

FLOOR DETECTOR FOR ELEVATOR SYSTEM

This invention relates to improvements in a floor detector system for an elevator system.

In the operation of an elevator system it is essential to sense the position of the elevator car.

5 This sensing is accomplished by an associated floor detector. A positional signal for the car delivered from the floor setector is used to display the position of the car on associated floors and in the car, and determine if the car is to be stopped and so on. The
10 floor displaying the position of the car is called hereinafter a "car floor" and the positional signal for the car is called hereinafter a "car-floor signal". There have been already employed various types of floor detector. One of the known floor detectors has com-
15 prised an electric reversible motor, a screw rod connected to the motor to be rotated thereby, a movable nut screw threaded onto the screw rod and held against rotational movement, and a plurality of sets of position contacts, one for each floor of a building,
20 selectively engageable by the movable nut during its movement along the screw rod. The floor detector has been arranged so that, during the ascent of the elevator car, for example, a car-floor signal is delivered each time the car passes through a pre-
25 determined point located above each floor. The car-

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floor signal operates to rotate the motor to move the movable nut up the screw resulting in the closure of the position contact set corresponding to the next succeeding floor in the direction of the ascent of the elevator car.

- 5 This closure of the position contact set delivers a car-floor signal which, in turn, stops the motor so that the nut position is in synchronization with the movement of the car and indicates the actual floor corresponding to the now closed contact set. The process as described
10 above is repeated to cause the movable nut to ascend stepwise with increments of one floor.

In the descent of the elevator car the movable nut is arranged to descend similarly with increments of one floor.

- 15 On the other hand, upon the start of the elevator car from each floor, an associated circuit has sensed therein an advance car position or an advance floor which is, for example, the next succeeding floor in the direction of travel of the car, in order to look for a call. In
20 the presence of a call registered on that floor or a call for that floor registered on the elevator car, a command landing signal is delivered to cause the car to land at the floor where the call has been registered. Otherwise the movable nut closes the position contact set corres-
25 ponding to that floor having no call registered thereon whereupon the above-mentioned advance floor proceeds to the last-mentioned floor.

If the elevator car is suddenly stopped before it reaches that floor corresponding to the advance car position then the synchronized floor is spaced from the advance floor by one floor because the advanced floor is set upon the start of the elevator car. When the car is then started, the advance floor is again re-set, so that the synchronized floor is now spaced from the new advance floor by two floors. Under these circumstances, it is impossible to operate the elevator car smoothly.

In order to correct this spacing between the synchronized and advance floors, the advance floor must be returned back to the synchronized floor with a complicated circuit configuration. Further the floor detector as described above has encountered problems such as abrasion of the components involved because it relies upon mechanical operation, and also it is of high manufacturing cost because of the use of the reversible motor which is expensive. There is a need for a floor detector which is high in reliability and economical.

Accordingly it is an object of the present invention to provide a new and improved floor detector system for an elevator system capable of preventing a spacing between a synchronized floor and an associated advance floor from changing even upon the sudden stoppage of an elevator car involved.

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The present invention provides a floor detector for an elevator system comprising an elevator car travelling within a shaft extending past a plurality of floors disposed one above the other, and means including an electronic computer for sensing success-
5 ively actual floors in synchronization with the travel of said elevator and advance floors in advance of associated actual floors, wherein there are provided between each pair of adjacent floors within said shaft
10 means for providing a first signal and a second signal on passage of the car, first calculation means in said computer responsive to the first signal to calculate the actual floor by effecting the addition or subtraction of one floor (depending on the direction of travel of
15 the car) to or from the existing actual floor stored in said electronic computer, and second calculation means in the computer responsive to the starting of said elevator car or to the second signal to calculate the advance floor by adding or subtracting a predetermined
20 number of floors (depending on the said direction of travel) to or from said actual floor.

Preferably the floor detector may comprise further means for causing the advance floor to coincide with the synchronized floor upon the stoppage of the
25 elevator car.

The present invention will become more readily apparent from the following detailed description taken

in conjunction with the accompanying drawings in which:

Figure 1 is a schematic front elevational view of a conventional floor detector for an elevator system;

Figure 2 is a schematic block diagram of one
5 embodiment of the elevator floor detector system of the present invention;

Figure 3 is a block diagram of the floor detector shown in Figure 2 composed of a micro-processor;

Figure 4 is a diagram illustrating a travel path
10 of the elevator car shown in Figure 2 and loci of the synchronized and advance floor for the elevator car plotted in ordinate against time in abscissa; and

Figure 5 is a flow chart programming the operation of the arrangement shown in Figures 2 and 3.

