each moving handrail 2 circulates in this manner. In addition, a drive unit or the like for driving the moving handrails 2 is provided inside the deck 1a.

[0014]

Fig. 2 is a view showing a state when flaw detection work is carried out using a moving handrail flaw detection apparatus according to an embodiment of the invention. A moving handrail flaw detection apparatus S according to the embodiment is constituted by an X-ray device 4, an X-ray control device 5, a personal computer 6, and a moving distance measuring device 7. The X-ray device 4 and the moving distance measuring device 7 are linked by a link plate 29 so as to move integrally. The X-ray control device 5 is a device for controlling the X-ray device 4 to execute non-destructive inspection. The personal computer 6 is connected to the X-ray control device

5 so that data of a taken image can be imported into the personal
computer 6 and displayed on a display.

[0015]

An X-ray flaw detection apparatus is one of non-destructive inspection methods for inspecting internal defects without destroying any material or any member. Using the fact that X-rays can be transmitted through substances, a subject to be inspected is irradiated with the X-rays, and a radiographic image is imported as an image so that existence or dimensions of a crack, a cavity, a foreign substance, etc. can be determined. On that occasion, it is necessary to take an image whose quality is high enough to determine dimensions or properties of a defect from the image. The X-ray flaw detection apparatus itself has been known, and a determination method using a personal computer has been also known. Therefore, description of the X-ray flaw detection apparatus and the determination method will be omitted. Incidentally, a result of flaw detection may be determined by an experienced inspector in place of or in addition to the determination using the personal computer.

[0016]

Fig. 3 is a front view of the moving distance measuring device 7 mounted on the moving handrail 2. Fig. 4 is a schematic view showing the moving distance measuring device 7 sectionally taken on line

A-A in Fig. 3. Fig. 5 is a plan view of Fig. 3. Figs. 3 and 5 show the state where the moving distance measuring device 7 has been linked with the X-ray device 4. Incidentally, a moving handrail guide 31 in Fig. 4 is omitted in Fig. 3 while only the top surface of the moving handrail guide is depicted.

[0017]

In these drawings, the distance measuring device has a structure divided into two upper and lower pieces, that is, an upper measuring portion 7a and a lower drive portion 7b. The upper measuring portion 7a has a retention plate 9, first latch locks 10 for fixing a mouse, first reception portions 11 for receiving the first latch locks 10, second reception portions 12 for receiving second latch locks 18, side plates 13, a first roller 14 and a roller shaft 15. An optical mouse 8 is put on a mouse fixation portion 9b, and the optical mouse 8 is fixed by the mouse retention plate 9.

[0018]

The retention plate 9 includes a cover portion 9a and the mouse fixation portion 9b. When the first latch locks 10 provided in the cover portion 9a are linked with the first reception portions 11 placed on the side plates 13, the optical mouse 8 put on the mouse fixation portion 9b is pressed from above against the mouse fixation portion 9b so that the optical mouse 8 cannot move vertically. The

retention plate 9 retains the state of the optical mouse 8.

[0019]

The side plates 13 support the optical mouse 8 from the opposite left and right sides. Two holes 13a1 and 13a2 or 13b1 and 13b2, one first reception portion 11 and one second reception portion 12 are provided in each of front and rear side plates 13a and 13b. Two shafts of the drive portion 7b are inserted into the two holes 13a1 and 13a2 or 13b1 and 13b2. The first roller 14 is in contact with the surface of the moving handrail 2. When the moving distance measuring device 7 moves along the moving handrail 2, the first roller 14 rotates in accordance with the moving distance of the moving distance measuring device 7. The surface roughness in the surface of the first roller 14 is made high enough to transmit the rotation state (rotation amount) of the first roller 14 to a laser portion of the optical mouse 8 efficiently. The first roller 14 is supported between the side plates 13 rotatably by the roller shaft 15.

