

COMMAND SPEED GENERATOR SYSTEM FOR ELEVATOR CAR

This invention relates to improvements in a command speed generator system for an elevator car.

Speed feedback control systems for controlling the speed of the elevator car in accordance with a command deceleration signal are employed in order that the elevator car is decelerated while maintaining a comfortable ride and lands accurately at that floor of a building at which the car is predetermined to be stopped due to a call registered thereon or on the elevator car. It has been recently proposed to cause the elevator car to decelerate and land at such a floor by using an electronic computer.

To this end, it has been a common practice to count the output from a pulse generator connected to the elevator hoist motor to determine the distance of movement of the elevator car. When a position sensor disposed in the elevator shaft senses that the elevator car reaches a predetermined distance short of that floor at which the elevator car is predetermined to land, the distance of movement of the car is entered into the electronic computer at the beginning of each of its calculating time periods. The electronic computer calculates the residual distance to the abovementioned floor by subtracting the distance of movement of the car from the predetermined distance. Following this the computer reads

out a command deceleration signal stored with respect to the calculated residual distance in a read only memory. Then the speed of the elevator car is controlled in accordance with the command deceleration signal thus read out.

The electronic computer has a calculating or an interrupting time period normally not synchronized with the time of operation of the position sensor. Therefore, when the elevator car reaches the position sensor, the calculation of the residual distance is not always immediately initiated. The time point at which the position sensor is operated occurs, in many cases, between successive calculating time periods of the electronic computer with the result that the elevator car may travel a distance L in the worst case where L is equal to the product of car speed v and the calculating time period Δt . However the electronic computer has stored therein the predetermined distance (which is designated by the reference character A) at the beginning of the calculating time period resulting in the setting of a magnitude of residual distance greater by the distance L than the actual distance. In other words, while the command deceleration signal to be delivered should properly have a magnitude V_1 corresponding to the residual distance $(A - L)$, a command deceleration signal is actually delivered having a magnitude V_2 corresponding to the residual distance A and thus

greater than the magnitude V_1 . That is, there has been delivered a command deceleration signal having an error till the landing of the elevator car. The magnitude V_2 is greater than that of the proper
5 command deceleration signal resulting in deterioration of the landing accuracy.

Accordingly it is an object of the present invention to eliminate the objection to the prior art practice as described above by the provision of a new
10 and improved command speed generator system for an elevator car for generating a command deceleration signal free from a distance error regardless of a time point where an output from a position sensor involved is entered into an associated electronic computer.

15 The present invention provides a command speed generator system for an elevator car comprising counter means for counting pulses corresponding to a distance of movement of the elevator car, an electronic computer into which, for each of predetermined
20 calculating time periods thereof, a count on the counter means is entered upon the elevator car reaching a predetermined distance short of a floor at which the elevator car is predetermined to stop, said electronic computer subtracting the entered count from said pre-
25 determined distance to calculate the residual distance between the actual position of the elevator car and the floor, signal generator means connected to said electronic computer to deliver a command deceleration

signal corresponding to said residual distance, and a resetting circuit connected to said counter means to generate a pulse for resetting said counter means to zero in response to said elevator car reaching said
5 predetermined distance.

Preferably the resetting circuit means includes a pair of AND gates one of which includes a first input applied with an "up" signal indicating ascent of the elevator car, a second input applied with a range
10 sensing signal indicating the elevator car entering a predetermined range below the said floor during the ascent of the elevator car, a third input applied with a positional signal indicating the elevator car reaching the predetermined distance during the ascent
15 of the elevator car, and a fourth input applied with the positional signal through a NOT gate and an attenuation network to produce the pulse for resetting the counter means to zero, and the other of the AND gates including a first input applied with a "down"
20 signal indicating descent of the elevator car, a second input applied with a range sensing signal indicating the elevator car entering the predetermined range above the floor during the descent of the elevator car, a third input applied with a positional signal indicating
25 the elevator car reaching the predetermined distance during the descent thereof, and a fourth input applied with the positional signal through a NOT gate and an attenuation circuit to form the pulse for resetting the

counter means to zero.