15 Referring now to Figure 1 of the drawings, there is illustrated a conventional floor detector for an elevator system. The arrangement illustrated comprises a floor selector 10 disposed within a machine compartment (not shown) including an electric reversible motor
20 12 for the floor detector 10, a screw rod 14 connected to the motor 12 to be rotated thereby, and a movable nut 16 screw threaded onto the screw rod 14 and held against rotational movement.

A plurality of sets of position contacts 18-1,
25 18-2 are disposed along the screw rod 14 one for each floor of a building served by an associated system. The sets of position contacts are arranged to sandwich

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selectively the movable nut 16 therebetween to be put in their closed position. They are designated by the reference numeral 18 with a suffix 1, 2, 3, ..., identifying the floors. For example, the reference numeral 18-1 designates the set of position contacts corresponding to a first one of the floors. When the nut 16 is moved along the screw rod 14 by rotation of the rod, the nut is successively engaged by the sets of position contacts 18-1, 18-2, 18-3, ..., to sense successively the actual floor of the elevator car (not shown).

In Figure 1 the position contact set 18-1 is shown as being close through the movable nut 16. This means that the elevator car (not shown) is located on the first floor. When the elevator car travels upwardly and passes through a predetermined point above the first floor, a car-floor signal is delivered as will be described later. The motor 12 responds to that car-floor signal to be rotated thereby to move the nut 14 upwardly through the rotational movement of the screw rod 14. During this upward movement, the nut 14 engages the set of position contacts 18-2 for the second floor to close the contacts to deliver another car-floor signal. The motor 12 is stopped in response

to the latter signal and the corresponding actual floor is sensed by the closed position contact set 18-2. That is, the actual floor is the second floor.

When the elevator car further travels upwardly 5 and passes through a predetermined position above the second floor, the electric motor 12 is similarly rotated to move the movable nut 16 further upwardly through the rotational movement of the screw rod 14 until position contact set 18-3 is similarly operated.

10 In this way the movable nut 16 ascends stepwise with increments equal to one floor.

On the other hand, upon the start of the elevator car from the first floor, an associated circuit (not shown) senses thereon an advance position of the 15 elevator car or an advance floor corresponding, for example, to the second floor which is in advance of the actual first floor by one floor. This is because a call is looked for. If a call has been registered on the second floor, a command stopping or landing signal is 20 delivered to stop the elevator car on the second floor. In the absence of a call registered on the second floor, the engagement of the movable nut 16 with the position contact set 16-2 results in the advance floor as described above proceeding to the third floor.

25 The process as described above is repeated to

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cause the movable nut 16 to ascend stepwise with increments of one floor.

In this way the advance floor has been set upon the start of the car. Under these circumstances, if the
5 elevator car is suddenly stopped before the car arrives at the advance floor then the actual floor is spaced from the advance floor by one floor in the example as described above. When the elevator car is then started, the starting causes the advance floor to be set again with
10 the result that it is now spaced from the actual floor by two floors. Under these circumstances, it is impossible to operate the elevator car smoothly.

In order to correct such a spacing between the advance and synchronized floor, the advance floor must
15 be returned back to the synchronized floor, which is attended with the necessity of using a complicated circuit configuration. Further the floor selector 10 has encountered problems such as abrasion of the components involved because it relies upon mechanical operation, and
20 an increase in manufacturing cost because the reversible electric motor is expensive.

Referring now to Figure 2, there is schematically illustrated one embodiment of the floor detector of the present invention. The arrangement illustrated comprises
25 a plurality of floors, in this case, a first, a second, a third and a fourth floor 1F, 2F, 3F and 4F respectively

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are shown as being located at predetermined equal intervals one above another; floors disposed above the fourth floor are not shown. A first array of cams or switch actuators 20, 22 and 24 are disposed at predetermined distances above the floors 1F, 2F, 3F and 4F respectively, vertically aligned with one another and with edges of the floors. A second array of cams or switch actuators 26, 28 and 30 are disposed below the cams or switch actuators 20, 22 and 24 respectively, vertically aligned with one another and with the edges of the floors and spaced therefrom by predetermined equal intervals respectively. Therefore all the switch actuators are disposed in vertically aligned relationship in a hoistway (not shown) extending through the floors 1F, 2F, 3F and 4F. However the array of cams or switch actuators 20, 22 and 24 are horizontally staggered from the array of switch actuators 26, 28 and 30.

