The invention relates to a load detector having a sensor (32) for detecting a rotational angle of a rotational member (35) which performs rotational movement in accordance with variations in load. On the basis of the value detected by the sensor (32), the load detector determines the status of a cable (18, 40). As a result, fracture in the cable (18, 40) can be perceived without fail, and it is possible to avoid overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.
Description

Field of the Invention

[0001] The invention relates to a load detector for detecting load exerted on a passenger car, a method for controlling the detector, and an elevator system.

Background Art

[0002] By reference to Figs. 8 and 9, a conventional load detector for an elevator system will now be described.

[0003] Fig. 8 is a schematic drawing showing a conventional load detector. In Fig. 8, reference numeral 1 designates a base provided in a hoistway or a machine room; 3 designates a plurality of shackle rods which penetrate through the base 1 and support on one end thereof a pull cable suspending a passenger car or the like; 5 designates spring seats provided at upper ends of the respective shackle rods 3; 7 designates nuts to be used for determining the effective length of shackle springs; 8 designates nuts to be used for fixing pulley mounts; 10 designates a plurality of shackle springs for cushioning load variations exerted on the plurality of shackle rods 3; 12 designates a plurality of pulley mounts which are supported by the shackle rods 3 and support movable pulleys; 13 designates a plurality of movable pulleys which move in synchronism with vertical variations in the shackle rods 3; 15 designates a frame for supporting the load detector; 16 designates a plurality of fixed pulleys which are supported on the frame 15 and around which operating-side cables are passed; 18 designates an operating-side cable whose one end is supported by a detection pulley and whose other end is supported by a fixing member via the movable pulleys and the fixed pulleys; 20 designates a rod screw serving as a fixing member; 22 designates a nut to be used for positioning the rod screw 20; 30 designates a spindle fixedly provided on the frame 15; 32 designates a sensor which is provided on a detection pulley and detects a rotational angle of the detection pulley; 35 designates a detection pulley which serves as a rotary member, the member rotating in synchronism with movement of the operating-side cable 18 and movement of a tension-side cable; 35a designates a notch formed in the detection pulley 35; 37 designates fixing hardware which meshes with the notch 35a and supports the operating-side cable 18 and the tension-side cable; 40 designates a tension-side cable whose one end is supported by the fixing hardware 37 and whose other end is supported by a tension spring; and 42 designates a tension spring serving as a rotational force supply section for imparting rotational force to the detection pulley 35 in the non-loading direction.

[0004] Here, a cable anchor section of the elevator system is constituted of the shackle rods 3, the shackle springs 10, the spring seats 5, the nuts 7, and the base...
ward. At this time, the operating-side cable 18 has already been subjected to the tension imposed by the tension-side cable 40 and the pull spring 42, and hence the detection pulley 35 rotates counterclockwise in the drawing. The sensor 32 detects the rotational angle of the detection pulley 35 and the load provided in the passenger car from the thus-detected rotational angle.

A value of the thus-detected load of the passenger car is transferred to a control section in a drive source of the hoisting machine, wherein the control section controls an inverter. In accordance with the detected value, the rotational speed of the hoisting machine around which the pull cable is passed is finely controlled. If the value of the detected load of the passenger car has exceeded a predetermined value, control operation is performed such that warning sound for reporting overload is issued in the passenger car.

Fig. 9 is schematic diagram showing another conventional load detector. The load detector shown in Fig. 9 differs from that shown in Fig. 8 in that a weight 45 is used in place of the tension spring 42 used for imparting tension to the operating-side cable 18. Specifically, one side of the tension cable 40 is connected to the fixing hardware 37 of the detection pulley 35, and the other side of the same is connected to the weight 45. The load detector is identical with that shown in Fig. 8 in terms of the operation of the other respective members and the operation of the load detector.

In the event that the operating-side cable 18 or the tension-side cable 40 has been broken, the above-described load detector presents a problem of permitting loading of cargo exceeding allowable load or failing to control rotation of the detection pulley 35, which in turn results in idle running of the detection pulley 35.

More specifically, when the tension-side cable 40 and the operating-side cable 18 have become broken, no tension is exerted on the operating-side cable 18, and hence the detection pulley 35 fails to appropriately rotate in synchronism with the vertical movement of the shackle rods 3. Therefore, the load of the passenger car cannot be detected appropriately. Even when the load of the passenger car has become excessive, such a change cannot be detected, and the passenger car is caused to ascend or descend while remaining in an overloaded state, which in turn may cause a fracture in the pull cable or other problems.

In the event that the operating-side cable 18 has become ruptured, the detection pulley 35 is subject to solely the counterclockwise rotational force exerted by the pull spring 42 or the counterweight 45, and the tension-side cable 40. Therefore, the detection pulley 35 excessively rotates in the counterclockwise direction. As a result, electric wires (or a wire harness) of the sensor 32 or other elements may be entangled with and cut by the spindle 30.

