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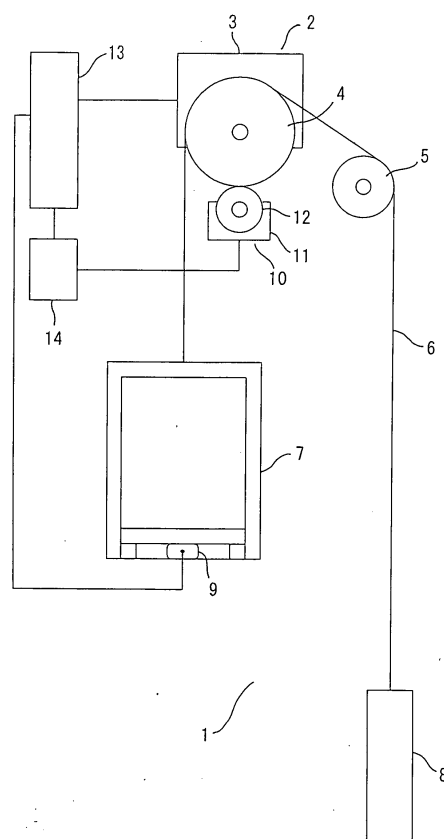
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(54) **ELEVATOR**

(57) In an elevator apparatus, a main rope suspending a car and a counterweight is wound around a drive sheave of a drive device. The car side and the counterweight side are in balance with each other when the value of a weight load in the car is smaller than 1/2 of the maximum loading weight of the car. The car is provided with a weighing device for measuring a value of the weight load in the car. A torque assist device is provided within a hoistway. An assist control device controls the torque assist device so as to impart auxiliary torque to the drive sheave when the value of the weight load in the car as determined based on information from the weighing device becomes larger than the predetermined value.

FIG. 1



Description

Technical Field

[0001] The present invention relates to a rope type elevator apparatus in which an elevator car and a counterweight are raised and lowered by drive of a hoisting machine.

Background Art

[0002] Conventionally, JP 05-38182 A discloses an elevator apparatus in which a sheave for suspending an elevator car and a counterweight is driven by a plurality of drive systems in order to achieve an increase in elevator capacity. In the conventional elevator apparatus, the allocation of output power among the respective drive systems is determined based on the required torque.

[0003] In the conventional elevator apparatus, in order to achieve miniaturization of the respective drive systems, the weight of the counterweight is set to be the same as the sum of 1/2 of the car's maximum loading weight (weight at full passenger capacity) and the car's own weight. That is, the car side and the counterweight side are in balance with each other when the number of passengers on board the car is at 1/2 of the full passenger capacity.

[0004] It is known, however, that there is generally a rather low probability of passengers being on board at 1/2 of the full passenger capacity of the car. In the case of home elevators, in particular, the number of passengers on board is usually one or two in many cases. Further, in recent years, large-capacity elevator apparatuses are increasingly installed in large offices in order to cope with the loads at peak times when people come to work, during the lunchtime, and when people leave work, for example; however, during the normal operation time other than the peak times, the number of passengers on board is not more than 1/2 of the full passenger capacity in the overwhelming majority of cases. Accordingly, the conventional elevator apparatus involves a large amount of wasted energy consumption during the normal operation time.

Disclosure of the Invention

[0005] The present invention has been made with a view toward solving the above-mentioned problems, and it is therefore an object of the present invention to provide an elevator apparatus capable of reducing the amount of energy consumption.

[0006] An elevator apparatus according to the present invention includes: a drive device having a drive device main body and a drive sheave rotated by the drive device main body; a main rope wound around the drive sheave; a car suspended from one end portion of the main rope; a counterweight suspended from the other end portion of the main rope and being in balance with the car side

when a value of a weight load in the car is smaller than 1/2 of a maximum loading weight of the car; a torque assist device for imparting an auxiliary torque to the drive sheave; a weighing device for measuring the value of the weight load in the car; and an assist control device for controlling the torque assist device so that the torque assist device imparts the auxiliary torque to the drive sheave when the value of the weight load determined based on information from the weighing device becomes larger than a predetermined value.

Brief Description of the Drawings

[0007] Fig. 1 is a front view showing an elevator apparatus according to Embodiment 1 of the present invention.

Best Mode for carrying out the Invention

[0008] Hereinbelow, preferred embodiments of the present invention will be described with reference to the drawings.