The present invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

5 Figure 1 is a block diagram of one embodiment of the command speed generator system of the present invention and a schematic view of an elevator system with which the present invention is operatively associated;

10 Figure 2 is a schematic diagram illustrating the status of data stored in the read only memory device shown in Figure 1;

Figure 3 is a circuit diagram of the details of the resetting circuit shown in Figure 1;

15 Figure 4 is a graph illustrating waveforms developed at various points in the arrangement shown in Figure 3; and

Figure 5 is a flow chart illustrating a program for the operation of the arrangement shown in Figure 1.

20 Figure 1 of the drawings illustrates one embodiment of the command speed generator system of the present invention and an elevator system with which the present invention is operatively associated. The arrangement illustrated comprises an electric hoist
25 motor 10, a hoist wheel 12 driven by the hoist motor 10, and a traction rope 14 trained over the hoist wheel 12 and connected at opposite ends to an elevator car 16 and a counterweight 18. The elevator car 16 is

provided on the outer surface of the ceiling thereof at one edge with a switch forming an up position sensor 20. The up position sensor 20 is arranged to engage a cam 22 disposed in the elevator shaft at a
5 predetermined distance A below a floor 24 served by the elevator car 16. That is, the cam 22 is operated when the elevator car 16 ascends and is located at the predetermined distance A short of a floor 24.

It will readily be understood that a cam such as
10 shown by the reference numeral 22 is located at the predetermined distance short of each floor.

The hoist motor 10 is connected to a pulse generator 26 for generating pulses whose number is proportional to the number of rotations of the hoist
15 motor 10. The pulse generator 26 is connected to a counter 28 for counting the pulses from the pulse generator 26. The counter 28 is reset to zero by a resetting circuit 28A and is connected to an electronic computer, in the example illustrated, a
20 micro-processor 30, commercially available as TYPE 8085 from Intel. However it is to be understood that the electronic computer may comprise any suitable marketed micro-processor.

The micro-processor 30 includes an input port 38A
25 connected to the switch 20 and also to a data bus 32, and a read only memory device 10B (which is abbreviated hereinafter to an "ROM"), a random access memory device (which is abbreviated hereinafter to an "RAM")

30C, a central processor 30E and an output port 30F connected to the data bus 32. The input port 30A and the ROM 30B are arranged to supply data to the data bus 32 while the output port 30F is arranged to receive data from the data bus 32. The RAM 30C and central processor 30E are arranged to apply data to and from the data bus 46.

In the example illustrated, the input port 30A, the ROM 30B, the RAM 30C, the central processor 30E and the output port 30F are of TYPES 8212, 2716, 2114A, 8085A and 8212 commercially available from Intel respectively.

The ROM 30B has stored therein a plurality of command deceleration magnitudes in the form of a plurality of data tables 30B1, 20B2, 30B3, ..., 30Bn-1, and 30Bn (see Figure 2) corresponding to different residual distances between the actual position of the elevator car and an associated floor such as the floor 24 and including the predetermined distance A for each pair of adjacent floors. The RAM 30 has data stored at addresses therein and data can be written into and read out from addresses in the RAM 38.

The output port 30F is connected to both the resetting circuit 28A and a command deceleration generator 34 connected to the hoist motor 10 through a control circuit 36.

The resetting circuit 28A is preferably of a circuit configuration as shown in Figure 3. The

arrangement illustrated comprises a pair of AND gates 40 and 42, an OR gate 44 including a pair of inputs connected to outputs of the AND gates 40 and 42 respectively, and another OR gate 46 including one
5 input connected to the output of the OR gate 44 and an output connected to the counter 28.

