ELEVATOR SIGNALING SYSTEM

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ABSTRACT

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, in which guide lamps are provided at each floor so that passengers waiting in the hall of a floor originating a hall call can be informed of expected arrival of one of the elevator cars responding to such hall call. In the system, the elevator cars are divided into a plurality of groups each consisting of a plurality of elevator cars servicing adjoining service floor landing portions and one guide lamp is provided for each elevator car group so that, when one of the elevator cars in one group responds to the hall call, the guide lamp associated with this group is energized. In order to energize these guide lamps, means for selecting one of the elevator car groups which can respond to hall calls are provided for each elevator car group.

7 Claims, 22 Drawing Figures
### FIG. 20

<table>
<thead>
<tr>
<th>W</th>
<th>Z</th>
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<tbody>
<tr>
<td>10F</td>
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<td>9F</td>
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<tr>
<td>1F</td>
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### FIG. 21

```
M2DW  ┌───┐
   r2  │   │
  └───┘
M1ODW ┌───┐
   r2  │   │
  └───┘
M2UW  ┌───┐
   r2  │   │
  └───┘
MIUW  ┌───┐
   r2  │   │
  └───┘
C1OA  ┌───┐
   r   │   │
  └───┘
C9A   ┌───┐
   r   │   │
  └───┘
C2A   ┌───┐
   r   │   │
  └───┘
C1A   ┌───┐
   r0  │   │
  └───┘
  CA
```
1

ELEVATOR SIGNALING SYSTEM

This invention relates to improvements in an elevator signaling system which is especially effective 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 unable, 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 arrangement 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 deenergized 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 expensive. 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 guaranty 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 energizing the guiding means.

It is the first feature of the present invention that a plurality of elevator cars arranged for parallel operation are divided into a plurality of groups each consisting of elevator cars associated with adjoining floor landing portions and one guiding means is provided for each elevator car group.

The second feature of the present invention resides in the fact that one of the elevator car groups is determined to respond to a hall call and means for selecting the hall call responding elevator car group, that is, a hall call response determining circuit, is provided for each elevator car group.

Other objects, features and advantages of the present invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings.

FIG. 1 is a schematic view showing a prior art arrangement of guide lamps;
FIGS. 2a and 2b are schematic views showing preferred arrangements of guide lamps according to the present invention;
FIG. 3 is a schematic view showing the operation of group controlled elevator cars to which the present invention is applied;
FIGS. 4 to 13 show an embodiment of the present invention for use in a 10 — story building having three elevator cars A to C arranged for parallel operation, in which;
FIG. 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;
FIG. 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;
FIG. 6 shows a circuit for computing the means value of stop requesting calls for the elevator cars A to C;
FIG. 7 shows a reference voltage generating circuit for supplying reference voltages to comparators shown in FIG. 8;

FIG. 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;

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

FIG. 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;

FIG. 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;

FIG. 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

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

FIGS. 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:

FIG. 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;

FIG. 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;

FIG. 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;

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

FIG. 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

FIG. 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.

FIG. 20 shows schematically the manner of energization of the guide lamps in the second embodiment of the present invention.

FIG. 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 FIGS. 1, 2a and 2b, and in this description, guide lamps are used as guiding means.

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

In the prior art arrangement shown in FIG. 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 deenergized 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 FIGS. 2a and 2b. Referring to FIG. 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. Thus, the prior art defect can be considerably obviated.

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 FIG. 2b, showing 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 the 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 pro-
cess is such that the operating conditions including the interval 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 is 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.

The service zones will be described with reference to FIG. 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 9th 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 stoppages 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 upper or lower terminal 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.

FIGS. 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.

FIG. 4 shows a circuit for detecting the positional 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 FIG. 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 — 01ODA2 . . . OR elements
11UA — 19UA, 12DA — 110DA . . . INHIBIT elements
r₁, r₂ . . . Resistors
da . . . Positional interval signal representing the positional interval between the elevator car A and the succeeding elevator car

It will be seen in FIG. 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 interrupted 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 r₁ and the signal representing the positional interval between the elevator cars appears across the resistor r₂.