The invention has been conceived to solve the problem and provides a highly-reliable load detector which prevents vertical movement of a passenger car remaining in an overloaded state even if a fracture has arisen in a cable passed around a detection pulley serving as a rotary member and prevents occurrence of a fracture in components such as sensors, as well as a method for controlling the load detector, and an elevator system.

Disclosure of the Invention

The invention provides a load detector having a sensor for detecting a rotational angle of a rotational member which performs rotational movement in accordance with variations in load. On the basis of the value detected by the sensor, the load detector determines the status of a cable. As a result, fracture in the cable can be perceived without fail, and there can be avoided overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

The invention also provides the improved load detector which identifies whether or not the cable is in a normal state or an anomalous state by determining whether or not a value detected by the sensor falls within a predetermined range. As a result, fracture in the cable can be perceived without fail, and there can be avoided overburden of the elevator system, which would otherwise be caused by ascending/descending of the passenger car while the same remains in an overloaded state.

The invention also provides the improved load detector which determines a normal range of a cable status by addition or subtraction of a margin to or from the value detected by the sensor when allowable load is exerted on the cable or no load is exerted on the same. As a result, fracture in the cable can be perceived without fail, and there can be avoided overburden of the elevator system, which would otherwise be caused by ascending/descending of the passenger car while the same remains in an overloaded state.

The invention also provides the improved load detector having a rotational member which performs rotational movement in accordance with variations in load, and a rotational movement regulation member for regulating a rotational range of the rotational member. As a result, even if fracture has arisen in the cable passed around the rotational member, the rotational movement of the rotational member can be stopped at a predetermined rotational angle. Hence, there is lessened the chance of fracture arising in components, such as sensors, provided in the detector.

The invention provides the improved load detector which determines the status of the cable on the basis of the value detected by the sensor which detects the rotational angle of the rotational member. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle, thereby lessening the chance of fracture arising in components, such as a sensor, provided in the elevator system. Fur-
ther, fracture in the cable can be perceived without fail, and there is avoided overburden of the elevator system, which would otherwise be caused by ascending/descending of the passenger car while the same remains in an overloaded state.

[0022] The invention provides the improved load detector which identifies whether the cable is in a normal state or an anomalous state by determining whether or not the value detected by the sensor falls within the predetermined range. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle, thereby lessening the chance of fracture arising in components, such as a sensor, provided in the elevator system. Further, fracture in the cable can be perceived without fail, and there is avoided overburden of the elevator system, which would otherwise be caused by ascending/descending of the passenger car while the same remains in an overloaded state.

[0023] The invention also provides the improved load detector which determines a normal range of a cable status by addition or subtraction of the margin to or from the value detected by the sensor when allowable load is exerted on the cable or no load is exerted on the same. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle, thereby lessening the chance of fracture arising in components, such as a sensor, provided in the elevator system. Further, fracture in the cable can be perceived without fail, and there is avoided overburden of the elevator system, which would otherwise be caused by ascending/descending of the passenger car while the same remains in an overloaded state.

[0024] According to the invention, in the improved load detector, the rotational movement regulation member regulates supply of rotational force to the rotational member from the rotational power supply section linked to a tension-side cable. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle, thereby lessening the chance of fracture arising in components, such as a sensor, provided in the detector.

[0025] According to the invention, in the improved load detector, the movable range of a tension spring serving as a rotational force supply section is limited by the regulation cable serving as the rotational movement regulation member. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle, thereby lessening the chance of fracture arising in components, such as a sensor, provided in the detector.

[0026] According to the invention, in the improved load detector, the rotational movement regulation member regulates supply of rotational force to the rotational member by limiting the travel of movable pulleys. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle, thereby lessening the chance of fracture arising in components, such as a sensor, provided in the detector.

[0027] According to the invention, in the improved load detector, the rotational movement regulation member is constituted of first and second pulley mounts, one or more of them having a slide mechanism. As a result, rotational movement of the rotational member can be stopped at a predetermined rotational angle, thereby lessening the chance of fracture arising in components, such as a sensor, provided in the detector.

[0028] The invention also provides an elevator system equipped with the improved load detector. By means of the load detector, fracture in the cable can be perceived without fail, and there is avoided overburden on an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state. Further, the rotational movement of the rotational member can be stopped at a predetermined rotational angle, thereby lessening the chance of fracture arising in components, such as a sensor, provided in the detector.

