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[54] ELEVATOR CONTROL SYSTEM WITH PRIORITY DISPATCHING CAPABILITY

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[52] **U.S. Cl.** .....**187/29 R**

[51] **Int. Cl.**.....**B66b 1/22**

[58] **Field of Search**.....187/29

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[57] **ABSTRACT**

In a multicar elevator system, means are provided to assign priority status to a call for service having the longest waiting time. The nearest available car to the landing at which that call is made is assigned to respond to only that call. The car responding to a priority call may also be assigned to respond to calls made at an adjacent located in the direction of travel of the car to the priority call landing.

26 Claims, 6 Drawing Figures

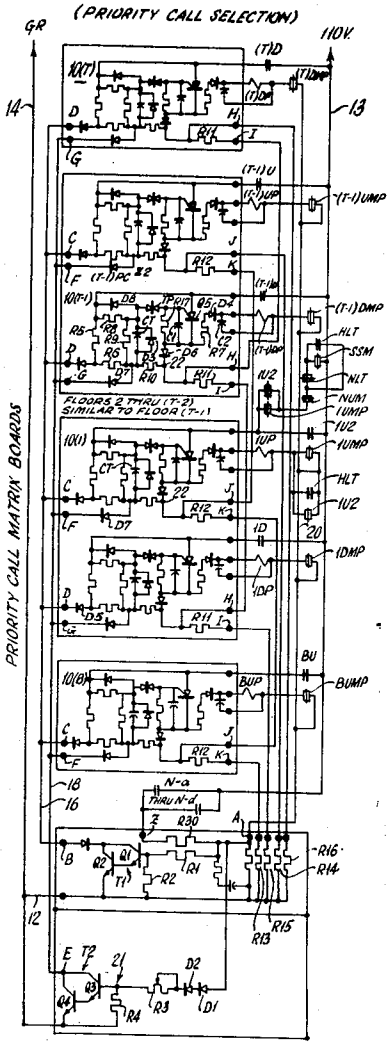


Fig. 1.

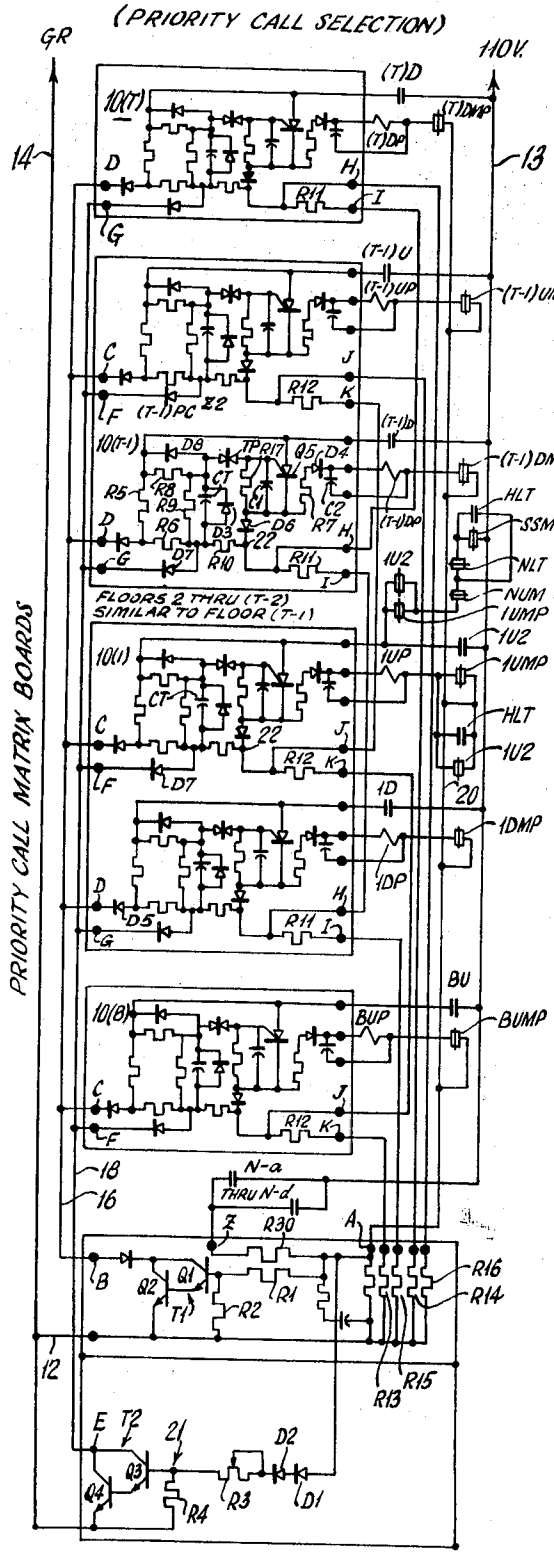
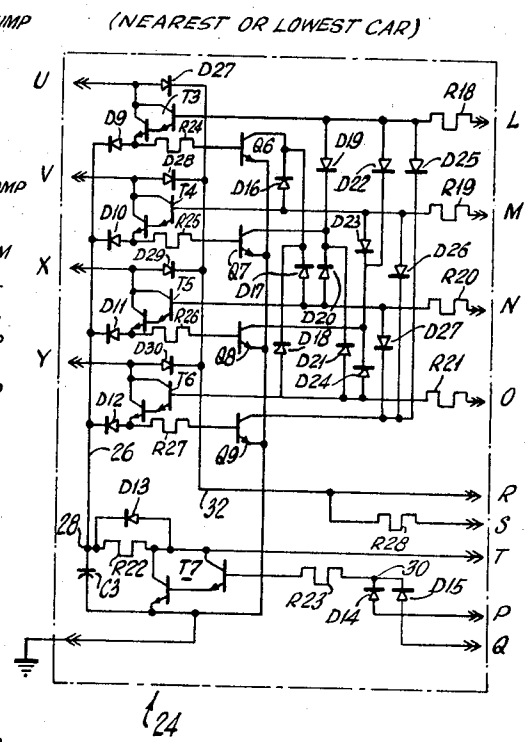