[0020]

The lower drive portion 7b has link shafts 16, support plates 17, second latch locks 18, drive force input portions 19, first to third rotation shafts 20, 23 and 26, first to fourth gears 21, 22, 24 and 25, and taps 28. The lower drive portion 7b is put onto the moving handrail guide 31 through the taps 28. The lower drive portion

7b is mounted between the moving handrail guide 31 and the moving handrail 2 in the state in which the moving handrail 2 is sandwiched between the second roller 27 and the first roller 14.

[0021]

The link shafts 16 are inserted into the holes 13a1, 13a2, 13b1 and 13b2 made in the side plates 13 of the measuring portion 7a, so as to link the measuring portion 7a with the drive portion 7b. As apparent from Figs. 3 to 5, the link shafts 16 are provided in the left and right four places. The support plates 17 are provided as a pair of front and rear support plates designated by the reference signs 17a and 17b in Fig. 5. The support plates 17 support the drive portion 7b in its opposite end portions so that the first to fourth gears 21, 22, 24 and 25 provided in the drive portion 7b can engage with corresponding gears of the first to third rotation shafts 20, 23 and 26.

[0022]

The second latch locks 18 hook their front ends on the second reception portions 12 so as to link the measuring portion 7a with the drive portion 7b. Each drive force input portion 19 has a fitting portion 19a to which the drive shaft of an electric driver 50 as an external drive source is linked. Acquiring a drive force from the rotating drive shaft of the electric driver 50 through the fitting

portion 19a, the drive force input portion 19 gives the drive force to a gear group in a subsequent stage. The first rotation shaft 20 is linked with the drive force input portion 19 so as to rotate due to the drive force given by the drive force input portion 19. The first gear 21 is provided coaxially with the first rotation shaft 20 so as to rotate together with the first rotation shaft 20. Incidentally, the drive force input portions 19 are provided in opposite end portions of the first rotation shaft 20 as shown in Fig. 4.

[0023]

The second gear 22 engages and rotates with the first gear 21 so as to rotate the second rotation shaft 23. The third gear 24 is linked with the second rotation shaft 23 so as to rotate coaxially with the second rotation shaft 23. The third gear 24 engages with the fourth gear 25 so as to rotate the fourth gear 25. The fourth gear 25 is linked with the third rotation shaft 26 coaxially therewith, so as to rotate together with the third rotation shaft 26.

[0024]

The second roller 27 is linked with the third rotation shaft 26 coaxially therewith, so as to rotate together with the third rotation shaft 26. The rotation of the second roller 27 is transmitted to a recess portion bottom 2a of the moving handrail 2, and the moving

distance measuring device 7 moves in the longitudinal direction of the moving handrail 2 in the state in which the moving handrail 2 is sandwiched between the first roller 14 and the second roller 27. The taps 28 are provided to make it easy to put and move the moving distance measuring device 7 on the moving handrail guide 31. The taps 28 may be replaced by driven rollers respectively.

[0025]

When the measuring portion 7a and the drive portion 7b are attached to the moving handrail 2 respectively and linked with each other, the moving distance measuring device 7 is attached to the moving handrail 2. The moving distance measuring device 7 is linked with the X-ray device 4 after the moving distance measuring device 7 is attached to the moving handrail 2. This link is performed through the link plate 29.

[0026]

One end of the link plate 29 is linked with the measuring portion 7a, and the other end thereof is linked to a side plate of the X-ray device 4 through magnets 30, so that the moving distance measuring device 7 and the X-ray device 4 are integrated. Since the link plate 29 is linked with the X-ray device 4 due to the magnetic force of the magnets 30, the link plate 29 can be released from the link easily. Thus, the workability is excellent.

[0027]

Flaw detection work using the moving handrail flaw detection apparatus S configured as described above is carried out in the following method.

[0028]

The general escalator 100 includes the balustrades 3, the moving handrails 2 moving along the balustrades 3, and the steps 1 moving in sync with the moving handrails 2, as shown in Fig. 1. Each moving handrail 2 is put on the moving handrail guide 31 placed on corresponding one of the balustrades 3. The moving handrail 2 is inspected after the moving handrail 2 is removed from the moving handrail guide 31 placed on the balustrade 3. That is, for inspection of the moving handrail 2 using the X-ray device 4, the moving handrail 2 is removed from the moving handrail guide 31 placed on the balustrade 3 and sandwiched between the first and second rollers 14 and 27 of the moving distance measuring device 7, and X-ray radiography is performed while the X-ray device 4 is moved along the moving handrail 2. Data obtained by the radiography on this occasion are imported into the personal computer 6 through the X-ray control device 5, and stored as image data.

