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# [54] ELEVATOR CONTROL SYSTEM

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[73] Assignee: **Hitachi, Ltd.,** Japan

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[52] **U.S. Cl.** .............................................. **187/29 R**
[51] **Int. Cl.²** .............................................. **B66B 3/00**
[58] **Field of Search** ........................................ 187/29

[56] **References Cited**

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*Primary Examiner*—Robert K. Schaefer
*Assistant Examiner*—W. E. Duncanson Jr.
*Attorney, Agent, or Firm*—Craig & Antonelli

[57] **ABSTRACT**

In an elevator control system comprising a plurality of elevator cars serving a plurality of floors wherein a hall call generated is registered, so that a car ready to answer that hall call is selected and operatively connected with a guide lamp for informing the waiting prospective passenger which of the cars was selected, the improvements wherein the registration of the hall call is not cancelled but maintained in the event that a car other than the car which was made ready to answer the hall call arrives earlier and is decelerated to serve that floor from which that hall call was originated, the hall call registration being cancelled only when the car indicated by the guide lamp is decelerated to serve the floor.

**8 Claims, 15 Drawing Figures**

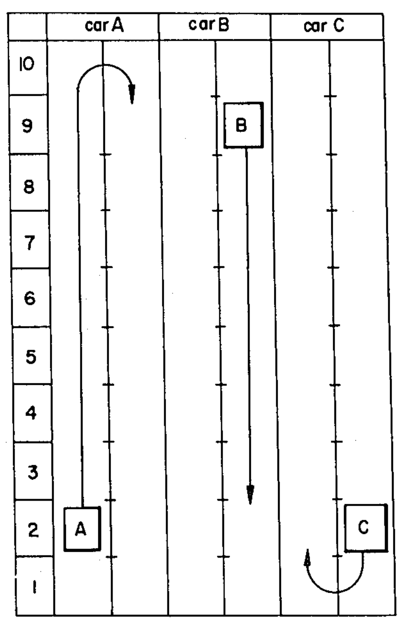


FIG.1

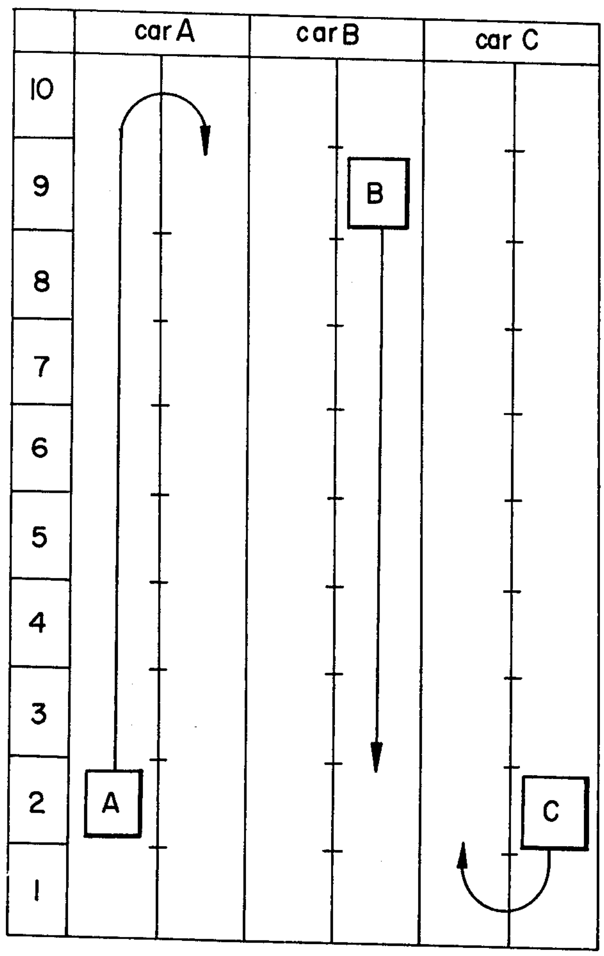
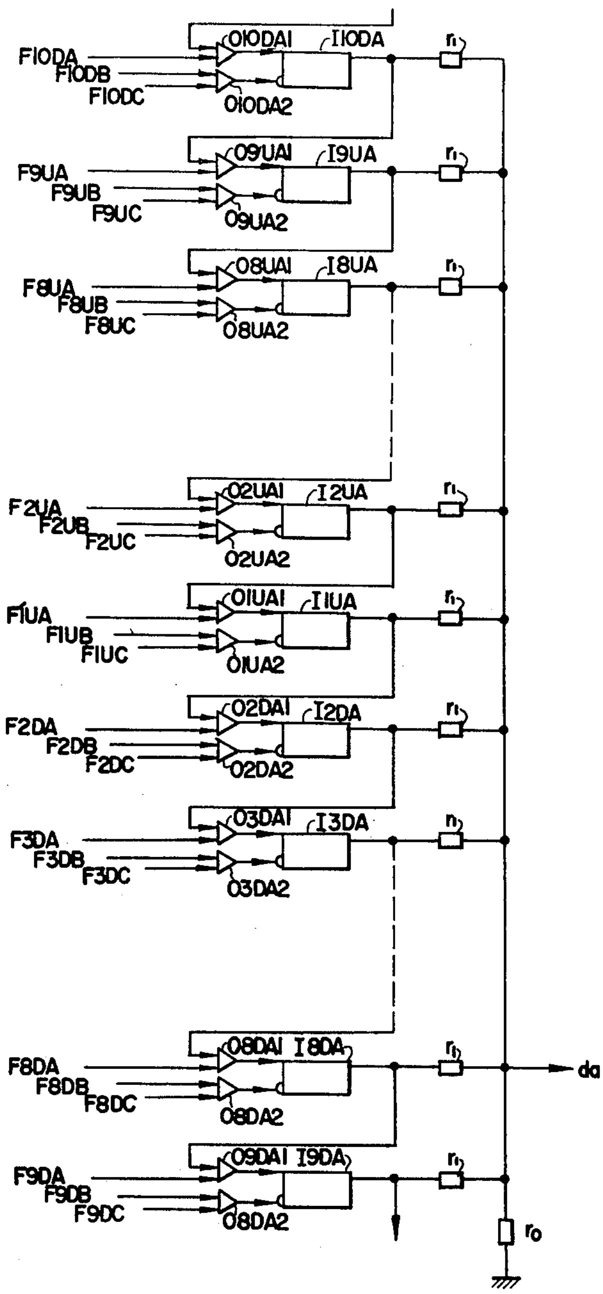


