

# PATENT SPECIFICATION (11)

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## (54) APPARATUS FOR DETECTING ABNORMAL CONDITION OF WIRE ROPE

(71) We, MITSUBISHI DENKI KABUSHIKI KAISHA, of 2—3 Marunouchi 2-chome, Chiyoda-ku, Tokyo, Japan, 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:—

This invention relates to apparatus for detecting abnormal condition in a wire rope, particularly for an elevator.

Recent high speed and high rise elevators have resulted in wire ropes such as a main elevator rope being used under remarkably severe conditions in comparison with conventional elevator rope from the viewpoints of twist, slip and wear. Accordingly, element wires of the wire rope sever readily. Damage of the wire rope causes not only difficulty as far as the wire rope itself is concerned, but also causes serious difficulties because projecting strands from the rope may foul instruments in a hatchway and cause damage to the instrument or complete breakage of the wire rope. For these reasons elevator safety is impaired.

However, it is not easy to detect breakage in the element wires, particularly when the travel height is high and the wire rope is long. Sometimes a breakage of an element wire occurs suddenly during driving of the elevator.

When the elevator is driven with a broken strand, the strand is gradually loosened to cause damage to instruments in the hatchway.

It is an object of the present invention to provide an apparatus for detecting abnormal condition of a wire rope which has a simple structure and allows detection of a broken element wire at an early stage to overcome the above-mentioned disadvantages.

According to one aspect of the invention there is provided an apparatus for detecting abnormal condition of a wire rope, said apparatus comprising a detector element, a part of which is movably mounted adjacent to the outer surface of a wire rope and

another part of which is held on a fixed part and is actuated by movement of said first part due to an abnormal condition of the rope as it passes adjacent said first part.

According to another aspect of the invention there is provided an apparatus for detecting abnormal condition of a wire rope for an elevator apparatus having a main rope holding a cage and a counterweight at ends thereof which is wound on a cylindrical surface of a driving sheave of a traction machine, said apparatus comprising a supporter, one end of which is fixed on a fixed part of said traction machine and the other end of which faces the cylindrical surface of said driving sheave such as to leave a gap therebetween, and a detector element, one part of which is pivotally connected on said supporter in such a way as to face said main rope wound on said driving sheave with a gap between the rope and the detector element, and another part of which is held on a fixed part and is actuated by movement of said one part when said one part is turned by contact with a projecting part of strands of said wire rope when such projecting part occurs at the outer surface of said wire rope to thereby detect abnormal conditions of the rope.

According to another aspect of the invention there is provided an apparatus for detecting abnormal condition of a wire rope for an elevator apparatus having a main rope holding a cage and a counterweight at ends thereof which is wound on a cylindrical surface of a driving sheave of a traction machine; said apparatus comprising a supporter, one end of which is fixed on a fixed part of said traction machine and the other end of which faces the cylindrical surface of said driving sheave in such a way as to leave a gap therebetween; a detector element one end of which is pivotally connected to said supporter and the other end of which faces said main rope wound on said driving sheave in such a way as to leave a gap between the element and the main rope; a switch which is held on a fixed part of said traction machine or said supporter and an

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operating part of which is disposed adjacent to said detector element; and a contact plate which is held on an end of said detector element to face said switch and which contacts the operating part of said switch whereby said detector element is turned by contacting with a projecting part of strands of said wire rope when such projecting occurs at the outer surface of said wire rope as an abnormal condition, said operating part being thus detached from said contact plate.

The invention will further be described with reference to the accompanying drawings, of which:—

Figure 1 is a schematic view of one embodiment of an elevator apparatus having apparatus for detecting abnormal condition of a wire rope according to the present invention;

Figure 2 is a sectional view taken along the line II—II of Figure 1;

Figure 3 is a left side view of the apparatus of Figure 2.

Figure 4 is a circuit diagram of part of the embodiment of Figures 1 to 3;

Figure 5 is a sectional view of another embodiment of the apparatus for detecting the abnormal condition of the wire rope according to the present invention; and

Figure 6 is a left side view of the apparatus of Figure 5.

Referring to Figures 1 to 4, one embodiment of the present invention will be illustrated.

