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(54) ELEVATOR SIGNALLING 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:—

This invention relates to improvements in an elevator signaling system for use in a building having a plurality of elevator cars arranged in parallel for servicing a plurality of service floor landings.

A lamp incorporated in a call button unit is energized when the push button is manipulated by a passenger waiting in the hall of a floor so that the passenger can be informed of the fact that the hall call is registered. However, when a plurality of elevator cars are arranged in parallel for parallel operation, the passenger waiting in the hall of the floor has been unable to identify the elevator car which arrives at the floor earliest of all. This is because it has been impossible, at the time at which the hall call has been registered, to foresee the arrival of the earliest elevator car at the floor originating the hall call.

Therefore, prior art arrival information means, which are disposed at individual landing portions of each floor and are energized when elevator cars start to decelerate to stop at a specific floor, have been the sole means for passengers to know the arrival of the earliest elevator car before such elevator car arrives at the floor.

However, knowing the expected arrival of the elevator car by the energization of the arrival information means, the passengers may rush to the floor landing portion for the specific elevator car resulting in extreme confusion at this floor landing portion and those passengers who are waiting in the hall portion remote from this floor landing portion may miss the elevator car. Although indicators are disposed at the individual floor landing portions beside the arrival information means to indicate the positions of the individual elevator cars, it is not easy for the passengers to look at all of these elevator car position indicators to judge which elevator car is the earliest one.

A system for offering early information of elevator cars serving passengers waiting in the hall has been proposed recently for overcoming the defect above described and providing better service. According to this system, operating conditions of individual elevator cars are continually detected so as to early determine the elevator car which can most efficiently respond to a hall call when such hall call is originated. In this system, guide lamps are provided at the floor landing portions of each floor besides the conventional arrival information lamps so that the passengers waiting in the hall of a floor originating a hall call can be informed of the elevator car determined to service this floor by the illumination of the corresponding guide lamp. Therefore, the passengers waiting in the hall can identify early the first arriving elevator car by the illumination of the guide lamp.

As described above, one guide lamp is disposed at the floor landing portion for each individual elevator car in the proposed system. Consider a case in which, after the determination of the hall call responding elevator car on the basis of the operating conditions of all the elevator cars, this specific elevator car is rendered incapable of servicing for the reason that it is loaded to the full capacity or is disabled. In such a case, another elevator car which should respond to the hall call must be newly selected or determined so that it services the floor landing instead of the full-loaded or disabled elevator car. Incidentally, the guide lamp associated with the elevator car rendered incapable of servicing must be de-energized and the guide lamp associated with the newly selected elevator car must be energized. Such a change in the serving elevator cars tends to occur especially when the traffic is busy. Thus, such a change gives rise to not only confusion of the passengers waiting in the hall but also disbelief of the guide lamp system, thereby reducing the marked effect of the guide lamps. Further, due to the fact that one guide lamp is provided for each individual elevator car, the system must include the control circuits and guide lamps for the individual elevator cars and is thus complex in structure and expen-

sive. Provision of many elevator cars is required increasingly with the increase in the height and scale of buildings, and the defect pointed out in the above tends to become more marked.

It is therefore an object of the present invention to provide an elevator signaling system for use in a building having a plurality of elevator cars arranged for parallel operation in which guiding means of improved reliability are provided so that passengers waiting in the hall can be more reliably informed of an elevator car which can respond to a hall call.

Another object of the present invention is to provide a very inexpensive elevator signaling system which has simplified guiding means and simplified circuits including a hall call response determining circuit for selectively energising the guiding means.

The present invention therefore provides, in an elevator system in which a plurality of elevator cars are arranged in parallel for serving a plurality of service floor landings of a building, an elevator signalling system in which said plurality of elevator cars are grouped into a plurality of car groups each consisting of elevator cars associated with adjoining floor landing locations, comprising, means for selecting, out of said car groups, one car group containing cars which can respond to a hall call, and guide means situated at each floor landing and adapted to be actuated in response to the output of said selecting means, to inform persons waiting at the landing where the said call has been generated, as to which group of cars has been allocated the call.

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

Figure 1 is a schematic view showing a prior art arrangement of guide lamps.

Figures 2a and 2b are schematic views showing preferred arrangements of guide lamps according to the present invention.

Figure 3 is a schematic view showing the operation of group controlled elevator cars to which the present invention is applied.

Figures 4 to 13 show an embodiment of the present invention for use in a 10-storied building having three elevator cars A to C arranged for parallel operation, in which:

Figure 4 shows a circuit for detecting the positional interval between the elevator car A and the succeeding elevator car, such circuit being provided for each individual elevator car;

Figure 5 shows a stop requesting call detecting circuit associated with the elevator car A, such circuit being also provided for each of the remaining elevator cars;

Figure 6 shows a circuit for computing the mean value of stop requesting calls for the elevator cars A to C;

Figure 7 shows a reference voltage generating circuit for supplying reference voltages to comparators shown in Figure 8;

Figure 8 shows a time interval estimating circuit associated with the elevator car A, such circuit being also provided for each of the remaining elevator cars;

Figure 9 shows a hall call response zone determining circuit associated with the elevator car A, such circuit being also provided for each of the remaining elevator cars;

Figure 10 shows a circuit for generating an inhibit signal after determination of the hall call responding elevator car, such circuit being provided for each floor and direction;

Figure 11 shows a circuit for determining the priority order of the elevator cars in response to a hall call, such circuit being provided for each floor and direction;

Figure 12 shows a guiding means energizing circuit associated with the elevator car A, such circuit being also provided for each of the remaining elevator cars; and

Figure 13 shows an arrangement of guiding means in which a guide lamp is provided for each elevator car group according to a feature of the present invention, such guiding means being provided for each floor and direction;

Figures 14 to 19 show another embodiment of the present invention for use in a 10-storied building having six parallel operating elevator cars A to F divided into two groups, one group W consisting of the elevator cars A to C and the other group Z consisting of the elevator cars D to F, in which:

Figure 14 shows a circuit for generating a signal representing an apparent position of the elevator car group W, such circuit being also provided for the other elevator car group and for each of other apparent positions;

Figure 15 shows a hall call response determining circuit associated with the elevator car group W, such circuit being provided for the other elevator car group;

Figure 16 shows a circuit for determining the priority order of the elevator car groups in response to a hall call, such circuit being provided for each floor;

Figure 17 shows a circuit for generating an inhibit signal after determination of the responding elevator car group, such circuit being provided for each floor;

Figure 18 shows a guiding means energizing circuit associated with the elevator car group W, such circuit being also provided for the other elevator car group; and

Figure 19 shows an arrangement of guiding means associated with the elevator car group W, such means being also provided for the other elevator car group.