[0029]

Animation processing is performed on the stored image data

by software operating in the personal computer 6. In the animation processing, the radiography data of the X-ray device 4 are checked with the moving distance of the X-ray device 4. The moving distance is measured using the output of the optical mouse 8 placed on the moving distance measuring device 7.

[0030]

As described previously, the moving distance measuring device 7 is constituted by the measuring portion 7a on which the optical mouse 8 is mounted, and the drive portion 7b to which the torque of the drive shaft of the electric driver 50 is transmitted and which moves the moving distance measuring device 7 as a whole along the moving handrail 2 due to the transmitted drive force. The optical mouse 8 is firmly pressed from both sides by the opposite side plates 13a and 13b, and pressed vertically by the retention plate 9 so as to be prevented from moving. The vertical pressing is obtained by the retention force generated between the first latch locks 10 and the reception portions 11 when the first latch locks 10 are linked with the reception portions 11. When being pressed in this manner, the optical mouse 8 can be prevented from being displaced relatively to each side plate 13 of the measuring portion 7a.

[0031]

In addition, the measuring portion 7a is linked with the X-ray

device 4 by the link plate 29 and the magnets 30 bonded to the link plate 29. There is no fear that the measuring portion 7a and the X-ray device 4 are displaced from each other. Thus, there is no fear that the optical mouse 8 and the X-ray device 4 are displaced from each other.

[0032]

When the moving handrail 2 is held by the moving distance measuring device 7, the drive portion 7b is first put on the moving handrail guide 31 and pressed by hand. After that, the moving handrail 2 is put on the drive portion 7b, and the measuring portion 7a is put further thereon. On that occasion, the link shafts 16 of the drive portion 7b are inserted into the holes 13a1, 13a2, 13b1 and 13b2 made in the side plates 13 of the measuring portion 7a, and further the second reception portions 12 attached to the side plates 13 are linked with the second latch locks 18 attached to the support plates 17 of the drive portion 7b. Thus, the measuring portion 7a and the drive portion 7b of the moving distance measuring device 7 are positioned and then firmly linked.

[0033]

Since the measuring portion 7a and the drive portion 7b are firmly linked in this manner, there is no fear that a gap occurs between the surface of the moving handrail 2 and the first roller

14 and between the recess portion bottom 2a of the moving handrail 2 and the second roller 27. Thus, when a drive force is inputted to the drive force input portion 19 of the measuring portion 7a of the moving distance measuring portion 7, for example, by the electric driver 50 or the like, the drive force is transmitted to the second roller 27 which is the final stage so that the measuring portion 7a and the drive portion 7b move integrally in the longitudinal direction of the moving handrail 2 sandwiched between the first roller 14 and the second roller 27. On that occasion, the drive portion 7b can move smoothly because the drive portion 7b is put onto the moving handrail guide 31 through the taps 28.

[0034]

In this embodiment, the drive portion 7b is not mounted with a motor serving as a drive source so that the moving distance measuring device 7 moves due to a drive force obtained from an external drive source. The electric driver 50, particularly a rechargeable electric driver a worker can carry around is preferable as the external drive source in view of work. This is because the rechargeable electric driver is driven by a rechargeable battery mounted on the rechargeable electric driver itself so that no power cord is attached and lies in the way during work.

[0035]

To this end, for moving the moving distance measuring device 7, an attachment 51 is attached to a chuck of the electric driver 50, and a front end of the attachment 51 is inserted into a fitting portion 19a of the drive force input portion 19 so as to drive the electric driver 50. Due to the drive of the electric driver 50, the drive force input portion 19 rotates. Due to the rotation of the drive force input portion 19, the first gear 21 attached to the same rotation shaft 20 as the drive force input portion 19 rotates. The first gear 21 engages with the second gear 22. The second gear 22 also rotates when the first gear 21 rotates. As for the relation between the number of teeth in the first gear 21 and the number of teeth in the second gear 22, the number of teeth in the second gear 22 is larger and the ratio therebetween is constant. The number of rotations in the first gear 21 is reduced as the second gear 22 rotates.