The AND gate 40 includes a first input applied with an "up" signal 48, a second input applied with a range sensing signal 50, a third input applied with a
10 positional signal 52 for the up direction and a fourth input connected to an output of a NOT gate 54 through a resistor 56 with the junction of the resistor 56 and the fourth input connected to ground through a capacitor 58. The positional signal 52 is also applied to the
15 input to the NOT gate 54.

The up signal 48 is put in its high level H during the ascent of the elevator car 16 and the range sensing signal 50 is put in its high level H when the elevator car 16 enters a predetermined constant range
20 below or above the floor to which the travelling car 16 is nearest in the direction of travel thereof, in the example illustrated, the floor 24. The positional signal 52 is put in its high level H upon the position sensor 20 engaging the cam 22.

25 Similarly the AND gate 42 includes a first input applied with a "down" signal 60, a second input connected to the second input (range sensing signal) to the AND gate 40, a third input applied with a positional signal

62 for the down direction and a fourth input connected to an output of a NOT gate 64 through a resistor 66 with the junction of the resistor 66 and the fourth input connected to ground through the capacitor 68.

5 The positional signal 62 is also applied to the input to the NOT gate 64.

The down signal 60 is put in its high level H during the descent of the elevator car 16 and the positional signal 62 is put in its high level H upon
10 a position sensor (not shown) for the down direction engaging a cam (not shown) also disposed at the predetermined distance A above each floor.

Also the OR gate 46 includes the other input applied with clock pulses 70 with a predetermined pulse
15 repetition period delivered from the central processor 30E.

The operation of the arrangement shown in Figure 1 will now be described in conjunction with both Figure 2 wherein there is shown the status in which
20 data was stored in the ROM 30B; and Figure 4 wherein there are illustrated waveforms developed at various points in the arrangement shown in Figure 3.

When the elevator car 16 travels upwards, an up travel relay (not shown) is energized and generates an
25 "up" signal 48 in its high level H and the pulse generator 26 generates pulses which are, in turn, counted by the counter 28. When the elevator car 16 reaches the predetermined distance A short of that

floor on which the car is predetermined to be stopped due to the presence of a call registered thereon or on the car, in the example illustrated, the floor 24, the position sensor 20 engages the up cam 22 resulting in the generation of the up positional signal 52 in its high level H from the up position sensor 20 (see waveform labelled 48, Figure 4). When the central processor 30E senses that positional signal 52 through the input port 30A, the same reads out the predetermined distance A stored in the ROM 30B therefrom and writes it into the RAM 30C at an address destined therefor. Then the count on the counter 28 is applied to the central processor 30E through the input port 30A for each of the calculating time periods and the central processor 30E subtracts the applied output from the predetermined distance A read out from the RAM 30C to calculate the residual distance R between the actual position of the elevator car 16 and the floor 24.

Meanwhile command deceleration magnitudes are successively picked up from the data table 30B1, 30B2, ..., 30Bn stored in the ROM 30B one for each calculating time period and are successively supplied to the command deceleration generator 34 through the output port 30F. In the generator 34 the command deceleration magnitudes are successively converted to corresponding analog magnitudes respectively which, in turn, control the hoist motor 10 through the control circuit 36. This results in the elevator car 16 decelerating smoothly

until it lands accurately at the floor 24.

During the ascent thereof the elevator car 16 enters a predetermined constant range below the floor 24 to cause range sensing signal 50 to be put in its high level H as shown at waveform labelled 50 in Figure 4. Under these circumstances, the engagement of the position sensor 20 with the cam 22 causes the positional signal 52 to be put in its high level H as shown at waveform labelled 52 in Figure 4.

The up signal 48, the range sensing signal 50 and the positional signal 52 as described above are applied to the first, second and third inputs to the AND gate 40 while the positional signal 52 is also applied to the fourth input to the AND gate 40 through the NOT gate 54 and the resistor 56 interconnected serially. The NOT gate 54 provides an output in its low level L but the output 58a from the resistor 56 is gradually decreased to its low level L with a time constant as determined by the resistor 56 and the capacitor 58 forming an attenuation network as shown at waveform labelled 58a in Figure 4.