Figure 20 shows schematically the manner of energization of the guide lamps in the second embodiment of the present invention;

Figure 21 shows a stop requesting call detecting circuit preferably employed in the second embodiment of the present invention so as to detect the number of stop requesting calls for the elevator car A, such circuit being also provided for each of the remaining elevator cars.

The general concept of the present invention will be described with reference to Figures 1, 2a and 2b, and in this description, guide lamps are used as guiding means.

Figure 1 shows a prior art arrangement of guide lamps, while Figures 2a and 2b show guide lamp arrangements in the present invention, and these figures are sectional views of floor landings. In Figures 1, 2a and 2b, eight elevator cars A to T are shown arranged for parallel operation.

In the prior art arrangements shown in Figure 1, eight guide lamps SA to SH are disposed at the floor landing portions for the respective elevator cars A to H. In response to a hall call, one of the elevator cars is determined to respond to this hall call and the guide lamp disposed at the floor landing portion for the selected elevator car is energized so that passengers waiting in the hall of the floor originating the hall call can identify the specific elevator car responding to the hall call. When, for example, the elevator car A is determined to service the floor originating the hall call, the guide lamp SA is energized at the floor from which the hall call is originated.

However, there may be a case in which the elevator car A which is determined to respond to the hall call cannot service the floor landing having the energized guide lamp SA for the reason that the elevator car A is full loaded or disabled. In such a case, another elevator car for serving the floor landing must be newly determined and the passengers waiting in the hall of the specific floor must be informed of the change of the arriving elevator car. Suppose, for example, that the elevator car B is the newly determined elevator car for serving the floor landing, then the guide lamp SA must be de-energized and the guide lamp SB must now be energized. However, as described previously, this gives rise to confusion of the passengers waiting in the hall and disbelief of the guiding means and is thus undesirable.

According to the present invention, eight elevator cars A to H are divided into a plurality of groups and one guide lamp is provided for each group as shown in Figures 2a and 2b. Referring to Figure 2a, the eight elevator cars A to H are divided into two groups, one consisting of the elevator cars A to D and the other consisting of the elevator cars E to H, and guide lamps SABCD and SEFGH are provided for the respective groups. Therefore, even when the elevator car determined to serve the floor landing is changed from A to B as above described, the guide lamp SABCD can be kept in the energized state.

Further, various circuits (described in detail later) constituting means for selecting the responsive elevator car group thereby energizing the corresponding signal lamp need not be provided for each elevator car and such means may merely be provided for each elevator car group. Thus, the selecting means are very simple in structure and inexpensive. Furthermore, the change of the energized guide lamps giving rise to confusion can also be completely avoided.

Referring to Figure 2b another arrangement according to the present invention, eight elevator cars A to H are divided into four groups each consisting of two elevator cars and guide lamps SAB to SGH are provided for respective groups.

In the later description, the present invention will be described with reference to a modern control process proposed for very efficiently controlling a plurality of elevator cars arranged for parallel operation. According to this control process, a plurality of parallel operating elevator cars are organically associated with one another so that all the elevator cars can be efficiently controlled. The manner of control in this control process is such that the operating conditions including the distance between the elevator cars and the number of floors at which each elevator car should stop are detected and the elevator cars are controlled so that each elevator car can be spaced by the same interval from the other elevator cars and stops at the same number of floors. Further, each elevator car has its own service zone for responding to a hall call originating from this range, and this service zone is continuously variable depending on the operating conditions. Thus, a hall call originating from a floor is transmitted to the elevator car having the service zone including that floor and this elevator car is determined to respond to the hall call. That is, it is conditioned so that each elevator car responds to a hall call originating from its own service zone.

One possible way of assigning service zones will be described with reference to the example of Figure 3. Suppose now that three elevator cars A to C are arranged to serve the floor landings of a building having ten floors, with the elevator car A moving upward from the 2nd floor, the elevator car B moving downward from the 9the floor and the elevator car C moving downward from the 2nd floor. In this case, the elevator cars A to C have the respective service zones shown by the arrows. When an up hall call is originated from the 8th floor in such a situation, this hall call is transmitted solely to the elevator car A and is not transmitted to the other elevator cars B and C since this hall call is

included in the service zone of the elevator car A. Therefore, the elevator car A is determined to respond to this hall call, and this is an effective means for early determining the elevator car responding to the hall call.

The term "interval" is used to include not only the physical or spatial interval between the actual or physical positions of the elevator cars but also the time interval calculated on the basis of the number of expected stops of the elevator cars as well as the sum of the spatial interval and the time interval.

Further, the term "position signal" is used to include not only the signal representing the floor position or distance from the bottom terminal but also the signal representing the position forward of the physical position of the elevator car when it is moving in either direction. For example, when the elevator car is moving upward past the 3rd floor, the position signal may represent the 4th floor position when the elevator car is moving at a low speed, the 5th floor position when the elevator car is moving at an intermediate speed, and the 6th floor position when the elevator car is moving at a high speed.

Figures 4 to 13 show various circuits employed in an embodiment of the present invention in which it is assumed that three elevator cars A to C serve the service floor landings of a building having ten floors.

Figure 4 shows a circuit for detecting the spatial interval between the elevator cars. This circuit detects the interval between the elevator car A and the succeeding elevator car B or C.