[0036]

In the embodiment, the fitting portion 19a of the drive force input portion 19 consists of a fitting hole or groove provided in a shaft end of the first rotation shaft 20, and is paired and fitted with the front end of the attachment 51 of the electric driver 50 so that the rotational drive force can be transmitted from the electric driver 50 to the drive force input portion 19.

[0037]

When the second gear 22 rotates, the third gear 24 attached to the second rotation shaft 23 coaxial with the second gear 22 rotates. When the second gear 22 rotates one turn, the third gear 24 also rotates one turn. As for the relation between the number of teeth in the second gear 22 and the number of teeth in the third gear 24, the number of teeth in the second gear 22 is larger and the ratio therebetween is constant. The third gear 24 engages with the fourth gear 25. When the third gear 24 rotates, the fourth gear 25 rotates. As for the relation between the number of teeth in the third gear 24 and the number of teeth in the fourth gear 25, the number of teeth in the third gear 24 is larger and the ratio therebetween is constant. The number of rotations in the third gear 24 is reduced as the fourth gear 25 rotates.

[0038]

When the fourth gear 25 rotates, the second roller 27 attached to the third rotation shaft 26 coaxial with the fourth gear 25 rotates together with the fourth gear 25 and at the same number of turns. When the rotational force given by the electric driver is reduced to rotate the second roller 27 slowly in this manner, the distance measuring device can be moved along the moving handrail 2 smoothly by large motive power. That is, the gear group consisting of the

first to third rotation shafts 20, 23 and 26 and the first to fourth gears 21, 22, 24 and 25 constitute a reduction mechanism 40 for reducing the rotation speed given to the drive force input portion 19 and transmitting the reduced rotation speed to the second roller 27.

[0039]

Next, description will be made about a flaw detection method using the moving handrail flaw detection apparatus S configured thus.

[0040]

Fig. 6 is an explanatory view showing a method carried out according to the background art, in which a distance measuring device is moved manually and animation processing is performed using image data of an animation taken by the X-ray device 4 and output data of the distance measuring device. In Fig. 6, an animation 32 obtained by X-ray radiography is stored as an animation file. The animation 32 is divided into still images 32a to 32f for each frame. The number of divided still images depends on a frame rate. For example, the animation is divided here into still images for every 0.1 second.

[0041]

In data stored in a moving distance data file 33 in which each moving distance is recorded base on the output of the optical mouse 8 acquired in the background-art method in which the distance measuring device is moved manually, a cumulative moving distance from the

animation recording start time to that time is recorded at a constant interval. Still images whenever the moving distance reaches a fixed distance are extracted to acquire images for the fixed distance, and connected to form a panorama image 34. The panorama image formed thus is constituted by still images designated by the reference signs 34a to 34e.

[0042]

Fig. 7 is an explanatory view showing a method in which the moving distance measuring device 7 according to the embodiment is moved using the electric driver 50 as a drive source, and animation processing is carried out using image data of an animation taken by the X-ray device 4 and output data of the moving distance measuring device 7. In Fig. 7, in a moving distance data file 35, a moving distance measured with the moving distance measuring device 7 moved at a constant velocity is recorded as a cumulative moving distance from the animation recording start time to that time at a constant interval. In the embodiment, still images whenever the moving distance reaches a fixed distance are extracted to acquire images for the fixed distance, and connected to form a panorama image 36. The panorama image formed thus is constituted by still images designated by the reference signs 36a to 36e.