Embodiment 1

[0009] Fig. 1 is a front view showing an elevator apparatus according to Embodiment 1 of the present invention. Referring to Fig. 1, a hoisting machine 2 as a drive device is provided in an upper portion of a hoistway 1. The hoisting machine 2 has a drive device main body 3 including a motor, and a drive sheave 4 provided to the drive device main body 3 and rotated through the drive of the drive device main body 3. Further, a deflector sheave 5 is provided near the hoisting machine 2.

[0010] A plurality of main ropes 6 are wound around the drive sheave 4 and the deflector sheave 5. A car 7 is connected to one end portion of each main rope 6, and a counterweight 8 is connected to the other end portion of each main rope 6. The car 7 and the counterweight 8 are suspended within the hoistway 1 by the respective main ropes 6. Further, the car 7 and the counterweight 8 are raised and lowered within the hoistway 1 as the drive sheave 4 rotates.

[0011] Provided in a lower portion of the car 7 is a weighing device 9 for measuring the value of the weight load (for example, the weight of a heavy load such as a passenger or luggage) inside the car 7. It should be noted that the weighing device used may be one which measures the weight load in the car 7 by obtaining the tension in the main rope 6.

[0012] The weight of the counterweight 8 is smaller than the sum of 1/2 of the weight of the maximum loading weight of the car 7 (the weight at the full passenger capacity of the car) and the self weight of the car 7. That is, the car 7 side and the counterweight 8 side are in balance with each other when the value of the weight load in the car 7 is equal to a reference weight that is smaller than 1/2 of the maximum loading weight of the

car 7. Accordingly, when the value of the weight load in the car 7 is equal to the reference weight, the output torque of the hoisting machine 2 becomes minimum (the lower limit value).

[0013] The hoisting machine 2 is set such that its output torque becomes maximum (the upper limit value) when the difference in weight between the car 7 side and the counterweight 8 side becomes equal to the reference weight. That is, the hoisting machine 2 is set such that its output torque becomes maximum when there is no weight load in the car 7 and when the weight load in the car 7 is equal to a weight (predetermined value) that is twice the reference weight. Accordingly, the hoisting machine 2 is capable of raising and lowering the car 7 and the counterweight 8 individually within the range in which the difference in weight between the car 7 side and the counterweight 8 side is not larger than the reference weight.

[0014] In this example, the passenger capacity of the car 7 is 10 people. Further, the weight of the counterweight 8 is equal to the sum of the self weight of the car 7 and the combined weight of two people. That is, when the number of passengers on board the car 7 is two, which is less than 1/2 (5 people) of the passenger capacity (10 people) of the car 7, the car 7 side and the counterweight 8 side are in balance with each other. That is, the combined weight of two passengers is set as the reference weight.

[0015] Further, the hoisting machine 2 is set such that its output torque becomes maximum when the car 7 is empty and when four passengers are on board the car 7. That is, the hoisting machine 2 is set such that its output capacity becomes maximum when the difference in weight between the car 7 side and the counterweight 8 side is equal to the combined weight of two passengers. Accordingly, the hoisting machine 2 is capable of raising and lowering the car 7 and the counterweight 8 individually when the difference in weight between the car 7 side and the counterweight 8 side is not larger than the combined weight of two passengers.

[0016] In the hoistway 1, there is provided a torque assist device 10 for imparting to the drive sheave 4 auxiliary torque for supplementing a shortage in the output torque of the hoisting machine 2 by adding a rotary force to the drive sheave 4. The torque assist device 10 is provided separately from the hoisting machine 2. Further, the torque assist device 10 is arranged below the hoisting machine 2. Further, the torque assist device 10 has an assist device main body 11 including a motor, and a contact roller 12 that is in contact with the outer peripheral portion of the drive sheave 4 and is rotated through the drive of the assist device main body 11.

[0017] The outer peripheral portion of the contact roller 12 is provided with a high-friction member for preventing the slippage of the contact roller 12 with respect to the drive sheave 4. The drive sheave 4 is rotated through the rotation of the contact roller 12. As a result, the rotation torque of the assist device main body 11 is transmit-

ted to the drive sheave 12 as the auxiliary torque via the contact roller 12.

[0018] Further, in the hoistway 1, there are provided an elevator control device 13 for controlling the operation of the elevator, and an assist control device 14 for controlling the drive of the torque assist device 10. The hoisting machine 2, the weighing device 9, and the assist control device 14 are electrically connected to the elevator control device 13. The elevator control device 13 controls the hoisting machine 2 based on information from the weighing device 9.

