1453080

PATENT SPECIFICATION (11) 1453080

(21) Application No. 52823/73 (22) Filed 14 Nov. 1973
(31) Convention Application No. 115525/72 (32) Filed 20 Nov. 1972 in
(33) Japan (JA)
(44) Complete Specification published 20 Oct. 1976
(51) INT CL² B66B 1/14
(52) Index at acceptance
G3N 252 265B 353 361 381 BS BW



(54) ELEVATOR CONTROL SYSTEM

(71) We, HITACHI, LTD., a Corporation organized under the laws of Japan, of 5—1, 1-chome, Marunouchi, Chiyoda-Ku, Tokyo, Japan, 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:—

The present invention relates to an improved elevator control system used with an elevator system comprising a plurality of elevator cars serving a plurality of floors.

In common practice, when a hall call button is depressed by a waiting prospective passenger, a lamp incorporated in the hall call button is turned on to inform the prospective passenger of the registration of the hall call, which is maintained effective until it is cancelled by the arrival of any one of the cars to serve the floor. This is advantageous in preventing troublesome repetition of the operation of the hall call button on one hand and a plurality of cars from serving one hall call.

The prospective passenger, on the other hand, is not sure which of the cars is ready to answer the hall call, because it is impossible to predict at the time of generation of the hall call which of the cars actually arrives first at the floor from which the hall call was originated.

The increased recent demand for improved car service has led to the efforts of those skilled in the art to develop a system for informing a prospective passenger earlier which of the cars is ready to serve him. In the system described in our co-pending application No. 11889/73 (Serial No. 1,429,674) the operating condition of each car is detected at each moment so as to select early a car which is capable of serving most efficiently a hall call generated. A guide lamp provided on the landing of the floor from which the hall call was originated is turned on to inform the prospective passenger of the expected earliest arrival of the car to serve him. The availability of this early information on the first-arriving car enables the prospective passenger to move into position in front of the hoistway door for that particular car early enough to prepare himself to take that car, thus eliminating the need for watching the movement of all of the remaining cars.

It was already mentioned that the hall call is maintained effective only until the arrival of any one of the cars, and the shortcoming of the above-mentioned elevator control system has proved to be an inconvenience which often occurs at rush hours when a car other than the car the service of which was indicated to the prospective passenger is decelerated to stop at that calling floor by a cage call, in spite of the fact that a hall call is not transmitted to any car other than the indicated car.

When the car other than the car indicated by the guide lamp serves earlier the floor from which the hall call was originated, the registration of the hall call from that floor is cancelled inconveniently, with result that the particular car selected for indication on the guide lamp passes by the floor without being decelerated for serving the floor. This has so far been considered to be instrumental in improved efficiency in car service, saving wasteful stoppage of cars. The failure of the car selected for indication on the guide lamp to serve the floor where the prospective passenger was waiting, however, causes not only the confusion of the prospective passenger but is a discredit to the guide lamp. The problem becomes even more serious when the car which has arrived earlier is situated farther than the landings adjacent to the landing to which the prospective passenger was moved by the indication on the guide lamp. In such a case, the prospective passenger, if he fails to take the car that has arrived at his floor earlier, must take trouble to depress the hall call button again, thus offsetting the expected advantage of efficient car service by reduction of the number of times cars stop.

In accordance with the present invention there is provided an elevator control system comprising a plurality of elevator cars serving a plurality of floors, means for register-

ing a hall call from a hall landing means actuated in response to the registration of the hall call, to designate one car, or one car and at least one alternative car to answer the said hall call, and to inform a passenger waiting at the said hall landing that the car has, or the cars have, been so designated; separate means for detecting deceleration of each car near, or its stoppage at, the said hall landing, and means for cancelling the registration of the said hall call only in response to an output from the detecting means of the said designated one car or of one of the said designated cars.

The present invention may thus provide an elevator control system which enhances the believability of the guide lamp for informing prospective passengers which of the cars is going to answer the hall calls from from, thereby improving the car service to them.

In one embodiment of the invention, the registration of a hall call from a landing of a floor is cancelled only when that car which is indicated on the guide lamp at that landing of the floor to serve the same floor is decelerated to stop, or actually stops, thereat.

In an alternative embodiment of the invention, the registration of a hall call from a landing of a floor is cancelled only when the car indicated on the guide lamp at the landing to serve that landing, or a car running in an immediately adjacent hoistway, arrives at the floor whichever is earlier.

