(54) Title: OVERSPEED GOVERNOR APPARATUS FOR ELEVATOR SYSTEM

(57) Abstract: An overspeed governor apparatus of an elevator system for detecting an overspeed of an elevator car traveling in an upward or downward direction for thereby actuating an upward or downward safety gear. The overspeed is determined as a function of position of the elevator car. The overspeed can be prevented with high reliability.
DESCRIPTION

OVERSPEED GOVERNOR APPARATUS FOR ELEVATOR SYSTEM

TECHNICAL FIELD

The present invention relates to an overspeed governor apparatus (also referred to as "overspeed governor" or simply as "governor") for an elevator system.

BACKGROUND TECHNIQUES

In an elevator system, an overspeed governor apparatus is generally employed. The overspeed governor apparatus serves as an independent safety system in parallel to a drive system for the elevator car.

The presently known overspeed governor is put into operation upon occurrence of two situations, which will be described below.

First Situation

When a fault should take place in the drive system of an elevator system, the elevator car tends to travel at an overspeed.

The overspeed governor is designed to detect such overspeed to thereby stop or shut down operation of the drive system. In that case, if the shutdown operation of the drive system is inadequate, the overspeed governor will engage with a safety device (also referred to as the safety gear), to thereby stop positively downward movement or travel of the elevator car.

In the case of an elevator system in which a counterweight
is employed in combination with the elevator car driven to travel in the upward direction, an upward safety device or gear is employed.

In the conventional elevator system known heretofore, a brake of a traction machine or an upward safety gear mounted on the elevator car or a downward safety gear provided in association with a counterweight, for example, is used for the purpose of adjusting or regulating the overspeed mentioned above.

Second Situation

When a fault or trouble takes place in a suspension system for the elevator car, the latter will move downward.

In that case, the overspeed governor apparatus detects the overspeed of the car at that time point to engage with the downward safety gear installed on the elevator car.

In the specification of USP No. 6,173,813, there is disclosed a governor apparatus of the structure designed for improving the response or reaction speed of the safety gear system. More specifically, an electronic governor which incorporates an accelerometer attached to the elevator car is disclosed in this publication.

In more concrete, upon occurrence of a fault or trouble in the suspension device, the downward safety gear is immediately put into operation upon detection of an over-acceleration without waiting for the car reaching overspeed. In that case, the overspeed is determined by integrating the acceleration as measured to the speed. In response, the electronic governor opens a separately provided safety circuit which includes an electromagnet. As a result of this, electric power supply
to the electromagnet is interrupted, which in turn results in activation of the downward safety gear.

Heretofore, improvement of the mechanical governor apparatus has certainly been proposed. By way of example, such an arrangement may be mentioned in which the operation of the overspeed governor apparatus is prevented by means of a pin which is adapted to be removed or retracted, for example, by means of an electromagnet.

More specifically, when a controller issues a command for driving the elevator car to the drive system, the pin has to be retracted or pulled out. In that case, when the elevator car does not move in response to the command or when the traction force of a traction sheave is inadequate or when the elevator car does move due to insufficiency of the braking effort of the brake, then the movement of the elevator car which can not be controlled is suppressed or prevented by actuating the upward safety gear or the downward safety gear by means of the governor whose actuation or operation is prevented.

Disadvantages of the mechanical overspeed governor apparatus known heretofore and the electronic overspeed governor disclosed in the specification of USP No. 6,173,813 reside in that the governor apparatus can operate only at the overspeed based on the rated speed of the elevator system or only at the zero speed, as can be seen in several mechanical overspeed governor apparatuses known heretofore.

When the moving elevator car reaches a location closer to one of the extremities of the car path, the overspeed governor will respond only to the overspeed set previously (i.e., preset overspeed). As a result
of this, there may unwantedly occur such situation that the elevator car will strike against a buffer before the overspeed governor is tripped.

Further, when a fault or trouble occurs in the elevator car when it is traveling upward and when no upward safety device or gear is provided or when the upward safety gear can not stop the elevator car in time, then the counterweight may strike against the buffer.

In that case, jump of the elevator car may take place independent on the speed of the elevator car. Accordingly, there arises the necessity of providing a space at a top portion of the elevator shaft for accommodating the jump of the elevator car. Incidentally, it should be added that the buffers for the elevator car and the counterweight, respectively, are ordinarily designed on the basis of the rated speed of the elevator car with a certain range or margin of the overspeed being also taken into consideration.

Figure 6 of the accompanying drawings shows a pendulum type overspeed governor apparatus (also referred to simply as the pendulum governor) known heretofore. Parenthetically, the pendulum governor shown schematically in Fig. 6 is a commercially available one.