The following symbols are used in Figure 4:

F1UA—F9UA ... Position signals representing the 1st to the 9th floor position respectively when the elevator car A is moving upward

F2DA—F10DA ... Position signals representing the 2nd to the 10th floor position respectively when the elevator car A is moving downward

F1UB—F9UB ... Position signals representing the 1st to the 9th floor position respectively when the elevator car B is moving upward

F2DB—F10DB ... Position signals representing the 2nd to the 10th floor position respectively when the elevator car B is moving downward

F1UC—F9UC ... Position signals representing the 1st to the 9th floor position respectively when the elevator car C is moving upward

F2DC—F10DC ... Position signals representing the 2nd to the 10th floor position respectively when the elevator car C is moving downward

01UA1—09UA2, 02DA1—010DA2 ... OR elements

I1UA—I9UA, I2DA—I10DA ... INHIBIT elements

r, r_o ... Resistors

da ... Positional interval signal representing the positional interval between the elevator car A and the succeeding elevator car

It will be seen in Figure 4 that the OR elements and INHIBIT elements are connected endlessly to transmit successively the position signal representing the position of the elevator car A until the transmission of this position signal is intercepted by the INHIBIT element to which the position signal representing the position of the elevator car B or C is applied. The position signals representing the positions of the elevator cars are applied through the corresponding INHIBIT elements to the resistors r and the signal representing the positional interval between the elevator cars appears across the resistor r_o.

Suppose, for example, that the elevator car A is moving upward from the 8th floor, the elevator car B is moving upward from the 2nd floor, and the elevator C is moving downward from the 5th floor. In this case, the elevator car B is the succeeding elevator car for the elevator car A. The position signal F8UA representing the position of the elevator car A is transmitted to the INHIBIT element I2UA by way of the route O8UA1—I8UA—O7UA1 ... I3UA—O2UA1—I2UA. However, the position signal F2UB representing the position of the elevator car B is in the state "1" and is applied to the INHIBIT element I2UA by way of the route O2UA2—I2UA. Therefore, the output signal of the INHIBIT element I2UA is in the state "0" and the position signal F8UA cannot be transmitted any more. It will be understood that the output signals of the respective INHIBIT elements I8UA, I7UA, I6UA, I5UA, I4UA and I3UA are in the state "1", and these signals are applied through the associated resistors r to the resistors r_o so that a signal corresponding to the interval of 6 floors appears across the resistor r_o. This signal is the interval signal da. Thus, when the resistance ratio between the resistors r and r_o is selected to be $r > r_o$, a signal proportional to the number of floors existing between the positions of the elevator cars A and B appears across the resistor r_o. Even when the number of elevator cars is more than three, positional interval detection can be similarly easily attained by applying the position signals representing the positions of the elevator cars except the elevator car A to the OR elements O1UA2—O9UA2 and O2DA2—O10DA2 respectively.

Figure 5 shows a circuit for detecting the number of calls requesting stoppage of the elevator car A. Signals M1UA—M9UA and M2DA—M10DA are generated calling for

stoppage of the elevator car A. When a hall call or cage call is originated calling for stoppage of the elevator car A at one of the floors, the signal corresponding to this floor takes the state "1". Resistors r and r_0 are provided as in Figure 4 so as to obtain a signal CA proportional to the number of calls requesting stoppage.

Figure 6 shows a circuit for summing up the stop requesting calls for the individual elevator cars and computing the mean value of such calls. Signals CA to CC are obtained in the manner described with reference to Figure 5. Contacts NOA1, NOA2, NOB1, NOB2, NOC1 and NOC2 are opened when the elevator cars A, B and C are not in controlled operation. The circuit includes resistors R_1 and an operational amplifier OP_1 delivering an inverted output.

All the contacts NOA1—NOC1 are in the closed position when the elevator cars A, B and C are under controlled operation. When the inputs CA, CB and CC corresponding to the respective elevator cars A, B and C are applied to the circuit shown in Figure 6, the operational amplifier OP_1 delivers an output C which is given by

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

When one of the elevator cars, for example, the elevator car A is not in controlled operation, the output C of the operational amplifier OP_1 is given by

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

It will be seen that the output C of the operational amplifier OP_1 is the mean value of the stop requesting calls for the individual elevator cars. Even when the number of elevator cars is more than three, the mean value can be similarly easily obtained by providing a required number of input terminals and associated elements.

Figure 7 shows a circuit for obtaining reference voltages to be applied to comparators shown in Figure 8. Contacts NOA3, NOB3 and NOC3 are in the open position when the elevator cars A, B and C are in controlled operation. Therefore, an operational amplifier OP_2 delivers an output V_{OP2} which is given by

$$V_{OP2}=-\frac{R_4}{R_3}(-V)=\frac{R_4}{R_3}V$$

The output voltage V_{op2} of the operational amplifier OP_2 will have a value of, for example, 6 volts when the resistance ratio between the resistors R_3 and R_4 is suitably selected. When one of the elevator cars, for example, the elevator car A is not in controlled operation, the contact NOA3 is closed and the output voltage V_{OP2} of the operational amplifier OP2 is given by

$$V_{OP2}=-\frac{R_4}{R_3}(-V)-\frac{R_4}{R_2}(-V)$$

$$=R_4V\left(\frac{1}{R_3}+\frac{1}{R_2}\right) \quad (2)$$

This output voltage V_{OP2} will have a value of, for example, 10 volts when the resistance of the resistors R_2 is suitably selected. Such output voltage V_{OP2} of the operational amplifier OP2 is suitably divided by variable resistors R5 and R6 to obtain reference voltages V_1 and V_2 to be applied to comparators shown in Figure 8. The reference voltages V_1 and V_2 may be 5 volts and 4 volts respectively when the output voltage V_{OP2} of the operational amplifier OP2 is 6 volts, while these reference voltages V_1 and V_2 may be 8.3 volts and 6.6 volts respectively when V_{OP2} is 10 volts. Even when the number of elevator cars is more than three, the reference voltages can be similarly easily obtained by providing a required number of resistors R_2 and contacts.