Some embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:—

Fig. 1 is a diagram for explaining the operation of an elevator control system according to an embodiment of the invention;

Figs. 2 to 13 show an actual example of the invention as applied to an elevator system comprising three cars A, B and C serving 1st to 10th floors, among which;

Fig. 2 is a diagram showing a detection circuit provided for car A for detecting the spatial interval between car A and the succeeding car, a like circuit being provided for each of the other cars;

Fig. 3 is a diagram showing a circuit for detecting the number of calls to be answered by car A, a like circuit being provided for each of the other cars;

Fig. 4 is a diagram showing a circuit for counting an average number of calls to be served by each of cars A to C;

Fig. 5 is a diagram showing a reference voltage generator circuit used with the comparator shown in Fig. 6;

Fig. 6 shows a circuit for providing a signal which is used to set the size of a service zone for car A a like circuit being provided for each of the remaining cars;

Fig. 7 is a diagram showing a circuit for setting the service zone of car A, a like circuit being provided for each of the remaining cars;

Fig. 8 is a circuit provided for each floor which operates once a given car has been designated to serve a call from that floor, so as to prevent another car from answering the call;

Fig. 9 is a circuit provided for each floor for establishing a priority order in which the three cars are to answer a hall call from that floor;

Fig. 10 is a diagram showing a circuit provided for car A for making a decision that car A should serve a hall call, a like circuit being provided for each of the other cars;

Fig. 11 is a diagram showing a circuit for driving a guide lamp for car A, a like circuit being provided for each of the other cars;

Fig. 12 is a diagram showing an embodiment of a detection circuit for detecting the direction of travel of car A and the nature of a call for car A, a like circuit being provided for each of the other cars;

Fig. 13 is a diagram showing an embodiment of part of the reset circuit for registration and cancellation of a hall call by car A, additional circuitry being required for each of the other cars as indicated;

Fig. 14 is a diagram showing another embodiment of the circuit for detecting the direction of travel of car A and the nature of a call therefor, in the case of group operation, a like circuit being provided for each of the other cars; and

Fig. 15 is a diagram showing a circuit provided for each floor for energizing a guide lamp for each car group in the embodiment of Fig. 14.

Prior to explaining the invention, a group elevator control system to which the present invention is suitably applied will be briefly described below.

The diagram of Fig. 1 is for explaining the operation of a group control system used with an elevator system comprising cars A to C serving the first to 10th floors, to which the present invention may be applied. The purpose of a group control system is to efficiently control the operation of all the cars included in the system by systematically relating the cars to each other. To achieve this purpose, such factors concerning the operating conditions of the cars as the intervals between cars and the number of floors to be served by each car are detected to spread the load between cars as far as possible. Further, a service zone of each car which covers the floors expected to be served by the particular car in response to hall calls from such floors is determined and changed at each moment in accordance with the operating condition of the car. Thus, a hall call originating from a floor is transmitted to

a car having the service zone covering that floor, requiring it to serve the floor. In other words, the service zone of a car is an important factor in making decision that that car is required to answer a hall call originating from within that service zone.

The service zone will be explained more in detail with reference to Fig. 1. As shown, car A is travelling up at the 2nd floor, car B travelling down at the 9th floor and car C travelling down at the 2nd floor. The service zones of the cars include the floors as indicated by arrows respectively. Assuming that an up hall call is generated from the 8th floor, the hall call the origin of which is included in the service zone of car A is transmitted to the control device for car A, so that it is determined that car A is required to serve the hall call. This constitutes an effective means to determine early which of the cars is to answer a hall call. The car which was specified to serve the hall call is indicated on the guide lamp on the floor from which the hall call was originated, thus informing the prospective passenger which of the cars is to serve him.

The above-described elevator group control system as applied to the present invention will be explained with reference to Figs. 2 and 3 showing an embodiment. Prior to the explanation, certain terms used in this specification will be defined as follows: An "interval" means a spatial interval between the physical positions of two given elevator cars. A "position signal" means a signal representing physical or actual position expressed in the form of the floor number or distance and/or a provisional position which is in advance of the corresponding actual position. For instance, the provisional position of a car travelling up at the 3rd floor may be the 4th, 5th or 6th floor depending on whether it is running at low, medium or high speed, respectively.

It is also assumed in the embodiment under consideration that cars A to C serve the 1st to 10th floors.

