

# PATENT SPECIFICATION

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## (54) POSITION SENSOR DEVICE FOR ELEVATOR CAR

(71) We, MITSUBISHI DENKI KABUSHIKI KAISHA, of 2—3 Marunouchi 2-chome, Chiyodaku, Tokyo, Japan, a Japanese Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

10 This invention relates to a position sensor device (which may also serve as a position-to-speed converter device) for use with an elevator car.

15 Moving members such as elevator cars are adapted to move along the path of movement having a finite length and accordingly it is a common practice to limit the moving speed thereof at either end of the path of movement in order to ensure their security at that end. In elevator systems, therefore, it has been already proposed to sense the actual position of the elevator car and compare a command speed corresponding to the sensed position of the car that is an output from the particular position-to-speed converter with the actual speed of the car thereby to maintain the security of the car. Conventional position-to-speed converters have been disadvantageous in that the position of the elevator car is erroneously sensed due to the horizontal movement of the car. This horizontal movement of the elevator car is caused from a guiding member attached in vibration proof relationship to the car to guide the latter along an associated guide rail.

40 Accordingly it is an object of the present invention to provide a new and improved position sensor device for use with an elevator car substantially free from an error in sensing a position of the elevator car travelling along either end portion of its stroke.

45 The present invention provides a position sensor device comprising a guide rail for engaging a guiding member disposed on an associated elevator car, a first roller mountable on the associated elevator car and kept in touch and operative with

the guide rail or with a first cam member disposed at a predetermined spatial position relative to the guide rail, a second cam member disposed at a predetermined spatial position relative to the guide rail or the first cam member, a second roller mountable on the associated elevator car and kept in touch and operative with the second cam member, and a converter disposed on the associated elevator car to produce an output in response to the relative rotation between at least two elements, one of the elements being actuated by the first roller, the other element being actuated by the second roller.

65 Preferably, the second cam member may be a cam member disposed on a plurality of supporting arms projecting from the guide rail to be directed to an end of the guide rail so as to cause one end of the cam member to more approach the guide rail than the other end thereof.

75 The present invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

80 Figure 1 is a fragmental elevational view of an elevator car including a conventional position sensor device and located adjacent to one end portion of an associated hoistway;

Figure 2 is a circuit diagram of the position sensor device shown in Figure 1;

85 Figure 3 is another circuit diagram of the position sensor device shown in Figure 1;

Figure 4 is a fragmental elevational view of an elevator car including a position sensor device constructed in accordance with the principles of the present invention and located adjacent to the one end portion of an associated hoistway;

95 Figure 5 is a fragmental elevational view in an enlarged scale of a modification of the present invention operatively associated with the arrangement shown in Figure 3; and

Figure 6 is a view similar to Figure 5 but illustrating another modification of the present invention.

Throughout the Figures like reference 100

numerals designate the identical or similar components.

In Figure 1 of the drawings, there is illustrated an elevator car including a conventional position sensor device and located adjacent to one end portion, in this case, an upper end portion of an elevator's shaft or hoistway. The arrangement illustrated comprises a guide rail 12 (only the upper end portion of which is illustrated) vertically fixed to one wall of a hoistway generally designated by the reference numeral 10 by keep plates 14 and a rod-shaped cam member 16 supported by a plurality of parallel cross arms 18 perpendicularly extending from the guide rail 12 so as to cause that end of the cam member 16 adjacent to the end of the guide rail 12 to be close to the guide rail 12 than the other end thereof. A similar cam member is also disposed on the other or lower end portion of the hoistway although it is not illustrated.

In Figure 1 an elevator car 20 is shown as being located adjacent to the upper end portion of the hoistway 10 by having a guiding member 22 attached thereto to engage the guide rail 12. The guide member 22 is well known as a roller type guide shoe and formed of three rollers 22a mounted in vibration proof relationship to the elevator car 20 through flexible members to engage the guide rail 12.