Referring to the figure, a governor rope (not shown) drives a sheave 3. A cam 26 is securely fixed onto a side surface of the sheave 3. When the sheave 3 is rotating, a cam follower wheel 27 follows the profile of the cam 26. The cam follower wheel 27 is mounted on a pendulum member 4 at one end thereof. A spring member 15 is provided for resiliently urging the cam follower wheel 27 toward and against the cam 26. The pendulum member 4 is provided with a hook 4a at the other free end thereof and
adapted to rotate around a pivotal shaft 4b defining a supporting point.

As the speed of the sheave 3 increases, the pendulum member 4 reaches such a point at which the cam follower wheel 27 no longer follows the cam 27 due to the inertia of the pendulum member 4. The point at which the cam follower wheel 27 can no longer follow the cam 26 is primarily determined by the spring member 15.

In the case where a spring of high rigidity is used as the spring member 15 or where the compression of the spring member 15 is increased by decreasing the mounting length thereof, the speed at the time point at which the cam follower wheel 27 can no longer follow the cam 26 increases correspondingly.

When the rotation speed of the sheave 3 increases further, the motion of the pendulum member 4 will also increase correspondingly up to a level at which one of notches 11 formed integrally in the cam 26 will catch the hook 4a of the pendulum member 4. Then, the rotation of the sheave 3 is prevented, giving rise to generation of a traction between the sheave 3 and the rope. By making use of this traction force, the upward or downward safety device attached to the rope of the governor is put into actuation.

In the case of the pendulum type governor apparatus illustrated in Fig. 6, a pin 21 can be used to prevent or block the motion of the pendulum member 4 regardless of the rotation speed of the sheave 3. In the state shown in Fig. 6, the pin 21 lies at a retracted position. More specifically, the pin 21 can be held in this retracted state by means of a spring (not shown) and is adapted to be actuated by an electromagnet
22. This mechanism is used for the purpose of testing. Operation of the governor apparatus can be blocked through remote control with the aid of a push button array.

At this juncture, it should be mentioned that the function of the pin 21 can be reversed. By way of example, the pin 21 is forcibly held at the retracted position by means of the electromagnet 22 while allowing the pin 21 to project outward when the electric power supply to the electromagnet 22 is interrupted.

The mechanism described above can be used, for example, for preventing the uncontrolled movement of the elevator car. When the door of the elevator car or that of the elevator shaft is opened, the electric power supply to the electromagnet 22 is interrupted. If, whatever the reason, the elevator car starts to move, operation of the governor is blocked with the upward or downward safety device being put into actuation.

The conventional overspeed governor apparatuses described above are so arranged that the tripping operation is performed in dependence on the speed regardless of the position or location of the elevator car. Due to this circumstance, it is necessary to install buffers to prevent the car from passing the terminal floors.

By way of example, the brake is designed to operate at a trip speed of 1.15 times as high as the rated speed while the braking device (safety gear) provided for the elevator car is actuated at a trip speed of 1.25 times as high as the rated speed.

Consequently, in the case of the conventional overspeed governor apparatus, operation thereof is triggered at a preset speed regardless
of the location of the elevator car. Accordingly, it has been necessary not only to install the buffers at the terminal floors, respectively, but also to secure the margin space at each of the terminal floors for accommodating the jump of the elevator car at the terminal floor.

As is apparent from the foregoing, the conventional overspeed governor apparatus known heretofore is effective only in the case where a fault or trouble takes place in the suspension device at the path ends of the car. However, in other situations in which the deceleration at the extremities of the car path is not adequate or sufficient, the conventional overspeed governor apparatus is not in the position to prevent or suppress the overspeed, giving rise to great disadvantage.

The present invention has been made for solving the problems mentioned above and contemplates as an object thereof to provide an overspeed governor apparatus for an elevator system which apparatus can prevent or suppress the overspeed with high reliability while allowing the buffer size to be diminished by lowering the actuation speed of the governor as the distance to the terminal decreases in the course of upward/downward traveling of the elevator car.

DISCLOSURE OF THE INVENTION

In the overspeed governor apparatus for the elevator system according to the present invention, the overspeed governor is so improved that the trip speed therefor decreases gradually in the regions located close to the extremities, respectively, of the car path.

Basically, it is contemplated that regardless of the location
of installation of the governor and irrespective of the mechanical type
or the electric type, the governor operation speed is caused to lower
at the top and bottom terminals, respectively, of the elevator shaft,
to thereby reduce the jump or jumping height of the elevator car and the
buffer size at the extremity portions, respectively, of the elevator shaft.

With the arrangement described above, the trip speed of the
overspeed governor apparatus can be decreased on the basis of a minimum
guaranteed deceleration and activation distances for the upward and
downward safety devices.