Referring to Fig. 2 showing a circuit for detecting the spatial interval between car A and a succeeding car, reference symbols F1UA to F9UA show position signals for car A in up travel indicating the 1st to 9th floors respectively, symbols F2DA to F10DA position signals for car in down travel indicating the 2nd to 10th floors respectively, symbols F1UB to F9UB position signals for car B in up travel indicating the 1st to 9th floors respectively, symbols F2DB to F10DB position signals for car B in down travel indicating the 2nd to 10th floors, symbols F1UC to F9UC position signals for car C in up travel indicating the 1st to 9th floors, symbols F2DC to F10DC position signals for car C in down travel indicating the 2nd to 10th floors respectively, symbols O1UA1 to O9UA2 and O2DA1 to O10DA2 "OR" elements, symbols I1UA to I9UA and 12DA to I10DA inhibit elements, symbols r_1 and r_0 resistors and symbol *da* a signal indicating the spatial interval between car A and the succeeding car.

As shown in the drawing, the service floors F1U, F2D, F3D . . . F9D, F10D, F9U, F8U . . . F2U and F1U are endlessly connected, through which position signals F1UA to F9UA and F2DA to F10DA are transmitted in sequence until they are interrupted by either a position signal of car B or that of car C when signal *da* representing a spatial interval is obtained from signals from each floor and the resistors r_1 and r_0.

It is assumed now that car A is travelling up at the 8th floor, car B travelling up at the 2nd floor and car C travelling down at the 5th floor, car B succeeding car A. Position signal F8UA of car A is applied through F8UA, O8UA1, I8UA, O7UA1 . . . I3UA, O2UA1 and I2UA in that order. Position signal F2UB of car B which is in the state of "1" is applied through O2UA2 and I2UA thereby to prevent the output from being produced by the inhibit element I2UA, so that no signal is applied to the following stages.

As will be noted from the above description, inhibit elements I8UA, I7UA . . . I4UA and I3UA produce "1" signals and a signal corresponding to the position signal representing the six floors is produced across the resistor r_0 through the resistors r_1 connected to the above-mentioned inhibit elements, which signal constitutes signal *da*. In this case, if the value of r_1 is larger than that of r_0, a signal in proportion to the number of floors is produced across the resistor r_0.

Referring to Fig. 3 showing the circuit for detecting the number of hall calls to be served by car A, reference symbols M1UA to M9UA and M2DA to M10DA are signals representing the floors to be served by car A, among which those signals corresponding to hall calls or cage calls which have been generated are converted into the state of "1". As in the circuit of Fig. 1, signal CA proportional to the number of calls to be served is obtained across the resistor r_0.

The circuit of Fig. 4 is provided for the purpose of calculating the average number of hall calls for each car by the calculating processes of addition and division of the number of hall calls to be served by each car. Reference symbols CA to CC show signals representing the number of calls to be served by cars A to C respectively as calculated by the circuit of Fig. 3, and symbols NOA1, NOA2, NOB1, NOB2, NOC1 and NOC2 contacts adapted to be opened when cars A to C are released from controlled

operation respectively. Symbol R_1 shows resistor and OP_1 an inverting operational amplifier.

As long as cars A to C are in controlled operation, all of the contacts NOA1, NOA2, NOB1, NOB2, NOC1 and NOC2 are closed. Let the call inputs for cars A to C during such period be CA, CB and CC, then the output C of the operational amplifier is expressed as

$$C=\frac{\frac{-R_1}{3}}{R_1}(CA+CB+CC)=\frac{-1}{3}(CA+CB+CC) \quad (1)$$

When car A is released from controlled operation,

$$C=-\frac{\frac{R_1}{2}}{R_1}(CB+CC)=\frac{-1}{2}(CB+CC)$$

In other words, the output C of the operational amplifier gives an average number of hall calls to be answered by each car.

A circuit for producing reference voltages used in the circuit of Fig. 6 is shown in Fig. 5. When cars A to C are in controlled operation the contacts NOA3 to NOC3 are opened, and therefore the output of the operation amplifier OP2 is given as

$$Vop_2=\frac{-R_4}{R_3}(-V_0)=\frac{R_4}{R_3}V_0 \quad (2)$$

By appropriately selecting the resistors R_3/R_4, adjustment is possible to obtain Vop_2 of 6 volts.

When car A is released from controlled operation, on the other hand, contact NOA3 is closed and the output of the operational amplifier OP2 is

$$Vop_2=-\frac{R_4}{R_3}(-V_0)-\frac{R_4}{R_2}(-V_0)=R_4V_0\left(\frac{1}{R_3}+\frac{1}{R_2}\right)$$

In this case, also, it is possible to make Vop_2 of 10 volts by appropriately selecting the value of resistor R_2. In this way, the output voltage of the operational amplifier is appropriately divided by the variable resistors R_5 and R_6 to obtain reference voltages V_1 and V_2 for the comparator used in the circuit of Fig. 6. Thus, reference voltages V_1 and V_2 are made 5 and 4 volts respectively when Vop_2 is 6 volts, whereas they are made 8.3 and 6.6 volts when Vop_2 is 10 volts.

