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ROPED ELEVATOR



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Detailed explanation of the invention

Technical field of the invention

This invention relates to a rope-type elevator that is made so as to reduce the vibrations that are generated at the time of taking up the rope with a winding mechanism or the like.

Prior technology

As a rope-type elevator used in the past, for example, there is the one such as is shown in Figure 5. In this same figure, (101) is a car compartment that is installed movable up and down in hoistway (102), and a pair of car ropes (104, 105) are attached by means of car frame (103) to the upper section of this car compartment (101). In other words, car ropes (104, 105) are provided in support channel (106), suspension rod (107) is provided in this support channel (106), and this suspension rod (107) is attached to car frame (103) through the medium of spring seats (108) and a number of spiral coil springs (109). A number of ropes (110) are strung in car ropes (104, 105), and these ropes (110) are hung on drive sheave (111) of the winding mechanism.

Incidentally, vibrations are generated when the winding mechanism is driven and rope (110) is pulled by drive sheave (111). However, if these vibrations are transferred to the car compartment (101), it gives passengers an unpleasant feeling. Thus, it is relieved by springs (109).

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Problems to be solved by the invention

In this type of a rope-type elevator used until now, the vibrations that were created from drive sheave (111) of the wind-up mechanism were propagated to car (101) through the ropes (110). There was the problem that the isolation frequency ratio u ($u = f/f_N$) of the characteristic vibration frequency f of ropes (110) and the characteristic vibration frequency f_N of the springs (109) became $u = 1$ and resonated, and this resonance imparted an unpleasant sensation to the passengers within the car.

The purpose of this invention is to offer a rope-type elevator wherein, even if the rope and the coils resonate, this resonance is made to be suppressed as low as possible.

Means to solve the problem

In order to achieve these kinds of purposes, in this invention, a construction is used that is equipped with a car that is installed freely movable up and down in a hoistway, a sheave installed in the upper part of this hoistway, a rope strung on this sheave for the purpose of pulling the above-mentioned car, a suspension rod attached to the end of this rope, springs installed between this suspension rod and the above-mentioned car for the purpose of cushioning vibrations, a cylinder device which attenuates the above-mentioned vibrations and has a flow control valve, a car position detector which detects the car position in order to calculate the rope length, a load detector for the purpose of detecting the load placed on the car, and a control panel that calculates the characteristic

vibration frequency f of the rope from the length of the above-mentioned rope, calculates the characteristic frequency vibration frequency f_N of the springs from the entire weight of the car, next calculates the vibration frequency ratio u ($u = f/f_N$), and is made so as to constrict the flow volume control valve of the above-mentioned cylinder device when $u = 1$ or $u \approx 1$.

Embodiment of the invention

Below, this invention is explained based on the figures. Figure 1 to Figure 4 are drawings showing one application example of a rope-type elevator related to this invention.

In Figure 1, car (1) is installed vertically movable in the elevator hoistway, and this car (1) comprises car frame (2), and car compartment (3) that is supported in car frame (2). Support channel (4) is arranged above cross-head channel (2a) of car frame (2), and a pair of sheaves (7, 8) used for the car are attached to this support channel (4) through the medium of support tabs (5, 6).

Suspension rod (9) is firmly attached facing downward through the support channel (4), and this suspension rod (9) extends downward through a pair of C-shaped steel [beams] which construct the cross-head channel (2a). Circular bottom spring seat (10) is fastened at the tip of suspension rod (9) by means of tightening double nuts (11). On the other hand, circular upper spring seat (12), through which the suspension rod (9) passes, is attached to the bottom face of cross-head channel (2a).

A number of ropes (13) are strung on car sheaves (7, 8), and these ropes (13) are strung on the drive sheave (14) of the wind-up mechanism that is installed in the machine room. One end of

ropes (13) is fastened to a dead-end hitch beam (not illustrated) of the machine room, and the other end is fastened to a dead-end hitch beam in the same manner as the rope of the car side by means of a counterweight (not illustrated) that is installed for the purpose of counterbalancing car (1).

Coil spring (15) and a number of cylinder devices (16) are installed between the upper spring seat (12) and the lower spring seat (11). Cylinder devices (16) further attenuate the vibrations that are generated in the drive sheave (14) of the wind-up mechanism that has been cushioned by the coil spring (15).

Cylinder device (16), as is shown in Figure 2, comprises the cylinder (17) that is installed between the upper and lower spring seats (12, 10) and piston (18) that is installed inside this cylinder (17), and operating oil is filled into the upper and lower chambers (19, 20) that are formed separated by means of piston (18). Upper and lower chambers (19, 20) are linked by means of tubing (21) that fulfills the role as an orifice, and flow volume control valve (22) is installed midway in this tubing (21). Flow volume control valve (22) constricts and releases the operating oil that flows within tubing (21) based on commands from control panel (23).

A signal is input into control panel (23) from the rotary encoder (24) that is provided in the speed regulator or the like for the purpose of detecting the position of the car, and a signal is also input [into control panel (23)] from the load sensor (25) (load detector) that is installed in this floor surface for the purpose of detecting the load of the passengers riding in the car compartment (3).

Next, the operation of cylinder devices (16) is explained while referencing the flow chart shown in Figure 3.