Ordinarily, a normal car operation speed curve must lie within
a range defined by a speed characteristic curve of the overspeed governor
apparatus. By way of example, the minimum guaranteed deceleration of the
upward/downward safety devices is 0.2g (where g represents the
gravitational acceleration). The maximum acceleration/ deceleration of
the drive system is approximately 0.1g. This means that the normal
operation speed pattern is always located within the coverage of the
overspeed pattern with a sufficient margin.

As a result of this, the overspeed governor apparatus will
never be tripped during the normal operation. However, when the elevator
car speed crosses over the speed curve of the overspeed governor apparatus,
the latter is tripped and thus operation of the elevator system is stopped.

In the overspeed governor apparatus of the type described above,
there are generally employed three trigger points so far as it is possible.
In that case, there may be issued to the control system at the first trigger
point of the overspeed governor apparatus such a warning "speed of the
elevator car exceeds a nominal speed permissible for the position of the elevator car within the elevator shaft”.

Further, at the second trigger point corresponding to a higher speed, an overspeed switch which constitutes a part of the safety circuit of the elevator system is opened. When this overspeed switch is opened, the power supply to the electric motor and the brake is interrupted without any interference or support from the control system.

If the function effectuated at the second trigger point is inadequate, the upward or downward safety device is put into actuation at the third trigger point.

By virtue of the modified overspeed governor apparatus having the variable trip speeds, the elevator car can be protected by the overspeed governor apparatus over the entire traveling path. More specifically, the overspeed governor apparatus guarantees that the elevator car will always slow down before the car reaches the extremity of the path. Because the elevator car is decelerated before it reaches the top level, the counterweight will strike against the buffer at a low speed in an emergency case. In this conjunction, it is noted that the space reserved for accommodating the jump of the elevator car can be made much smaller because of the low speed of the elevator car. Besides, the buffer can also be implemented in a small size, because the buffer is designed on the basis of the speed of the elevator car at the extremity or end of its travel.

So far as the braking distance of the upward/downward safety device is sufficient with the deceleration remaining within 1g, no jump of the elevator car can take place. Accordingly, the possibility of the
counterweight striking against the buffer can be avoided. In that case, the space to be reserved for accommodating the jump of the elevator car can be spared. Of course, the buffer itself can be spared as well.

For realizing the overspeed governor apparatus of the type described above, there may be conceived several methods as exemplified by those mentioned below.

From the mechanical standpoint, the pendulum type governor apparatus is mounted on the elevator car with the rope being fixedly secured to the elevator shaft and spanned over the governor. As the elevator car moves up or down, the sheave of the overspeed governor apparatus starts to rotate correspondingly. A first embodiment of the present invention directed to this type mechanical governor apparatus will be described by reference to Fig. 1.

In the specification of USP No. 6,173,813, there is exemplarily disclosed an apparatus in which an accelerometer provided in association with the elevator car is used for measuring the over-acceleration to thereby determine the overspeed by integrating the acceleration signal, i.e., the so-called electronic governor.

However, in the conventional electronic governor such as mentioned above, the capabilities or functions thereof are not adequately made use of. In other words, the electronic governor is used only in conjunction with the downward travel of the elevator car. By integrating the speed signal, the distance traveled by the car can be derived. By combining this distance with one or more reference points set internally of the elevator shaft, the actual position of the elevator car within
the elevator shaft can be known.

A deceleration starting point can be set as a reference point. On the basis of this deceleration starting point, a maximum allowable speed based on the position determined by the accelerometer can be calculated by employing a processor.

As another alternative method, it is possible to make use of a reference table stored in a memory (storage) instead of calculating the maximum speed. The electronic governor can further be improved by implementing it in such a structure which is capable of detecting the distance over which the elevator car has traveled without a command from the controller, whereby "uncontrolled movement" can positively be prevented.

In the case where the overspeed or the over-acceleration or the uncontrolled movement takes place, the safety gear in the upward/downward direction can directly be actuated in such a manner as described in the specification of USP No. 6,173,813 or Japanese Patent Application Laid-Open Publication No. 66491/1992 (JP-A-4-66491). Two embodiments of the present invention directed to this type of overspeed governor apparatus will be described later on by reference to Figs. 4 and 5.

According to further practicable embodiments 2 and 3 of the present invention, an electronic governor is employed in parallel to a conventional mechanical overspeed governor apparatus which operates with a flyweight or a pendulum member.

When an overspeed or an over-acceleration takes place, a pin ordinarily retracted under the action of an electromagnet is applied under
a spring force, whereby the governor is tripped. Then, the upward/downward safety gear is put into actuation by the governor mentioned above. Two embodiments of the invention directed to this structure will be described later on by reference to Figs. 2 and 3.