In Fig. 6 is shown a circuit for setting the apparent spatial interval between car A and the preceding car, to which signals are applied from the circuits of Figs. 2 to 5. In the drawing under consideration, reference symbols OPA1 and OPA2 show operational amplifiers, symbols CMA1 and CMA2 comparators each producing a "1" signal when the sum of the two inputs thereto is zero or positive, symbol NA a N0T element, symbol IH an inhibit element and symbols E0A to E2A instruction signals to advance the position of car A to a provisional position, signals E0A, E1A and E2A instructing the position of car A to be advanced by zero, one and two floors provisionally, respectively.

The number CA of hall calls to be served by car A which is obtained from the circuit of Fig. 3 is subtracted from the average number C of hall calls obtained from the circuit of Fig. 4, whereby the operational amplifier OPA1 produces an output

$$Vop_{A1}=-(CA+C)=-CA+\frac{1}{3}(CA+CB+CC) \quad (3)$$

In like manner, the operational amplifier OPA2 produces an output

$$Vop_{A2}=\frac{-R9A}{R7A}Vop_{A1}-\frac{R9A}{R8A}da \quad (4)$$

Appropriate selection of the ratio of R7A to R9A permits the car interval of one floor to correspond to, say, one volt, and one hall call to, say 3 volts. This is equal to say that the time intervals of the cars are calculated by appropriately adjusting the balance between the weight of the spatial intervals and that of the number of hall calls. From equation (3),

$$Vop_{A2}=-K_1\left(-CA+\frac{CA+CB+CC}{3}\right)-K_2\,.\,da$$

$$=K_1CA-\frac{K_1}{3}(CA+CB+CC)-K_2\,.\,da \qquad (5)$$

It will be readily understood that when the number of hall calls to be answered is equal to the average number of hall calls, the first term is equal to the second term on the right side of equation (5), and therefore

$$Vop_{A2}=-K_2da.$$

On the other hand, when the number of hall calls to be served by car A is more than the average number of hall calls by one,

$$K_1CA-\frac{K_1}{3}(CA+CB+CC)=+3V$$

By contrast, if the number of hall calls to be served by car A is less than that of the average number of hall calls by one,

$$K_1CA-\frac{K_1}{3}(CA+CB+CC)=-3V$$

Thus the time interval of cars as related to the number of hall calls is obtained.

Assume, for example, that the spatial interval between car A and a succeeding car is 6 floors and the number of hall calls for car A is more than the average number of hall calls by one.

$$Vop_{A2}=+3V-6V=-3V$$

If reference voltages of 5 and 4 volts are used as V_1 and V_2 applied to the comparators CMA1 and CMA2 respectively, the comparator CMA1 which receives the reference voltage of 5 volts in addition to the input of −3 volts produces a "1" signal, while on the other hand the comparator CMA2 on receipt of the reference voltage of 4 volts in addition to the input of −3 volts also produces a "1" signal. The instruction signal E2A to advance the car position becomes "1", while the instruction signals E1A and E0A are both brought into the state of "0" because the inhibit element IH produces no output on one hand and a "1" signal is applied to the N0T element NA on the other.

When Vop_{A2} is −5V, the comparator CMA1 the two inputs of which are −5 and 5 volts produces a "1" signal, while the comparator CMA2 produces no output or is in the state of "0" on receipt of inputs of −5 and 4 volts. In this way, signals related to the work load for car A relative to the other cars are produced by the comparators CMA1 and CMA2 and the corresponding instructions E0A to E2A are produced to advance the positions of the cars as required.

The diagrams of Figs. 7 to 9 show a circuit for determining the service zone of car A on the basis of the position signal and interval signal obtained for car A. In the drawings, reference symbols A1UA1 to A9UA3 and A2DA1 to A10DA3 show AND elements, O1UA3 to O9UA5 and O2DA3 to O10DA5 OR elements, IN1UA1 to IN9UA3 and IN2DA1 to IN10DA3 inhibit elements, symbols 1U to 9U and 2D to 10D inhibition signals produced from the OR elements as shown typically in Fig. 9, symbols M1U to M9U and M2D to M10D inhibition signals typically produced as shown in Fig. 7, symbols L1UA to L9UA and L2DA to L10DA signals representing service zones of car A and are applied to the circuit of Fig. 10.