Accordingly the AND gate 40 produces a pulse 40a synchronous with the leading edge of the positional signal 82 and having a constant pulse width as shown at waveform labelled 40a in Figure 4. That pulse 40a is supplied to the OR gate 46 through the OR gate 44. As a result, the OR gate 46 applies a pulse 46a

identical to the pulse 40a (see waveform labelled 46a, Figure 4) to the counter 28 to reset it to zero. That is, the counter 28 is cleared.

When the central processor 30E delivers one
5 clock pulse 70 at the beginning of the next succeeding calculating period t_1 as shown at waveform labelled 70 in Figure 4, an initial magnitude $(A - \Delta S_1)$ of the residual distance is calculated and written into the RAM 30C in the calculating period t_1 where ΔS_1 as
10 shown in Figure 4 designates the distance through which the elevator car 16 travels between the time point where the position sensor 22 is operated and the time point where the calculation of the residual distance is initiated. This is followed by a calculation
15 of a residual distance $(A - \Delta S_1 - \Delta S_2)$ in the next succeeding calculating period t_2 where ΔS_2 as shown in Figure 4 designates the distance through which the elevator car 16 travels for the calculating period t_2 . Thereafter the calculation as described above is
20 repeated.

From the foregoing it is seen that the residual distance is correctly calculated in each succeeding calculating period. Therefore the landing accuracy is prevented from deteriorating due to a distance error.

25 While the present invention has been described in conjunction with the ascent of the elevator car it is to be understood that the process as described above is

repeated with the descent of the elevator car except for the following respects: the "down" signal 60 in its high level H is applied to the AND gate 42 with the range sensing signal 50 put in its high level H when
5 the elevator car enters a predetermined constant range above that floor having a call registered thereon or on the car in the direction of descent of the car as calculated by the central processor 30E. The positional signal 72 for the downward direction is similar to the
10 positional signal 48 and is similarly attenuated by an attenuation network formed of the resistor 66 and the capacitor 68.

The operation of the arrangement shown in Figure 1 will now be described in more detail with
15 reference to Figure 5 wherein there is illustrated a flow chart describing a program for the operation thereof.

The program is stored in the ROM 30B and is executed for each of predetermined constant time
20 periods or the calculating time periods as described above in conjunction with Figure 4 under the control of a timer (not shown). Also a separate program is executed to cause the central processor 39F to perform the initializing process required for the rise
25 of an associated elevator control system.

The program put in the step START goes to the step 400 where it is determined if a calculation route control flag is a binary ZERO. The flag is reset to

the binary ZERO by both an initializing program (not shown) and a program (not shown) executed during the stoppage of the elevator car 16. When the step 400 determines that the flag is of the binary ZERO, the

5 step 402 is reached where the signal from the position sensor 22 is applied to the central processor 30E through the input port 30A and whether or not the signal 52 (see Figure 3) is delivered by the position sensor 20 is determined. When the position sensor

10 20 delivers the signal 52 as determined in the step 402, the program goes to the step 404 where the flag is set to a binary ONE. Then in the step 406 the pre-determined distance A stored in the ROM 30B is read out therefrom and written into the RAM 30C at an

15 address destined therefor as a residual distance R.

Thereafter the steps 402, 404 and 406 are prevented from being executed until the elevator 16 is stopped on the floor 24.

On the other hand, when the step 402 determines

20 that the position sensor 20 does not deliver the signal 52, the program is put in the state in which the process of the step 406 has been completed to be executed.

It is assumed that the step 400 has determined

25 that the flag is not equal to the binary ZERO. In the assumed conditions, a residual distance R and a corresponding command deceleration magnitude are calculated in the steps 408 through 414 after the

elevator car 16 has approached the floor 24 and travelled past the cam 22. More specifically the program goes to the step 408 where the count on the counter 28 loads an accumulator (which is disposed
5 within the central processor 30E and not shown) through the input port 30A.

