PATENT SPECIFICATION

(11) 1 374 865

(21) Application No. 12419/72 (22) Filed 16 March 1972
(31) Convention Application No. 131 989
(32) Filed 7 April 1971 in
(33) United States of America (US)
(44) Complete Specification published 20 Nov. 1974
(51) International Classification B66B 1/28
(52) Index at acceptance
G3R 110F 112X 33C 4 8S 8W 9A 9C 9H

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(54) ELEVATOR CAR SPEED DICTATION APPARATUS

(71) We, OTIS ELEVATOR COMPANY, a corporation organized and existing under the laws of the State of New Jersey, United States of America, of 260 Eleventh Avenue, New York, New York, 10001, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to elevator controls and more particularly to apparatus for controlling the speed of elevator cars.

The invention provides an improved operation over that provided by previously known apparatus particularly apparatus such as that of Patent No 1,263,875 in which an elevator car is accelerated in response to a time controlled signal until it either reaches its rated running speed or until a signal to stop accelerating is generated. In order for the elevator to complete a trip upon which it attains its rated running speed, it starts to decelerate upon reaching stopping distance from a selected landing. This slow-down initially occurs in response to a time controlled deceleration signal. After a predetermined period, the slow-down operation is caused to begin to conform to that which would be provided by a signal which is operable to decelerate the car as a function of its distance from the selected landing notwithstanding the continued application of the time controlled deceleration signal. Conformity to the distance controlled signal takes place within a suitable period.

In those cases where the car does not attain its rated running speed it is caused to complete its trip in response to the signal to stop accelerating. This signal causes the production of a time controlled signal which causes acceleration to cease and deceleration to begin. Deceleration continues in response to this time controlled signal for the forementioned predetermined period at which time the slow-down operation is caused to begin to conform to that which would be provided by the distance controlled signal in the same manner as on a trip in which the car attains its rated running speed. From this it is obvious that deceleration may not conform to that which would be provided by the distance controlled signal for a considerable distance of travel of the car depending upon the actual speed being dictated to the car by the time controlled signal and that which is dictated by the distance controlled signal at the time that the conformation process begins.

On trips on which the car attains rated running speed and on those on which it comes close to attaining such speed the stopping distances are so large that any distance found to be necessary to attain conformity without discomforting passengers is a relatively short portion of the total required stopping distance, even in extreme cases where, at the time that the process toward conformity begins, the difference between the actual speed being dictated to the car by the time controlled signal and the speed being dictated by the distance controlled signal is considerable. In contrast, on short trips the required stopping distance can be so short that the distance required to produce conformity without discomforting passengers can be a considerable portion of the total required stopping distance, especially under the forementioned extreme circumstances. This may cause the deceleration on short trips to appear to passengers to be inconsistent with that produced on longer trips.

A contributing factor to this seeming inconsistency is the fact that on short trips the process of conformity takes place over a much closer range of distances to the landing at which the car is stopping than on longer trips. Whereas on a short trip the process of conformity may be just beginning at a particular distance from a landing, on a

longer trip at the same distance the process of conformity may be long over notwithstanding on both trips the initial difference between the dictated speeds was the same at the beginning of conformity. Thus although the process of conformity may be identical for both trips the deceleration for the short trip over that particular distance to the landing may be different from the deceleration over the same distance for the longer trip.

It is an object of this invention to start to control the speed of an elevator car on a trip in which it will not attain rated running speed in accordance with its distance from a selected landing at which it is to stop before the car starts its deceleration for that trip.

According to the invention there is provided speed dictation apparatus for an elevator car comprising a function generator for generating a voltage which in use varies continuously as a function of time and controls the car's acceleration on each trip, a landing selector mechanism arranged to control means for generating a voltage which in use varies continuously as a function of the distance the car is from a selected landing at which it is to stop on each trip, said latter voltage serving in use to control the car's deceleration on each trip, and signal generating means operable on each trip in which the car does not attain its rated running speed to generate a signal to stop accelerating in response to the selection of the landing at which the car is to stop, characterized by control equipment connected to said function generator and said means controlled by said landing selector mechanism for receiving both said time controlled voltage and said distance controlled voltage, said control equipment being adapted to operate in response to said signal to stop accelerating on any trip to cause said distance controlled voltage to control the speed of said car from before the car starts its deceleration for that trip by initiating before deceleration starts a gradual transfer from control in which said time controlled voltage predominates to control in which said distance controlled voltage predominates.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawing which shows schematically an elevator control system embodying the invention.