The arrangement comprises further an elevator car 32 arranged to travel upwardly and downwardly within the hoistway as described above and a pair of switches 34 and 36 disposed on a vertical plate erected on the outer surface of the ceiling of the elevator car 32 adjacent to one edge thereof. The switches 34 and 36 are positioned so that, during the travel of the elevator car 32 the switch 34 engages selectively the switch actuators 20, 22 and 24 to sense the actual floor position of the car while the switch 36 engages selectively the switch actuators 26, 28 and 30 to reset the advance floor. The

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The switches 34 and 36 are electrically connected to a floor detector 38.

In order to move the elevator car 32 upwardly and downwardly, the same is connected to a counterweight 40 through a traction rope 42 trained over a hoist wheel 44. The hoist wheel 44 is connected to a reversible electric hoist motor (not shown).

The floor detector 38 shown in Figure 2 includes an electronic computer. In the example illustrated the electronic computer comprises a micro-processor commercially available as TYPE 8085 from Intel. However it is to be understood that the microprocessor 38 is not limited thereby or thereto and may comprise any suitable digital computer commercially available.

The micro-processor includes an input port 38A connected to the switches 34 and 36 and a travel relay (not shown) and also to a data bus 46, and a read only memory device (which is abbreviated hereinafter to an "ROM") 38B, a random access memory device (which is abbreviated hereinafter to an "RAM") 38C, an interrupting period control timer 38D, a central processor 38E and an output port 38F connected to the data bus 46. The input port 38A and the ROM 38B are arranged to supply data to the data bus 46 while the timer 38D and the output port 38F are arranged to receive data from the data bus 46. The ram 38C and central processor 38E are arranged to apply and receive data to and from the data bus 46.

In the example illustrated, the input port 38A, the ROM 38B, the RAM 38C, the timer 38D, the central processor

38E and the output port 38F are of TYPES 8212, 2716, 2114A, 8155, 8085A and 8212 commercially available from Intel respectively.

The output port 10F is connected to an indicator 5 48 for indicating a car floor.

The ROM 38B has stored therein a deceleration pattern dependent upon the distances from the actual car positions to those associated floors at which the elevator car is predetermined to land due to calls registered on the 10 floors or the elevator car and others and is used only to read selectively the deceleration pattern out on the bus 40. The RAM 38C can write in and read out the actual and advance floors. The input port 38A receives the synchronization and advance resetting signals from the switches 34 15 and 36 and selectively delivers these signals to the central 38E, the ROM 38B and RAM 38C.

The operation of the arrangement shown in Figures 2 and 3 will now be described in conjunction with Figure 4, which illustrates the travel path for 20 the elevator car shown in Figure 2 and loci of the actual and advance floor developed in the operation of the arrangement shown in Figure 2. Assuming that the elevator car 32 is located at the first floor 1F, the actual and advance car positions are on the first floor 25 1F which is preliminary stored in the RAM 38C. Then the elevator car 32 is started and ascends along an operating line 50 as shown at dotted line describing the actual car position plotted in ordinate against time in absicca in Figure 4. Then the synchronization switch

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34 engages the switch activator 20 to deliver an output to the central processor 38E through the input port 38A. The central processor 38E calculates the actual floor as lying on the second floor 2F, according to a synchronization calculation programs stored in the RAM 38C. That is, the actual floor is changed from the first floor 1F to the second floor 2F as shown at arrowed broken line 52 running vertically between the first and second floors in Figure 4. The actual floor thus calculated is written in the RAM 38C at an address for the actual floor and is read out therefrom as the actual floor.

When the elevator car 32 has passed through the second floor 2F and the switch 34 thereon engages the switch actuator 22, the switch 34 delivers an output to the input port 38A. Then the central processor 38E effects the similar calculation as described in conjunction with the engagement of the switch 34 with the switch actuator 20 whereby the address for the actual floor position is rewritten in the RAM 38F as coinciding with the third floor 3F as shown at arrowed broken line 52 running vertically between the second and third floors 2F and 3F respectively. Thereafter the process as described above is repeated with the result that the actual floor is changed in stepped manner as shown at its locus expressed by stepped broken line 52.

On the other hand, upon the start of the elevator car 32 from the first floor 1F, the central processor

38E calculates the advance floor as being the second floor 2F, according to an advance calculation program stored in the ROM 38B, in response to the energization of a travel relay (not shown) to deliver a command car
5 start signal. The calculated advance floor is written in the RAM 38C at an address for the advance floor and is sensed as an advance floor.