FIG.2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F10DC
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I10DA
O10DA2
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F8UA
F8UB
F8UC
O8UA1
I8UA
O8UA2
F2UA
F2UB
F2UC
O2UA1
I2UA
O2UA2
F1UA
F1UB
F1UC
O1UA1
I1UA
O1UA2
F2DA
F2DB
F2DC
O2DA1
I2DA
O2DA2
F3DA
F3DB
F3DC
O3DA1
I3DA
O3DA2
F8DA
F8DB
F8DC
O8DA1
I8DA
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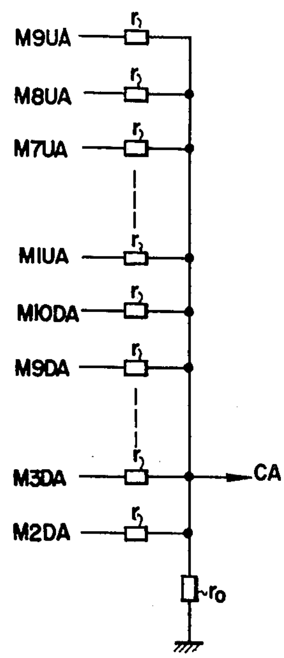
da
$r_0$

FIG.3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M7UA
M1UA
M10DA
M9DA
M3DA
M2DA
$r_1$
CA
$r_0$