[0043]

In flaw detection, an imaging result is determined based on data of the animations and the still images as shown in Figs. 6 and 7. The animation 32 taken by X-ray radiography by the X-ray device 4 as described previously is stored into the personal computer 6, and divided into still images 32a to 32f for every constant elapsed time (every 0.1 second here) by software operating in the personal computer 6. On the other hand, data of a moving distance for every constant elapsed time are stored in moving distance data files 33 and 35. Accordingly, to create a panorama image, the moving distance data files 33 and 35 and the divided still images 32a to 32f are arranged, and an elapsed time for each constant moving distance is read based on the contents of the moving distance data files 33 and 35. Next, still images at that time are extracted and connected. Panorama images 34 and 36 can be created thus.

[0044]

First, an animation processing method using a moving distance data file of a distance measuring device in the background art will be described. In the background art, a worker moves the X-ray device 4 by hand. The moving distance of the X-ray device 4 is not constant but has a variation. Such moving distances are recorded as a moving distance data file 33. In the example shown as the moving distance data file 33, the X-ray device 4 moves at an equal interval of 1

mm between 0.0 s to 0.2 s. However, the moving velocity is accelerated suddenly in 0.1 s between 0.2 s to 0.3 s, and the X-ray device 4 moves 3 mm. After that, the X-ray device 4 does not move but stops between 0.3 s to 0.7 s, and moves 1 mm between 0.7 s to 0.8 s.

[0045]

Based on the contents of the moving distance data file 33, an elapsed time is read for each constant moving distance (each 1 mm in this example), and still images at that time are extracted so that a panorama image is created in the following procedure.

[0046]

1) First, the still image 32b at the time 0.1 s corresponding to 1mm movement is extracted as a still image 34a.

[0047]

2) Next, the still image 32c at the time 0.2 s corresponding to 2 mm movement is extracted as a still image 34b. The still image 34b is arranged next to the still image 34a.

[0048]

3) Next, the time corresponding to 3 mm movement is searched but there are no data at that time in the moving distance data file 33. Thus, the data are not processed but skipped. It is determined that there are no data for a still image 34c so that, for example, a black frame is assigned to the still image 34c and arranged next to the

still image 34b.

[0049]

4) Next, the time corresponding to 4 mm movement is searched but there are no data at that time in the moving distance data file 33. Thus, the data are not processed but skipped. It is determined that there are no data for a still image 34d so that, for example, a black frame is assigned to the still image 34d and arranged next to the still image 34c.

[0050]

5) Next, the still image 32d at the time 0.3 s corresponding to 5 mm movement is extracted as a still image 34e, and arranged next to the still image 34d.

[0051]

The panorama image 34 processed in this manner is an image including black frames in the portions of the still images 34c and 34d.

[0052]

According to this method, radiographic images in the positions of 3 mm and 4 mm from the moving start point of the moving handrail 2 are not taken. If deterioration is in those positions, the deterioration will be missed.

[0053]

On the other hand, in the animation processing method using the moving distance data file 35 of the moving distance measuring device 7 in the embodiment, such imaging missing does not occur. The animation processing method in the embodiment will be described below.

[0054]

The moving distance measuring device 7 in the embodiment is not moved manually by a worker, but moved at a constant velocity by an external drive source such as the electric driver 50 and the reduction mechanism 40. Therefore, for example, as shown in the moving distance data file 35, 1 mm movement is recorded at 0.1 s, further 1 mm movement or 2 mm cumulative moving distance from the start is recorded at 0.2 s, 3 mm cumulative moving distance is recorded at 0.3 s, and 4 mm cumulative moving distance is recorded at 0.4 s. Based on the contents of the moving distance data file 35, an elapsed time for every constant moving distance (every 1 mm in this example) is read, and still images at that time are extracted so that a panorama image is created in the following procedure.

[0055]

1) First, the still image 32b at the time 0.1 s corresponding to 1 mm movement is extracted as a still image 36a.

[0056]

2) Next, the still image 32c at the time 0.2 s corresponding to 2 mm movement is extracted as a still image 36b. The still image 36b is arranged next to the still image 36a.

[0057]

3) Next, the still image 32d at the time 0.3 s corresponding to 3 mm movement is extracted as a still image 36c. The still image 36c is arranged next to the still image 36b.