Fig. 2.



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Fig. 3.

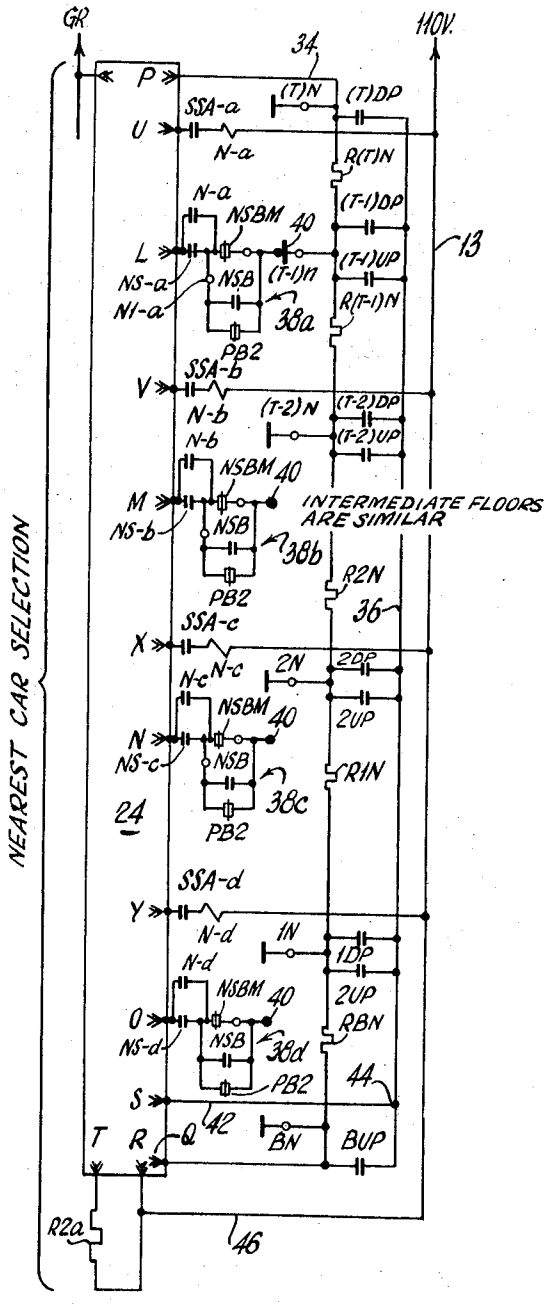
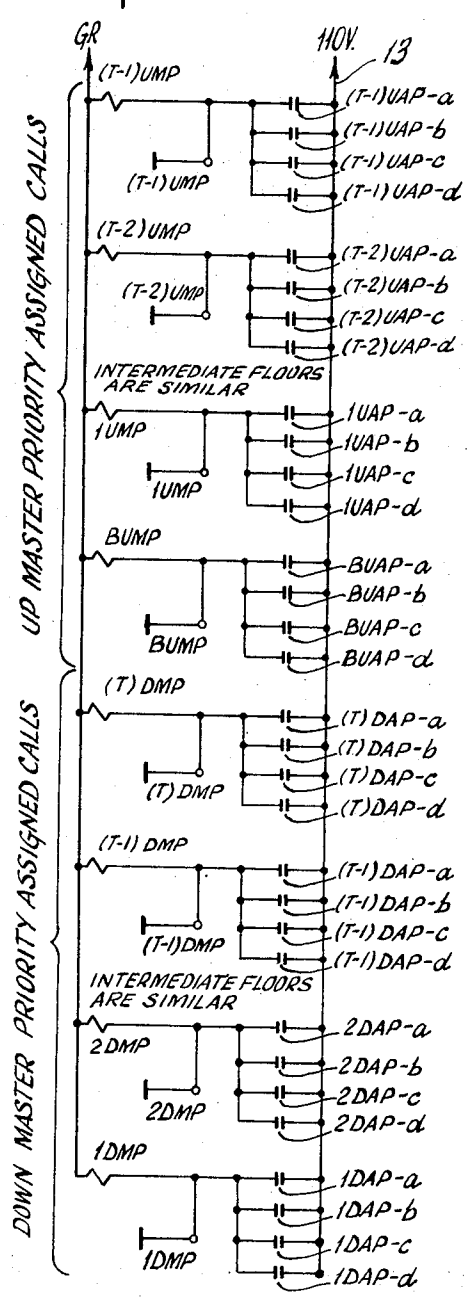