[0029] The invention also provides the elevator system, wherein the control section determines the status of the cable on the basis of the value detected by the sensor. Ascending and descending operation of a passenger car are controlled on the basis of the result of determination. By means of the control section, fracture in the cable can be perceived without fail, and hence there is avoided overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

[0030] The invention also provides a method for controlling a load detector equipped with a sensor for detecting a rotational angle of a rotational member which performs rotational movement in accordance with variations in load. The status of the cable is determined on the basis of the value detected by the sensor. Fracture in the cable can be perceived without fail, and there is avoided overburden on an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

[0031] Further, the invention also provides the improved method for controlling a load detector, wherein a determination is made to whether or not the value detected by the sensor falls within a predetermined range, thereby identifying whether or not the cable is in a normal or an anomalous state. Fracture in the cable can be perceived without fail, and there is avoided overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

[0032] Further, the invention also provides the improved method for controlling a load detector, wherein a normal range of a cable status is determined by addition or subtraction of the margin to or from the value detected by the sensor when allowable load is exerted on the cable or no load is exerted on the same. As a result,
fracture in the cable can be perceived without fail, and there is avoided overburden on an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

**Brief Description of the Drawings**

[0033]

Fig. 1 is a schematic diagram showing a load detector according to a first embodiment of the invention; Fig. 2 is a graph showing a relationship between a value output from a sensor and a rotational angle of a rotational member within the load detector shown in Fig. 1; Fig. 3 is a schematic drawing showing a state of the load detector shown in Fig. 1 in which an operating-side cable has become broken; Fig. 4 is a schematic drawing showing the load detector according to a second embodiment of the invention; Fig. 5 is a schematic drawing showing a state of the load detector shown in Fig. 4 in which a tension-side cable has broken; Fig. 6 is an enlarged view showing a movable pulley and a pulley mount of the load detector shown in Fig. 4; Fig. 7 is a cross-sectional view showing the movable pulley and the pulley mount, which are shown in Fig. 6 and taken along line X-X shown in the same; Fig. 8 is a schematic drawing showing a conventional load detector; and Fig. 9 is a schematic drawing showing another conventional load detector.

**Best Modes for Implementing the Invention**

[0034] In order to describe the invention in more detail, the invention will be described by reference to the accompanying drawings. Throughout the drawings, like elements or counterparts are assigned the same reference numerals, and their repeated explanations are simplified or omitted, as required.

[0035] By reference to Figs. 1 through 3, a load detector according to a first embodiment of the invention will be described. Fig. 1 is a schematic diagram showing a load detector according to a first embodiment of the invention; Fig. 2 is a graph showing a relationship between a value output from a sensor and a rotational angle of a rotational member within the load detector shown in Fig. 1; and Fig. 3 is a schematic drawing showing a state of the load detector shown in Fig. 1 in which an operating-side cable has become broken.

[0036] In Figs. 1 through 3, reference numeral 1 designates a base; 3 designates a plurality of shackle rods; 5 designates spring seats; 7, 8 designate nuts; 10 designates a plurality of shackle springs; 12 designates a plurality of pulley mounts which are supported by the shackle rods 3 and support movable pulleys; 13 designates a plurality of movable pulleys which move in synchronism with vertical variations in the shackle rods 3; 15 designates a frame for supporting the load detector; 16 designates a plurality of fixed pulleys supported on the frame 15; 18 designates an operating-side cable whose one end is supported by a detection pulley and whose other end is supported by a fixing member via the movable pulleys and the fixed pulleys; 20 designates a rod screw serving as a fixing member; 22 designates a nut to be used for positioning the rod screw 20; 30 designates a spindle fixedly provided on the frame 15; 32 designates a sensor, such as a tilt sensor, which is provided on a detection pulley and detects a rotational angle of the detection pulley; 33 designates a control section for determining the statuses of the cables 18, 40 in accordance with the value detected by the sensor 32; 35 designates a detection pulley which serves as a rotary member, the member rotating in synchronism with movement of the operating-side cable 18 and movement of a tension-side cable; 35a designates a notch formed in the detection pulley 35; 37 designates fixing hardware which meshes with the notch 35a and supports the operating-side cable 18 and the tension-side cable; 40 designates a tension-side cable whose one end is supported by the fixing hardware 37 and whose other end is supported by a tension spring; 42 designates a tension spring serving as a rotational force supply section for imparting rotational force to the detection pulley 35 in the non-loading direction; 50 designates a fixed screw fixedly provided on the frame 15; and 52 designates a regulation cable whose one end is supported on the fixed screw 50 and whose other end is supported by the tension spring 42.

[0037] Here, a cable anchor section of the elevator system is constituted of the shackle rods 3, the shackle springs 10, the spring seats 5, the nuts 7, and the base 1. The cable anchor section is set in the hoistway or the machine room. The unillustrated pull cable supported by lower ends of the respective shackle rods 3 suspends an unillustrated passenger car and an unillustrated counterweight within the hoistway. By means of driving operation of a hoisting machine, the passenger car and the counterweight are caused to ascend and descend in opposite directions.