FIG. 4

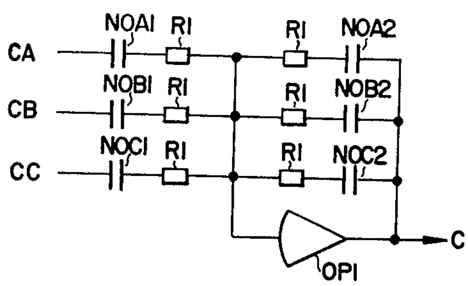



FIG. 5

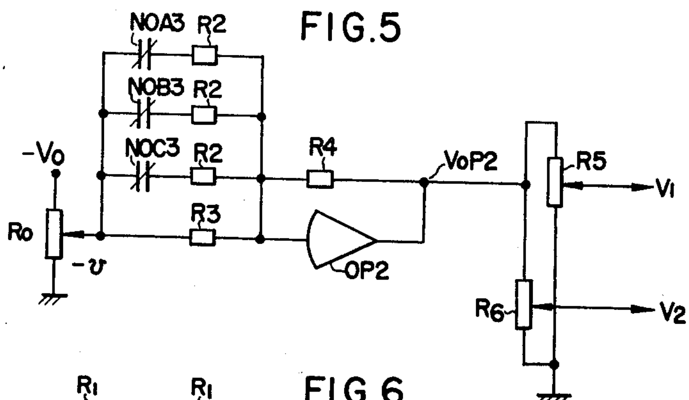



FIG. 6

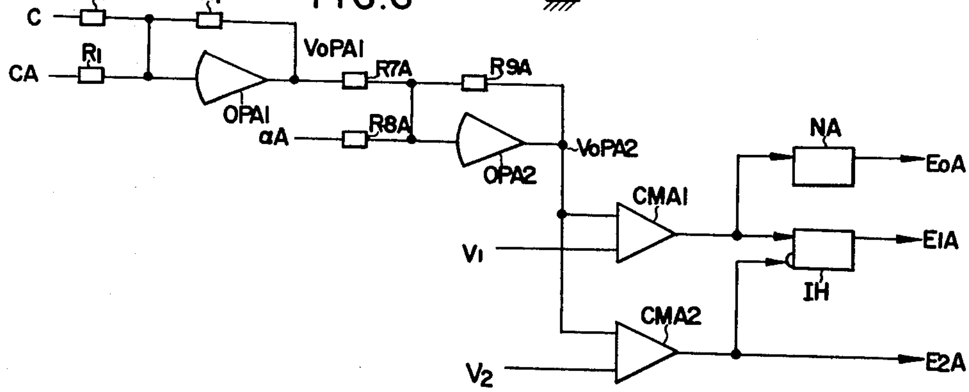
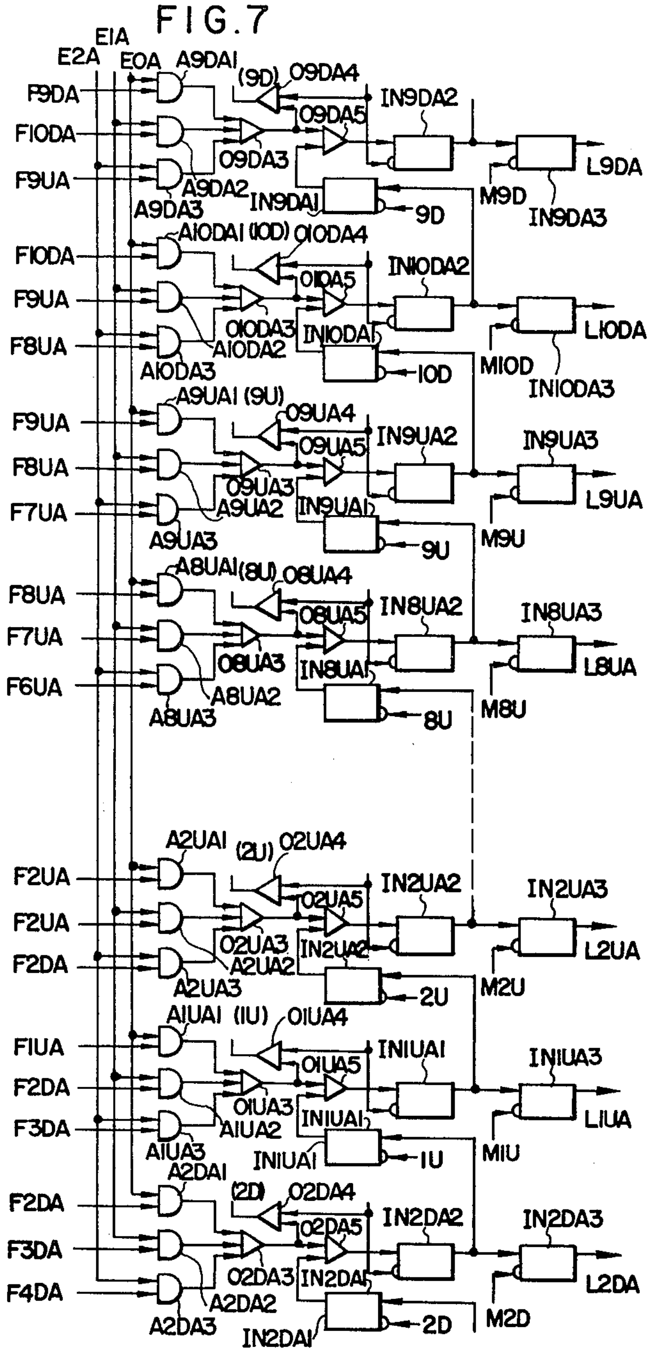


FIG.7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EIA
EOA
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IN9DA2
F9DA
FIODA
F9UA
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O9DA3
A9DA2
A9DA3
IN9DAI
9D
L9DA
M9D
IN9DA3
AIODAI
(IOD)
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F8UA
OIDA5
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AIODA3
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IOD
LIODA
MIOD
INIODA3
A9UAI
(9U)
O9UA4
IN9UA2
IN9UA3
F9UA
F8UA
F7UA
O9UA5
O9UA3
A9UA2
A9UA3
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9U
L9UA
M9U
A8UAI
(8U)
O8UA4
IN8UA2
IN8UA3
F8UA
F7UA
F6UA
O8UA5
O8UA3
A8UA2
A8UA3
IN8UAI
8U
L8UA
M8U
A2UAI
(2U)
O2UA4
IN2UA2
IN2UA3
F2UA
F2UA
F2DA
O2UA5
O2UA3
A2UA2
A2UA3
IN2UA2
2U
L2UA
M2U
AIUAI
(IU)
OIUA4
INIUAI
INIUA3
FIUA
F2DA
F3DA
OIUA5
OIUA3
AIUA2
AIUA3
INIUAI
INIUAI
IU
LIUA
MIU
A2DAI
(2D)
O2DA4
IN2DA2
IN2DA3
F2DA
F3DA
F4DA
O2DA5
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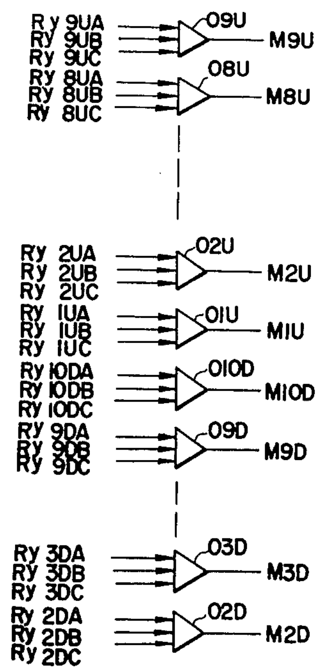
IN2DAI
A2DA2
A2DA3
IN2DAI
2D
L2DA
M2D