Figure 8 is a circuit for estimating the time interval between the elevator car A and the succeeding elevator car, and the outputs of the circuits shown in Figures 4 to 7 are applied to this circuit. The circuit shown in Figure 8 comprises operational amplifiers OPA1 and OPA2, comparators CMA1 and CMA2 which deliver "1" when the sum of the two inputs is zero or positive, resistors R1, R7A, R8A and R9A, a NOT element NA, and an INHIBIT element IH. Outputs E0A, E1A and E2A of this circuit are instructional signals for setting a notional position of the elevator car A which is ahead of the actual position. For instance, the position of the elevator car A can be apparently advanced by zero floor, one floor or two floors ahead of the actual position by the instruction signals E0A, E1A or E2A respectively. The operational amplifier OPA1 carries out subtraction of the signal CA applied from the circuit shown in Figure 5 from the signal C applied from the circuit shown in Figure 6. Thus, the output V_{OPA1} of the operational amplifier OPA1 is given by

$$V_{OPA1}=-(CA+C)=-CA+\tfrac{1}{3}(CA+CB+CC) \quad (3)$$

Similarly, the output V_{OPA2} of the operational amplifier OPA2 is given by

$$V_{OPA2} = -\frac{R9A}{R7A}V_{OPA1} - \frac{R9A}{R8A}da \quad (4)$$

When the ratios among the resistors R7A, R8A and R9A are suitably selected, one floor interval and one call may correspond to 1 volt and 3 volts respectively. Thus, the time interval between the elevator cars can be computed by suitably selecting the weight of the elevator car interval and the weight of the call. The equation (4) can be expressed as

$$V_{OPA2} = -K_1(-CA + (\frac{CA+CB+CC}{3} - K_2.da$$

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

It will be readily seen from the equation (5) that the first member in the equation (5) is equal to the second member and V_{OPA2} is given by $V_{OPA2} = -K_2.da$ when the number of stop requesting calls for each elevator car is equal to the mean value of such calls. However,

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

when the number of stop requesting calls for the elevator car A is greater by, for example, one than the mean value. On the other hand,

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

when the number of stop requesting calls for the elevator car A is smaller by one than the mean value. It will thus be seen that the "interval" calculation between the elevator cars takes into account the time interval arising from the number of calls.

Suppose now that there is a six-floor interval between the elevator car A and the succeeding elevator car and the number of stop requesting calls for the elevator car A is greater by one than the mean value, then V_{OPA2} is given by $V_{OPA2} = +3$ volts -6 volts $= -3$ volts. Suppose then that $V_1(=5$ volts) and $V_2(=4$ volts) are applied to the respective comparators CMA1 and CMA2 as the reference voltage signals. In this case, the output of the comparator CMA1 is "1" due to the fact that -3 volts and $+5$ volts are applied thereto, and the output of the comparator CMA2 is also "1" due to the fact that -3 volts and $+4$ volts are applied thereto. Thus, the position advancing instruction signal E2A takes the state "1", the position advancing instruction signal E1A appearing from the INHIBIT element IH takes the state "0", and the position advancing instruction signal E0A appearing from the NOT element NA takes the state "0".

When $V_{OPA2} = -5$ volts, the output of the comparator CMA1 is "1" due to the fact that -5 volts and $+5$ volts are applied thereto, while the output of the comparator CMA2 is "0" due to the fact that -5 volts and $+4$ volts are applied thereto. It will be understood that one of the position advancing instruction signals E0A, E1A and E2A is selectively delivered from the circuit depending on the result of estimation of the time interval between the elevator cars by the comparators CMA1 and CMA2.

Figures 9 to 11 show circuits for determining the service zone of the elevator car A on the basis of the signals including the position signals and position advancing instruction signals and judging as to whether the elevator car A should respond to a hall call. More precisely, Fig. 9 shows a circuit for determining as to whether the elevator car A should respond to a hall call and such circuit is provided for each elevator car. Figure 10 shows a circuit for generating inhibit signals after determination of an elevator car responding to a hall call and such circuit is provided for each floor and direction. Figure 11 shows a circuit for determining the priority order of elevator cars responding to a hall call and such circuit is also provided for each floor and direction.

The circuit shown in Figure 9 includes AND elements A1UA1 to A9UA4 and A2DA1 to A10DA4, OR elements, O1UA3 to O9UA5 and O2DA3 to O10DA5, and INHIBIT elements IN1UA1 to IN9UA3 and IN2DA1 to IN10DA3. Inhibit signals 1U to 9U and 2D to 10D are applied from the circuit shown in Figure 11 although only one signal 2U is shown in Figure 11. Inhibit signals M1U to M9U and M2D to M10D are applied from the circuit shown in Figure 10 in response to the application of signals Ry1UA2 to Ry9UC2 and Ry2DA2 to Ry10DC2 (described later) to respective OR elements 01U to O9U and O2D to 010D. Hall call signals HC1U to HC9U and HC2D to HC10D are originated from the 1st to the 9th floor to call for upward movement of the elevator cars and from the 2nd to the 10th floor to call for downward movement of the elevator cars respectively. Response determination signals L1UA to L9UA and L2DA to L10DA appear from the circuit shown in Figure 9.

Suppose now that the elevator car A is moving upward from the 2nd floor, while the preceding elevator car B is moving downward

from the 10th floor, and the position advancing instruction signals E0 for these two elevator cars A and B are generated. It is supposed further that the elevator car C is moving downward from the 5th floor.

Due to the fact that the elevator car A is situated at the 2nd floor and the position advancing instruction signal E0A therefore is in the state "1", an output signal or "1" appears from the AND element A2UA1 to be applied to the INHIBIT element IN2UA2 through the OR elements O2UA3 and O2UA5. The output signal of the INHIBIT element IN2UA2 is transmitted to the INHIBIT element IN3UA1 (not shown) associated with the 3rd floor, thence successively to the corresponding INHIBIT elements associated with the 4th to the 7th floor. Finally, the output signal of the INHIBIT element IN7UA2 associated with the 7th floor is applied to the INHIBIT element IN8UA1 to be applied to the INHIBIT element IN10DA1 by way of the route IN8UA1— O8UA5 — IN8UA2 —IN9UA — O9UA5 — IN9UA2 — IN10DA1.