[0038] The movable pulleys 13, the pulley mounts 12, the fixed pulleys 16, the detection pulley 35, the sensor 32, the operating-side cable 18, the tension-side cable 40, the tension spring 42, the regulation cable 52, and the fixed screw 50 constitute the load detector.

[0039] The load detector having the foregoing construction operates in the following manner.

[0040] First, the operating-side cable 18 is passed around the movable pulleys 13 and the fixed pulleys 16 one after another. The operating-side cable 18 imparts,
to the detection pulley 35, rotational force for rotating the detection pulley 35 in a clockwise direction in the drawing. The tension-side cable 40 and the pull cable 42 impart, to the detection pulley 35, rotational force for rotating the detection pulley 35 in a counterclockwise direction. As a result, predetermined tension is exerted on the operating-side cable 18.

[0041] If the load provided in the passenger car is heavier than the standard state, the shackle rods 3 press the shackle springs 10, thereby moving downward from the positions of the shackle rods 3 shown in Fig. 1. In association with movement of the shackle rods 3, the movable pulleys 13 and the pulley mounts 12 are also moved downward. As a result, the operating-side cable 18 rotates the detection pulley 35 in a clockwise direction in the drawing. The sensor 32 detects the rotational angle of the detection pulley 35 and the load provided in the passenger car on the basis of a value of the detected rotational angle.

[0042] When the load provided in the passenger car is lighter than the standard state, the shackle rods 3 are pressed upward by the spring force of the shackle springs 10 and moved upward from the positions shown in Fig. 1. In association with movement of the shackle rods 3, the positions of the movable pulleys 13 and the positions of the pulley mounts 12 are also moved upward. As a result, the operating-side cable 18 is also moved, and the detection pulley 35 is rotated counterclockwise in the drawing. The sensor 32 detects the rotational angle of the detection pulley 35 and the load provided in the passenger car from the thus-detected rotational angle.

[0043] A value of the thus-detected load of the passenger car is transferred to the control section 33. Subsequently, the information is transferred to a drive section of a hoisting machine and an operation section of the passenger car.

[0044] By reference to Figs. 2 and 3, operation of the load detector of the first embodiment to be performed at the time of occurrence of an anomaly will now be described. Fig. 2 is a graph showing a relationship between a value output from a sensor and a rotational angle of a rotational member within the load detector shown in Fig. 1.

[0045] In Fig. 2, the horizontal axis of the graph represents a rotational angle of the detection pulley 35, and the vertical axis of the same represents a value detected (output from) by the sensor 32 shown in Fig. 1.

[0046] When the load of the passenger car of the elevator system is in a standard state (i.e., a state shown in Fig. 1), the rotational angle of the detection pulley assumes a value of 0° (i.e., a point BL in the drawing). As shown in Fig. 2, the value detected by the sensor assumes a value of 0. In contrast, when the load of the passenger car is in an unloaded state, the detection pulley rotates counterclockwise in Fig. 1, and the sensor detects a value corresponding to NL shown in Fig. 2. Further, when the load of the passenger car is in an allowable load state, the detection pulley rotates clockwise in Fig. 1. The sensor detects a value corresponding to FL shown in Fig. 2. Here, the allowable load is an upper limit value of cargo of the passenger car determined in advance from a structural viewpoint and in view of legal regulations.

[0047] The load detector of the first embodiment determines the state of the operating-side cable and the tension-side cable on the basis of the value detected by the sensor. Specifically, a rotational angle L2 is determined by subtracting a margin M2 from a rotational angle NL obtained when no load is imposed on the passenger car. Further, a rotational angle L1 is determined by adding a margin M1 to a rotational angle FL obtained when an allowable load is exerted on the passenger car. A range defined between the rotational angles L1 and L2 is determined as a normal detection range S, wherein the detection pulley operates normally without involvement of any anomaly in the operating-side cable or the tension-side cable, such as fracture. Ranges outside the range defined between the rotational angles L1 and L2 are determined in advance from a structural viewpoint and in view of legal regulations.

[0048] When the value detected by the sensor has become greater than the maximum value or smaller than the minimum value, information to this effect is transmitted from the control section to the passenger car, the hoisting machine, or the like. Measures to prevent overloading of the passenger car are taken. Specifically, for example, ascending or descending operation of the passenger car is suspended by controlling the hoisting machine, or a warning sound is issued by controlling the operation panel provided in the passenger car. As a result, operation of the elevator system, which would otherwise be performed with the load detector being broken, can be prevented.