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 12UA by way of the route 08UA1 — 18UA — 07UA1 . . . 13UA — 02DA1 . . . 12UA. 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 12UA by way of the route 02UA2 — 12UA. Therefore, the output signal of the INHIBIT element 12UA 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 18UA, 17UA, 16UA, 15UA, 14UA and 13UA are in the state 1, and these signals are applied through the associated resistors r₁ to the resistor r₂ so that a signal corresponding to the interval of 6 floors appears across the resistor r₂. This signal is the interval signal da. Thus, when the resistance ratio between the resistors r₁ and r₂ is selected to be r₁>r₂, a signal proportional to the number of floors existing between the positions of the elevator cars A and B appears across the resistor r₂. 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 01UA2 — 09UA2 and 02DA2 — 01ODA2 respectively.

FIG. 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 \( r_s \) are provided as in FIG. 4 so as to obtain a signal CA proportional to the number of calls requesting stoppage.

FIG. 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 FIG. 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 — NOC2 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 FIG. 6, the operational amplifier \( OP_1 \) delivers an output \( C \) which is given by

\[
C = - \frac{R_1}{R_3} (CA + CB + CC) = - \frac{1}{3} (CA + CB + CC)
\]

(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

\[
C = - \frac{R_1}{R_3} (CB + CC) = \frac{1}{2} (CB + CC)
\]

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.

FIG. 7 shows a circuit for obtaining reference voltages to be applied to comparators shown in FIG. 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 \( V_{\text{ops}} \) which is given by

\[
V_{\text{ops}} = - R_i/R_3 - V = R_d R_s V
\]

The output voltage \( V_{\text{ops}} \) of the operational amplifier \( OP_2 \) will have a value of, for example, 6 volts when the resistance ratio between the resistors \( R_s \) and \( R_i \) 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 \( V_{\text{ops}} \) of the operational amplifier \( OP_2 \) is given by

\[
V_{\text{ops}} = - R_d/R_3 - V = R_d R_s V (1/R_3 + 1/R_2)
\]

(2)

This output voltage \( V_{\text{ops}} \) will have a value of, for example, 10 volts when the resistance of the resistors \( R_s \) is suitably selected. Such output voltage \( V_{\text{ops}} \) of the operational amplifier \( OP_2 \) is suitably divided by variable resistors \( R_S \) and \( R_6 \) to obtain reference voltages \( V_1 \) and \( V_2 \) to be applied to comparators shown in FIG. 8. The reference voltages \( V_1 \) and \( V_2 \) may be 5 volts and 4 volts respectively when the output voltage \( V_{\text{ops}} \) of the operational amplifier \( OP_2 \) is 6 volts, while these reference voltages \( V_1 \) and \( V_2 \) may be 8.3 volts and 6.6 volts respectively when \( V_{\text{ops}} \) 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 \( R_4 \) and contacts.

FIG. 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 FIGS. 4 to 7 are applied to this circuit. The circuit shown in FIG. 8 comprises operational amplifiers \( OP_1 \) and \( OP_2 \), comparators \( CMA1 \) and \( CMA2 \) which deliver 1 when the sum of the two inputs is zero or positive, resistors \( R_1, R_7A, R_8A \) and \( R_9A \), a NOT element \( NA \), and an INHIBIT element \( IH \). Outputs \( EOA \), \( E1A \) and \( E2A \) of this circuit are instruction signals for apparently advancing the position of the elevator car A from the actual position. For instance, the position of the elevator car A is apparently advanced by zero floor, one floor and two floors respectively from the actual position by the instruction signals \( EOA \), \( E1A \) and \( E2A \). The operational amplifier \( OP_1 \) carries out subtraction of the signal \( C \) applied from the circuit shown in FIG. 5 from the signal \( C \) applied from the circuit shown in FIG. 6. Thus, the output \( V_{\text{opA1}} \) of the operational amplifier \( OP_1 \) is given by

\[
V_{\text{opA1}} = -(CA + C) = -CA + 1/3(CA + CB + CC)
\]