In the above-mentioned arrangement, let us consider a hypothetical case in which the position advancing instruction signals E0A and E0B are both in the state of "1" for cars A and B respectively which are located at the second and 10th floors and travelling up and down respectively, car C being located at the 5th floor for down travel.

The fact that car A is situated at the 2nd floor and the instruction signal E0A is "1" causes a "1" signal to be produced from the AND element A2UA1, which signal is applied through the OR elements O2UA3, O2UA5 and inhibit elements IN2UA2 and IN2UA3 in that order. The signal from the OR element O2UA5 is applied through the inhibit element IN2UA2 to the inhibit element IN3UA1 for the 3rd floor, then up to the corresponding inhibit element for the 7th floor (not shown). The output signal from the 7th-floor inhibit element is applied to the inhibit element IN8UA1 wherefrom it is applied through O8UA5, IN8UA2, IN9UA1, O9UA5, IN9UA2 and IN10DA1. This signal causes the output signals of inhibit elements IN2UA3, IN9UA3 to become "1". The signal from the OR element O2UA3, on the other hand, is applied to the OR element O2UA4 and produced from the circuit as shown in Fig. 9 in the form of inhibition signal 2U. Under this condition, only the output from the OR element O2UA3 is applied to the OR element O2UA4 for car A, from which the signal is applied to the OR element O2UB4 and the inhibit element

IN2UB2, while the output of the OR element O2UB4 is applied to the OR element O2UC4 and inhibit element IN2UC2 for car. The output signal from the OR element O2UC4 is transformed into the inhibition signal 2U, which is applied to the inhibit elements IN2UA1, IN2UB1 and IN2UC1 as an inhibition input thereto as shown in Fig. 7.

In the event that cars A to C are travelling up at the 2nd floor, the inhibit elements IN2UA2, IN2UB2 and IN2UC2 are prohibited from producing their outputs in that order of priority. In the described case, the signal from the OR element O2UA3 for car A becomes "1" and is applied as in inhibition signal 2U to the inhibit element IN2UC1 to put the output of the inhibit element O2UA3 into the state of "0".

Similarly, the down travel of car B at the 10th floor causes the inhibition signal 10D to become "1", so that the output of the inhibit element IN10DA1 for car A is brought into the state of "0". The output signals L2UA to L9UA from the inhibit elements IN2UA3 to IN9UA3 become "1". These signals L2UA to L9UA represent the service zone of car A covering the 2nd floor up to the 9th floor up. Under this condition, the service zones of cars B and C respectively include the 10th floor down to the 6th floor down and the 5th floor down to the 1st floor up.

Signals L1UA to L9UA and L2DA to L10DA thus obtained are applied to the circuit of Fig. 10 for deciding on the response to hall calls, for car A.

Referring to Fig. 10, the signals L1UA to L9UA and L2DA to L10DA in combination with hall calls cause the response decision relays Ry1UA to Ry9UA and Ry2DA to Ry10DA to be energized through the amplifier elements R1UA to R9UA and R2DA to R10DA respectively. Contacts HC1Ua2 to HC9Ua2 and HC2DUa2 to HC10DUa2 are closed by the registration of corresponding hall calls.

The diagram of Fig. 11 shows a guide lamp energizing circuit provided for the purpose of informing the prospective passenger of expected car service by turning on the guide lamps S1UA to S9UA and S2DA to S10DA on the landings of the floors in response to the energization of relays Ry1UA to Ry9UA and Ry2DA to Ry10DA respectively.

Assume that car A is charged with the service zone of the 2nd floor up to the 9th floor up and an up hall call from the 8th floor is registered. Signals L2UA to L9UA are in the state of "1", and the contact HC8Ua2 is closed. A loop comprising L8UA, R8UA, Ry8UA, HC8Ua2 and P is formed thereby to energize the response decision relay Ry8UA. Thus it is decided that car A should answer the hall call, so that the signal from the relay Ry8UA is transmitted not only to the control device for car A but the guide lamp energizing circuit as shown in Fig. 11. The contact Ry8UAa1 is closed thereby to turn on the guide lamp S8UA on the 8th-floor landing for car A, thus informing the prospective passenger that car A is ready to answer the up hall call from the 8th floor.