FIG.8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Ry 9UB
Ry 9UC
O9U
M9U
Ry 8UA
Ry 8UB
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O8U
M8U
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Ry 2UC
O2U
M2U
Ry 1UA
Ry 1UB
Ry 1UC
O1U
M1U
Ry 10DA
Ry 10DB
Ry 10DC
O10D
M10D
Ry 9DA
Ry 9DB
Ry 9DC
O9D
M9D
Ry 3DA
Ry 3DB
Ry 3DC
O3D
M3D
Ry 2DA
Ry 2DB
Ry 2DC
O2D
M2D

FIG.9

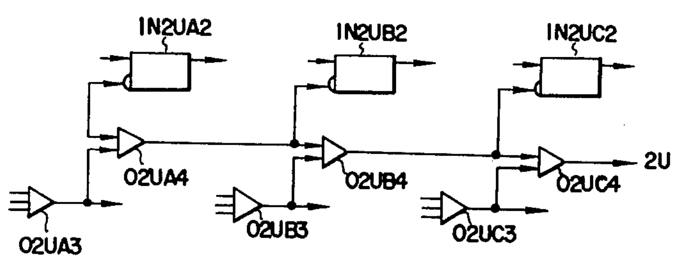
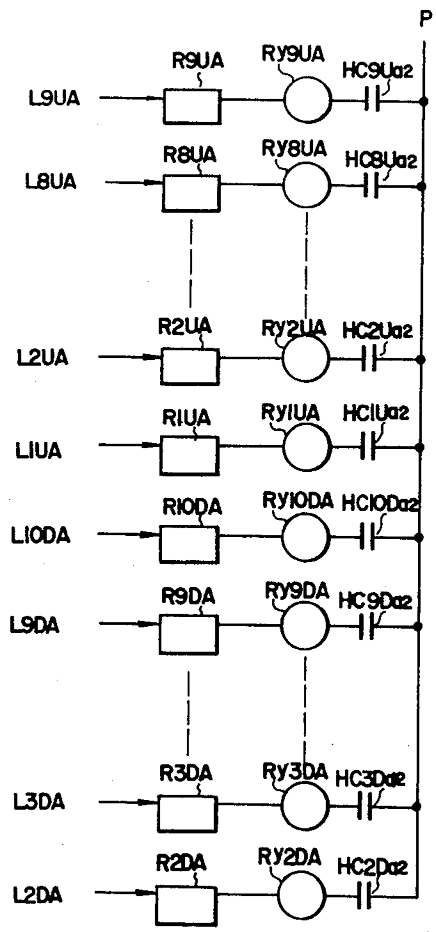

IN2UA2
IN2UB2
IN2UC2
O2UA4
O2UB4
O2UC4
2U
O2UA3
O2UB3
O2UC3

FIG. 10


P
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RY9UA
HC9Ua2
L8UA
R8UA
RY8UA
HC8Ua2
L2UA
R2UA
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L1UA
R1UA
RY1UA
HC1Ua2
L10DA
R10DA
RY10DA
HC10Da2
L9DA
R9DA
RY9DA
HC9Da2
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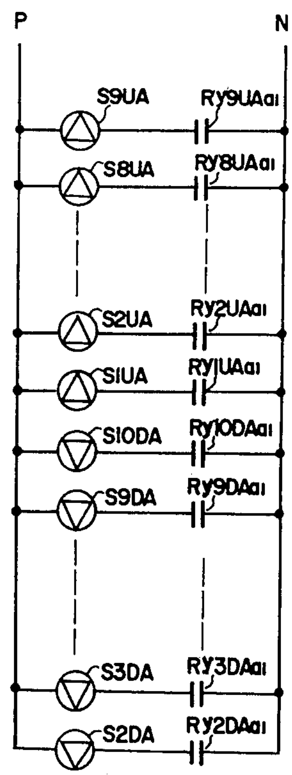
R3DA
RY3DA
HC3Da2
L2DA
R2DA
RY2DA
HC2Da2