Then the step 410 is reached where the central processor 30E is operated to read out the residual distance R stored in the RAM 30C at an address destined
10 therefor from the latter, to subtract the entered count from the read residual distance R to calculate a new residual distance R and write it into the RAM 30C.

Following this, a command deceleration magnitude is picked up from the data tables 30B1, 30B2, ..., 30Bn-1,
15 and 30Bn stored in the ROM 30B and then loads the accumulator in the step 412. That magnitude loaded in the accumulator is supplied via the output port 30F to the command deceleration generator device 34 in the step 414.

20 After the step 402 has determined that the position sensor 20 does not deliver the signal 62 or after either one of the steps 406 and 414 has been completed, the step 416 determines if the elevator car 16 is in the predetermined range above or below the floor 24.
25 If so, the range sensing signal 50 (see Figure 4) is put in its high level H in the step 418.

Then the step 420 determines if the elevator car 16 is ascending. If so, the up signal 48 (see Figure 4)

is put in its high level H in the step 422. The up signal 48 in its high level is applied to the reset circuit 28A through the output port 30A. At that time the program is completed to be executed. Therefore the
5 step END is reached.

On the other hand, when the step 420 determines that the elevator car 16 is not ascending and instead descending, the down signal 60 (see Figure 4) is put in its high level H. Then the down signal 60 is similarly
10 supplied to the resetting circuit 28A through the output port 30A. Accordingly the execution of the program has been completed.

From the foregoing it is seen that, in the described elevator speed control system, a counter
15 counts pulses corresponding to a distance of movement of an elevator car, and the resulting count is cleared upon the elevator car reaching a predetermined distance short of that floor on which the car is predetermined to be stopped. Thereafter the succeeding count is
20 entered into an associated processor for each of predetermined calculating time periods and is subtracted from the predetermined distance by the central processor to calculate the residual distance to the floor. Accordingly, the correct residual distance can be
25 calculated without any distance error dependent upon the time point where data are entered into the micro-processor or electronic computer.



CLAIMS:

1. A command speed generator system for an elevator car comprising counter means for counting pulses corresponding to a distance of movement of an elevator car, an electronic computer into which, for each of predetermined calculating time
5 periods thereof, a count on said counter means is entered upon said elevator car reaching a predetermined distance short of a floor at which said elevator car is predetermined to stop, said electronic computer subtracting the entered count from said predetermined distance to calculate the residual distance
10 between the actual position of the elevator car and the floor, signal generator means connected to said electronic computer to deliver a command deceleration signal corresponding to said residual distance, and a resetting circuit connected to said counter means to generate a pulse for resetting said
15 counter means to zero in response to said elevator car reaching said predetermined distance.
2. A command speed generator system for an elevator car as claimed in claim 1 wherein said resetting circuit includes a pair of AND gates one of which includes a first input applied
20 with an "up" signal indicating ascent of said elevator car, a second input applied with a range sensing signal indicating said elevator car entering a predetermined range below the said floor during the ascent of said elevator car, a third input
25 applied with a positional signal indicating said elevator car



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reaching said predetermined distance during the ascent of said elevator car, and a fourth input applied with said positional signal through a NOT gate and an attenuation network, to produce the pulse for resetting said counter means to zero, and

5 the other of the AND gates including a first input applied with a "down" signal indicating descent of said elevator car, a second input applied with a range sensing signal indicating said elevator car entering said predetermined range above said floor during the descent of said elevator car, a third input

10 applied with a positional signal indicating said elevator car reaching said predetermined distance during the descent thereof, and a fourth input applied with said positional signal through a NOT gate and an attenuation circuit to form the pulse for resetting said counter means to zero.

- 15 3. A command speed generator system for an elevator car, substantially as herein described with reference to the accompanying drawings.

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