(3)

Similarly, the output \( V_{\text{opA2}} \) of the operational amplifier \( OP_2 \) is given by

\[
V_{\text{opA2}} = -9A/R7A \cdot V_{\text{opA1}} - 9A/R8A \cdot da
\]

(4)

When the ratios among the resistors \( R_7A, R_8A \) and \( R_9A \) 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

\[
V_{\text{opA2}} = - K_i(-CA + CA + CB + CC)/3 - K_2/da = K_i CA - K_2/3(CA + CB + CC) - K_2/da
\]

(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 \( V_{\text{opA2}} \) is given by \( V_{\text{opA2}} = - K_2/da \) when the number of stop requesting calls for each elevator car is equal to the mean value of such calls. However, \( K_2/3(CA + CB + CC) = + 3 \) 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, \( K_i CA - K_2/3(CA + CB + CC) = - 3 \) 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 between the elevator cars in-
cludes the time interval taking into consideration 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 \( V_{\text{OPA}} \) is given by \( V_{\text{OPA}} = -4\) 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 due to the fact that \(-3\) volts and \(-5\) volts are applied thereto, and the output of the comparator CMA2 is also 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 EO A appearing from the NOT element NA takes the state 0.

When \( V_{\text{OPA}} = -5\) 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 EO A, 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.

FIGS. 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. FIG. 10 shows a circuit for generating inhibit signals and determination of an elevator car responding to a hall call and such circuit is provided for each floor. FIG. 11 shows a circuit for determining the priority order of elevator cars responding to a hall call and such circuit is provided for each floor.

The circuit shown in FIG. 9 includes AND elements A1UA1 to A9UA4 and A2DA1 to A1OD4, OR elements, O1UA3 to O9UA5 and O2DA3 to O1OD5, and INHIBIT elements IN1UA1 to IN9UA3 and IN2DA1 to IN10DA3. Inhibit signals IU1 to IU4 and 2D to 1D are applied from the circuit shown in FIG. 11 although only one signal 2U is shown in FIG. 11. Inhibit signals M1U to M9U and M2D to M10D are applied from the circuit shown in FIG. 10 in response to the application of signals R1U2A to R9UC2 and R2DA2 to R1D2C (described later) to respective OR elements O1U to O9U and O2D to O10D. 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 L1ODA appear from the circuit shown in FIG. 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 EO for these two elevator cars A and B are generated. It is supposed fur-
of the OR element 02UB4 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 exist 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 FIG. 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 FIG. 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.

FIG. 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, FIG. 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 relays Ry9UA to Ry9UC (FIG. 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 IN1ODA3 to IN8DA3 in FIG. 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 FIG. 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 FIG. 12 (arc extinguish circuit is not shown). Due to the energization of the relay R9UA, the signal Ry9UA2 is applied to the OR element 09U in FIG. 10 to provide the inhibit signal M9U as the inhibit input to the INHIBIT elements IN9UA3, IN9UB3 and IN9UC3 in FIG. 9. The self-holding amplifier element R9UA in FIG. 9 holds itself so that the guide lamp S9UBA 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 the modern elevator control process. It will be understood from the above description that the same guide lamp is kept energized in FIG. 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 FIGS. 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 EOA, E1A and E2A for the elevator car A are obtained by the circuits shown in FIGS. 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 the elevator car A and succeeding elevator car shown in FIG. 4, the position signals representing the positions of the elevator cars B to F are applied to the OR elements 01UA2 to 09UA2 and 02DA2 to 010DA2.

In the stop requesting call detecting circuit associated with the elevator car A shown in FIG. 5, 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 FIG. 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 the circuit shown in FIG. 5. Further, additional resistors R, and additional contacts NO7 to NOF2 associated with the elevator cars D to F are provided. Thus, the output CC of the operational amplifier OP1 represents the mean value of cage calls requesting stoppage.