When the passengers are boarded in car (1) and it departs in the direction of the target floor, the load of the passengers that have boarded car (1) is detected by means of load sensor (25) (Step S₁). When the load of the passengers that have boarded car (1) is detected, the total weight W (kgf) of the car (1) is known. The characteristic vibration frequency f_N (Hz) is

(Formula 1)

$$f_N = \frac{1}{2W} \sqrt{\frac{K}{W} g}$$

(Here, K: spring constant (Kgf/cm), and g: force of gravity (980 cm/sec²)), the characteristic vibration frequency f_N of spring (15) is calculated in control panel (23) (Step S₂).

Next, the position of car (1) is detected by means of rotary encoder (24) (Step S₃). When the position of car (1) is detected, the length of the rope (13) between the car sheave (8) and the drive sheave (14) of the wind-up mechanism is known. The characteristic vibration frequency f (Hz) of the above-mentioned intervening rope (13) is

(Formula 2)

$$f = \frac{n}{2L} \sqrt{\frac{S}{L}}$$

Here, L : rope length (m), S : rope (13) tensile strength (N), P : mass per unit length of rope (13) (kg/m), and n : degree of vibration) [sic]. Here, the tensile strength S (N) of rope (13) is known from the drive force of the wind-up mechanism. Thus, the characteristic vibration frequency f of above-mentioned interval of rope (13) is calculated in control panel (23) (Step S_4).

Next, the vibration frequency ratio $u = f/f_N$ is calculated from the calculated characteristic vibration frequency f_N of the spring (15) and the characteristic vibration frequency f of rope (13) (Step S_5).

Here, the changes in the relationship of the vibration frequency ratio u and the vibration propagation rate due to the flow volume control valve (22) of the cylinder device (16) are shown in Figure 4. When the flow volume control valve (22) of cylinder device (16) is opened the widest, the crest of the vibration propagation rate (resonance point of rope (13) and spring (15)) reaches a maximum where the vibration frequency ratio is in the vicinity of "1," and when the vibration frequency ratio exceeds " $\sqrt{2}$," the vibration propagation rate draws a steep curve and rapidly lowers. With the vibration frequency ratio in the vicinity of "1" due to constricting the flow volume control valve (22), the crest of the vibration propagation rate gradually becomes lower, and when the vibration ratio exceeds " $\sqrt{2}$," the vibration transfer rate does not become very low.

Therefore, when the vibration frequency ratio is "1," if the flow volume control valve (22) is constricted, the vibration propagation rate crest becomes low. On the other hand, when the vibration frequency ratio is not "1," the open condition of the flow volume control valve (22) [is when] the vibration propagation rate becomes low.

Thus, a decision is made as to whether the vibration frequency ratio u has become $u = 1$ (Step S_6). When the vibration frequency ratio u becomes $u = 1$, the flow volume control valve (22) has become constricted to the maximum (Step S_7). In this way, the peak of the vibration propagation rate is lowered, and the resonance of the rope (13) and spring (15) can be kept low. On the other hand, when the vibration frequency ratio u is $u \neq 1$, the flow volume control valve (22) opens (Step S_8). In this way, the vibration propagation rate can be lowered.

Therefore, the vibrations that are propagated from the drive sheave (14) of the wind-up mechanism to the car (1) through the medium of rope (13) can be suppressed to as low as possible even though rope (13) and spring (15) are resonant, and it can be suppressed to an even lower level when they are not resonant.

Effects of the invention

As was explained above, according to this invention, the characteristic vibration frequency f of the rope is calculated from the length of the rope; also, the characteristic vibration frequency f_N of the spring is calculated from the total weight of the car; next, the vibration frequency ratio u ($u = f/f_N$) is calculated, and since the flow volume control valve of the above-mentioned cylinder device is made so as to constrict when $u = 1$ or $u \neq 1$, the vibrations that are propagated from the sheave to the car through the medium of the rope can be kept as low as possible even if the rope and spring are resonant, can be suppressed to another level lower when not resonant, and there is no imparting of an unpleasant sensation to the passengers in the car.

Brief explanation of the figures

Figure 1 is a plan view showing one application example of a rope-type elevator related to this invention.

Figure 2 is a block view of the above.

Figure 3 is a flow chart showing the operation of the cylinder device.

Figure 4 is a chart showing the relationship between the vibration frequency ratio and the vibration propagation rate.

Figure 5 is a plan view of a rope-type elevator used until now.

Explanation of the keys

- 1. Car
- 9. Suspension rod
- 13. Rope
- 15. Spring
- 16. Cylinder device
- 22. Flow volume control valve
- 23. Control panel

Claim

1. A rope-type elevator characterized in that it is equipped with a car that is installed such that it can freely move up and down in a hoistway, a sheave that is installed at the top of the hoistway, a rope for pulling the above-mentioned car that is suspended from this sheave, a suspension rod to which the end of this rope is attached, a spring for the purpose of dampening vibrations which is installed between this suspension rod and the above-mentioned car, a cylinder device which attenuates the above-mentioned vibrations and has a flow volume control valve, a position detector for detecting the position of the car in order to calculate the length of the rope, and a control panel which calculates the characteristic vibration frequency f of the rope from the length of the above-mentioned rope, the characteristic vibration frequency f_N of the spring from the car load, and the next vibration frequency ratio u ($u = f/f_N$), and is made so as to constrict the flow volume control valve of the above-mentioned cylinder device when $u = 1$ or $u \approx 1$.