

PASSENGER CONVEYOR HANDRAIL INSPECTION METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a passenger conveyor handrail inspection method. Particularly, it relates to identification of an inspected position in inspection of an endless handrail.

2. Description of the Background Art

In a passenger conveyor of an escalator etc., steps on which passengers stand are linked to each other annularly and driven rotationally. In order to prevent the passengers from falling, handrails on which the passengers can put their hands are provided to be driven rotationally in connection with the steps. Each handrail is constituted by a plurality of components, including a cover of a resin material such as urethane or rubber provided in the surface of the handrail and a component called a tension member provided internally in the handrail for retaining strength.

Under these components, provided are a fixing portion for fixing the cover and a sliding portion sliding on the surface of a frame to which the handrail is attached when the handrail

is rotationally driven. Canvas or the like is used as the material of the sliding portion. As the aforementioned tension member, there are some members using a plurality of steel cords arranged in parallel. When the steel cords are broken or twisted, the strength of the handrail is lowered. In the inspection of the handrail, it is therefore necessary to inspect whether the steel cords are normal or not.

A flaw detection apparatus using X-rays and a through transmission method (e.g. see JP-A-10-10060) and a flaw detection apparatus using a magnetic leakage flux method (e.g. see JP-A-10-218541) have been disclosed as an apparatus for inspecting steel cords contained in a handrail. In order to shorten a flaw detection time in flaw detection performed by such an apparatus, measurement is performed while the apparatus is moved in a circumferential direction of a handrail. In X-ray flaw detection, measurement is performed while images are imported in continuously.

On that occasion, the handrail is connected endlessly. The position of a flaw cannot be identified in such a condition. Therefore, a measurement start position is marked as a reference position so that the position of a flaw can be identified easily. In JP-A-10-218541, an adhesive seal of iron foil of about 1

cm□ is used for identifying the start position.

Although an adhesive seal of iron foil is used for identifying the position of a flaw in steel cords in JP-A-10-218541, the flaw detection apparatus cannot diagnose deterioration of the steel cords in a portion to which the adhesive seal of iron foil is pasted, because the flaw detection apparatus receives a signal from the iron foil. The method for identifying a start position by means of marking such as an adhesive seal of iron foil may be also applied to an X-ray flaw detection apparatus. When an adhesive seal of iron foil which is opaque to X-rays is pasted, the seal is shown on an X-ray image so that the seal can be regarded as a reference position for the start of measurement.

However, when the area of the iron foil seal is too wide, a portion where steel cords are disconnected or twisted may overlap with the portion where the seal is pasted. In this case, the disconnection or the twisting is hidden on the X-ray image by the iron foil seal so that the flaw cannot be detected. On the contrary, when the area of the seal is narrowed, the area where steel cords are hidden can be narrowed so that the portion where flaw detection cannot be performed can be reduced. However, the smaller the area is, the more difficult it is for

the apparatus to recognize the marking.

SUMMARY OF THE INVENTION

The present invention has been developed in consideration of the aforementioned circumstances. An object of the invention is to provide a passenger conveyor handrail inspection method, by which a position where flaw detection is started can be identified easily and a region where flaw detection cannot be performed can be reduced.

In order to attain the aforementioned object, according to an aspect of the invention, there is provided a passenger conveyor handrail inspection method for inspecting a flaw of a tension member provided inside a handrail based on an image generated by performing through transmission of the handrail, the handrail being driven in sync with steps on which passengers stand, the method including the steps of: attaching a marker shaped like a belt to the handrail so that a longitudinal direction of the belt is inclined with respect to a conveyance direction of the handrail, the marker being made of a material opaque in the through transmission; detecting a range shielded by the marker in the image generated by the through transmission, so as to recognize a reference position for identifying a position of the generated image in the conveyance direction

of the handrail; and inspecting the flaw of the tension member from the generated image based on the reference position. Thus, it is possible to provide a passenger conveyor handrail inspection method, by which a position where flaw detection is started can be identified easily and a region where flaw detection cannot be performed can be reduced.

Preferably, a longitudinal end portion of the belt-like marker is formed with an angle corresponding to an inclination with respect to the conveyance direction in attachment of the marker to the handrail, and the marker is attached to the handrail in accordance with the angle of the longitudinal end portion of the marker. Thus, when a user attaches the marker in accordance with the angle provided in the end portion of the marker, the user can attach the marker with the same angle any number of times.

Preferably, the through transmission is photography using X-rays, and the marker is a sheet-like member containing metal powder for shielding the X-rays. Thus, there is no fear that the marker may cause damage to the handrail and the apparatus even if the marker in use is detached from the surface of the handrail.