FIG. 11


P
N
S9UA
RY9UAa1
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RY8UAa1
S2UA
RY2UAa1
S1UA
RY1UAa1
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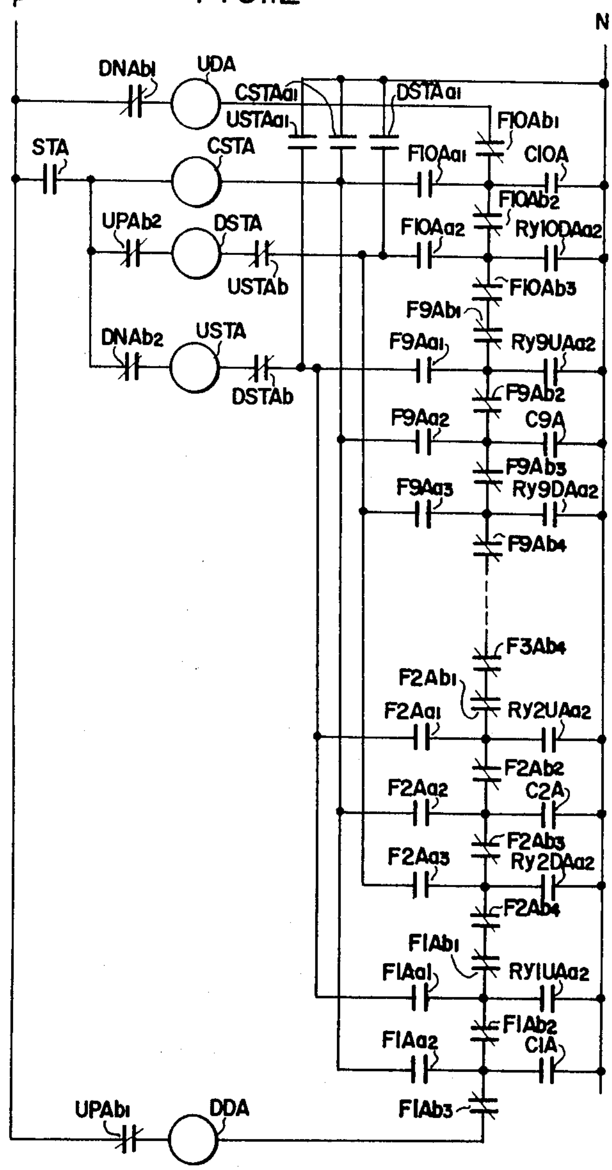
RY3DAa1
S2DA
RY2DAa1

FIG.12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UPAb2
DSTA
F10Aa2
Ry10DAa2
USTAb
F10Ab3
F9Ab1
DNAb2
USTA
F9Aa1
Ry9UAa2
DSTAb
F9Ab2
F9Aa2
C9A
F9Ab3
F9Aa3
Ry9DAa2
F9Ab4
F3Ab4
F2Ab1
F2Aa1
Ry2UAa2
F2Ab2
F2Aa2
C2A
F2Ab3
F2Aa3
Ry2DAa2
F2Ab4
F1Ab1
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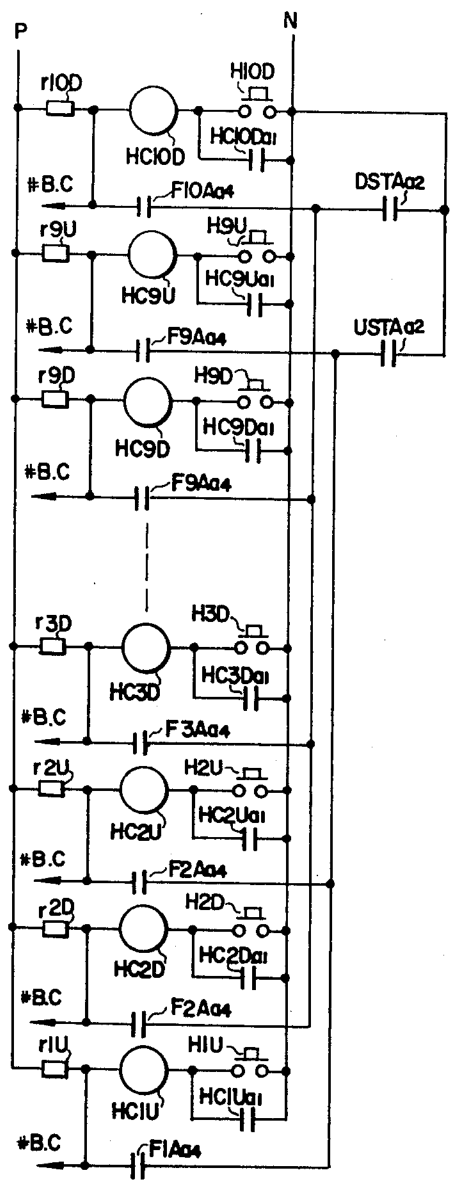
F1Ab2
F1Aa2
C1A
UPAb1
DDA
F1Ab3