[0019] The assist control device 14 is electrically connected to the torque assist device 10. The information from the weighing device 9 is input to the assist control device 14 via the elevator control device 13. The assist control device 14 controls the drive of the torque assist device 10 based on the information from the weighing device 9.

[0020] The assist control device 14 controls the torque assist device 10 so as to impart auxiliary torque to the drive sheave 4 when the value of the weight load determined based on the information from the weighing device 9 becomes larger than a weight (predetermined value) that is twice the reference weight, and to stop the output of the auxiliary torque when the value of the weight load becomes equal to or smaller than the predetermined value. Further, the torque assist device 14 controls the drive of the torque assist device 10 so as to adjust the value of the auxiliary torque imparted to the drive sheave 4 in accordance with the value of the weight load in the car 7.

[0021] That is, when the difference in weight between the car 7 side and the counterweight 8 side is not larger than the reference weight, the value of the torque required for raising and lowering the car 7 and the counterweight 8 falls within the permissible range of the output torque of the hoisting machine 2, so the car 7 and the counterweight 8 are raised and lowered as the drive sheave 4 is rotated by the output torque of only the hoisting machine 2. Further, when the difference in weight between the car 7 side and the counterweight 8 side is larger than the reference weight, the value of the requisite torque exceeds the permissible range of the output torque of the hoisting machine 2, so the auxiliary torque due to the torque assist device 10 is imparted to the drive sheave 4 in addition to the output torque of the hoisting machine 2. As a result, the drive sheave 4 is rotated by means of the combined torque of the output torque of the hoisting machine 2 and the auxiliary torque of the torque assist device 10, thus raising and lowering the car 7 and the counterweight 8. The value of the auxiliary torque imparted to the drive sheave 4 is adjusted according to the difference in weight between the car 7 side and the counterweight 8 side through the control of the assist control device 14.

[0022] In this example, the output torque of the hoisting machine 2 becomes short when the number of passengers inside the car 7 reaches 5 or more, so the auxiliary

torque from the torque assist device 10 is added through the control of the assist control device 14. Further, the value of the auxiliary torque is adjusted by the assist control device 14 according to the value of the weight load determined based on the information from the weighing device 9.

[0023] Next, operation will be described. The information from the weighing device 9 is constantly input to the elevator control device 13 and the assist control device 14. Accordingly, the value of the weight load in the car 7 is determined by the elevator control device 13 and the assist control device 14. The value of the output torque of the hoisting machine 2 is adjusted according to the value of the weight load in the car 7 through the control of the elevator control device 13.

[0024] When the value of the weight load in the car 7 is not larger than twice of the reference weight, that is, when the number of passengers inside the car 7 is not larger than 4, the drive of the torque assist device 10 is stopped through the control of the assist control device 14, so the imparting of the auxiliary torque to the drive sheave 4 is stopped. The drive sheave 4 is thus rotated solely by the output torque of the hoisting machine 2, and the car 7 and the counterweight 8 are raised and lowered within the hoistway 1.

[0025] When the value of the weight load in the car 7 becomes larger than twice of the reference weight, that is, when the number of passengers inside the car 7 becomes 5 or more, the torque assist device 1 is driven through the control of the assist control device 14, and the auxiliary torque is imparted to the drive sheave 4 together with the output torque of the hoisting machine 2. The value of the auxiliary torque at this time is adjusted by the assist control device 14 according to the value of the weight load in the car 7. The drive sheave 4 is thus rotated, and the car 7 and the counterweight 8 are raised and lowered within the hoistway 1.

[0026] In the elevator apparatus as described above, the balance between the car 7 side and the counterweight 8 side is achieved when the value of the weight load in the car 7 is equal to the reference weight that is smaller than 1/2 of the maximum loading weight of the car 7; when the value of the weight load in the car 7 becomes larger than twice of the reference weight, the auxiliary torque for supplementing a shortage in the output torque of the hoisting machine 2 is imparted to the drive sheave 4 by the torque assist device 10. Accordingly, the value of the maximum output torque of the hoisting machine 2 can be reduced to thereby achieve miniaturization of the hoisting machine 2. Further, most of the elevator operation during the normal operation time other than the peak times can be effected through the drive of only the miniaturized hoisting machine 2, thereby making it possible to reduce the amount of energy consumed for the elevator operation. Further, the counterweight 8 can be miniaturized, thereby achieving a reduction in the installation space of the elevator apparatus.