The operation of the circuits shown in Figs. 12 and 13 will now be explained. The circuit of Fig. 12 is for determining, in response to a hall call or cage call, the direction of travel of car A and the nature of a call generated, while the circuit shown in Fig. 13 is for registration and cancellation of a hall call by car A, additional circuitry being required for cars B and C as will be easily noted from the description which will be made later. In the drawings, reference symbol PN shows a DC power supply, symbol UDA a relay for deciding that car A should travel up of car A, symbol DDA a relay for deciding that car A should travel down, symbols UPAb1 and UPAb2, and DNAb1 and DNAb2, contacts of relays closed when car A is travelling up and down respectively, symbol CSTA a relay for detecting the stoppage of car A in response to a cage call, symbols USTA and DSTA relays turned on by the stoppage of car A in response to a hall call during its up and down travel respectively, symbol STA a relay contact closed when car A is decelerated or stopped, symbols F1Aa1 to F10Aa2 and F1Ab1 to F10Ab3 contacts *a* and *b* of relays which are closed and opened respectively, when car A is located at the 1st to 10th floors, symbols Ry1UAa to Ry10DAa contacts of the response decision relays Ry1UA to Ry10DA respectively shown in Fig. 10, symbols r1U to r9U and r2D to r10D resistors, symbols H1U to H9U up hall call buttons provided at the 1st to 9th floors respectively, symbols H2D to H10D down hall call buttons provided at the 2nd to 10th floors respectively, symbols HC1U to HC9U and HC2D to HC10D call registration relays energized in response to the operation of the hall call buttons H1U to H9U to H2D to H10D respectively, symbols HC1Ua to HC9Ua and HC2Da to HC10Da contacts of the call registration relays HC1U to HC9U and HC2D to HC10D respectively, and symbol #B, C the fact that similar hall call registration cancellation circuits for cars B and C are not shown in the drawing.

When a cage call for the 9th floor is issued from within car A in up travel at the 1st floor and the position detecting relay F1A (not shown) is turned on, the up travel decision relay UDA is turned on through the formation of a loop comprising P, DNAb, UDA, F10Ab1, F10Ab2, F10Ab3, F9Ab1, F9Ab2, C9A and N. Upon the deceleration

of car A in the vicinity of the 9th floor in response to the cage call for the 9th floor, the cage call service relay CSTA is turned on through P, STA, CSTA, F9Aa2, C9A and N and self-held through P, STA, CSTA, $CSTAa_1$ and N, thereby deciding that the 9th floor is being served in response to the cage call. In like manner, when a hall call instead of a cage call is issued for up or down travel, the relay USTA or DSTA is turned on respectively, thus recognizing the nature of the call issued at the time of car deceleration, as will be described more fully later.

Referring now to Fig. 13, the hall call registration relay HC9U is turned on through the loop consisting of P, r9U, HC9U, H9U and N and self-held through the loop consisting of P, r9U, HC9U, $HC9Ua_1$ and N at the press of the hall call button H9U for up travel at the 9th floor. At this moment, assume that car A has the service zone of up travel covering the 2nd to 9th floors and signals L2UA to L9UA in Fig. 7 are "1". The formation of the loop comprising L9UA, R9UA, Ry9UA, $HC9Ua_2$ and P in Fig. 10 causes the response decision relay Ry9UA to be turned on, so that the guide lamp S9UA of Fig. 11 is turned on through the loop comprising P, S9UA, $Ry9UAa_1$ and N and contacts $Ry9UAa_2$ are closed in Fig. 12. Thus the up travel decision relay UDA for car A is turned on through the loop comprising P, $DNAb_1$, UDA, $F10Aa_1$, $F10Ab_2$, $F10Ab_3$, $F9Ab_1$, $Ry9UAa_2$ and N thereby to detect the presence of a hall call issued from a floor above the position of A. When car A moves up farther and is decelerated as a result of the energized state of decision relay Ry9UA, the up hall call service relay USTA is turned on through the loop consisting of P, STA, $DNAb_2$, USTA, DSTAb, $F9Aa_1$, $Ry9UAa_2$ and N and self-held by way of the loop consisting of P, STA, $DNAb_2$, USTA, DSTAb, $USTAa_1$ and N. With the energization of the up hall call service relay USTA, the coils of the call registration relay HC9U are short-circuited by way of the loop comprising P, r9U, $F9Aa_4$, $USTAa_2$ and N. As a result, the call registration relay HC9U is turned off thereby to de-energize the response decision relay Ry9UA shown in Fig. 10. In other words, upon completion of service to the prospective passenger by the car indicated to him, the registered hall call is cancelled.

It will be apparent from the above explanation that the registration cancellation circuits for cars B and C the presence of which is shown by symbol #B, C in Fig. 13 comprises, like the registration cancellation circuit for car A or the circuit for short-circuiting the call registration relays HC1U to HC9U and HC2D to HC10D, contacts of position detecting relays and contacts of up hall call service relays and down hall call service relays.