[0058]

4) Next, the still image 32e at the time 0.4 s corresponding to 4 mm movement is extracted as a still image 36d. The still image 36d is arranged next to the still image 36c.

[0059]

5) Next, the still image 32f at the time 0.5 s corresponding to 5 mm movement is extracted as a still image 36e. The still image 36e is arranged next to the still image 36d.

[0060]

In the embodiment, a radiographic animation is taken thus while the X-ray device 4 is moved at a constant velocity. There occurs no imaging missing when still images are processed into a panorama image 36. Therefore, in the embodiment, flaw detection can be performed with high accuracy.

[0061]

Although the electric driver 50 is illustrated as an external drive source in the embodiment, a rotary power tool which can transmit a rotational drive force, for example, through an attachment attached and fitted to the drive force input portion 19 may give a drive force to the drive portion 7b in the same manner.

[0062]

In addition, an electric motor may be mounted as an internal drive source in place of the external drive source. However, when the electric motor is mounted, the apparatus size is increased, and further, the apparatus weight is increased, causing many disadvantages for maintenance work. It is therefore preferable to use an external drive source.

[0063]

As described above, the following effects can be obtained according to the embodiment.

[0064]

1) In the moving handrail flaw detection apparatus S having the X-ray device 4 and the moving distance measuring device 7 for measuring the movement amount of the X-ray device 4 so as to perform flaw detection in the moving handrail 2 of the escalator 100, the moving distance measuring device 7 has a moving mechanism (the reduction mechanism 40 and the second roller 27) for moving the X-ray device 4 at a constant

velocity. It is therefore possible to perform flaw detection on the moving handrail 2 by X-rays while moving the X-ray device 4 at a constant moving velocity.

[0065]

2) Due to the movement at the constant velocity, there is no fear that imaging missing occurs, but flaw detection can be performed with high accuracy.

[0066]

3) The moving distance measuring device 7 includes the measuring portion 7a which is located in the upper portion, the drive portion 7b which is located in the lower portion so that the moving handrail 2 can be sandwiched between the measuring portion 7a and the drive portion 7b, and the second latch locks 18 which link the measuring portion 7a and the drive portion 7b with each other. The optical mouse 8 is mounted on the measuring portion 7a. The reduction mechanism 40 and the second roller 27 for moving the moving distance measuring device 7 due to a drive force from an external drive source such as the electric driver 50 are provided in the drive portion 7b. Thus, the moving distance measuring device 7 and the X-ray device 4 can be moved easily at a constant velocity without providing a drive source in the moving distance measuring device 7 itself. Thus, it is possible to make accurate correspondence between the image

data taken by the X-ray device 4 and the moving distance.

[0067]

4) Since the moving distance measuring device 7 can be moved using a drive force of an external drive source such as the electric driver 50, the moving distance measuring device 7 can be moved at a constant velocity with a simple configuration. In addition, since the drive source is not provided in the moving distance measuring device 7 itself, the moving distance measuring device 7 can be made small in size and light in weight accordingly, and the workability can be also improved.

[0068]

5) Since the reduction mechanism 40 has the drive force input portions 19 for receiving a drive force from an external drive source and transmitting the drive force to the second roller 27, the second roller 27 can be driven by the drive force of the electric driver 50.

[0069]

6) Since the drive force input portions 19 are provided on the opposite sides of the moving handrail 2, the electric driver 50 can be linked from either side of the moving handrail 2 in accordance with working conditions. Thus, restrictions on the working conditions can be reduced so that the workability can be improved.

[0070]

7) Since a rotary power tool including the electric drive 50 can be used as an external drive source, it is not necessary to prepare any special device. For example, the rechargeable electric driver 50 is a tool a worker usually carries around. Therefore, the electric driver 50 can be made to function as an external drive source easily by simply changing an attachment of the electric driver 50.