In the meantime, the output signal of the OR element O2UA3 is applied to the OR element O2UA4 to produce the inhibit signal 2U for the other cars by means of the priority order determining circuit shown in Figure 11. The output signal of the OR element O2UA3 provides one of the inputs to the OR element O2UA4 associated with the elevator car A, but the other input is not connected to the OR element O2UA4. The output of the OR element O2UA4 is connected to the OR element O2UB4 and INHIBIT element IN2UB2 associated with the elevator car B, and the output of the OR element O2UB4 is connected to the OR element O2UC4 and INHIBIT element IN2UC2 associated with the elevator car C. Therefore, the INHIBIT elements IN2UA2, IN2UB2 and IN2UC2 associated with the respective elevator cars A, B and C are placed in the inhibit position after the priority order has been established in the order of the elevator cars A, B and C. Further, the output signal of the OR element O2UC4 provides the inhibit signal 20 thereby placing the INHIBIT elements IN2UR1, IN2UB1 and IN2UC1 associated with the respective elevator cars A, B and C in the inhibit state. In this description, the input signal to the INHIBIT element IN2UC1 associated with the elevator car C is inhibited and the output signal of the INHIBIT element IN2UC1 is "0". Similarly, due to the fact that the elevator car B is moving downward from the 10th floor, the inhibit signal 10D is in the state "1" thereby placing the INIHBIT element IN10DA1 associated with the elevator car A in the inhibit state and the output signal of the INHIBIT element IN10DA1 is in the state "0". Therefore, the output signals of the INHIBIT elements IN3UA3 to IN9UA3 associated with the elevator car A are in the state "1", and the service zone of the elevator car A in the above situation ranges from the 3rd to the 9th floor.

Suppose that both the elevator cars A and B are moving upward from the 2nd floor and the elevator car C is moving downward from the 10th floor. In this case, the position advancing instruction signals E0A, E0B and E0C take the state "1". In such a case too, "0" appears from the OR elements O2UA3 and O2UB3 as will be readily understood from the above description. It will be seen in the circuit shown in Figure 11, the output signal or "1" appearing from the OR element O2UA3 associated with the elevator car A is applied through the OR element O2UA4 to the INHIBIT element IN2UB2 associated with the elevator car B to place this INHIBIT element in the inhibit state. Therefore, the output signal of the OR element O2UB4 associated with the elevator car B is inhibited and cannot be transmitted any further.

It will thus be understood that, when two or more elevator cars are at the same floor, the priority order is established in the order of the elevator cars A, B and C and these elevator cars respond to a hall call in this order. This priority order may be determined in combination with the dispatching order of the elevator cars when these elevator cars exist at the dispatching floor or bottom terminal such as the lobby.

The response determination signals L1UA to L9UA and L2DA to L10DA in Figure 9 are applied through self-holding amplifier elements such as thyristors R1UA to R9UA and R2DA to R10DA to energize relays Ry1UA to Ry9UA and Ry2DA to Ry10DA respectively in a circuit shown in Figure 12 for energizing signaling means. The relay contacts of the relays Ry1UA to Ry9UA and Ry2DA to Ry10DA are selectively closed to decelerate the responding elevator car so as to stop same at the specific floor.

Figure 13 shows an arrangement of guiding means which is one of the features of the present invention. The guiding means comprises a guide lamp provided at each floor for each group of the elevator cars. In this arrangement, the elevator cars A, B and C are divided into two groups, one consisting of the elevator cars A and B and the other consisting of the elevator car C, and two guide lamps S9UAB and S9UC associated with the 9th floor are shown provided for the respective elevator car groups. For the sake of simplicity, Figure 13 shows only the guiding means disposed at the 9th floor to indicate upward movement of the responding elevator cars, but similar arrangements are provided at the other floors. The guide lamps S9UAB and S9UC are respectively energized in response to the closure of the contacts Ry9UA1 to

Ry9UC1 of the delays Ry9UA to Ry9UC (Figure 12) associated with the elevator cars A, B and C. Therefore, the guide lamp S9UAB is energized when one of the elevator cars A and B responds to an up hall call originating from the 9th floor, and the guide lamp S9UC is energized when the elevator car C responds to such hall call.

Suppose, for example, that the service zone of the elevator car A includes upward movement from the 7th to the 9th floor and downward movement from the 10th to the 8th floor, that is, the output signals of the INHIBIT elements IN7UA3 to IN9UA3 and IN10DA3 to IN8DA3 in Figure 9 are in the state "1", and an up hall call is originated from the 9th floor. In this case, the hall call signal HC9U appears and the two inputs are applied to the AND element A9UA4 associated with the elevator car A in Figure 9 so that an output signal appears from the AND element A9UA4. That is, the response determination signal L9UA appears from the AND element A9UA4 to energize the relay Ry9UA through the self-holding amplifier element or thyristor R9UA in Figure 12. Due to the energization of the relay R9UA, the signal Ry9UA2 is applied to the OR element O9U in Figure 10 to provide the inhibit signal M9U which is applied as the inhibit input to the INHIBIT elements IN9UA3, IN9UB3 and IN9UC3 in Figure 9. The self-holding amplifier element or thyristor R9UA holds itself so that the guide lamp S9UAB is kept energized by the contact Ry9UA1 of the energized relay Ry9UA. Thus, the elevator car A responds to the up hall call originating from the 9th floor. In order to prevent the remaining elevator cars from responding to this hall call, the inhibit signal M9U is applied to the INHIBIT elements IN9UA3 to IN9UC3. The passenger originating the up hall call at the 9th floor is informed that one of the elevator cars A and B serves the 9th floor landing and moves to the floor landing of the elevator cars A and B. When the elevator car A reaches the deceleration position beneath the 9th floor, the elevator car A is controlled by the signal of the relay Ry9UA so as to be decelerated to stop at the 9th floor. (Control circuits are not shown.) The self-holding amplifier element R9UA is released from the self-holding state when the elevator car A starts to decelerate or stops at the 9th floor.

The present invention has been described with reference to a recent elevator control process. It will be understood from the above description that the same guide lamp is kept energized in Figure 13 even when the elevator car responding to the hall call is changed from the elevator car A to the elevator car B. Therefore, confusion of passengers waiting in the hall due to the change of the illuminating guide lamp can be reduced to a minimum and the reliability of the guiding means can be improved. Further, the guiding means is inexpensive due to the fact that the number of the guide lamps can be reduced. This effect becomes more marked with the increase in the number of elevator cars arranged for parallel operation.

Another embodiment of the present invention will be described with reference to Figures 4 to 8 and 14 to 20. In this embodiment, a guide lamp is provided similarly for each elevator car group and an elevator car group responding to a hall call is determined unlike the preceding embodiment in which an elevator car responding to a hall call is determined. Therefore, hall call responding elevator car group selecting means such as a response determining circuit and a guiding means driving circuit are provided for each elevator car group. In the later description, it is assumed that six elevator cars A to F are arranged to serve the service floor landings of a building having ten floors, and the elevator cars A to C constitute one group named W, while the elevator cars D to F constitute the other group named Z.