[0049] In relation to the rotational angle of the detection pulley, the margin M2 for non-loading is set to a value of 10 to 15% the weight of the passenger car obtained when the passenger car is empty. Further, the margin M1 for allowable load is set to a value of 10 to 15% the weight of the passenger car obtained when the passenger car is loaded up to its capacity. For instance, when the value detected by the sensor continuously falls with-
in the anomaly detection range AS within a predetermined period of time, the control section can perceive fracture in the operating-side cable or the tension-side cable.

050] By reference to Fig. 3, a rotational movement regulation member in the load detector of the first embodiment, the member regulating counterclockwise rotational movement of the detection, will now be described. Fig. 3 is a schematic drawing showing a state of the load detector shown in Fig. 1 in which an operating-side cable has become broken.

051] As shown in Fig. 3, the operating-side cable 18 has broken at a rupture section P1. At this time, the operating-side cable 18 loses tension required to rotate the detection pulley 35 clockwise. As a result, the detection pulley 35 rotates counterclockwise (i.e., in the direction of the arrow shown in Fig. 3) by means of the tension spring 42 and the tension-side cable 40. When rotation of the detection pulley 35 has exceeded the normal detection range S, the control section 33 perceives rupture in the operating-side cable 18.

052] When the detection pulley 35 rotates in excess of the normal detection range S, the rotational movement force originating from the tension spring 42 is regulated in response to the length of the regulation cable 52. The rotational movement of the detection pulley 35 is eventually stopped. When the detection pulley 35 performs normal rotational movement, the regulation cable 52 becomes loosened, as shown in Fig. 1. In contrast, when the detection pulley 35 has rotated counterclockwise in excess of the normal range, the regulation cable 52 becomes stretched taut, as shown in Fig. 3. At this time, the pull spring 42 whose one end is supported by the regulation cable 52 does not contract to a free length and is held at a predetermined spring length. The rotation of the detection pulley 35 is suspended at that position.

055] In this way, there can be prevented occurrence of a failure, such as disconnection of the harness of the sensor 32, which would otherwise be caused by excessive rotation of the detection pulley 35 stemming from disconnection of the operating-side cable 18.

054] As described above, according to the load detector of the first embodiment, even when the cable passed around the detection pulley serving as a rotational member has become broken, the passenger car is prevented from ascending or descending while remaining in an overloaded state, and occurrence of breakage of components, such as a sensor, is prevented. Thus, high reliability can be achieved.

055] In the first embodiment, the pull spring 42 is used as a rotational power supply section. However, the rotational power supply section of the invention is not limited to the spring. For example, the weight 45 which is shown in Fig. 9 and has been described previously can also be used. A torsion spring may be provided on the spindle 30 of the detection pulley 35, and the spring may be used as a rotational force supply member. Even in such a case, an advantage identical with that yielded in the first embodiment is yielded.

056] By reference to Figs. 4 through 7, a load detector according to a second embodiment of the invention will now be described. Fig. 4 is a schematic drawing showing the load detector according to a second embodiment of the invention. Fig. 5 is a schematic drawing showing a state of the load detector shown in Fig. 4 in which a tension-side cable has broken. Fig. 6 is an enlarged view showing a movable pulley and a pulley mount of the load detector shown in Fig. 4. Fig. 7 is a cross-sectional view showing the movable pulley and the pulley mount, which are shown in Fig. 6 and taken along line X-X shown in the same.

057] The load detector of the second embodiment differs from the load detector of the first embodiment in that the regulation cable is not provided for the tension spring 42 and in that a pulley mount allocated to one of the movable pulleys is of slide type.

058] In Figs. 4 through 7, reference numeral 1 designates a base; 2 designates a plurality of shackle rods; 3 designates a plurality of shackle springs; 4 designates a rod; 5 designates pulley mounts; 6 designates a first pulley mount of the load detector shown in Fig. 4. Fig. 7 is a enlarged view showing a movable pulley and a pulley mount of the load detector shown in Fig. 4. Fig. 7 is a cross-sectional view showing the movable pulley and the pulley mount, which are shown in Fig. 6 and taken along line X-X shown in the same.

059] As shown in Fig. 4, one of the three movable pulleys 13 (i.e., the rightmost movable pulley shown in the drawing) is supported by a slide pulley mount formed from the first pulley mount 62 and the second pulley mount 63.
operate through the elongated hole 62a of the first pulley mount 62 and the hole of the second pulley mount 63. The flat washer 67, which is larger in diameter than the elongated hole 62a, is provided between the screw head of the screw 65 and the collar 68. The flat washer 72 and the lock washer 73 are interposed between the nut 70 and the collar 68. By reference to Fig. 7, the collar 68 is longer than the length determined by addition of the thickness of the first pulley mount 62 to the thickness of the second pulley mount 63. As a result, the first pulley mount 62 and the second pulley mount 63 enable smooth slide action of the first pulley mount 62 without being rigidly fastened by the screw 65 and the nut 70. The screw 65, the flat washers 67, 72, the nut 70, and the lock washer 73 serve as projection sections of the second pulley mount 63 which are to mesh with the elongated hole 62a of the first pulley mount 62.