FIG. 13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#B.C
F9Aa4
USTAa2
r9D
H9D
HC9D
HC9Da1
#B.C
F9Aa4
r3D
H3D
HC3D
HC3Da1
#B.C
F3Aa4
r2U
H2U
HC2U
HC2Ua1
#B.C
F2Aa4
r2D
H2D
HC2D
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HC1Ua1
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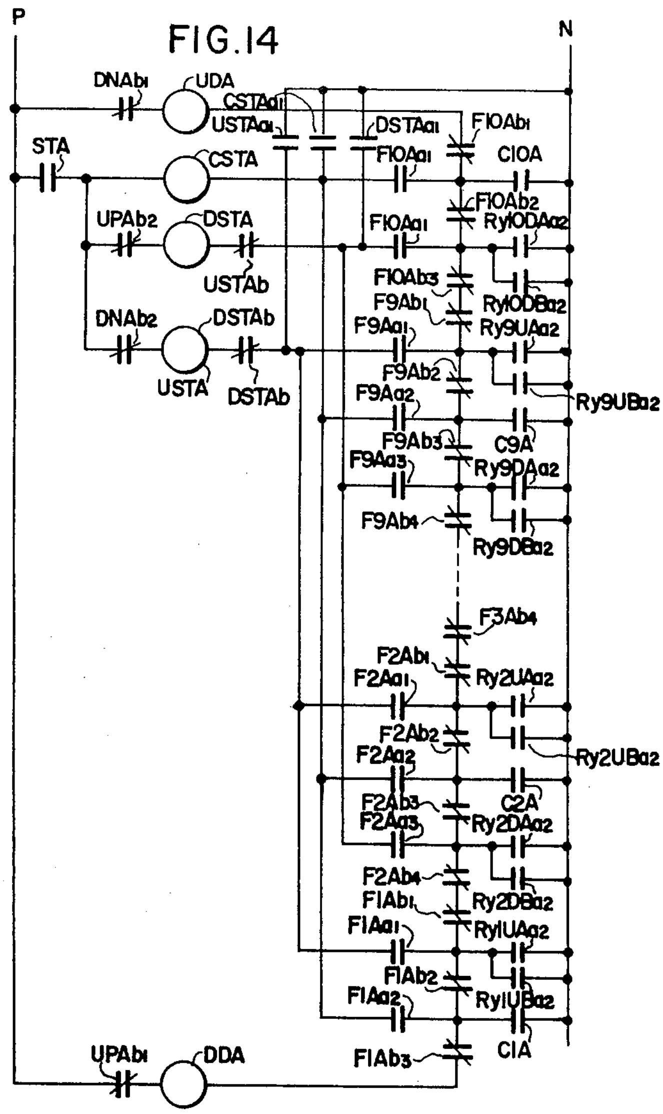
F1Aa4

FIG.14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F10Aa1
Ry10DAa2
USTAb
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DNAb2
DSTAb
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F9Ab4
Ry9DBa2
F3Ab4
F2Ab1
F2Aa1
Ry2UAa2
F2Ab2
F2Aa2
Ry2UBa2
F2Ab3
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F1Ab1
Ry2DBa2
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DDA
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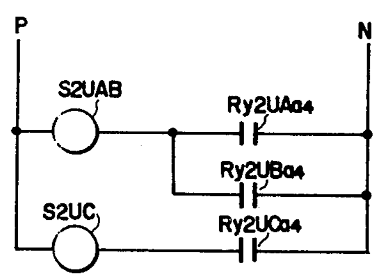
C1A

FIG.15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Ry2UBa4
S2UC
Ry2UCa4

## ELEVATOR CONTROL SYSTEM

The present invention relates to an improved elevator control system effectively 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 such a system, 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 which has been 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 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 the 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.



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

Another object of the invention is provide an elevator control system which eliminates wasteful deceleration and stoppage of cars for improved operation thereof.

One of the features of the invention lies in that 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 thereat.

Another feature of the invention is that 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 earlier.

The above and other objects, features and advantages will be made apparent by the detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a diagram for explaining the operation of an elevator group 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 **1**st to **10**th 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 determining the time interval between car A and other cars, a like circuit being provided for each of the remaining cars;

FIG. **7** is a diagram showing a circuit for determining 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 for prohibiting the answering to a hall call subsequent to the determination of which car to serve the hall call;

FIG. **9** is a circuit provided for each floor for determining the 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 to serve a hall call for car A, 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 specific to the present invention for detecting the direction of travel of car A and the nature of a hall call for car A, a like circuit being provided for each of the other cars;

FIG. 13 is a diagram showing an embodiment of the reset circuit specific to the invention for registration and cancellation of a hall call, a like circuit being required for each of the other cars;

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 hall call therefor, 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.