Consider a case in which car A receives an up hall call, while car B arrives earlier than car A at the 9th floor in response to a cage call issued therein. As will be apparent from Figs. 12 and 13, the response decision relay Ry9UB for car B is not energized because it did not answer the hall call. The up hall call service relay USTB for car B similar to the circuit of Fig. 12 is not energized and therefore the circuit for short-circuiting the hall call registration relay HC9U similar to that shown in Fig. 13 is not formed, thus maintaining the hall call registration relay HC9U energized.

As can be seen from the explanation of the above circuits, a hall call remains registered until the car the expected service of which is indicated to the prospective passenger in response to the hall call has arrived at the floor on which he is waiting. It does not matter whether the prospective passenger actually takes car A or not. But the important thing is to assure him that car A will stop at his floor without fail, since repeated changes in the car service schedule at a given floor adversely affects the operation of the system, since it gives rise to disbelief on the part of prospective passengers. This disadvantage is obviated by the present invention.

Other embodiments of the circuit for determining the direction of travel of car A and the circuit for determining the nature of a call issued during the deceleration and stoppage of car A are shown in Fig. 14. Unlike the preceding embodiment in which the registration of a hall call is cancelled only by the deceleration and stoppage of a car the expected service of which is indicated to the prospective passenger in response to the hall call, the embodiment under consideration is such that the deceleration and stoppage of the car involved or a car in the adjacent hoistway, whichever arrives earlier, causes the registration of the hall call from that floor to be cancelled. This is based on the self-evident theory that if, say, car B adjacent to car A arrives earlier at the calling floor in response to a cage call in spite of the fact that the expected service by car A has been indicated to the prospective passenger waiting at that floor, he will most probably take car B disregarding the indication of expected arrival of car A, with the result that car A stops at the calling floor for nothing at the sacrifice of the operating efficiency of car A and superior car group control.

In Fig. 14, like symbols show like component elements as in Fig. 12. It is also assumed that cars A and B are running along adjacent hoistways. The contacts $Ry1UBa_2$ to $Ry9UBa_2$ and $Ry2DBa_2$ to $Ry10DBa_2$ of the response decision relays Ry1UB to Ry9UB and Ry2DB to Ry10DB for car B

are connected in parallel with the contacts $Ry1UAa_2$ to $Ry9UAa_2$ and $Ry2DAa_2$ to $Ry10DAa_2$ of the response decision relays Ry1UA to Ry9UA and Ry2DA to Ry10DA for energizing the up hall call service relay USTA and the down hall call service relay DSTA respectively. The corresponding circuit for deciding the nature of a call for car B is likewise provided with contacts of the response decision relays of car A.

Assume that the up hall call button H9U of the 9th floor in Fig. 13 is depressed so that the hall call registration relay HC9U is self-held and it was decided that car B is to respond to the hall call. The response decision relay Ry9UB for car B is energized thereby to close the contact $Ry9UBa_2$. Under this condition, if car A arrives at the 9th floor earlier than car B for up travel because of a cage call issued in the cage of car B, the formation of the loop comprising P, STA, CSTA, $F9Aa_2$, C9A and N in Fig. 14 causes the cage call service relay CSTA to be energized and self-held. At the same time, the loop comprising P, STA, DNAb, USTA, $DSTAb_1$, $F9Aa_1$, $Ry9UBa_2$ and N is formed thereby to energize the up hall call service relay USTA. As a result, in spite of the fact that car B indicated for response has yet to arrive at the 9th floor, the cancellation loop comprising P, r9U, $F9Aa_4$, $USTAa_2$ and N as shown in Fig. 13 is formed thereby to reset the hall call registration relay HC9U, and the response decision relay Ry9UB for car B is also reset to prevent car B from stopping at the 9th floor.

As can be noted from the above explanation, a hall call is cancelled also when a car running in the hoistway adjacent to that of the car expected service of which has been indicated to the prospective passenger arrives earlier. This embodiment is applied also to the case where adjacent cars are on both sides of the car the expected response of which is indicated, by providing another set of contacts for each response decision relay in the circuit of Fig. 14.

The circuit shown in Fig. 15 is provided for the purpose of turning on a guide lamp common to a group of cars. For example, a guide lamp S2UAB common to cars A and B is provided for up travel at the 2nd floor, a like guide lamp being required for each floor for each direction of travel. Reference symbols $Ry2UAa_4$ to $Ry2UCa_4$ show contacts of the response decision relays Ry2UA to Ry2UC for cars A to C respectively.