In the drawings, the reference numeral 1 designates a floor for a machine room of elevator; 2 designates a driving machine; 2a designates a driving sheave; 3 designates a wire rope comprising plural main ropes which are wound on the driving sheave 2a. A cage 4 and a counterweight 5 are respectively connected to the ends of the wire rope to hang therefrom. The reference numeral 6 designates a supporter, a part of which is fixed on the fixed part of the driving machine 2 and another part of which is disposed to face the cylindrical surface of the driving sheave 2a with a gap; and 7 designates a detector, a part of which is pivotally held by the supporter 6 and another part of which faces the main rope 3 wound on the driving sheave 2a. Concave regions 7a are respectively formed to face the main ropes 3 with each gap *e*. The reference numeral 8 designates a detector element of a switch which is fitted on the supporter 6 and the operating part 8a of the detector element 8 is disposed to the detector 7. A contact plate 9 is fixed between the facing edges of the detector 7 and the detector element 8. The operating part 8a of the detector element 8 is in contact with the contact plate 9 under the conditions of Figures 2 and 3.

In Figure 4, the reference numeral 8b designates a normal closed contact for the

detector element 8; 10 designates a relay for detecting abnormal condition. 10a designates a normally opened contact; 10b designates a normally closed contact; 11 designates an alarm device for giving an alarm in the event of an abnormal condition; and 12 designates a control device for the elevator.

When the driving mechanism is driven, the cage 4 and the counterweight 5 respectively travel in opposite directions. When the main rope is normal is passes through the gap *e* without contact with detector 7. The detector element 8 is pressed against the contact plate 9 whereby the contact 8b is open and the relay for detecting abnormal condition 10 is turned off. The alarm device 11 is not actuated. The control device 12 is actuated by a circuit of (+) — (10b) 1 (12) — (—), whereby the elevator is operated under normal conditions.

When a projecting wire of a broken strand or an abnormal condition of the peripheral part of the rope such as an increase of diameter of the main rope 3 occurs the detector 7 is turned by contact with the projecting part of the main rope. The same happens if, for example, the main rope comes out of the guide groove of the driving sheave 2a. Under these circumstances the detector element 8 is disconnected from the contact plate 9 to allow the operating part 8a to project. The contact 8b is closed to turn on the relay 10 for detecting abnormal condition through the circuit (+) — (8a) — (10) — (—). The alarm device 11 is actuated by the circuit (=) — (10) — (11) — (—), and the contact 10b is opened to cut off the control device 12 whereby the elevator is stopped.

It is clear that the same effect can be attained by fixing the detector 7 and the detector element 8 on a fixed part around a deflector sheave of the elevator or a suspension sheave of the cage 4 or the floor 1.

Figures 5 and 6 show another embodiment of the apparatus of the present invention. In Figures 5 and 6, like reference numerals designate identical or corresponding parts of Figures 1 to 4.

The reference numeral 7 designates detectors which are respectively disposed to face each of the main ropes 3; 7b designates contact pieces made of a resilient material such as synthetic resin and each have a long concave groove 7a. The contact piece 7b is connected to the rotary end of the detector 7 through the groove by a small screw 13. The reference numeral 8 designates a detector element of a switch disposed near each of the detectors 7.

In the embodiment of Figures 5 and 6, each pair of the detector 7 and the detector element 8 are disposed around each of the main ropes 3 shown in the embodiment of Figures 1 to 4. The detailed description of

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this embodiment is omitted. However, it is clear that the same effect as that of the embodiment of Figures 1 to 4 can be attained in the embodiment of Figures 5 and 6.

5 In this embodiment, the contact piece 7b which is detachable and whose gap from the main rope 3 is adjustable, is used. The gap between the main rope 3 and the contact piece 7b can be adjusted and a buffering action is attained to prevent trouble such as a deformation of the detector 7 by shock of a projecting part of the main rope 3.

10 If the concave part 7a of the contact piece 7b is damaged the contact piece can be exchanged. The detector 7 can be easily maintained this way. If both a detector 7 and a detector element 8 are damaged, the function for detecting the abnormal condition of the main rope 3 is partially maintained.