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 the group control system used with an elevator system comprising cars A to C serving the first to 10th floors. 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 equalize them 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 traveling up at the second floor, car B traveling down at the ninth floor and car C traveling down at the second 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 eighth 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 and/or time interval based on the number of floors to be served. 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 traveling up at the third floor may be the fourth, fifth and sixth 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 first 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 first to ninth floors respectively, symbols F2DA to F10DA position signals for car in down travel indicating the second to 10th floors respectively, symbols F1UB to F9UB position signals for car B in up travel indicating the first to ninth floors respectively, symbols F2DB to F10DB position signals for car B in down travel indicating the second to 10th floors, symbols F1UC to F9UC position signals for car C in up travel indicating the first to ninth floors, symbols F2DC to F10DC position signals for car C in down travel indicating the second to 10th floors respectively, sybmols 01UA1 to 09UA2 and 02DA1 to 010DA2 "OR" elements, symbols I1UA to I9UA and I2DA 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 an 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 traveling up at the eighth floor, car B traveling up at the second floor and car C traveling down at the fifth floor, car B suceeding car A. Position signal F8UA of car A is applied through F8UA, 08UA1, I8UA, 07UA1 . . . I3UA, 02UA1 and I2UA in that order. Position signal F2UB of car B which is in the state of 1 is applied through 02UA2 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 through the resistors $r_1$ and $r_0$.

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 an operational resistor and $OP_1$ an operational amplifier through which the polarities of input and output are reversed.

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

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

When car A is released from controlled operation,

$$C = -\frac{\frac{R_1}{2}}{R_2}(CB + CC) = \frac{-1}{2}(CB + CC)$$

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

$$Vop_2 = \frac{-R_4}{R_3}(-V_o) = \frac{R_4}{R_3}V_o \qquad (2)$$

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

$$Vop_2 = -\frac{R_4}{R_3}(-V_o) - \frac{R_4}{R_2}(-V_o) = R_4V_o\left(\frac{1}{R_3} + \frac{1}{R_2}\right)$$

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 determining the interval between car A and other cars, 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 NOT element, symbol IH an inhibit element and symbols EOA 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

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

In like manner, the operational amplifier OPA2 produces an output

$$Vop_{A2} = \frac{-R9A}{R7A}\,Vop_{A1} - \frac{R9A}{R8A}dA \qquad (4)$$

Appropriate selection of the ratio of R7A to R9A permits the car interval of one floor to correspond to, say, 1 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),

$$\begin{aligned} Vop_{A2} &= -K_1\left(-CA + \frac{CA + CB + CC}{3}\right) - K_2dA \\ &= K_1CA - \frac{K_1}{3}(CA + CB + CC) - K_2dA \qquad (5) \end{aligned}$$

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,

$$K_1CA - \frac{K_1}{3}(CA + 0\,CB + CC) = +3V$$

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 six 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 NOT 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, the time intervals between cars are determined 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, IN-1UA1 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 traveling up and down respectively, car C being located at the fifth floor for down travel.

The fact that car A is situated at the **2**nd 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 third floor, then up to the corresponding inhibit element for the seventh floor (not shown). The output signal from the seventh-floor inhibit element is applied to the inhibit element IN8UA1 wherefrom it is applied through O8UA5, IN8UA2, IN-9UA1, 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 traveling up at the 2nd floor, the inhibit elements IN2UA2, IN2UB2 and IN2UC2 are prohibited from producing their outputs in that or order of priority. In the described case, the signal from the OR element O2UA3 for car A becomes 1 and is applied as an 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 IN-9UA3 become 1. These signals L2UA to L9UA represent the service zone of car A covering the second floor up to the ninth floor up. Under this condition, the service zones of cars B and C respectively include the 10th floor down to the sixth floor down and the fifth floor down to the first floor up.

Singlas 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 second floor up to the ninth floor up and an up hall call from the eighth 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 answer to 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 Ry8UAal is closed thereby to turn on the guide lamp S8UA on the eighth-floor landing for car A, thus informing the prospective passenger that car A is ready to answer the up hall call from the eighth floor.

Explanation will be made now of the circuits shown in **FIGS. 12** and **13** which incorporate the features of the invention. 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 at the time of deceleration and stoppage, while the circuit shown in **FIG. 13** is for registration and cancellation of a hall call for car A, similar circuits 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 on the up travel of car A, symbol DDA a relay for deciding the down travel of car A, symbols UPAb and DNAb contacts *b* of relays closed when car A is traveling 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 energized when car A is decelerated or stopped, symbols F1Aa1 to F10Aa2 and F1Ab1 to F10Ab3 contacts *a* and *b* of relays which are energized when car A is located at the 1st to 10th floors respectively, 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 first to ninth floors respectively, symbols H2D to H10D down hall call buttons provided at the second 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 and 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 No. 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 ninth 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 ninth floor in response to the cage call for the ninth 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 ninth 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.