According to the presented invention, there are obtained advantages, which will be mentioned below.

Slow-down or deceleration of the elevator car can be guaranteed at the extremity or end of the travel of the elevator car.

The space for accommodating the jump height of the elevator car can be diminished or spared completely.

Stroke size of the buffer can be reduced or the buffer can be spared completely.

BRIEF DESCRIPTION OF DRAWINGS

The drawings show overspeed governor apparatuses or governors according to five different embodiments of the present invention and a conventional governor, in which:

Fig. 1 is a front view showing an overspeed governor apparatus of variable trip speed which is implemented as a mechanical governor according to a first embodiment of the present invention;

Fig. 2 is a block diagram showing an overspeed governor apparatus and a safety gear system provided with an electronic governor based on an acceleration measurement principle according to a second embodiment of the present invention;

Fig. 3 is a block diagram showing an overspeed governor apparatus
and a safety gear system provided with an electronic governor based on a distance measurement principle according to a third embodiment of the present invention;

Fig. 4 is a block diagram showing an electronic governor implemented as based on the acceleration measurement principle and adapted to actuate directly an upward/downward safety gear according to a fourth embodiment of the present invention;

Fig. 5 is a block diagram showing an electronic governor designed for directly actuating the upward/downward safety gear by making use of distance measurement according to the fourth embodiment of the present invention; and

Fig. 6 shows in a front view and a side view a hitherto known pendulum type overspeed governor apparatus which provides a basis for the apparatuses according to the first to third embodiments of the present invention shown in Figs. 1 to 3, respectively.

BEST MODES FOR CARRYING OUT THE INVENTION

Embodiment 1

Figure 1 shows a mechanical overspeed governor apparatus or a governor according to a first embodiment of the present invention.

Referring to the figure, a pendulum type overspeed governor apparatus 2 (hereinafter also referred to simply as the governor 2) is disposed on an elevator car 1. A governor rope 5 is fixed at one end thereof to the ceiling of an elevator shaft. This governor rope 5 is spanned over a governor sheave 3 through diverting pulleys 6a and 6b and has the other
end secured to a mass or weight 7, whereby a tension is applied to the governor rope 5. The diverting pulleys 6a and 6b are mounted on the elevator car 1 for guiding the rope 5.

When rotation of the sheave 3 is prevented or blocked by a pendulum member 4, a torque is applied to the overspeed governor apparatus on the whole under the action of a traction force. In that case, the governor 2 can rotate around a pivot point 12. At this time point, a spring 13 serves to prevent the governor 2 from falling under its weight even when the sheave 3 rotates freely.

When the elevator car 1 is moving downwardly, the governor 2 in the blocked state rotates in the counterclockwise direction to thereby pull a safety gear rod 10, as a result of which a downward safety gear (not shown) is put into operation (see, for example, Japanese Patent Application Laid-Open Publication No. 211181/1991 (JP-A-3-211181)).

On the other hand, when the elevator car 1 is moving upwardly, the governor tends to rotate clockwise to thereby push the safety gear rod 10, whereby an upward safety gear is put into actuation.

The pendulum member 4 cooperates with a spring member 15 to thereby determine a trip speed. In this conjunction, it is noted that in the case of the conventional governor, the spring member 15 has an endpoint fixedly secured (refer to Fig. 6). As described hereinbefore, when the spring force of the spring member 15 is increased, the trip speed will correspondingly increase. In the case of the conventional overspeed governor apparatus, the force of the spring member 15 is set by taking into consideration the rated speed of the elevator car.
The overspeed governor apparatus according to the first embodiment of the present invention differs from the conventional overspeed governor apparatus in that the spring member 15 is not fixedly secured at one end thereof but a cam follower wheel 14 which follows a cam member 8 is mounted on the spring member 15 at the one end, as can be clearly seen from Fig. 1.

When the cam follower wheel 14 is pressed towards the governor, the spring member 15 is compressed, as a result of which the force of the spring member 15 is intensified, whereby the trip speed is increased.

On the other hand, when the height of the cam member 8 decreases when the cam follower wheel 14 follows the curved profile of the cam member 8 under the effort of the spring member 15, the length of the spring member 15 becomes longer or stretched. As a result of this, the force of the spring member 15 decreases, whereby the trip speed becomes lower.

The cam member 8 is fixedly mounted on a side wall of the elevator shaft (i.e., a path of the elevator car 1). As can be understood from the above, the trip speed of the governor 2 changes in conformance with the geometrical form or profile of the cam member 8. At a location where the cam member 8 has the greatest thickness (as viewed in Fig. 1), the highest trip speed can be achieved. When the cam follower wheel 14 leaves the cam member 8, the trip speed becomes zero.