15 As described above, one or more detectors are movably mounted adjacent to an outer surface of the wire rope and are held on a fixed part near the passage of the wire rope. Increase of the diameter of the wire rope or abnormal condition of the outer surface such as a break of a strand can be detected by the detectors whereby the abnormal condition of the wire rope can be detected with high reliability. No inspections are necessary and trouble caused by the abnormal condition of the wire rope can be prevented.

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WHAT WE CLAIM IS:—

1. An apparatus for detecting abnormal condition of a wire rope, said apparatus comprising a detector, a part of which is movably mounted adjacent to the outer surface of a wire rope and another part of which is held on a fixed part and is actuated by movement of said first part due to an abnormal condition of the rope as it passes adjacent said first part.

2. An apparatus according to claim 1 wherein a concave part is formed on said detector where it faces the outer surface of said wire rope in such a way as to leave a gap between the rope and the detector.

3. An apparatus according to claim 1 wherein the first-mentioned part of the detector is rotatably mounted so as to turn when it is contacted by a projecting part of said wire rope.

4. An apparatus for detecting abnormal condition of a wire rope for an elevator apparatus having a main rope holding a cage and a counterweight at ends thereof which is wound on a cylindrical surface of a driving sheave of a traction machine, said apparatus comprising a supporter, one end of which is fixed on a fixed part of said traction machine and the other end of which faces the cylindrical surface of said driving sheave such as to leave a gap therebetween,

and a detector element, one part of which is pivotally connected on said supporter in such a way as to face said main rope wound on said driving sheave with a gap between the rope and the detector element, and another part of which is held on a fixed part and is actuated by movement of said one part when said one part is turned by contact with a projecting part of strands of said wire rope when such projecting part occurs at the outer surface of said wire rope to thereby detect abnormal conditions of the rope.

5. An apparatus according to claim 4 wherein said cage and said counterweight are respectively connected at opposite ends of a plurality of main ropes which are wound on the cylindrical surface of said driving sheave of said traction machine and wherein a plurality of concave parts are formed on said detector element to face the outer surfaces of said main ropes in such a way as to leave a gap between each concave part and a respective main rope.

6. An apparatus according to claim 4 wherein said cage and said counterweight are respectively connected at opposite ends of a plurality of main ropes which are wound on the cylindrical surface of said driving sheave of said traction machine and wherein a plurality of detector elements each having concave parts respectively face the outer surfaces of said main ropes in such a way as to leave a gap between each element and a respective main rope.

7. An apparatus for detecting abnormal condition of a wire rope for an elevator apparatus having a main rope holding a cage and a counterweight at ends thereof which is wound on a cylindrical surface of a driving sheave of a traction machine; said apparatus comprising a supporter, one end of which is fixed on a fixed part of said traction machine and the other end of which faces the cylindrical surface of said driving sheave in such a way as to leave a gap therebetween; a detector element one end of which is pivotally connected to said supporter and the other end of which faces said main rope wound on said driving sheave in such a way as to leave a gap between the element and the main rope; a switch which is held on a fixed part of said traction machine or said supporter and an operating part of which is disposed adjacent to said detector element; and a contact plate which is held on an end of said detector element to face said switch and which contacts the operating part of said switch whereby said detector element is turned by contacting with a projecting part of strands of said wire rope when such projecting part occurs at the outer surface of said wire rope as an abnormal condition, said operating part being thus detached from said contact plate.



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this embodiment is omitted. However, it is clear that the same effect as that of the embodiment of Figures 1 to 4 can be attained in the embodiment of Figures 5 and 6.

In this embodiment, the contact piece 7b which is detachable and whose gap from the main rope 3 is adjustable, is used. The gap between the main rope 3 and the contact piece 7b can be adjusted and a buffering action is attained to prevent trouble such as a deformation of the detector 7 by shock of a projecting part of the main rope 3.

If the concave part 7a of the contact piece 7b is damaged the contact piece can be exchanged. The detector 7 can be easily maintained this way. If both a detector 7 and a detector element 8 are damaged, the function for detecting the abnormal condition of the main rope 3 is partially maintained.