Explanation will be made now of the operation of the hall call registration and cancellation circuits shown in FIG. **13.**

Referring again to FIG. **12,** 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 ninth 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. **6** 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. **1** is turned on through the loop comprising *eo*, S9UA, $Ry9UAa_1$ and *e'o* and acts on the circuit of FIG. **12.** 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 an upper floor. When car A moves up farther and is decelerated in response to a signal from the response 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 by him was cancelled.

It will made apparent from the above explanation that the registration cancellation circuits for cars B and C the presence of which is shown by symbol No. 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 ninth 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 above explanation, according to the control system of the invention, 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 for his service. This offers a big advantage of superior elevator service taking into consideration the psycological state of the prospective passenger. Repeated changes in the car service schedule at a given floor is an adverse factor in the car arrival forecasting system, giving rise to disbelief on the part of prospective passengers. Such 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 disclosed 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 circuit for deciding the nature of a call for car B is also provided with the contacts of the response decision relay of car A.

Assume that the up hall call button H9U of the ninth 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, $F9Aa_1$, $Ry9UBa_2$ 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 ninth 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 ninth 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 the 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 response decision relay.

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 second 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 respond to the 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 causes 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 even if a car other than cars A and B arrives at the calling floor.

The present invention is obviously applied with equal effect to such case as 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 requires parallel provision of additional response decision relay contact.

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 was already disclosed, and the present invention is applied to such system with equal effect 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.

In addition to the above-described embodiments, the present invention is applied with equal effect to every elevator system comprising a plurality of cars or car groups serving a plurality of floors.

The circuit for recognizing the nature of a call and the circuit for registration and cancellation of a hall call to achieve the objects of the invention are not confined to those mentioned above but may be presented in various forms.

Although the above explanation was made with reference to an elevator group control system in which the operation of each elevator car 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 the position advancing signals E0A to E3A are not figured out. In such a case, the position signals F1UA to F9UA and F2DA to F10DA for car A are directly applied to the OR elements O1UA3 to O9UA3 and O2DA3 to O10DA3 shown in FIG. 7.

Further, the invention is 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 is claimed is:

1. An elevator control system comprising a plurality of elevator cars serving a plurality of floors, means for registering a hall call from a prospective passenger, means responsive to said registering means for selecting a car or car group to answer said hall call, means for directing said selected car to proceed to and stop at the floor from which the hall call originated, means responsive to said selecting means for informing a prospective passenger waiting on the landing of a floor at which the specified car or car group will respond to the hall call from the prospective passenger, means for detecting the deceleration or stoppage of the car selected by said selecting means at the floor from which the hall call was originated, and means for cancelling the registration in said registering means of said hall call from said floor only in response to said detector means de-

tecting deceleration or stoppage of that car at said floor.

2. An elevator control system according to claim 1, in which said means for detecting the deceleration or stoppage of a car the expected service of which the prospective passenger waiting at the calling floor is informed of includes for each car, means for detecting the floor where the car is decelerated and means for detecting floors the hall call from which the car is required to answer, and AND means to which the outputs from said two means are applied.

3. An elevator control system according to claim 1, in which said means for detecting the deceleration or stoppage of a specified car includes means for detecting the deceleration or stoppage of a car in the hoistway adjacent to that of a car the expected service of which the prospective passenger waiting at the floor from which the hall call was originated is informed of.

4. An elevator control system according to claim 3, in which said means for detecting the deceleration or stoppage of a car in the adjacent hoistway includes for each car a means for detecting the floor where the car is decelerated and means for detecting floors the hall call from which the car in the adjacent hoistway has responded, and AND means to which the outputs from said two means are applied for logical operation.

5. An elevator control system according to claim 1, in which said means for detecting the deceleration or stoppage of a specified car includes means for detecting the deceleration or stoppage of the specified car or a car in the adjacent hoistway.

6. An elevator control system according to claim 5, in which said means for detecting the deceleration or stoppage of cars includes means for detecting the floor the hall call from which was answered by the specified car and means for detecting the floor the hall call from which the car in the adjacent hoistway has answered, OR means to which the outputs from said two means are applied, means for detecting the floor at which one of said cars is decelerated or stopped, and AND means to which the outputs from the last-mentioned detector means and said OR means are applied.

7. An elevator control system according to claim 1, in which said means for detecting the deceleration or stoppage of a specified car includes means for detecting the deceleration or stoppage of a car included in the car group of which the prospective passenger waiting at the calling floor is informed.

8. An elevator control system according to claim 7, in which said means for detecting the deceleration or stoppage of a car includes means for detecting the floor at which the car included in the car group is decelerated or stopped and means for detecting the floor the hall call from which the car group has responded, both of said floor detecting means being provided for each car group, and AND means to which the outputs from said two detector means are applied.

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