[0061] Operation of the load detector having the foregoing construction to be performed during normal operation will now be described.

[0062] First, as in the case of the first embodiment, the operating-side cable 18 is passed around the movable pulleys 13 and the fixed pulleys 16 one after another. When the load provided in the passenger car is heavier than the standard state, the detection pulley 35 rotates clockwise, and the sensor 32 detects the rotational angle of the detection pulley 35. In contrast, when the load provided in the passenger car is lighter than the standard state, the detection pulley 35 rotates counterclockwise, and the sensor 32 detects the rotational angle of the sensor 32.

[0063] As shown in Fig. 4, the first pulley mount 62 is located at the upper end position within the movable range by the elongated hole 62a.

[0064] Next, operation of the load detector of the second embodiment to be performed at the time of occurrence of an anomaly will now be described. First, as in the case of the first embodiment, even in the load detector of the second embodiment, when the value detected by the sensor 32 has exceeded the maximum value or become smaller than the minimum value, information to this effect is transmitted from the control section 33 to the passenger car, the hoisting machine, or the like, thereby taking measures to prevent overloading of the passenger car.

[0065] As shown in Fig. 5, when the tension-side cable 40 has become broken, the above-described slide pulley mechanism acts as a rotational movement regulation member. Fig. 5 is a schematic drawing showing a state of the load detector shown in Fig. 4 in which a tension-side cable has broken.

[0066] As shown in Fig. 5, the tension-side cable 40 is broken at a rupture section P2. At this time, the tension-side cable 40 loses the tension required to rotate the detection pulley 35 in a counterclockwise direction, whereupon the detection pulley 35 is rotated clockwise (i.e., the direction of the arrow shown in Fig. 5) by the operating-side cable 18. When the rotation of the detection pulley 35 has exceeded the normal detection range S, the control section 33 perceives occurrence of fracture in the tension-side cable 40 in the manner mentioned above.

[0067] When the detection pulley 35 has rotated in excess of the normal detection range S, the movable pulley 13 having the slide pulley mechanism moves downward along the elongated hole 62a. The first pulley mount 62 comes to a stop at a position corresponding to the lower end of the movable range of the elongated hole 62a. As a result, the rotational movement of the detection pulley 35 is stopped.

[0068] In this way, there can be prevented occurrence of a failure, such as disconnection of the harness of the sensor 32, which would otherwise be caused by excessive rotation of the detection pulley 35 due to disconnection of the operating-side cable 18.

[0069] As described above, as in the case of the first embodiment, according to the load detector of the second embodiment, even when the cable passed around the detection pulley serving as a rotational member has become broken, the passenger car is prevented from ascending or descending while remaining in an overloaded state, and occurrence of breakage of components, such as a sensor, is prevented. Thus, high reliability can be achieved.

[0070] In the second embodiment, the elongated hole 62a is provided in the first pulley mount 62, and the projection section formed from the screw 65 or the like is provided on the second pulley mount 63. Alternatively, the elongated hole 62a may be provided on the second pulley mount 63, and the projection section may be provided on the first pulley mount 62. Even in such a case, an advantage identical with that yielded in the second embodiment can be yielded.

[0071] The slide pulley mount mechanism is not limited to the construction described in connection with the second embodiment. For instance, a stud may be provided on the second pulley mount 63, and the stud may be configured so as to mesh with the elongated hole 62a. Further, a location where the slide pulley mount mechanism is to be placed is not limited to that described in connection with the second embodiment. For instance, the movable pulley 13 provided in the center of the drawing may be provided with the slide pulley mount mechanism.

[0072] Although in the embodiments the acceleration sensor provided in the detection pulley 35 is used as the sensor 32, the sensor of the invention is not limited to the acceleration sensor. The sensor employed by the invention may be embodied by any sensor, so long as the sensor can detect a rotational angle of the detection pulley. For instance, the sensor of the invention may be embodied by a so-called rotary encoder, wherein a plurality of slits are formed in a rotation surface of the detection pulley, and displacements developing in the slits are detected by an optical sensor disposed outside the detection pulley.
In the embodiments, the rotational movement regulation member to be used in the event of occurrence of fracture in the operating-side cable 18 and the rotational movement regulation member to be used in the event of occurrence of fracture in the tension-side cable 40 are provided separately. However, these members may be provided collectively in a single load detector.