[0027] Further, the difference in weight between the

car 7 side and the counterweight 8 side is the same between when the value of the weight load in the car 7 is equal to a weight (predetermined value) that is twice the reference weight and when there is no weight load in the car 7, so it is possible to make the most of the capacity of the hoisting machine 2 to thereby prevent an increase in the capacity of the torque assist device 10.

[0028] Further, the value of the auxiliary torque is adjusted according to the value of the weight load in the car 7 by the assist control device 14 performing control on the torque assist device 10, thereby making it possible to prevent the amount of energy consumed by the torque assist device 10 from increasing more than necessary.

[0029] Further, the torque assist device 10 is provided separately from the hoisting machine 2, whereby the handling of the torque assist device 14 and hoisting machine 2 is facilitated to thereby facilitate the maintenance and inspection work.

[0030] Further, the torque assist device 10 has the control roller 12 that contacts the drive sheave 4 to transmit the auxiliary torque to the drive sheave 4, whereby the auxiliary torque can be imparted to the drive sheave 4 by means of the simple construction.

[0031] It should be noted that while in the above-described example the elevator control device 13 and the assist control device 14 are provided separately from each other within the hoistway 1, the assist control device 14 may be mounted to the elevator control device 13.

[0032] Further, while in the above-described example the auxiliary torque from the torque assist device 10 can be transmitted to the drive sheave 4 through the contact of the contact roller 12 with the drive sheave 4, the auxiliary torque from the torque assist device 10 may be transmitted to the drive sheave 4 by means of a power transmission belt. In this case, the hoisting machine 2 is provided with a pulley that is rotated integrally with the drive sheave 4, and the torque assist device 10 is provided with a pulley that is rotated by the assist device main body 11. Further, the power transmission belt is wound between the respective pulleys.

[0033] Further, while in the above-described example the torque assist device 10 and the hoisting machine 2 are provided separately from each other, it is also possible to coaxially connect the rotary shaft of the torque assist device 10 to the rotary shaft of the drive sheave 4. This makes it possible to dispense with the contact roller 12 to thereby reduce the number of parts.

[0034] Further, the torque assist device 10 may be incorporated into the drive device main body 3 to be integrated therewith. This makes it possible to reduce the installation spaces of the hoisting machine 2 and torque assist device 10.

[0035] Furthermore, while in the above-described example the present invention is applied to the elevator apparatus of the 1:1 roping system in which the one end portion of the main rope 6 is connected to the car 7 and the other end portion of the main rope 6 is connected to the counterweight 8, the present invention may be ap-