In view of the fact that cars A and B have a common guide lamp, even if it has been decided that car A should respond to a hall call, the arrival of car B earlier than car A at the calling floor in response to a cage call from within car B will cause the prospective passenger to take car B in the belief that car B has responded to his call. This eliminates the need for the service by car A and requires the hall call to be cancelled. In other words, the guide lamp used in this case has the functions to forecast the arrival of either car A or car B, and therefore the guide lamp must be reset upon completion of service by car A or B, while it is required to be maintained ON if a car other than cars A and B arrives at the calling floor.

The present invention may obviously be applied to a case such as that mentioned above. Even though the circuit of Fig. 14 is directly applied to a car group including a couple of cars, the application of the same circuit to a group involving more than two cars only requires parallel provision of additional response decision relay contacts.

In the above-mentioned embodiment with a common guide lamp for a plurality of cars, a service zone for each car is defined, a car to respond to a hall call specified and then a common guide lamp for the group including the specified car is turned on thereby to inform the prospective passenger of the expected arrival of the car. It is not necessary, however, to specify a car to respond to a hall call, but it suffices only if a car group ready to serve the hall call is determined to turn on the common guide lamp for that group. An elevator group control system incorporating such operating principle, is described in our co-pending application No. 49326/73 (Serial No. 1,452,288) and the present invention may be applied to such system in such a manner that only the arrival of a car included in a group indicated on the common guide lamp causes a hall call registration to be cancelled, while it remains uncancelled even on the arrival of a car belonging to another car group. The present invention may also be used with control systems of the kind described in our UK Patents Nos. 1,351,224 and 1,305,960.

Although the above explanation has been given with reference to an elevator group control system in which the operation of all the elevator cars is systematically correlated by detecting such factors as the intervals between cars and the number of calls to be served to achieve the improved operating efficiency of an elevator system including a plurality of cars, the present invention is not limited to such group control system but may be applied with equal effect to a system in which the circuits of Figs. 2 to 6 are omitted and position advancing signals E0A to E2A are not used. In such a case, the position signals F1UA to F9UA and F2DA to F10DA for car A may be directly applied to the OR elements O1UA3 and O2DA3 to O10DA3 shown in Fig. 7.

Further, the invention can be applied to a case in which instead of specifying a car on the basis of the service zone thereof, a car situated the nearest to the calling floor is

specified as a car to answer the hall call from that floor and indicated on the guide lamp on that floor.

WHAT WE CLAIM IS:—

1. An elevator control system comprising a plurality of elevators cars serving a plurality of floors, means for registering a hall call from a hall landing, means actuated in response to the registration of the hall call, to designate one car, or one car and at least one alternative car to answer the said hall call, and to inform a passenger waiting at the said hall landing that the car has, or the cars have, been so designated; separate means for detecting deceleration of each car near, or its stoppage at, the said hall landing, and means for cancelling the registration of the said hall call only in response to an output from the detecting means of the said designated one car or of one of the said designated cars.

2. An elevator control system as claimed in claim 1, in which the said designating means acts to designate one car and at least one alternative car, and in which the said alternative car is located in a hoistway adjacent the said one car.

3. An elevator system as claimed in claim 1 or claim 2, in which the means for cancelling the registration of the said hall call comprises means at each floor for detecting deceleration or stoppage of a designated car, means at each floor for detecting the occurrence of a hall call which the said car is to answer, and means arranged to cancel the registration when outputs are registered from both said means simultaneously.

4. An elevator control system substantially as herein described with reference to Figures 12—14 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1976.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

specified as a car to answer the hall call from that floor and indicated on the guide lamp on that floor.

WHAT WE CLAIM IS:—

1. An elevator control system comprising a plurality of elevators cars serving a plurality of floors, means for registering a hall call from a hall landing, means actuated in response to the registration of the hall call, to designate one car, or one car and at least one alternative car to answer the said hall call, and to inform a passenger waiting at the said hall landing that the car has, or the cars have, been so designated; separate means for detecting deceleration of each car near, or its stoppage at, the said hall landing, and means for cancelling the registration of the said hall call only in response to an output from the detecting means of the said designated one car or of one of the said designated cars.

2. An elevator control system as claimed in claim 1, in which the said designating means acts to designate one car and at least one alternative car, and in which the said alternative car is located in a hoistway adjacent the said one car.

3. An elevator system as claimed in claim 1 or claim 2, in which the means for cancelling the registration of the said hall call comprises means at each floor for detecting deceleration or stoppage of a designated car, means at each floor for detecting the occurrence of a hall call which the said car is to answer, and means arranged to cancel the registration when outputs are registered from both said means simultaneously.

4. An elevator control system substantially as herein described with reference to Figures 12—14 of the accompanying drawings.

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