Referring specifically to the drawing, an elevator car 10 and its counterweight 11 in typical fashion are supported by hoist ropes 12. The car is enabled to move whenever brake 13 is lifted and motor 14 receives power from motor control equipment 15 to rotate sheave 16. Motor control equipment 15 may be any suitable well known equipment.

Connected between car 10 and counterweight 11 is a tape 19 which is driven over a sprocket 21 as car 10 moves between any of the landings L1 to LT. Sprocket 21 drives the shaft of landing selector mechanism 22. This mechanism may be any one of several well known types having an advance floor scanner.

Shaft 694 of selector mechanism 22 is rotated through an angle proportional to the distance between the position of the car and the position being scanned by the advance floor scanner and is connected through gear box GB2 to drive sliding contact, or wiper, BR1 of coarse potentiometer POT1. This potentiometer has its center point grounded and its end terminals connected across voltages designated as V5— and V5+. Its output voltage is proportional to the distance between the position of the car and the position being scanned by the advance floor scanner.

Motor control equipment 15 is connected through contacts HXA1 (coil circuit not shown) to the output circuit of speed regulating equipment including a speed determining output voltage generator and voltage control equipment. The speed determining output voltage generator includes operational amplifier MIA arranged as an integrating amplifier having input circuits through resistors DAR1, COR5 and COR9. Condenser MIQ connected in parallel with resetting resistor MIDR through contacts HXA3 together with positive and negative voltage clamping circuits are connected from the input to the output of amplifier MIA. The positive clamping circuit includes diode PCD and resistors PCR1 and PCR2 connected to a voltage source designated V1—. The negative voltage clamping circuit includes diode NCD and resistors NCR1 and NCR2 connected to a positive voltage source V1+.

The voltage control equipment of the speed regulating equipment includes inverting amplifier COA1, its input and output resistors COR1 and COR3 and its scaling resistor COR2. Input resistor COR1 is connected to the output circuit of integrating amplifier MIA. Output resistor COR3 is connected in one of the input circuits to summation amplifier COA2. Connected to the second input circuit to summation amplifier COA2 through resistor HDCR is sliding contact BR1 of potentiometer POT1. The output circuit of amplifier COA2 is connected through contacts SC1 of a stop accelerating switch (coil circuit not shown) to resistor COR5.

Also connected to the output circuit of amplifier COA2 through contacts SC2 of the stop accelerating switch is the input resistor COR6 of integrating amplifier COA3.

Condenser CQ together with resistors COR7, COR8 and contacts SC3 are connected from the input to the output of amplifier COA3. This output is also connected through contacts SC4 of the stop accelerating switch to input resistor COR9 of integrating amplifier MIA.

The improved operation is provided by the stop accelerating switch whose coil is suitably energized in response to the generation in the well known manner of the signal to stop accelerating during operation at less than rated running speed. This enables the operation of integrating amplifier COA3 and its associated condenser CQ and resistors COR6, COR7, COR8 and COR9 as will be explained.

To understand the operation of this improved apparatus, reference will be made to its operation during a trip in which the car does not attain its rated running speed. Throughout the acceleration of the car 10 a time controlled signal from a suitable function generator is applied along line DA(2) in suitable fashion to produce an output from the speed regulating equipment including operational amplifier MIA. This output is applied to inverting amplifier COA1 so that it can be algebraically summed with the distance controlled output from the landing selector mechanism applied through sliding contact BR1 of potentiometer POT1. These two signals are applied to summation amplifier COA2 which produces an output equivalent to the difference between the magnitudes of these two signals.