At this juncture, it is to be noted that the pendulum member 4 is so implemented that the arm of the pendulum member 4 on which the cam follower wheel 27 is mounted at a free end portion is heavier than the other arm of the pendulum member 4 at which the hook 4a is formed.
(see Fig. 1). Accordingly, the hook 4a follows a path in which notches 11 are formed in a cam 26. By virtue of this arrangement, tripping of the overspeed governor apparatus 2 is effectuated. At the end of the travel of the elevator car 1, the thickness or height of the cam member 8 decreases gradually to zero. Consequently, the trip speed will gradually decrease as well.

By implementing the cam member 8 in such form as shown in Fig. 1, the trip speed of the governor 2 becomes zero in the region where the cam member 8 is absent at any rate.

**Embodiment 2**

Figure 2 is a block diagram showing an overspeed governor system according to a second embodiment of the present invention. The overspeed governor system according to the instant embodiment of the invention is implemented in the form of a combination of a conventional overspeed governor apparatus known heretofore and an electronic governor provided additionally.

The conventional portion of the overspeed governor system shown in Fig. 2 is composed of an elevator car 16, an overspeed governor apparatus 17, a governor rope 18 and a tension sheave 19 having a suspended tension weight 20. (The governor can be positioned in e.g. the machine room, in the shaft or the car roof.)

The governor rope 18 is secured to a safety gear mounted on the elevator car 16. When the moving speed of the elevator car 16 reaches an overspeed of the governor 17 which is set in advance, the governor 17 is tripped, whereby the governor rope 18 is pulled by the governor
17, bringing about actuation of an upward or downward safety gear mounted on the elevator car 16. As the governor 17, there may be employed the conventional one equipped with a governor trigger composed of an electromagnet 22 and a pin 21 as described hereinbefore by reference to Fig. 6.

In the case of the overspeed governor apparatus according to the instant embodiment of the present invention shown in Fig. 2, the electromagnet 22 is so arranged as to hold the pin 21 in a retracted state against the spring force of a spring.

More specifically, for the purpose of holding or retaining continuously the pin 21 in the retracted state, an electric power is continuously supplied to the electromagnet 22 from an uninterrupted power supply source (UPS) through an electrical circuit 23.

On the other hand, when the electric power supply to the electromagnet 22 is interrupted due to opening of the contact of the relay 24, i.e., upon deenergization of the relay 24), the overspeed governor apparatus (governor 17) is tripped, which results in that the upward or downward safety gear is actuated.

The relay 24 mentioned above is so arranged as to be controlled through an electronic circuit provided in association with a controller 100. More specifically, only when three conditions which will be described later on are all validated, the contact of the relay 24 is closed in response to an output signal "H level" outputted from an AND gate circuit 25. Thus, the electric power is supplied to the electromagnet 22 from the uninterrupted power supply source UPS.
By contrast, in the case where at least any one of the three conditions is not validated or satisfied, the contact of the relay 24 is opened (i.e., become off), whereupon the governor 17 is tripped.

The three conditions mentioned above are basically determined by measuring the acceleration $\alpha$ of the elevator car 16 by means of an accelerometer 31. The measured acceleration $\alpha$ is used as input information for the electronic circuit.

The electronic circuit mentioned just above includes an integrating circuit 32 which is designed for integrating the measured acceleration $\alpha$ to thereby determine a speed $V_t$. Further, the electronic circuit includes an integrator 33 which is designed for integrating the speed $V_t$ to thereby determine a relative travel distance $L_t$.

On the basis of the relative travel distance $L_t$ determined in this manner and one or two reference points (switches) $Pr$ provided internally of the elevator shaft, it is possible to know the accurate position of the elevator car 16 within the elevator shaft. In other words, an absolute value $L_a$ of the measured distance can be determined.

Further, on the basis of the position of the elevator car 16 represented by the absolute value $L_a$, a first overspeed value $Vs_1$ and a second overspeed value $Vs_2$ can be determined. In practical applications, these first and second overspeed values $Vs_1$ and $Vs_2$ can be determined on the basis of the position (absolute value $L_a$) of the elevator car 16 or computed by means of a microprocessor or microcomputer. Alternatively, the overspeed values $Vs_1$ and $Vs_2$ can also be determined by referencing a lookup table stored in a memory (storage unit).
The first overspeed value $V_{s1}$ and the second overspeed value $V_{s2}$ determined in this way are compared with an actual speed $V_t$ by means of comparators 41 and 42, respectively.

In operation, when the speed $V_t$ is higher than the first overspeed value $V_{s1}$ inclusive (i.e., when $V_t \geq V_{s1}$), the comparator 41 issues an alarm signal to the controller 100.