At first, position advancing instruction signals E0A, E1A and E2A for the elevator car A are obtained by the circuits shown in Figures 4 to 8 as in the preceding embodiment.

Since the number of the elevator cars in this embodiment is six, it is necessary to suitably vary the circuits as described below. Further, due to the fact that the elevator car group responds to a hall call, each elevator car can only detect cage calls.

In the positional interval detecting circuit for detecting the positional interval between th elevator car A and succeeding elevator car shown in Figure 4, the position signals representing the positions of the elevator cars B to F are applied to the OR elements O1UA2 to O9UA2 and O2DA2 to O10DA2.

In the stop requesting call detecting circuit associated with the elevator car A, the circuit corresponding to that shown in Figure 5 for the previous embodiment, cage calls can only be detected since an elevator car responding to a hall call is not determined so quickly. Therefore, cage call signals C1A to C10A are applied to obtain a signal CCA representing the number of cage calls.

In the mean value computing circuit shown in Figure 6, the inputs are the signals CCA to CCF representative of the cage calls registered in the respective elevator cars A to F and these signals are derived from a circuit of the type shown in Figure 5. Further, additional resistors R_1 and additional contacts NOD1 to NOD2 associated with the elevator cars D to F are provided. Thus, an output CC of the operational amplifier OP1 represents the mean value of cage calls requesting stoppage.

Similarly, additional contacts NOD3 to NOF3 and additional resistors R2 must be

provided in the reference voltage generating circuit shown in Figure 7.

In the time interval estimating circuit associated with the elevator car A shown in Figure 8, the inputs are the signal CC representing the mean value of cage calls (from the circuit of the type shown in Figure 5, referred to above) and the signal CCA representing the number of cage calls registered in the elevator car A.

By varying the circuits shown in Figures 4 to 8 in the manner above described, it is possible to obtain the position advancing instruction signals E0A to E2A as in the preceding embodiment.

Figures 14 to 17 show circuits for establishing the service zones of the elevator car group W consisting of the elevator cars A to C and judging as to whether this group should respond to a hall call.

Figure 14 shows an example of an apparent position signal generating circuit associated with the elevator car group W for generating a signal which represents that the apparent position of this group is the second floor upward. Similar circuits are required for other apparent positions and for the other elevator car group. As shown in Figure 14, position signals F1UA to F2DC and position advancing instruction signals E0A to E2C are applied to respective AND elements A2UA1 to A2UC3 associated with the elevator cars A to C. Therefore, when, for example, the elevator car A is moving upward from the 1st floor and the position advancing instruction signal E1A appears, an output or "1" appears from the AND element A2UA2 and an apparent position signal f2UW representing that the apparent position of the elevator car group W is the second floor upward appears from an OR element O2UW3.

Figure 15 shows a circuit for judging as to whether the elevator car group W should respond to a hall call, and such circuit is also provided for the other elevator car group. This circuit is entirely similar to the circuit portion disposed in the stages after the OR elements O1UA5 to O9UA5 and O2DA5 to O10DA5 in the hall call response determining circuit associated with the elevator car A shown in Figure 9. In the preceding embodiment, the apparent position signal for the elevator car A is detected in the circuit portion disposed in the stages before the OR elements O1UA3 to O9UA3 and O2DA3 to O10DA3 in Figure 9, but in this embodiment, such signal is detected by the circuit shown in Figure 14. The circuit shown in Figure 15 establishes the hall call responding service zones for the elevator car group W and determines as to whether this elevator car group should respond to a hall call originating from the service zones.

Figure 16 shows a circuit for determining the priority order of the elevator car groups in responding a hall call and this circuit corresponds to the circuit shown in Figure 11. In this embodiment, the priority order of the elevator car groups responding to a hall call is determined instead of the priority order of the elevator cars.

Figure 17 shows a circuit for generating an inhibit signal after the determination of the call responding elevator car group and this circuit corresponds to the circuit shown in Figure 10.

After the determination of the elevator car group which should respond to a hall call by the circuits shown in Figures 14 to 17, circuits shown in Figures 18 and 19 energize guiding means for guiding passengers waiting in the hall toward the responding elevator car group.

Figure 18 shows a circuit for energizing guiding means associated with the elevator car group W, and the same arrangement is provided for the other elevator car group. This circuit corresponds to the circuit shown in Figure 12 in the preceding embodiment. When the elevator car group W responds to hall calls, corresponding relays Ry1UW to Ry9UW and Ry2DW to Ry10DW are energized by associated self-holding amplifier elements R1UW to R9UW and R2DW to R10DW.

Figure 19 shows an arrangement of guiding means associated with the elevator car group W, and the same arrangement is provided for the other elevator car group. Figure 19 corresponds to Figure 13 in the preceding embodiment. Guide lamps S1UW to S9UW and S2DW to S10DW are provided so that passengers waiting in the halls can be informed that they are served by one of the elevator cars A to C in the group W.

Operation of the second embodiment of the present invention will now be described.

Suppose now that the elevator car A is moving upward from the 2nd floor and the position advancing instruction signal E0A appears. In response to the application of both the position signal F2UA and the position advancing instruction signal E0A to the AND element A2UA1, an output or "1" appears from the AND element A2UA1 to be applied to the OR element O2UW3 and the signal f2UW is applied through the OR element O2UW2 and INHIBIT element IN2UW2 to the INHIBIT element IN2UW3 in Figure 15. Further, the output of the INHIBIT element IN2UW2 is applied to the INHIBIT element IN3UW1 (not shown) associated with the 3rd floor. Suppose that the preceding elevator car D is situated at the 8th flood, the output of the INHIBIT element IN3UW1 is transmitted through the successive INHIBIT elements until it is applied to the INHIBIT element IN7UW2 associated with the 7th floor, and the output of the INHIBIT element IN7UW2 is applied to the INHIBIT element IN8UW1.