Similarly, additional contacts NO3 to NOF3 and additional resistors R2 must be provided in the reference voltage generating circuit shown in FIG. 7.

In the time interval estimating circuit associated with the elevator car A shown in FIG. 8, the inputs are the signal CC representing the mean value of cage calls and the signal CCA representing the number of cage calls registered in the elevator car A.

By varying the circuits shown in FIGS. 4 to 8 in the manner above described, it is possible to obtain the position advancing instruction signals EOA to E3A as in the preceding embodiment.

FIGS. 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.

FIG. 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 FIG. 14, position signals FIUA to F2DC and position advancing instruction signals EOA 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.

FIG. 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 O1ODA5 in the hall call response determining circuit associated with the elevator car A shown in FIG. 9. In the preceding embodiment, the apparent position signal for the elevator car A is detected in the circuit portion disposed in the stages after the OR elements O1UA3 to O9UA3 and O2DA3 to O1ODA3 in FIG. 9, but in this embodiment, such signal is detected by the circuit shown in FIG. 14.

The circuit shown in FIG. 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.

FIG. 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 FIG. 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.

FIG. 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 FIG. 10.

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

FIG. 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 FIG. 12 in the preceding embodiment. When the elevator car group W responds to hall calls, corresponding relays Ry1UW to Ry9UW and Ry2DW to Ry1ODW are energized by associated self-holding amplifier elements R1UW to R9UW and R2D2 to R1ODW.

FIG. 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. FIG. 19 corresponds to FIG. 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 EOA appears. In response to the application of both the position signal F2UA and the position advancing instruction signal EOA to the AND element A2UA1, an output of 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 FIG. 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 floor, 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 FIG. 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 F8U for the group Z takes the state 1 and the inhibit signal 8U appears in the circuit similar to that shown in FIG. 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 of 1 appears from the AND element A2UW in FIG. 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 Ry2UW is closed in FIG. 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 02U shown in FIG. 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 FIG. 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.

FIG. 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 FIGS. 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 percent 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 requesting stoppage of each elevator car is solely derived from the circuit shown in FIG. 5. This is because hall calls are not applied to each individual elevator car but to the elevator car group and the stoppage of the 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 FIG. 21. This circuit is associated with the elevator car A. Cage call signals C1A to C1OA registered in the elevator car A are applied to respective resistors r1 and hall call signals M1UW to M9UW and M2DW to M10DW are applied to respective resistors r2 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 r1 and r2 must be selected to give the relation r1 = r2.3. In other words, the total number of hall calls applied to the responding elevator car group W is equally divided into one-third 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 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 in no way limited to the embodiments described hereinbefore and 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 another. However, the present invention is in no way limited to the control means illustrated in the drawing. For instance, the circuits shown in FIGS. 4 to 8 for obtaining the position advancing instruction signals EQA to EQA 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 02UW3 shown in FIG. 14 so as to obtain the position signal representing the apparent position of the group W.

Further, although the elevator car or elevator car group which 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 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 origin of hall calls. For example, the AND elements A1UW to A9UW and A2DW to A10DW in FIG. 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 origin of hall calls.

What is claimed is:

1. An elevator signaling system for use in a building having a plurality of elevator cars arranged in parallel for serving a plurality of service floor landings, comprising means for selecting one group of the elevator cars which can respond to a hall call among a plurality of elevator car groups in response to origin of the hall call, and guiding means adapted to be actuated in response to the application of the output of said selecting means, said guiding means being disposed at each floor landing and provided for each elevator car group.

2. An elevator signaling system as claimed in claim 1, wherein said means for selecting the elevator car group that can respond to a hall call includes means for identifying the elevator car which can respond to the hall call and means for actuating the guiding means associated with the elevator car group including said identifying elevator car in response to the application of the output of said identifying means.

3. An elevator signaling system as claimed in claim 2, wherein said means for identifying the elevator car that can respond to a hall call includes means for establish-