The first one of the three conditions mentioned above is determined by checking the actual speed $V_t$ derived from the acceleration $\alpha$. In other words, the comparator 42 generates the output signal of high (H) level when the speed $V_t$ is lower than second overspeed value $V_{s2}$ (i.e., when $V_t < V_{s2}$), whereas when the speed $V_t$ is not lower than the second overspeed value $V_{s2}$ (i.e., when $V_t \geq V_{s2}$), the comparator 42 generates an output signal of low (L) level for tripping the governor 17.

The second condition is determined by checking the travel distance over which the elevator car 16 has traveled without being controlled. To this end, an integrator 43 integrates the speed $V_t$ to thereby determine a relative travel distance $L_{t1}$ over which the elevator car 16 has traveled in the state where the driving command C issued from the controller 100 is absent. In this conjunction, it should however be added that when the drive command C is issued from the controller 100, the relative travel distance $L_{t1}$ is held zero.

Subsequently, a comparator 44 compares the relative travel distance $L_{t1}$ with "uncontrolled maximum travel distance $I_{max}$". When $L_{t1} < I_{max}$, the comparator 44 generates an output signal of high (H) level.

On the other hand, in the case where the condition that $L_{t1}$
? Imax is satisfied, i.e., when the elevator car 16 has traveled over a greater distance than the uncontrolled maximum travel distance, the comparator 44 generates an output signal of low (L) level for thereby tripping the governor 17.

The third condition is determined by checking the measured acceleration \( \alpha \). More specifically, a comparator 45 compares the measured acceleration \( \alpha \) with the over-acceleration value \( \alpha_s \). When the measured acceleration \( \alpha \) is higher than the over-acceleration \( \alpha_s \) (i.e., when \( \alpha > \alpha_s \)), the comparator 45 generates an output signal of high (H) level. On the contrary, when \( \alpha > \alpha_s \), the comparator 45 generates an output signal of low (L) level to thereby trip the governor 17.

When all the three conditions are detected as being satisfied by the comparators 42, 44 and 45, the AND gate circuit 25 produces the output signal of high (H) level. As a result of this, the relay 24 is supplied with electric power, i.e., electrically energized, whereby electric power is fed to the electromagnet 22 via the normally open contact of the relay 24.

On the other hand, when it is detected by the comparator 42, 44 or 45 that any one of the three conditions is not satisfied, the AND gate circuit 25 produces the output signal of low (L) level, to thereby open the normally open contact of the relay 24, as a result of which the governor apparatus 17 is caused to be tripped.

**Embodiment 3**

Figure 3 is a block diagram showing schematically a configuration of an elevator system equipped with an overspeed governor.
apparatus according to a third embodiment of the present invention. In Fig. 3, components same as or equivalent to those described previously by reference to Fig. 2 are denoted by like reference numerals and repeated description thereof is omitted.

In the case of the system now under consideration, a measured distance \( L \) outputted from a distance measuring sensor \( 51 \) is directly made use of in the electronic circuit without using the measured acceleration \( \alpha \) (see Fig. 2) as the input information. Except for this difference, the system according to the instant embodiment of the invention is substantially similar to the system according to the first embodiment described hereinbefore (see Fig. 1).

The distance \( L \) may be measured by resorting to e.g. laser or radar technique. The electronic circuit is designed to determine the first overspeed value \( V_{s1} \) and the second overspeed value \( V_{s2} \) directly on the basis of the measured distance \( L \).

Further, the measured distance \( L \) is also used for deriving the relative travel distance \( L_{t1} \) covered by the elevator car \( 16 \) in the state where the drive command \( C \) is not issued from the controller \( 100 \).

The speed \( V_t \) can be derived by differentiating the measured distance \( L \) as a function of time by means of a differentiator \( 52 \). On the other hand, the measured acceleration \( \alpha \) can be derived by differentiating the speed \( V_t \) by means of a differentiator \( 53 \).

The derived speed value \( V_t \) is used in combination with the first overspeed value \( V_{s1} \) and the second overspeed value \( V_{s2} \) in the comparators \( 41 \) and \( 42 \), respectively, as described hereinbefore.
On the other hand, the relative travel distance \( d_{r1} \) is used in combination with the uncontrolled maximum travel distance \( L_{\max} \) in the comparator 44, while the acceleration \( a \) is used in combination with the over-acceleration value \( s \) in the comparator 45.

With the system configuration shown in Fig. 3, the basic tripping operation for the governor 17 is identical with that described previously in conjunction with Fig. 2. It goes without saying that advantageous effects similar to those of the system described hereinbefore (Fig. 2) can equally be achieved in the system shown in Fig. 3.