A position sensor device generally designated by the reference numeral 24 is fixedly secured to the elevator car 20 on the same side as the guiding member 22 and near to that corner of the elevator car adjacent to the cam member 16, in this case, the righthand corner as viewed in Figure 1. More specifically, the position sensor device 24 includes a horizontal shaft 24a rotatably disposed within a box-shaped casing 24b upwardly extending from the top surface of the elevator car 20, an arm 24c fixedly secured at one end to the shaft 24a to be normally vertically pendent therefrom, and a roller 24d rotatably mounted to the other end of the arm 24c. The roller 24d is so positioned that, when the car 20 ascends from its position illustrated in Figure 1, only the roller 24d abuts against the rod-shaped cam member 16 to be kept in touch therewith. Thus the roller 24d rolls along the cam member 16 while it is displaced in the lefthand direction as viewed in Figure 1 to rotate the shaft 24a in a clockwise direction as viewed in Figure 1 through the arm 24c.

The position sensor device 24 further includes an electric circuit as shown in Figure 2 disposed within the casing 24b. In Figure 2 a variable coupling transformer 24e includes a primary winding connected across a commercial source of alternating current 26 and a secondary winding

connected across a pair of AC inputs to a full-wave rectifier bridge 24f formed of four semiconductor diodes. The bridge 24f includes a pair of DC outputs having a smoothing capacitor 24g connected thereacross to reduce ripples included in a full-wave rectified output from the bridge 24f. The shaft 24a as shown in Figure 1 is operatively coupled to the transformer 24e so that the rotation of the shaft 24a causes a change in degree of coupling of the transformer 24e and therefore a change in transformation ratio of the primary to the secondary winding.

The position sensor device 24 may include an electric circuit as shown in Figure 3. In Figure 3 a source of direct current 26' is connected across a series combination of resistors 24h and 24i. The resistor 24h includes a plurality of taps, in this case four, each connected to the junction of both resistors 24h and 24i through a set of normally closed contacts serially interconnected. For example, the leftmost tap as viewed in Figure 3 on the resistor 24h is connected to contact set 24j. When the car ascends along the upper end portion of the hoistway, the shaft 24a is rotated as above described to cause the contact sets 24j, 24k, 24l and 24m to be successively opened in the named order by any suitable means (not shown) with the result that a voltage across the resistor 24i is stepwise decreased.

Referring back to Figure 1, the elevator car 20 travels upwardly and downwardly while it is guided by the guide rail 12. When the car 20 moves upwardly or downwardly in an intermediate portion of the hoistway 10, the position sensor device 24 has the arm 24c vertically pendent as shown in Figure 1. Assuming that the elevator car 10 travels upwardly from its position illustrated in Figure 1, the roller 24d abuts against the cam member 16 as the car ascends. Therefore, as above described, the roller 24d rolls along the rod-shaped cam member 16 while it is displaced in a lefthand direction as viewed in Figure 1 to rotate the shaft 24a in the clockwise direction as viewed in Figure 1 through the arm 24c. This clockwise rotation of the shaft 24a causes a decrease in degree of coupling of the variable coupling transformer 24e resulting in a decrease in a voltage induced across the secondary winding thereof.

From the foregoing it is appreciated that the position-to-speed conversion device 24 is operative to convert the position of the elevator car 20 relative to the end of its stroke to an angle of rotation of the shaft 24a through the utilization of the rod-shaped cam member 16 and then to indicate a corresponding speed represented by an

output from the variable coupling transformer 24.

In Figure 3, the normally closed contact sets 24j, 24k, 24l and 24m correspond to predetermined positions of the car to be sensed and are successively opened through the rotation of the shaft 24a (see Figure 1) to develop a voltage across the resistor 24j stepwise decreased in accordance with the position of the elevator car relative to the end of its stroke. Accordingly the shaft 24a cooperates with the arrangement of Figure 3 to perform the operation of the position sensor device as in Figure 2.

Since the guiding member 22 is supported to the elevator car 20 to be vibration-proof, the same may be deflected. This results in the displacement of the elevator car 20 relative to the guide rail 12 in bilateral directions as viewed in Figure 1. This displacement of the elevator car 20 relative to the guide rail 12 causes an error in a rotational angle of the shaft 24a. Therefore, it has been difficult to provide a position sensor device having a high accuracy.