When the advance resetting switch 36 on the elevator car 32 engages the switch actuator 26 during
10 this ascent thereof, the switch 36 delivers an output to the central processor 38F through the input port 38A. As in the engagement of the switch 34 with the switch actuator 23, the central processor 38E reads out the actual floor at that time from the RAM 38C and calculates
15 the advance floor as the sum of the actual floor and two floors (see arrowed solid line 54 running vertically between the second and third floors 32F and 43F respectively and dotted line forming a downward extension thereof). This results in the re-writing of the address
20 for the advance floor in the RAM 38C. Thereby the advance floor at that time is sensed to lie on the third floor 3F and is held at and after that time, as shown at horizontal solid line running in the same level, as the third floor 3F.

25 When the elevator car 32 passes through the second floor 2F and its switch 36 engages the switch actuator 28, the switch 36 delivers an output to the input port 38A.

Thereafter the central processor 38I effects the similar calculation as described above with the result that in the RAM the address for the advance floor is re-written as the fourth floor 4F.

5 Then the process as described above is repeated.

Therefore it will readily be understood that the advance floor is changed as shown by the stepped solid line 54.

Assuming that, when the advance floor proceeds
10 to the fourth floor 4F, an up call has been registered on that floor, the advance floor is held on the fourth floor 4F. Under these circumstances, the hoist motor (not shown) senses separately the actual position of the elevator car 32 from the number of rotations
15 thereof. Then a deceleration pattern corresponding to the distance between the sensed actual car position and the fourth floor 4F is read out from the ROM 38B. Accordingly the elevator car 32 is decelerated following the read-out deceleration pattern and a comfortable
20 rise is maintained until the car 32 lands at the fourth floor 4F.

It is to be noted that, when the elevator car 32 is stopped to denenergize and drop out the travel relay (not shown), the actual floor at that time is always
25 written into the RAM 38C at the address for the advance floor. As described above, the advance floor is calculated on the basis of the associated actual

floor. Therefore the advance floor is not erroneously determined unless the associated actual floor is wrong. Also even if the elevator car is suddenly stopped during its travel, the advance floor is corrected to
 5 the associated actual floor as in the normal landing of the elevator car as described above. This is because the above mentioned travel relay (not shown) is deenergized and drops out.

From the foregoing it will readily be understood
 10 that upon the start of the elevator car from any floor other than the first floor the advance floor similarly proceeds to that floor located just above the starting floor.

While the present invention has been described in
 15 conjunction with the calculation of the advance floor by which two floor is added to the actual floor it is to be understood that any desired number of the floors may be added to the actual floor in accordance with the speed of travel of the elevator car.

20 Also it will be understood that the process as described above in conjunction with the ascent of the elevator car is equally applicable to the descent thereof. In the latter case it is to be noted that the calculation of the advance floor is to subtract the
 25 number of the floors from the actual floor.

The operation of the arrangement shown in Figures 2 and 3 will now be described in more detail.

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with reference to Figure 5 wherein there is illustrated a flow chart describing a program for the operation of the arrangement performed by the micro-processor shown in Figure 3. The program is stored in the ROM 38B and is
5 started in interrupting manner at predetermined constant time periods by an interrupting period-control timer 38D. Also another program (not shown) is arranged to execute an initializing process required for an associated elevator control system to rise by the micro-processor.

10 The program is started in the step START and entered into the step 500A where the travel relay is energized to deliver a command car start signal and then the step 500 where it is determined if the travel relay (not shown) is in its deenergized state. If the relay is in its deenergized
15 state (car not moving) as determined in the step 500 then the step 502 is entered where the advance floor FSA is always maintained to coincide with the actual floor FSY. If the travel relay is not in its deenergized state as determined in the step 500 then the step 504 is entered.
20 The step 504 determines if the car is ascending. If so, a program is executed for calculation of the advance and actual floor during the ascent of the elevator floor.

More specifically, the step 506 determines if the switch 34 is on its ON position by engaging any one of the
25 switch actuators 20, 22 and 24. If the switch 34 is in its ON position as determined in the step 506 then the program enters the step 508 where it is determined

whether or not a calculation route control flag A is equal to a binary ZERO. If the flag A is not equal to the binary ZERO as determined in the step 508, the calculation of the actual floor is stopped and proceeds
5 to that of the advance floor as described later.