**Embodiment 4**

Figure 4 shows schematically and generally a configuration of an elevator system provided with an electronic overspeed governor apparatus (also referred to as the electronic governor) according to a fourth embodiment of the present invention. In Fig. 4, components same as or equivalent to those described previously (Fig. 2) are denoted by like reference numerals and repeated description thereof is omitted.

In the case of the system according to the instant embodiment of the invention, the electronic governor (not shown) is provided with a pin 21U and an electromagnet 22U which cooperate to constitute an upward governor trigger and a pin 21D and an electromagnet 22D which cooperate to constitute a downward governor trigger and is so arranged as to directly actuate the upward safety gear or the downward safety gear.

Upon power supply via the electric circuitry 23U or 23D, the upward safety gear or the downward safety gear is directly triggered by the electromagnet 22U or 22D combined with the spring.
In case the power supply is absent, the safety gears mentioned above will be actuated by the spring. For evading such situation, electric power is supplied to the electromagnets 22U and 22D constantly without interruption. This steady power supply circuit is divided into two electric circuitries 23U and 23D. The electric circuitry 23U serves to supply electric power to the upward safety gear while the electric circuitry 23D serves to supply electric power to the downward safety gear. In other words, the electronic circuit 23 shown in Fig. 1 is so expanded as to be capable of discriminating the upward and downward movements, respectively.

A relay 24U for the electromagnet 22U is connected in parallel with the electric circuitry 23U, while a relay 24D for the electromagnet 22D is connected in parallel with the electric circuitry 23D, wherein the relay 24U is electrically energized in response to the output signal of an AND gate circuit 25U associated with a comparator 44U with the relay 24D being electrically energized in response to the output signal of an AND gate circuit 25D provided in association with a comparator 44D.

The AND gate circuit 25U has an input terminal to which the output signal of a comparator 62 is applied. Similarly, the AND gate circuit 25D has input terminals to which the output signals of the comparators 45 and 63 are applied, respectively.

Referring to Fig. 4, in the system according to the fourth embodiment of the invention, the third overspeed values \( V_{s3U} \) and \( V_{s3D} \) are employed in addition to the first overspeed value \( V_{s1} \) and the second overspeed value \( V_{s2} \) mentioned previously.
The third overspeed value $V_{3U}$ in the upward (UP) direction is inputted to the comparator 62 to be compared with the actual speed $V_t$. Similarly, the third overspeed value $V_{3D}$ in the downward (DOWN) direction is inputted to the comparator 63 to undergo comparison with the actual speed $V_t$.

The third overspeed value $V_{3U}$ or $V_{3D}$ is employed for actuating the upward travel safety gear or downward travel safety gear in dependence on the traveling direction (UP and DOWN) of the elevator car (not shown).

The first overspeed value $V_{s1}$ is used for issuing an alarm to the controller 100 as in the case of the preceding embodiments.

The second overspeed value $V_{s2}$ is used for opening the contact of the relay 61 (safety circuit). The safety circuit including the relay 61 serves for interrupting the power supply to the machines and the brake system.

The over-acceleration value $a_s$ is used only when a fault or trouble takes place occurs in the suspension system. Thus, this value is used in the course of downward traveling of the elevator car.

The "uncontrolled movement" should be classified into the upward uncontrolled movement and the downward uncontrolled movement in order to identify discretely the safety gear to be put into actuation.

With the system configuration shown in Fig. 4, the so-called "uncontrolled movement" can be suppressed or prevented more positively with high reliability.

**Embodiment 5**

Figure 5 is a block diagram showing schematically and generally
a configuration of an elevator system provided with an electronic overspeed governor apparatus according to a fifth embodiment of the present invention. In Fig. 5, components same as or equivalent to those described previously (Fig. 3 and Fig. 4) are denoted by like reference numerals and repeated description thereof is omitted.

In the system now under consideration, the acceleration is not measured but the measured distance \( L \) is used straightforwardly as in the case of the third embodiment described hereinbefore. Except for this difference, the system according to the instant embodiment is essentially identical with that of the fourth embodiment shown in Fig. 4 in respect to the configuration and the operation.

Referring to Fig. 5, the electrical circuit is so designed as to determine the relative travel distance \( L_{tU} \) over which the elevator car 16 has traveled upwardly in the state where the drive command \( C \) is not issued and the relative travel distance \( L_{tD} \) over which the elevator car 16 has traveled downwardly in the state where the drive command \( C \) is not issued.

Thus, the comparator 44U associated with the upward travel of the elevator car compares the relative travel distance \( L_{tU} \) with the maximum travel distance \( L_{max} \), whereas the comparator 44D associated with the downward travel of the elevator car compares the relative travel distance \( L_{tU} \) with the maximum travel distance \( L_{max} \).