The rotational movement regulation member of the invention is not limited to those described in connection with the embodiments. For instance, a projection may be provided at a predetermined location on the rotational surface of the detection pulley 35, and a stopper member to mesh with the projection may be provided outside the detection pulley 35, thereby regulating the rotational angle of the detection pulley 35.

As is obvious, the invention is not limited to the embodiments and is susceptible to modifications other than those suggested in the embodiments, as required, within the technical scope of the invention. The number, positions, and geometries of the constituent members are not limited to those mentioned in the embodiments. The preferred number, positions, and geometries may be determined in carrying out the invention.

Industrial Applicability

As mentioned above, a load detector of the invention has a sensor for detecting a rotational angle of a rotational member which performs rotational movement in accordance with variations in load. On the basis of the value detected by the sensor, the load detector determines the status of a cable. As a result, fracture in the cable can be perceived without fail, and hence the load detector is useful as a load detector capable of avoiding overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

The load detector of the invention identifies whether the cable is in a normal state or an anomalous state by determining whether or not the value detected by the sensor falls within a predetermined range. As a result, fracture in the cable can be perceived without fail, and hence the load detector is useful as a load detector capable of avoiding overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

The load detector of the invention determines a normal range of a cable status by addition or subtraction of a margin to or from the value detected by the sensor when allowable load is exerted on the cable or no load is exerted on the same. As a result, fracture in the cable can be perceived without fail, and hence the load detector is useful as a load detector capable of avoiding overburden of the elevator system, which would otherwise be caused by ascending/descending of the passenger car while the same remains in an overloaded state.

The load detector of the invention determines whether or not the cable is in a normal state or an anomalous state by determining whether or not the value detected by the sensor falls within a predetermined range. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle. Therefore, the load detector is useful as a load detector which lessens the chance of fracture arising in components, such as sensors, provided in the elevator system. Further, fracture in the cable can be perceived without fail, and hence the load detector is useful as a load detector capable of avoiding overburden of the elevator system, which would otherwise be caused by ascending/descending of the passenger car while the same remains in an overloaded state.

The load detector of the invention determines a normal range of a cable status by addition or subtraction of the margin to or from the value detected by the sensor when allowable load is exerted on the cable or no load is exerted on the same. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle. Therefore, the load detector is useful as a load detector which lessens the chance of fracture arising in components, such as sensors, provided in the elevator system. Further, fracture in the cable can be perceived without fail, and hence the load detector is useful as a load detector capable of avoiding overburden of the elevator system, which would otherwise be caused by ascending/descending of the passenger car while the same remains in an overloaded state.
In the load detector of the invention, the rotational movement regulation member regulates supply of rotational force to the rotational member from the rotational power supply section linked to the tension-side cable. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle. Therefore, the load detector is useful as a load detector which lessens the chance of fracture arising in components, such as a sensor, provided in the detector.

In the load detector of the invention, the movable range of a tension spring serving as the rotational force supply section is limited by the regulation cable serving as the rotational movement regulation member. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle. Therefore, the load detector is useful as a load detector which lessens the chance of fracture arising in components, such as a sensor, provided in the detector.

In the load detector of the invention, the rotational movement regulation member regulates supply of rotational force to the rotational member by limiting the travel of movable pulleys. As a result, the rotational movement of the rotational member can be stopped at a predetermined rotational angle. Therefore, the load detector is useful as a load detector which lessens the chance of fracture arising in components, such as a sensor, provided in the detector.

An elevator system of the invention is an elevator system equipped with the improved load detector. By means of the load detector, fracture in the cable can be perceived without fail, and hence the elevator system is useful as an elevator system capable of avoiding overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

A method for controlling a load detector according to the invention is for controlling a load detector equipped with a sensor for detecting a rotational angle of a rotational member which performs rotational movement in accordance with variations in load. The status of the cable is determined on the basis of the value detected by the sensor. Fracture in the cable can be perceived without fail, and hence the method is useful as a load detector control method which enables avoidance of overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

Under the method for controlling a load detector according to the invention, a determination is made to whether or not the value detected by the sensor falls within a predetermined range, thereby identifying whether or not the cable is in a normal or an anomalous state. Fracture in the cable can be perceived without fail, and hence the method is useful as a load detector control method which enables avoidance of overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

Under the method for controlling a load detector according to the invention, a normal range of a cable status is determined by addition or subtraction of the margin to or from the value detected by the sensor when allowable load is exerted on the cable or no load is exerted on the same. As a result, fracture in the cable can be perceived without fail, and hence the method is useful as a load detector control method which enables avoidance of overburden of an elevator system, which would otherwise be caused by ascending/descending of a passenger car while the same remains in an overloaded state.