On the other hand, when the flag A is equal to the binary ZERO as determined in the step 508, the step 510 is entered. In the step 510 the actual floor is read out from the RAM 38C at an address destined there-
10 for and increased by one after which the sum of the actual floor plus one is written in the ram 38C as a new actual floor. Then the flag A is set to a binary ONE in the step 512 whereupon the program for calculating the actual floor is completed.

15 On the other hand, when the step 506 determines that the switch 34 is not in its ON position, the flag A is reset to a binary ZERO resulting also in the end of the program for calculating the actual floor.

It is to be noted that the calculation route
20 control flag A is also reset to a binary ZERO by the initializing program (not shown) and a program (not shown) executed during the stoppage of the elevator car.

After the completion of the program for calculating the actual floor, the program for calculating the
25 advance floor is started. First the step 516 determines if the advance setting switch 36 is in its ON position by engaging any one of the switch actuators 26, 28 and 30. If so, the next succeeding step 518

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determines if a calculation route control flag B is equal to the binary ZERO. If the switch 36 is not in its ON position, then the flag B is reset to a binary ZERO in the step 520 after which no process after the
5 step 516 is prevented from processing unless the flag A is again reset to a binary ZERO.

Like the flag A, the flag B is arranged to be also reset to a binary ZERO by the initializing program (not shown) and the program (not shown) executed during the
10 stoppage of elevator car.

If the flag B is not equal to the binary ZERO as determined in the step 518 then the step END is reached. On the other hand, when the flag B is equal to the binary ZERO as determined in the step 518, the actual floor FSY
15 is read out from the RAM 38C at the address thereof and increased by two (2) in the step 522. In the step 522 also the resulting sum is written into the RAM 38C at an address destined therefor in the step 522 as a new advance floor. Following this, the flag B is set to a binary ONE
20 in the step 524 whereupon the calculation of the advance floor is completed. That is, the step RND is reached after which the step 524 is prevented from processing unless the flag B is again reset to a binary ZERO.

After the descent of the elevator car has been
25 determined in the step 504, programs for calculating the actual and advance floor during the descent of the elevator car are executed in a series of steps similar to

the steps 506 et seqq excepting that the subtraction rather than the addition is effected in the steps similar to the steps 510 and 522.

From the foregoing it is seen that the present
5 invention provides a floor detector for an elevator system including first calculation means responsive to the passage of a first switch on an elevator car through each of first switch actuators disposed in an associated hoistway to calculate the actual floor
10 through the addition or subtraction of one floor effected by an electronic computer or a micro-processor involved, and second calculation means responsive to the start of the elevator car, or to the passage of a second switch on the car through each of second switch
15 actuators disposed in the hoistway, to calculate an advance floor through the addition or subtraction of a predetermined number of the floors, for example, two floors effected by the micro-processor. The actual and advance floors thus calculated are written in an
20 associated RAM at predetermined addresses and used in the next succeeding calculation.

The present invention has several advantages. For example, the present invention provides a floor detector for an elevator system of high reliability
25 because it does not rely upon mechanical operation, which is economical. As the advance floor is calculated on the basis of the associated actual floor, the advance floor is not erroneously calculated unless the

actual floor is erroneously determined. Also even upon the sudden stoppage of the elevator car, the advance floor at the re-start thereof is corrected to coincide with the actual floor because an associated travel relay is deenergized. Further since the advance floor is arranged to coincide with the actual floor upon the stoppage of the elevator car, the elevator can be smoothly operated without the occurrence of an error in the position of the advance floor relative to the associated actual floor.



1. A floor detector for an elevator system comprising an elevator car travelling within a shaft extending past a plurality of floors disposed one above another, and means including an electronic computer for sensing
5 successively actual floors in synchronization with the travel of said elevator and advance floors in advance of associated actual floors, wherein there are provided between each pair of adjacent floors within said shaft means for providing a first signal and a second signal
10 on passage of the car, first calculation means in said computer responsive to the first signal to calculate the actual floor by effecting the addition or subtraction of one floor (depending on the direction of travel of the car) to or from the existing actual floor stored in said
15 electronic computer, and second calculation means in the computer responsive to the starting of said elevator car or to the second signal to calculate the advance floor by adding or subtracting a predetermined number of floors (depending on the said direction of travel) to or
20 from said actual floor.

2. A floor detector as claimed in claim 1 wherein there is further provided means for causing said advance floor to coincide with said actual floor upon a stoppage of said elevator car.

3. A floor detector for an elevator system, substantially as herein described with reference to Figures 2 to 5 of the accompanying drawings.