Preferably, the marker is formed in such a manner that

a layer containing the metal powder is coated with another material layer and a layer of an adhesive agent for attaching the marker to the handrail is provided on the surface of the other material layer. Thus, the marker can be attached removably and used repeatedly.

According to the invention, it is possible to provide a passenger conveyor handrail inspection method, by which a position where flaw detection is started can be identified easily and a region where flaw detection cannot be performed can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view showing the positional relation between a handrail and a handrail inspection apparatus according to an embodiment of the invention;

Fig. 2 is a view schematically showing the state of steel cords contained in the handrail according to the embodiment;

Fig. 3 is a view showing examples of flaws in the steel cords contained in the handrail according to the embodiment;

Figs. 4A-4C are views showing examples of images photographed with X-rays according to the embodiment;

Figs. 5A-5C are views showing examples of start markers attached to the handrail according to the background art and

the embodiment; and

Figs. 6A-6C are views showing examples of images photographed with X-rays according to the background art and the embodiment.

DETAILED DESCRIPTION OF THE INVENTION

An embodiment of the invention will be described in detail below with reference to the drawings. Fig. 1 is a structural view of a handrail inspection apparatus according to the embodiment. An X-ray irradiation device 1 is placed on one side of a handrail 2 which is a moving handrail. An optical receiver 3 is placed on an opposite side to the X-ray irradiation device 1 with respect to the handrail 2. Since the optical receiver 3 emits light upon receipt of X-rays, an X-ray image can be generated when the light emission state of the optical receiver 3 is photographed by a camera 4 which is an image acquiring device. The X-ray irradiation device 1, the optical receiver 3 and the camera 4 are attached to a housing 5 which is shown as a housing 5a and a housing 5b in Fig. 1.

Next, description will be made on steel cords which serve as a tension member buried in the handrail 2. Fig. 2 is a view schematically showing the structure of steel cords inside the handrail 2. Eighteen steel cords 20 are buried in the handrail

2. The steel cords 20 function as a tension member of the handrail 2.

In such steel cords 20, disconnections 21, 22 and 23 or twisting 24 may occur as shown in Fig. 3. It is an object of the handrail inspection apparatus to find such disconnections 21 to 23 and such twisting 24 from the aforementioned X-ray image. Figs. 4A-4C show examples of X-ray images generated by the handrail inspection apparatus.

Fig. 4A shows an example of an X-ray image in which the state of the steel cords 20 which are normal is shown. Fig. 4B shows an example of an X-ray image in which the state of the steel cords 20 in which twisting occurred is shown. Fig. 4C shows an example of an X-ray image in which the state of the steel cords 20 in which disconnection occurred is shown.

The handrail inspection apparatus according to the embodiment collects images as shown in Figs. 4A-4C continuously in a circumferential direction of the handrail, and combines the collected images to generate an image of the whole handrail. On this occasion, the handrail inspection apparatus generates the image by photographing at such timings that images photographed in adjacent positions are prevented from overlapping with each other and that any portion of the handrail

is prevented from being missed.

In such a handrail inspection apparatus, a start marker is attached so that a reference point for an inspection start position can be specified in the handrail connected endlessly, and the position of a flaw can be identified easily when the flaw is detected. Figs. 5A-5C show examples of structures of start markers according to the background art and the embodiment.

Figs. 5A and 5B show examples of structures of start markers 7 and 8 according to the background art. In the structure of each start marker 7, 8 according to the background art, a rectangular marker is attached to put the long sides of the rectangle perpendicularly to the circumferential direction of the handrail. In addition, the lengths of the short sides of the rectangles serving as the markers in the examples of Figs. 5A-5B are different from each other.

Fig. 5C is a view showing the structure of a start marker 9 according to the embodiment. In the structure of the start marker 9 according to the embodiment as shown in Fig. 5C, a rectangular marker whose short sides are short in length in the same manner as in the example of Fig. 5B is attached and disposed to be inclined with respect to the circumferential direction of the handrail. In other words, in the structure

of the start marker 9 according to the embodiment, the belt-like marker is attached obliquely with respect to the circumferential direction of the handrail.

Figs. 6A-6C are views showing examples of X-ray photographs generated in the structures of the start markers in Figs. 5A-5C respectively. Each of Figs. 6A-6C shows a "normal" state, a "twisting" state and a "disconnection" state. In addition, each of Figs. 6A and 6B shows images photographed in the state where the start marker is disposed at an end of the image, that is, in the state where the start marker attached to the handrail is disposed at an end of a range of the image photographed by the camera 4.

In each of Figs. 6A-6C, the portion of the start marker is illustrated as a shaded portion in order to simplify the illustration. However, the portion of the start marker is indicated as solid black in an actually photographed image in the same manner as the frame of the image. Thus, it is difficult to distinguish the portion of the start marker from the frame.