The present invention contemplates to avoid the difficulty to the prior art practice as above described by the provision of a position sensor device for an elevator car unaffected by a lateral displacement of the elevator car relative to an associated guide rail.

One embodiment of the present invention will now be described in conjunction with Figure 4.

In the arrangement illustrated in Figure 4, a compensation shaft 24a' is disposed coaxially with the shaft 24a. Then an L-shaped arm 24n is fixedly secured at one end to the shaft 24a' to be rotatable about the axis of the shaft 24a' and connected at the other end to a compensation roller 24p. The roller 24p abuts against the guide rail 12 by means of a spring (not shown) through the arm 24n and rolls along the guide rail 12.

In other respects the arrangement is identical to that shown in Figure 1.

The shaft 24a' is operatively coupled to one of the windings of the variable coupling transformer 24e (see Figure 2), for example, the primary winding and the shaft 24a is operatively coupled to the other or secondary winding of the transformer 24e.

Assuming that the elevator car 20 travels upwardly from its position illustrated in Figure 4, the roller 24d abuts against the rod-shaped cam member 16. Thus, as the car 20 ascends, the shaft 24a is rotated in the clockwise direction as viewed in Figure 4 to rotate the secondary winding in a direction to decrease the degree of coupling between the primary and secondary windings as above described. This results in

a decrease in voltage induced across the secondary winding.

On the other hand, the travelling car 20 may be displaced in bilateral directions as viewed in Figure 4 through the deflection of the vibration-proof mounting members for the guiding member 22 resulting from the horizontal vibration of the car. This displacement of the car 20 causes the roller 24p rolling along the guide rail 12 to be horizontally deflected. For example, the elevator car 20 may be displaced with respect to the guide rail 12 in a lefthand direction as viewed in Figure 4. This leftward displacement of the car causes the shaft 24a to be displaced in the lefthand direction along with the car 20 in spite of the roller 24d being maintained in engagement with the cam member 16. Thus the shaft 24a is minutely rotated in the counterclockwise direction as viewed in Figure 4 with the result that the clockwise rotation of the secondary winding of the transformer 24e is correspondingly decreased.

At the same time, the roller 24p is pushed by the guide rail 12 to rotate the shaft 24a' in a counterclockwise direction as viewed in Figure 4 through the L-shaped arm 24n. Thereby the primary transformer 24e winding is minutely rotated in the counterclockwise direction to compensate for the decrease in clockwise rotation of the secondary winding as above described.

As a result, the horizontal movement of the elevator car 20 does not affect the relative rotation between the primary and secondary windings of the transformer 24e. This means that an output from the position sensor device includes no error due to any horizontal movement of the elevator car.

The position sensor device as shown in Figure 4 may utilize the arrangement illustrated in Figure 3. In this case, each of contact sets such as shown in Figure 3 is mounted to a disc fixed to the shaft 24a' to be rotatable therewith. As above described, a difference in rotation between the shafts 24a and 24a' does not include a horizontal component of the movement of the elevator car and hence all the contact sets 24j through 24l have respective operating points unaffected by the horizontal movement of the elevator car. This is true in the case when the elevator car is horizontally moved in the righthand direction as viewed in Figure 4.

Figure 5 shows a modification of the L-shaped arm 24n connected to the shaft 24a' operatively coupled to the arrangement of Figure 3 with the shaft 24a.

As shown in Figure 4, that end portion 24n' of the L-shaped arm 24n fixedly secured to the shaft 24a' has an enlarged lateral dimension and provided with an array of switches 24js, 24ks, 24ls and 24ms at such

positions that the switches are successively actuated by a cam member 24c' rotated about axis of the shaft 24a as a result of the movement of the roller 24d as above described. The switches 24j through 24ms include respective rollers and have respectively disposed therein the contact sets 24j through 24m as shown in Figure 3 but not shown in Figure 5.