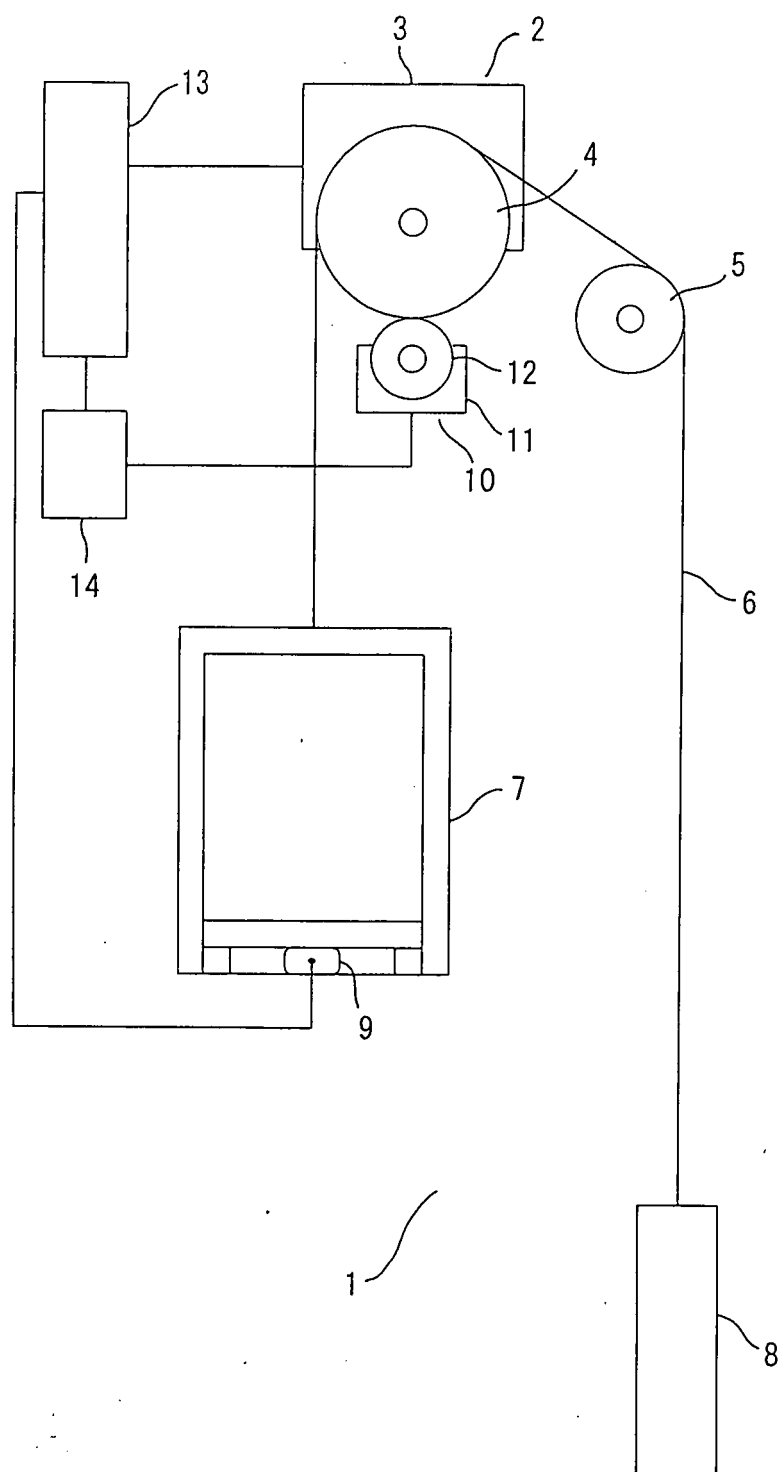
plied to an elevator apparatus of a 2: 1 roping system in which a car suspension pulley and a counterweight suspension pulley, on each of which the main rope is wound up, are provided to the car 7 and the counterweight 8, respectively. In this case, the one and the other end portions of the main rope are connected to an upper portion of the hoistway 1. Further, the main rope 6 is wound around the car suspension pulley, the drive sheave 4, and the counterweight suspension pulley in the stated order from the one end portion to the other end portion thereof.

acterized in that the torque assist device is incorporated into the drive device main body.

Claims

1. An elevator apparatus, **characterized by** comprising:
 - a drive device having a drive device main body and a drive sheave rotated by the drive device main body;
 - a main rope wound around the drive sheave;
 - a car suspended by the main rope;
 - a counterweight suspended by the main rope and being in balance with the car side when a value of a weight load in the car is smaller than 1/2 of a maximum loading weight of the car;
 - a torque assist device for imparting an auxiliary torque to the drive sheave;
 - a weighing device for measuring the value of the weight load in the car; and
 - an assist control device for controlling the torque assist device so that the torque assist device imparts the auxiliary torque to the drive sheave when the value of the weight load determined based on information from the weighing device becomes larger than a predetermined value.
2. An elevator apparatus according to Claim 1, **characterized in that** a difference in weight between the car side and the counterweight side is the same between when the value of the weight load is the predetermined value and when there is no weight load.
3. An elevator apparatus according to Claim 1, **characterized in that** a value of the auxiliary torque is adjusted according to the value of the weight load.
4. An elevator apparatus according to Claim 1, **characterized in that** the torque assist device is provided separately from the drive device.
5. An elevator apparatus according to Claim 1, **characterized in that** the torque assist device has a contact roller that contacts the drive sheave to transmit the auxiliary torque to the drive sheave.
6. An elevator apparatus according to Claim 1, **char-**

FIG. 1



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/009368

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ B66B11/08		
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 ⁷ B66B1/00-B66B11/08		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005 Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 1-271381 A (Hitachi, Ltd.), 30 October, 1989 (30.10.89), Page 1, lower right column, lines 10 to 20; page 6, upper right column, line 2 to page 7, upper left column, line 2; Fig. 10 (Family: none)	1-4 5-6
A	JP 61-127588 A (Hitachi, Ltd.), 14 June, 1986 (14.06.86), Claims; page 2, lower right column, line 5 to page 3, upper left column, line 18; Fig. 1 (Family: none)	1, 4, 6
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 24 March, 2005 (24.03.05)		Date of mailing of the international search report 12 April, 2005 (12.04.05)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/009368

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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REFERENCES CITED IN THE DESCRIPTION

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