As described above, one or more detectors are movably mounted adjacent to an outer surface of the wire rope and are held on a fixed part near the passage of the wire rope. Increase of the diameter of the wire rope or abnormal condition of the outer surface such as a break of a strand can be detected by the detectors whereby the abnormal condition of the wire rope can be detected with high reliability. No inspections are necessary and trouble caused by the abnormal condition of the wire rope can be prevented.

#### WHAT WE CLAIM IS:—

1. An apparatus for detecting abnormal condition of a wire rope, said apparatus comprising a detector, a part of which is movably mounted adjacent to the outer surface of a wire rope and another part of which is held on a fixed part and is actuated by movement of said first part due to an abnormal condition of the rope as it passes adjacent said first part.

2. An apparatus according to claim 1 wherein a concave part is formed on said detector where it faces the outer surface of said wire rope in such a way as to leave a gap between the rope and the detector.

3. An apparatus according to claim 1 wherein the first-mentioned part of the detector is rotatably mounted so as to turn when it is contacted by a projecting part of said wire rope.

4. An apparatus for detecting abnormal condition of a wire rope for an elevator apparatus having a main rope holding a cage and a counterweight at ends thereof which is wound on a cylindrical surface of a driving sheave of a traction machine, said apparatus comprising a supporter, one end of which is fixed on a fixed part of said traction machine and the other end of which faces the cylindrical surface of said driving sheave such as to leave a gap therebetween,

and a detector element, one part of which is pivotally connected on said supporter in such a way as to face said main rope wound on said driving sheave with a gap between the rope and the detector element, and another part of which is held on a fixed part and is actuated by movement of said one part when said one part is turned by contact with a projecting part of strands of said wire rope when such projecting part occurs at the outer surface of said wire rope to thereby detect abnormal conditions of the rope.

5. An apparatus according to claim 4 wherein said cage and said counterweight are respectively connected at opposite ends of a plurality of main ropes which are wound on the cylindrical surface of said driving sheave of said traction machine and wherein a plurality of concave parts are formed on said detector element to face the outer surfaces of said main ropes in such a way as to leave a gap between each concave part and a respective main rope.

6. An apparatus according to claim 4 wherein said cage and said counterweight are respectively connected at opposite ends of a plurality of main ropes which are wound on the cylindrical surface of said driving sheave of said traction machine and wherein a plurality of detector elements each having concave parts respectively face the outer surfaces of said main ropes in such a way as to leave a gap between each element and a respective main rope.

7. An apparatus for detecting abnormal condition of a wire rope for an elevator apparatus having a main rope holding a cage and a counterweight at ends thereof which is wound on a cylindrical surface of a driving sheave of a traction machine; said apparatus comprising a supporter, one end of which is fixed on a fixed part of said traction machine and the other end of which faces the cylindrical surface of said driving sheave in such a way as to leave a gap therebetween; a detector element one end of which is pivotally connected to said supporter and the other end of which faces said main rope wound on said driving sheave in such a way as to leave a gap between the element and the main rope; a switch which is held on a fixed part of said traction machine or said supporter and an operating part of which is disposed adjacent to said detector element; and a contact plate which is held on an end of said detector element to face said switch and which contacts the operating part of said switch whereby said detector element is turned by contacting with a projecting part of strands of said wire rope when such projecting occurs at the outer surface of said wire rope as an abnormal condition, said operating part being thus detached from said contact plate.

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8. An apparatus according to claim 7 wherein said cage and said counterweight are respectively connected at opposite ends of a plurality of main ropes which are wound on the cylindrical surface of said driving sheave of said traction machine and wherein a plurality of concave parts are formed on said detector element to face the outer surfaces of said main ropes each in such a way as to leave a gap between each concave part and a respective main rope.

9. An apparatus according to claim 7 wherein said cage and said counterweight are respectively connected at opposite ends of a plurality of main ropes which are wound on

the cylindrical surface of said driving sheave of said traction machine and wherein a plurality of detector elements each having concave parts respectively face the outer edges of said main ropes in such a way as to leave a gap between each element and a respective main rope.

10. An apparatus substantially as hereinbefore described with reference to Figures 1 to 4 or Figures 5 to 6 of the accompanying drawings.

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