In succession, the relay 24U and relay 24D are driven via the associated AND gate circuits 25U and 25D, whereby the safety gear is put into operation.
INDUSTRIAL APPLICABILITY

As is apparent from the foregoing description, there has been provided according to the teachings of the present invention the overspeed governor apparatus for the elevator system which can positively prevent or suppress the overspeed of the elevator car without fail.

More particularly, owing to the inventive arrangement for decreasing or reducing the trip speed as the elevator car approaches the terminal floor, the speed of the elevator car at which it collides with the buffer can theoretically be zeroed. Thus, theoretically, the buffer can be spared.

Thus, deceleration of the elevator car can be ensured at least at a location close to the end or terminal point of traveling of the elevator car. By virtue of this feature, the space for accommodating jump of the car (i.e., margin space usually provided at a top of the elevator shaft) can be reduced or spared to great advantage.

Besides, because the stroke of the buffer can be diminished, the size or dimensions of the elevator shaft can also be reduced.
CLAIMS

1. An overspeed governor apparatus of an elevator system for detecting occurrence of overspeed of an elevator car traveling in an upward or alternatively in a downward direction in the elevator system, to thereby actuate an upward or alternatively downward safety device, characterized in that a value of said overspeed is determined as a function of position of said elevator car.

2. An overspeed governor apparatus of an elevator system as set forth in claim 1, characterized in that said overspeed governor apparatus comprises a memory in which the overspeeds as determined as a function of said position is stored as values associated with a cam fixedly disposed internally of an elevator shaft of said elevator car, and that said memory stores said overspeed values in terms of a continuous profile of said cam or alternatively as discrete values which can be discerned with marks, respectively.

3. An overspeed governor apparatus of an elevator system as set forth in claim 1 or 2, said overspeed governor apparatus being implemented as a pendulum type overspeed governor apparatus equipped with a spring member for determining a trip speed, characterized in that degree of compression of said spring member is caused to change by means of said cam fixedly disposed internally
of said elevator shaft of said elevator car.

4. An overspeed governor apparatus of an elevator system as set forth in claim 3, characterized in that said overspeed governor apparatus is disposed on a roof of the elevator car which is driven by means of a rope having one end portion fixedly secured and the other end portion coupled to a tension weight.

5. An overspeed governor apparatus of an elevator system as set forth in claim 1, characterized in that said overspeed governor apparatus is implemented as a mechanical overspeed governor apparatus which is mechanically tripped by an electronic type governor provided additionally or alternatively by a means controlled directly by a safety circuit provided separately, and that said safety circuit provided separately is controlled by said additionally provided electronic type governor.

6. An overspeed governor apparatus of an elevator system as set forth in claim 1, characterized in that said upward or downward safety device is actuated directly by means of said electronic type overspeed governor.

7. An overspeed governor apparatus of an elevator system as set forth in claim 1, characterized in that said upward and downward safety devices are controlled, respectively, via separate safety circuits.
constituted by two independent loops each controlled by said electronic
overspeed governor.

8. An overspeed governor apparatus of an elevator system as set
forth in claim 5 or 6, characterized in that said electronic type governor
is designed for deriving a speed of said elevator car and a relative distance
traveled by said elevator car by using a measured acceleration of said
elevator car,

deriving an absolute distance by combining said relative
distance with one or plural reference points marked internally of said
elevator shaft, and

arithmetically determining the overspeed value at a current
position of said elevator car or alternatively determining said overspeed
value by referencing a table stored in a memory and determining said overspeed
value as a function of position of said elevator car through table lookup
instead of the arithmetic determination.

9. An overspeed governor apparatus of an elevator system as set
forth in claim 5 or 6, characterized in that said electronic type governor
is designed for deriving speed and acceleration of said elevator car on
the basis of a measured distance thereof,

determining arithmetically the overspeed value at a current
position of said elevator car on the basis of said measured distance or
alternatively determining said overspeed value as a function of position
of said elevator car through table lookup instead of the arithmetic
determination.

10. An overspeed governor apparatus of an elevator system as set forth in claim 5 or 6, characterized in that when all of undermentioned conditions:

- speed of said elevator car is not higher than the overspeed value of said elevator car which depends on the position thereof,
- acceleration of said elevator car is lower than an over-acceleration value thereof, and
- distance over which said elevator car has traveled without command issued from a controller is shorter than a predetermined value are satisfied simultaneously,

said downward safety device is prevented from being actuated.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B66B 5/04

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 5/00-5/28

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>
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<td>JP 2001-354372 A (MITSUBISHI DENKI KABUSHIKI KAISHA) 2001.12.25 (Family:none)</td>
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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
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  "O" document referring to an oral disclosure, use, exhibition or other means
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"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

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Date of the actual completion of the international search: 29.07.02

Date of mailing of the international search report: 20.08.02

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