As above described in conjunction with Figure 4, the movement of the elevator car in the lefthand direction, for example, causes the rotation of the shaft 24a in the counterclockwise direction as viewed in Figure 5 while at the same time the shaft 24a' is also rotated in the counterclockwise direction. Therefore, the cam member 24c' has its position remaining unchanged with respect to the roller type switches 24js, 24ks, 24ls and 24ms. In other words, the operating point of each contact set is not affected by the horizontal movement of the elevator car.

In a modification of the present invention shown in Figure 6, the position sensor device 24 is pivotally supported by the shaft 24a' above the elevator car (not shown) so as to be rotated about the axis of the shaft 24a' by means of the roller 24p (see Figure 4) through the L-shaped arm 24n. The device 24 may include either the variable coupling transformer 24e and the associated components as shown in Figure 2 or the contact sets 24j through 24m and the associated components as shown in Figure 3.

As in the arrangement as shown in Figures 4 and 5, the position sensor device 24 as shown in Figure 6 produces an output in response to the rotation of the device relative to the shaft 24a. Accordingly the output from the device is not affected by the horizontal movement of the elevator car.

Thus it is seen that the present invention provides a position sensor device having a simple construction and producing an output unaffected by the horizontal movement of an associated moving member such as an elevator car caused from a mating guiding member attached in vibration-proof relationship to the moving member.

While the present invention has been illustrated and described in conjunction with a few preferred embodiments thereof it is to be understood that the numerous changes and modifications may be resorted to without departing from the scope of the present invention as defined in the appended claims. For example, in order to eliminate noise generated during the travel of the elevator car resulting from the roller 24p always rolling along the guide rail 12 in the arrangement of Figure 4, the roller 24p may be normally put at its position where it

does not engage the guide rail 12 and advance to its position illustrated in Figure 4 through the rotation of the shaft 24a due to the roller 24d abutting against the rod-shaped cam member 16 upon the elevator car 12 approaching the end of its stroke. Also a vertical cam member in the form of a rod may be additionally disposed in order to cause the roller 24p to engage the same.

Further, while the contact sets 24j through 24m have been described to be included in the position sensor device it will readily be understood that they may serve as those contact sets required for controlling an associated elevator car for purposes other than the purpose described herein and unaffected by the horizontal movement of the car.

#### WHAT WE CLAIM IS:—

1. A position sensor device comprising a guide rail for engaging a guiding member disposed on an associated elevator car, a first roller mountable on the associated elevator car and kept in touch and operative with said guide rail or with a first cam member disposed at a predetermined spatial position relative to said guide rail, a second cam member disposed at a predetermined spatial position relative to said guide rail or said first cam member, a second roller mountable on the associated elevator car and kept in touch and operative with said second cam member, and a converter disposed on the associated elevator car to produce an output in response to the relative rotation between at least two elements, one of said elements being actuated by said first roller, the other element being actuated by said second roller.

2. A position sensor device as claimed in claim 1 wherein said second cam member is a rod-shaped cam member disposed on a plurality of supporting arms projecting from said guide rail to be directed to an end of said guide rail so as to cause one end of said cam member to more approach the guide rail than the other end thereof.

3. A position sensor device as claimed in claim 1 or 2 wherein said converter includes a variable coupling transformer, having a primary winding connected to the one element and a secondary winding connected to the other element, said relative rotation between said two elements changing a degree of coupling between said primary and secondary windings.

4. A position sensor device as claimed in claim 1 or 2 wherein said converter includes a group of contact sets corresponding to positions of the elevator car to be sensed and disposed stationarily with respect to the one element and a third cam member

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positions that the switches are successively actuated by a cam member 24c' rotated about axis of the shaft 24a as a result of the movement of the roller 24d as above described. The switches 24js through 24ms include respective rollers and have respectively disposed therein the contact sets 24j through 24m as shown in Figure 3 but not shown in Figure 5.