In the case where the short sides of the rectangular start marker 7 are long in length as shown in Fig. 5A, the image is hidden by the start marker even when the start marker 7 is disposed at the end of the image. As a result, as shown in Fig. 6A,

the range of the image becomes very narrow so that the handrail inspection apparatus can detect the start marker. However, as shown in Fig. 6A, the range hidden by the start marker is wide so that the portion of disconnection is also hidden. Thus, it is difficult to detect any flaw of the steel cords.

In the case where the short sides of the rectangular start marker 8 are short in length as shown in Fig. 5B, the range hidden by the start marker 8 as shown in Fig. 6B is narrower than the case of Fig. 6A. Thus, the performance for detecting any flaw of the steel cords is improved. When the start marker 8 is disposed at an end of the image in the case where the short sides of the rectangular start marker 8 is short in length, it is however likely that the handrail inspection apparatus cannot detect the start marker 8 because the width of the start marker 8 making the image narrow is too small, as shown in Fig. 6B.

On the other hand, in the case where the belt-like start marker 9 is attached obliquely with respect to the circumferential direction of the handrail as shown in Fig. 5C, the width of the start marker 9 is about the same as that in the case of Fig. 5B. Therefore, as shown in Fig. 6C, the range hidden by the start marker 9 can be suppressed substantially

to the same extent as that in the case of Fig. 5B.

Further, since the belt-like start marker 9 is attached obliquely with respect to the circumferential direction of the handrail, the range where the start marker 9 is disposed can be widened in the circumferential direction of the handrail. Thus, there is no fear that it is difficult for the handrail inspection apparatus to detect the start marker 9 because the start marker 9 is disposed at the end of the image and assimilated to the frame of the image, as shown in Fig. 6B.

As described above, in the passenger conveyor handrail inspection method according to the embodiment, the start marker 9 shaped like a belt and made of a material opaque in X-ray photographing is attached to the handrail 2 so that the longitudinal direction of the belt is inclined with respect to the conveyance direction of the handrail 2. The range shielded by the start marker 9 in an image generated by the X-ray photographing is detected so that a reference position for identifying the position of the generated image in the conveyance direction of the handrail can be determined. It is therefore possible to provide a passenger conveyor handrail inspection method, by which a position where flaw detection is started can be identified easily and a region where flaw

detection cannot be performed can be reduced.

Of the shape of the start marker 9 according to the embodiment, the shape of the end portion in the direction perpendicular to the circumferential direction of the handrail has an angle with respect to the longitudinal direction of the belt-like start marker 9 as shown in Fig. 5C. Therefore, when the user attaches the start marker 9, the user can attach the start marker 9 in accordance with the angle provided in the end portion. Thus, the user can attach the start marker 9 with the same angle any number of times.

In addition, the start marker 9 is constituted by a thin material sheet containing metal powder for shielding X-rays. Therefore, even when the start marker 9 in use is detached from the handrail surface, there is no fear that the start marker 9 may cause damage to the handrail and the apparatus. Further, a laminate in which coating layer as other material layers are provided to coat a thin material layer containing the aforementioned metal powder, and an adhesive for attaching the start marker 9 to the handrail is then applied to the surface of one of the coating layers may be used as the start marker 9. Thus, the start marker 9 can be attached removably and used repeatedly.

What is claimed is:

1. A passenger conveyor handrail inspection method for inspecting a flaw of a tension member provided inside a handrail based on an image generated by performing through transmission of the handrail, the handrail being driven in sync with steps on which passengers stand, the method comprising the steps of:

attaching a marker shaped like a belt to the handrail so that a longitudinal direction of the belt is inclined with respect to a conveyance direction of the handrail, the marker being made of a material opaque in the through transmission;

detecting a range shielded by the marker in the image generated by the through transmission, so as to recognize a reference position for identifying a position of the generated image in the conveyance direction of the handrail; and

inspecting the flaw of the tension member from the generated image based on the reference position.

2. A passenger conveyor handrail inspection method according to Claim 1, wherein:

a longitudinal end portion of the belt-like marker is formed with an angle corresponding to an inclination with respect to the conveyance direction in attachment of the marker to the handrail, and the marker is attached to the handrail in

accordance with the angle of the longitudinal end portion of the marker.

3. A passenger conveyor handrail inspection method according to Claim 1 or 2, wherein:

the through transmission is photography using X-rays;
and

the marker is a sheet-like member containing metal powder for shielding the X-rays.

4. A passenger conveyor handrail inspection method according to Claim 3, wherein:

the marker is formed in such a manner that a layer containing the metal powder is coated with other material layers and a layer of an adhesive agent for attaching the marker to the handrail is provided on a surface of one of the other material layers.