The output signal from amplifier COA2 is applied through contacts SC2 and resistor COR6 to integrating amplifier COA3. As a result, it charges the associated condenser CQ to the magnitude of its difference voltage. The time constant of this charging circuit is maintained at a relatively small value owing to the presence of engaged contacts SC3 in parallel with resistor COR8. When the signal to stop accelerating is produced by suitable signal generating means in the well known manner, the advance floor scanner is stopped at a location representing the selected floor at which the car is to stop and the stop accelerating switch operates to open its contacts SC2 and SC3 and to close its contacts SC1 and SC4. As a result, the input to the speed regulating equipment at the instant the signal to stop accelerating is generated comprises three signals: first, the output of the time controlled signal function generator applied along line DA(2), which constitutes a signal which if permitted to would by itself cause the operation of the car to transfer gradually from acceleration according to time to deceleration according to time in the well-known manner; second, a signal whose magnitude is equal to the difference between the magnitudes of the output of the speed regulating equipment and the landing selector mechanism; and third, a signal exactly opposite in polarity and equal in magnitude to this difference signal. Thereafter condenser CQ discharges through resistors COR7 and COR8 and this discharging voltage by being applied as an input to the speed regulating equipment causes the output of that equipment to seek conformity with the continuous distance controlled signal in a gradual fashion. Throughout this operation the distance controlled signal generated by the landing selector mechanism effectively controls the speed of the car and thus a transfer from control by time to control by distance is produced without any discontinuity in operation.

It is to be noted that at the time the signal to stop accelerating is generated, resistor COR8 is inserted in the discharge path of condenser CQ to change the time constant of this circuit. This altered time constant is so chosen as to insure that the output from the speed regulating equipment is in conformity with the distance controlled signal substantially at the instant that the distance controlled signal starts to dictate constant deceleration.

Thus it may be seen that the invention, at least in its preferred embodiment, may operate to cause the deceleration of an elevator car on short trips to appear to passengers to be consistent with that produced on longer trips.

WHAT WE CLAIM IS:—

1. Speed dictation apparatus for an elevator car comprising a function generator for generating a voltage which in use varies continuously as a function of time and controls the car's acceleration on each trip, a landing selector mechanism arranged to control means for generating a voltage which in use varies continuously as a function of the distance the car is from a selected landing at which it is to stop on each trip, said latter voltage serving in use to control the car's deceleration on each trip, and signal generating means operable on each trip in which the car does not attain its rated running speed to generate a signal to stop accelerating in response to the selection of the landing at which the car is to stop, characterized by control equipment connected to said function generator and said means controlled by said landing selector mechanism for receiving both said time controlled voltage and said distance controlled voltage, said control equipment being adapted to operate in response to said signal to stop accelerating on any trip to cause said distance controlled voltage to control the speed of said car from before the

Condenser CQ together with resistors COR7, COR8 and contacts SC3 are connected from the input to the output of amplifier COA3. This output is also connected through contacts SC4 of the stop accelerating switch to input resistor COR9 of integrating amplifier MIA.

The improved operation is provided by the stop accelerating switch whose coil is suitably energized in response to the generation in the well known manner of the signal to stop accelerating during operation at less than rated running speed. This enables the operation of integrating amplifier COA3 and its associated condenser CQ and resistors COR6, COR7, COR8 and COR9 as will be explained.

To understand the operation of this improved apparatus, reference will be made to its operation during a trip in which the car does not attain its rated running speed. Throughout the acceleration of the car 10 a time controlled signal from a suitable function generator is applied along line DA(2) in suitable fashion to produce an output from the speed regulating equipment including operational amplifier MIA. This output is applied to inverting amplifier COA1 so that it can be algebraically summed with the distance controlled output from the landing selector mechanism applied through sliding contact BR1 of potentiometer POT1. These two signals are applied to summation amplifier COA2 which produces an output equivalent to the difference between the magnitudes of these two signals.

The output signal from amplifier COA2 is applied through contacts SC2 and resistor COR6 to integrating amplifier COA3. As a result, it charges the associated condenser CQ to the magnitude of its difference voltage. The time constant of this charging circuit is maintained at a relatively small value owing to the presence of engaged contacts SC3 in parallel with resistor COR8. When the signal to stop accelerating is produced by suitable signal generating means in the well known manner, the advance floor scanner is stopped at a location representing the selected floor at which the car is to stop and the stop accelerating switch operates to open its contacts SC2 and SC3 and to close its contacts SC1 and SC4. As a result, the input to the speed regulating equipment at the instant the signal to stop accelerating is generated comprises three signals: first, the output of the time controlled signal function generator applied along line DA(2), which constitutes a signal which if permitted to would by itself cause the operation of the car to transfer gradually from acceleration according to time to deceleration according to time in the well-known manner; second, a signal whose magnitude is equal to the difference between the magnitudes of the output of the speed regulating equipment and the landing selector mechanism; and third, a signal exactly opposite in polarity and equal in magnitude to this difference signal. Thereafter condenser CQ discharges through resistors COR7 and COR8 and this discharging voltage by being applied as an input to the speed regulating equipment causes the output of that equipment to seek conformity with the continuous distance controlled signal in a gradual fashion. Throughout this operation the distance controlled signal generated by the landing selector mechanism effectively controls the speed of the car and thus a transfer from control by time to control by distance is produced without any discontinuity in operation.