In the meantime, the apparent position signal f2UW passes through the OR elements O2UW1 and O2UZ1 in Figure 16 to provide the inhibit signal 2U for the elevator car groups W and Z. This inhibit signal 2U is applied to the INHIBIT element IN2UW1 and to the INHIBIT element IN2UZ1 (not shown). Due to the fact that the elevator car D is ready to move upward from the 8th floor, the apparent position signal f8UZ for the group Z takes the state "1" and the inhibit signal 8U appears in the circuit similar to that shown in Figure 16 to be applied to the INHIBIT element IN8UW1. Therefore, the service zone of the elevator car A in the group W is determined so that it responds to up hall calls originating from the 2nd to the 7th floor. The service zones of the elevator cars B and C are similarly determined by the circuits common to the group W. Thus, the hall call responding service zones of the group W consisting of the elevator cars A to C can be determined.

Suppose that an up hall call HC2U is originated from the 2nd floor in the state in which a portion of the service zones of the group W ranges from the 2nd to the 7th floor as above described. In this case, an output or "1" appears from the AND element A2UW in Figure 15 to provide the response determination signal L2UW. This signal L2UW is applied to the self-holding amplifier element R2UW thereby energizing the relay Ry2UW. Due to the energization of the relay Ry2UW, the relay contact Ry2UW1 is closed in Figure 19 to energize the guide lamp S2UW so that the passengers waiting in the hall are informed that one of the elevator cars in the group W responds to the up hall call originating from the 2nd floor. Further, the inhibit signal M2U appearing from the OR element O2U shown in Figure 17 is applied to the INHIBIT element IN8UW3 associated with the group W and to the INHIBIT element IN8UZ3 (not shown) associated with the group Z in Figure 15 so that one of the two groups responds solely to the hall call.

The relay Ry2UW is continuously energized to provide the signal for the group W consisting of the elevator cars A to C. The self-holding amplifier element R2UW holds itself until one of the elevator cars A to C serves the 2nd floor originating the up hall call. That is, the elevator car which has reached the deceleration point associated with the 2nd floor earliest of all serves the 2nd floor originating the up hall call. In this case, therefore, it is most possible that the elevator car A serves the 2nd floor originating the up hall call. Even when the elevator car A is full loaded, for example, and passes the 2nd floor without stopping at this floor, one of the remaining elevator cars B and C in the same group services the floor originating the hall call.

Figure 20 is a chart for facilitating the understanding of the second embodiment of the present invention, and symbols Δ are used to illustrate the service zones of the groups W and Z by way of example. The service zones of the group W include upward movement from the 4th to the 6th floor, downward movement from the 4th to the 2nd floor, and downward movement from the 10th to the 8th floor, while the service zones of the group Z include upward movement from the 1st to the 3rd floor, upward movement from the 7th to the 9th floor, and downward movement from the 7th to the 5th floor.

When an up hall call is originated from the 4th floor in such a state, the group W is instructed to respond this hall call and the corresponding guide lamp is energized to guide passengers waiting in the hall toward the floor landing portions for the group W. Consider a case in which one of the elevator cars in the group W situated adjacent to the floor originating the hall call cannot serve this floor due to the full-loaded condition or any other conditions although this elevator car has been instructed to serve the floor. Even in such a case, the same guide lamp can be kept energized due to the fact that the hall call signal is applied to the circuits associated with the remaining elevator cars in the same group.

In the second embodiment of the present invention, the hall call response determining circuit, guiding means driving circuit and other circuits shown in Figures 14 to 19 are provided for each elevator car group. Thus, the system is very simple in structure and inexpensive compared with prior art systems in which such circuits are provided for each elevator car. For instance, the costs of the control circuits are by about 40% less than heretofore when six elevator cars are divided into two groups as described in the second embodiment.

In the second embodiment of the present invention, the signal representing the number of cage calls solely requesting stoppage of each elevator car is derived from the circuit shown in Figure 5. This is because hall calls are not applied to each individual elevator car but to the elevator car group and the stop requesting hall calls cannot be detected. However, due to the fact that hall calls are applied to the individual elevator car groups, calls including hall calls can be detected by a circuit as shown in Figure 21. This circuit is associated with the elevator car A. Cage call signals C1A to C10A registered in the elevator car A are applied to respective resistors r_1 and hall call signals M1UW to M9UW and M2DW to M10DW are applied to respective resistors r_2 associated with the elevator car group W including the elevator car A which is instructed to respond. Since the elevator car group consists of the three elevator cars,

the resistances of the resistors r_1 and r_2 must be selected to give the relation

$$r_1 = \frac{r_2}{3}.$$

In other words, the total number of hall calls applied to the responding elevator car group W is equally divided into 1/3 so that the divided hall calls can be applied to each individual elevator car.

It will be understood from the foregoing description that, in the elevator signaling system according to the present invention, a guide lamp is provided at each floor for each elevator car group so that passengers waiting in the hall of one of the floors can identify the elevator car group servicing such floor, and various circuits for controlling the operation of the elevator cars are provided for each elevator car group. Thus, the elevator signaling system is very simple in structure and inexpensive. Further, by virtue of the fact that the necessity for changing the illuminating guide lamp due to the change of the elevator car servicing the floor can be reduced or completely eliminated, the reliability of the elevator signaling system can be improved, and very satisfactory service can be offered to the passengers waiting in the hall.

The present invention is similarly effectively applicable to a building having more floors and more elevator cars divided into a larger number of groups.

The embodiments of the present invention have been described with reference to control means in which, in order to attain efficient operation of elevator cars arranged in parallel, means for detecting the interval between the elevator cars, means for detecting the number of stop requesting calls and other means are provided so as to control the elevator cars which are organically associated with one another. However, the circuits shown in Figures 4 to 8 for obtaining the position advancing instruction signals E0A to E2A may be eliminated. In such a case, the position signals F2UA to F2UC representing the positions of the respective elevator cars A to C may be directly applied to the OR element O2UW3 shown in Figure 14 so as to obtain the position signal representing the apparent position of the group W.

Further, although the elevator car group should respond to a hall call is determined on the basis of the service zones, the present invention is in no way limited to such an arrangement. For instance, the group including the elevator car which is nearest to the floor originating a hall call may be primarily determined to respond to the hall call.