As above described in conjunction with Figure 4, the movement of the elevator car in the lefthand direction, for example, causes the rotation of the shaft 24a in the counterclockwise direction as viewed in Figure 5 while at the same time the shaft 24a' is also rotated in the counterclockwise direction. Therefore, the cam member 24c' has its position remaining unchanged with respect to the roller type switches 24js, 24ks, 24ls and 24ms. In other words, the operating point of each contact set is not affected by the horizontal movement of the elevator car.

In a modification of the present invention shown in Figure 6, the position sensor device 24 is pivotally supported by the shaft 24a' above the elevator car (not shown) so as to be rotated about the axis of the shaft 24a' by means of the roller 24p (see Figure 4) through the L-shaped arm 24n. The device 24 may include either the variable coupling transformer 24e and the associated components as shown in Figure 2 or the contact sets 24j through 24m and the associated components as shown in Figure 3.

As in the arrangement as shown in Figures 4 and 5, the position sensor device 24 as shown in Figure 6 produces an output in response to the rotation of the device relative to the shaft 24a. Accordingly the output from the device is not affected by the horizontal movement of the elevator car.

Thus it is seen that the present invention provides a position sensor device having a simple construction and producing an output unaffected by the horizontal movement of an associated moving member such as an elevator car caused from a mating guiding member attached in vibration-proof relationship to the moving member.

While the present invention has been illustrated and described in conjunction with a few preferred embodiments thereof it is to be understood that the numerous changes and modifications may be resorted to without departing from the scope of the present invention as defined in the appended claims. For example, in order to eliminate noise generated during the travel of the elevator car resulting from the roller 24p always rolling along the guide rail 12 in the arrangement of Figure 4, the roller 24p may be normally put at its position where it

does not engage the guide rail 12 and advance to its position illustrated in Figure 4 through the rotation of the shaft 24a due to the roller 24d abutting against the rod-shaped cam member 16 upon the elevator car 12 approaching the end of its stroke. Also a vertical cam member in the form of a rod may be additionally disposed in order to cause the roller 24p to engage the same.

Further, while the contact sets 24j through 24m have been described to be included in the position sensor device it will readily be understood that they may serve as those contact sets required for controlling an associated elevator car for purposes other than the purpose described herein and unaffected by the horizontal movement of the car.

#### WHAT WE CLAIM IS:—

1. A position sensor device comprising a guide rail for engaging a guiding member disposed on an associated elevator car, a first roller mountable on the associated elevator car and kept in touch and operative with said guide rail or with a first cam member disposed at a predetermined spatial position relative to said guide rail, a second cam member disposed at a predetermined spatial position relative to said guide rail or said first cam member, a second roller mountable on the associated elevator car and kept in touch and operative with said second cam member, and a converter disposed on the associated elevator car to produce an output in response to the relative rotation between at least two elements, one of said elements being actuated by said first roller, the other element being actuated by said second roller.

2. A position sensor device as claimed in claim 1 wherein said second cam member is a rod-shaped cam member disposed on a plurality of supporting arms projecting from said guide rail to be directed to an end of said guide rail so as to cause one end of said cam member to more approach the guide rail than the other end thereof.

3. A position sensor device as claimed in claim 1 or 2 wherein said converter includes a variable coupling transformer, having a primary winding connected to the one element and a secondary winding connected to the other element, said relative rotation between said two elements changing a degree of coupling between said primary and secondary windings.

4. A position sensor device as claimed in claim 1 or 2 wherein said converter includes a group of contact sets corresponding to positions of the elevator car to be sensed and disposed stationarily with respect to the one element and a third cam member



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rotatable with the other element to successively actuate said contact sets.

5 5. A position sensor device as claimed in any of claims 1 to 4 wherein a box member having one of at least two elements of said converter pivotably secured thereto is supported by said elevator car, the element of the converter being moved by means of said first roller.

10 6. A position sensor device as claimed in any of claims 1 to 5 wherein said first roller is arranged to abut against said guide rail or said first cam member through the rotation

of the one element due to said second roller abutting against said second cam member.

7. A position sensor device as claimed in Claim 1 and substantially as herein described with reference to and as illustrated in the accompanying figures 2 to 6.

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