[0071]

8) In the measuring portion 7a, the rotation amount of the first roller 14 rotating in contact with the moving handrail 2 is detected contactlessly by the optical mouse 8, and the movement amount of the X-ray device 4 is detected thereby, so that the movement amount can be detected with high accuracy. On that occasion, it will go well as long as the optical mouse 8 of the personal computer 6 carried around for maintenance is put on the mouse fixation portion 9b and the optical mouse 8 is fixed by the mouse retention plate 9. It is therefore unnecessary to carry around any special device for measurement also in this case, but the general versatility is excellent.

[0072]

Incidentally, the flaw detection unit in the scope of claims corresponds to the X-ray device 4 in the embodiment; the movement

amount measuring unit corresponds to the moving distance measuring device 7; the passenger conveyor corresponds to the escalator 100; the moving handrail flaw detection apparatus corresponds to the reference sign S; the moving handrail corresponds to the reference sign 2; the moving mechanism corresponds to the reduction mechanism 40 and the second roller 27; the measuring portion corresponds to the reference sign 7a; the drive portion corresponds to the reference sign 7b; the link unit corresponds to the second latch locks 18, 18a and 18b; the reduction mechanism corresponds to the reference sign 40; the roller corresponds to the second roller 27; the external drive source corresponds to the electric driver 50; the drive force input portion corresponds to the reference sign 19; the first roller provided in the measuring portion corresponds to the reference sign 14; and the optical mouse corresponds to the reference sign 8.

[0073]

Further, the invention is not limited to the aforementioned embodiment. Various modifications can be made without departing from the gist of the invention. All the technical items included in the technical ideas stated in the scope of claims are subject matters of the invention. The aforementioned embodiment shows a preferred example. From the contents disclosed herein, those skilled in the art can implement various alternatives, revisions,

modifications or improvements, which are included in the technical scope stated in the scope of the accompanying claims.

[Reference Signs List]

[0074]

- 2 moving handrail
- 4 X-ray device
- 7 moving distance measuring device
- 7a measuring portion
- 7b drive portion
- 8 optical mouse
- 9 retention plate
- 14 first roller
- 18, 18a, 18b second latch lock
- 19a drive force input portion
- 27 second roller
- 40 reduction mechanism
- 50 electric driver
- 100 escalator (passenger conveyor)
- S moving handrail flaw detection apparatus

[CLAIMS]

[Claim 1]

A moving handrail flaw detection apparatus for a passenger conveyor, comprising: a flaw detection unit; and a movement amount measuring unit which measures a movement amount of the flaw detection unit; wherein:

the movement amount measuring unit includes a moving mechanism which moves the flaw detection unit at a constant velocity and along a longitudinal direction of the moving handrail.

[Claim 2]

A moving handrail flaw detection apparatus according to Claim 1, wherein:

the movement amount measuring unit includes a measuring portion which is located in an upper portion, a drive portion which is located in a lower portion so that the moving handrail can be sandwiched between the measuring portion and the drive portion, and a link unit which links the measuring portion and the drive portion with each other; and

the moving mechanism is provided in the drive portion.

[Claim 3]

A moving handrail flaw detection apparatus according to Claim 1 or 2, wherein:

the moving mechanism includes a reduction mechanism which reduces a drive force from a drive source, and a roller which is driven by the reduction mechanism so as to rotate in contact with the moving handrail.

[Claim 4]

A moving handrail flaw detection apparatus according to any one of Claims 1 through 3, wherein:

a drive source for the moving mechanism is an external drive source; and

a drive force input portion which receives a drive force from the external drive source is provided in the moving mechanism.

[Claim 5]

A moving handrail flaw detection apparatus according to Claim 4, wherein:

the drive force input portion is provided on each of opposite sides of the moving handrail.

[Claim 6]

A moving handrail flaw detection apparatus according to Claim 4 or 5, wherein:

the external drive source is a rotary power tool.

[Claim 7]

A moving handrail flaw detection apparatus according to Claim

6, wherein:

the power tool is an electric driver.

[Claim 8]

A moving handrail flaw detection apparatus according to Claim

2, wherein:

the measuring portion is provided with a roller which rotates in contact with the moving handrail, and an optical mouse which detects a rotation amount of the roller so as to detect the movement amount of the flaw detection unit.