It is to be noted that at the time the signal to stop accelerating is generated, resistor COR8 is inserted in the discharge path of condenser CQ to change the time constant of this circuit. This altered time constant is so chosen as to insure that the output from the speed regulating equipment is in conformity with the distance controlled signal substantially at the instant that the distance controlled signal starts to dictate constant deceleration.

Thus it may be seen that the invention, at least in its preferred embodiment, may operate to cause the deceleration of an elevator car on short trips to appear to passengers to be consistent with that produced on longer trips.

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1. Speed dictation apparatus for an elevator car comprising a function generator for generating a voltage which in use varies continuously as a function of time and controls the car's acceleration on each trip, a landing selector mechanism arranged to control means for generating a voltage which in use varies continuously as a function of the distance the car is from a selected landing at which it is to stop on each trip, said latter voltage serving in use to control the car's deceleration on each trip, and signal generating means operable on each trip in which the car does not attain its rated running speed to generate a signal to stop accelerating in response to the selection of the landing at which the car is to stop, characterized by control equipment connected to said function generator and said means controlled by said landing selector mechanism for receiving both said time controlled voltage and said distance controlled voltage, said control equipment being adapted to operate in response to said signal to stop accelerating on any trip to cause said distance controlled voltage to control the speed of said car from before the

car starts its deceleration for that trip by initiating before deceleration starts a gradual transfer from control in which said time controlled voltage predominates to control in which said distance controlled voltage predominates.

2. Speed dictation apparatus according to claim 1, characterized in that said function generator generates the time controlled voltage which controls the acceleration of the car and a time controlled voltage having a desired deceleration pattern which is generated during deceleration of the car and said control equipment includes speed regulating equipment which receives the accelerating and decelerating time controlled voltages and the distance controlled voltage and produces an output voltage which gradually transfers from being more a function of said time controlled signals and less a function of said distance controlled signal to being more a function of the latter and less a function of the former until said output voltage conforms to said distance controlled voltage and controls the deceleration of the car as the distance controlled voltage would notwithstanding the continued application of said decelerating time controlled voltage.

3. Speed dictation apparatus according to claim 2, characterized in that in use said speed regulating equipment produces a difference voltage proportional to the difference between said output voltage and said distance controlled voltage which during deceleration said speed regulating equipment algebraically sums with said decelerating time controlled voltage to cause said output voltage to conform to said distance controlled voltage.

4. Speed dictation apparatus according to claim 3, characterized in that said control equipment includes a capacitive circuit adapted to operate during each trip in which the car does not attain its rated running speed to receive said difference voltage and to store a voltage equal in magnitude and opposite in polarity to said difference voltage until the signal to stop accelerating is generated whereupon the control equipment disconnects said capacitive circuit from the further reception of said difference voltage and connects it to apply its stored voltage to said speed regulating equipment to be algebraically summed with said accelerating time controlled voltage and said difference voltage so that upon the generation of said signal to stop accelerating the input voltages to said speed regulating equipment include the accelerating time controlled voltage, the difference voltage between said output voltage and said distance controlled voltage and a voltage opposite in polarity and equal in magnitude to said difference voltage.

5. Speed dictation apparatus according to claim 4, characterized in that said capacitive circuit includes an integrating amplifier whose charging time constant is shorter before the generation of a signal to stop accelerating than it is after so that said capacitive circuit charges more rapidly to store said opposite voltage than it discharges in applying its stored voltage to said speed regulating equipment.

6. Speed dictation apparatus substantially as herein described with reference to the accompanying drawing.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1974.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.