In the embodiments of the present invention, the guide lamps associated with the group responding to hall calls are energized in response to appearance of the hall calls. However, the guide lamps need not be energized in response to the hall calls and the guide lamps included in the service zones of the associated elevator car group may be continuously energized irrespective of origination of hall calls. For example, the AND elements A1UW to A9UW and A2DW to A10DW in Figure 15 may be eliminated and the output signals of the INHIBIT elements IN1UW3 to IN9UW3 and IN2DW3 to IN10DW3 may be directly applied to energize the guide lamps. Further, the guide lamps may be energized with a predetermined delay time after origination of hall calls.

In accordance with the provisions of Section 9 of the Patents Act 1949, attention is hereby directed to our British Patent Specifications Nos. 1,351,224, 1,305,960 and 1,429,674.

WHAT WE CLAIM IS:—

1. In an elevator system in which a plurality of elevator cars are arranged in parallel for serving a plurality of service floor landings of a building, an elevator signalling system in which said plurality of elevator cars are grouped into a plurality of car groups each consisting of elevator cars associated with adjoining floor landing lcations, comprising, means for selecting, out of said car groups, one car group containing cars which can respond to a hall call, and guide means situated at each floor landing and adapted to be actuated in response to the output of said selecting means, to inform persons waiting at the landing where the said call has been generated, as to which group of cars has been allocated the call.

2. An elevator signalling system as claimed in Claim 1, wherein said selecting means includes means for juding which elevator car can best respond to a hall call among said plurality of elevator cars in response to origination of the hall call and means responsive to said judging means for identifying the car group to which the car judged to be responsive belongs to thereby produce an output to said guiding means.

3. An elevator signalling system as claimed in Claim 1, wherein said means for selecting one of the elevator car groups containing cars which can respond to a hall call includes means for setting service zones of each elevator car group, means for detecting coincidence between the floor originating a hall call and the service zones set by said service zone setting means, and means for actuating that guiding means belonging to the group whose zones include the floor originating the hall call.

4. An elevator signalling system as claimed in Claim 3, wherein said service zone setting means includes means responsive to a position signal of each of the elevator cars belonging to the respective car groups, for producing posi-

the resistances of the resistors r_1 and r_2 must be selected to give the relation

$$r_1 = \frac{r_2}{3}.$$

In other words, the total number of hall calls applied to the responding elevator car group W is equally divided into 1/3 so that the divided hall calls can be applied to each individual elevator car.

It will be understood from the foregoing description that, in the elevator signaling system according to the present invention, a guide lamp is provided at each floor for each elevator car group so that passengers waiting in the hall of one of the floors can identify the elevator car group servicing such floor, and various circuits for controlling the operation of the elevator cars are provided for each elevator car group. Thus, the elevator signaling system is very simple in structure and inexpensive. Further, by virtue of the fact that the necessity for changing the illuminating guide lamp due to the change of the elevator car servicing the floor can be reduced or completely eliminated, the reliability of the elevator signaling system can be improved, and very satisfactory service can be offered to the passengers waiting in the hall.

The present invention is similarly effectively applicable to a building having more floors and more elevator cars divided into a larger number of groups.

The embodiments of the present invention have been described with reference to control means in which, in order to attain efficient operation of elevator cars arranged in parallel, means for detecting the interval between the elevator cars, means for detecting the number of stop requesting calls and other means are provided so as to control the elevator cars which are organically associated with one another. However, the circuits shown in Figures 4 to 8 for obtaining the position advancing instruction signals E0A to E2A may be eliminated. In such a case, the position signals F2UA to F2UC representing the positions of the respective elevator cars A to C may be directly applied to the OR element O2UW3 shown in Figure 14 so as to obtain the position signal representing the apparent position of the group W.

Further, although the elevator car group should respond to a hall call is determined on the basis of the service zones, the present invention is in no way limited to such an arrangement. For instance, the group including the elevator car which is nearest to the floor originating a hall call may be primarily determined to respond to the hall call.

In the embodiments of the present invention, the guide lamps associated with the group responding to hall calls are energized in response to appearance of the hall calls. However, the guide lamps need not be energized in response to the hall calls and the guide lamps included in the service zones of the associated elevator car group may be continuously energized irrespective of origination of hall calls. For example, the AND elements A1UW to A9UW and A2DW to A10DW in Figure 15 may be eliminated and the output signals of the INHIBIT elements IN1UW3 to IN9UW3 and IN2DW3 to IN10DW3 may be directly applied to energize the guide lamps. Further, the guide lamps may be energized with a predetermined delay time after origination of hall calls.

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WHAT WE CLAIM IS:—

1. In an elevator system in which a plurality of elevator cars are arranged in parallel for serving a plurality of service floor landings of a building, an elevator signalling system in which said plurality of elevator cars are grouped into a plurality of car groups each consisting of elevator cars associated with adjoining floor landing lcations, comprising, means for selecting, out of said car groups, one car group containing cars which can respond to a hall call, and guide means situated at each floor landing and adapted to be actuated in response to the output of said selecting means, to inform persons waiting at the landing where the said call has been generated, as to which group of cars has been allocated the call.

2. An elevator signalling system as claimed in Claim 1, wherein said selecting means includes means for juding which elevator car can best respond to a hall call among said plurality of elevator cars in response to origination of the hall call and means responsive to said judging means for identifying the car group to which the car judged to be responsive belongs to thereby produce an output to said guiding means.

3. An elevator signalling system as claimed in Claim 1, wherein said means for selecting one of the elevator car groups containing cars which can respond to a hall call includes means for setting service zones of each elevator car group, means for detecting coincidence between the floor originating a hall call and the service zones set by said service zone setting means, and means for actuating that guiding means belonging to the group whose zones include the floor originating the hall call.

4. An elevator signalling system as claimed in Claim 3, wherein said service zone setting means includes means responsive to a position signal of each of the elevator cars belonging to the respective car groups, for producing posi-

tion signals associated with each of the car groups for setting a range in which the car group is caused to respond to a hall call generated.

5. An elevator signalling system constructed and arranged substantially in accordance with any preceding claim and as described herein with reference to the accompanying drawings.

LANGER PARRY,
Chartered Patent Agents,
59—62 High Holborn,
London, WC1V 6EJ.
Agents for the Applicants.

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