Claims

1. A load detector comprising:
   - a rotational member around which a cable is passed and which rotates in association with movement of the cable;
   - a sensor for detecting a rotational angle of the rotational member;
   - a control section for determining the status of the cable on the basis of a value detected by the sensor.

2. The load detector according to claim 1, wherein the control section determines that the cable is in a normal state when the value detected by the sensor
falls within a range defined between a predetermined maximum detected value and a predetermined minimum detected value.

3. The load detector according to claim 2, wherein the predetermined maximum detected value is obtained by addition of a margin to a value detected when allowable load is exerted, and the predetermined minimum detected value is obtained by subtraction of a margin from a value detected when no load is exerted.

4. A load detector comprising:
   a rotational member around which a cable is passed and which rotates in association with movement of the cable; and
   a rotational movement regulation member for regulating a range of rotational movement of the rotational member.

5. The load detector according to claim 4, further comprising:
   a sensor for detecting a rotational angle of the rotational member; and
   a control section for determining the status of the cable on the basis of the value detected by the sensor.

6. The load detector according to claim 5, wherein the control section determines that the cable is in a normal state when the value detected by the sensor falls within a range defined between a predetermined maximum detected value and a predetermined minimum detected value.

7. The load detector according to claim 6, wherein the predetermined maximum detected value is obtained by addition of a margin to a value detected when allowable load is exerted, and the predetermined minimum detected value is obtained by subtraction of a margin from a value detected when no load is exerted.

8. The load detector according to any one of claims 4 through 7, wherein:
   the cable has a tension-side cable whose one end is supported by the rotational member and whose other end is supported by a rotational force supply section which imparts rotational force in a non-loading direction of the rotational member; and
   the rotational movement regulation member regulates supply of rotational force from the rotational force supply section.

9. The load detector according to claim 8, wherein:
   the rotational force supply section is a tension spring or a weight; and
   the rotational movement regulation member is a regulation cable whose one end is supported by the tension spring or the weight and whose other end is supported by a fixed section.

10. The load detector according to any one of claims 4 through 7, wherein:
    the cable has an operating-side cable whose one end is supported by the rotational member and whose other end is supported by the fixed section by way of a movable pulley which moves in association with magnitude of load; and
    the rotational movement regulation member is a member for regulating travel of the movable pulley.

11. The load detector according to claim 10, wherein:
    the rotational movement regulation member has:
    a first pulley mount which supports the movable pulley and has a through hole or a projection section; and
    a second pulley mount which has a projection section or a through hole to be engaged with the through hole or the projection section and which enables sliding action of the first pulley mount.

12. An elevator system comprising the load detector defined in any one of claims 1 through 11.

13. The elevator system according to claim 12, wherein ascending and descending operation of a passenger car within a hoistway is regulated on the basis of a result of detection of status of the cable performed by the load detector.

14. A method for controlling a load detector, the detector comprising a rotational member around which a cable is passed and which rotates in association with movement of the cable, and a sensor for detecting a rotational angle of the rotational member, the method comprising the step of:
    determining the status of the cable on the basis of a value detected by the sensor.

15. The method for controlling a load detector according to claim 14, wherein the step of determining the status of the cable is a step of determining that the cable is in a normal state when the value detected by the sensor falls within a range defined between
a predetermined maximum detected value and a predetermined minimum detected value.

16. The method for controlling a load detector according to claim 15, wherein the predetermined maximum detected value is obtained by addition of a margin to a value detected when allowable load is exerted, and the predetermined minimum detected value is obtained by subtraction of a margin from a value detected when no load is exerted.
Fig. 2

value detected by the sensor

maximum value

minimum value

anomaly detection range AS

normal detection range S

anomaly detection range AS

rotational angle
Fig. 3
INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/11183

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl' B66B/02, B66B/14, B66B1/44, B66B7/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int.Cl' B66B/02, B66B/14, B66B1/44, B66B7/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>JP, 2-8176, A (Mitsubishi Electric Corp.), 11 January, 1990 (11.01.90), Page 2, upper right column, line 15 to lower right column, line 7; Figs. 1 to 3 (Family: none)</td>
<td>1-16</td>
</tr>
<tr>
<td>A</td>
<td>JP, 45-11436, Y1 (Hitachi, Ltd.), 21 May, 1970 (21.05.70), Column 1, lines 26 to 30; Fig. 1 (Family: none)</td>
<td>1-16</td>
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☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search
28 March, 2002 (28.03.02)

Date of mailing of the international search report
09 April, 2002 (09.04.02)

Name and mailing address of the ISA/ Japanese Patent Office
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Form PCT/ISA/210 (second sheet) (July 1998)