Fig. 4.



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Fig. 5.

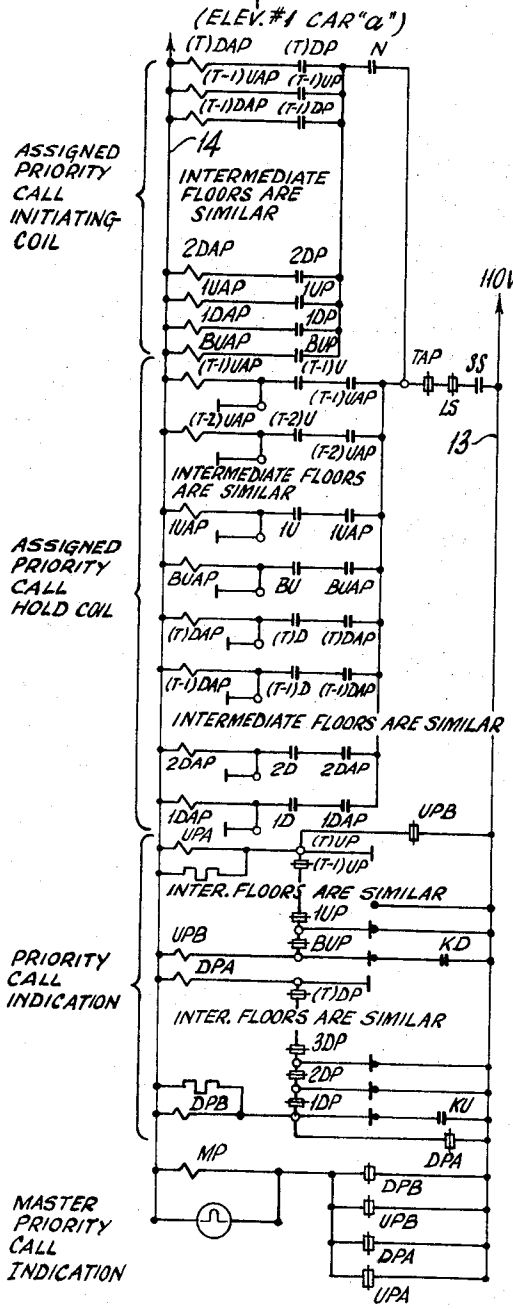
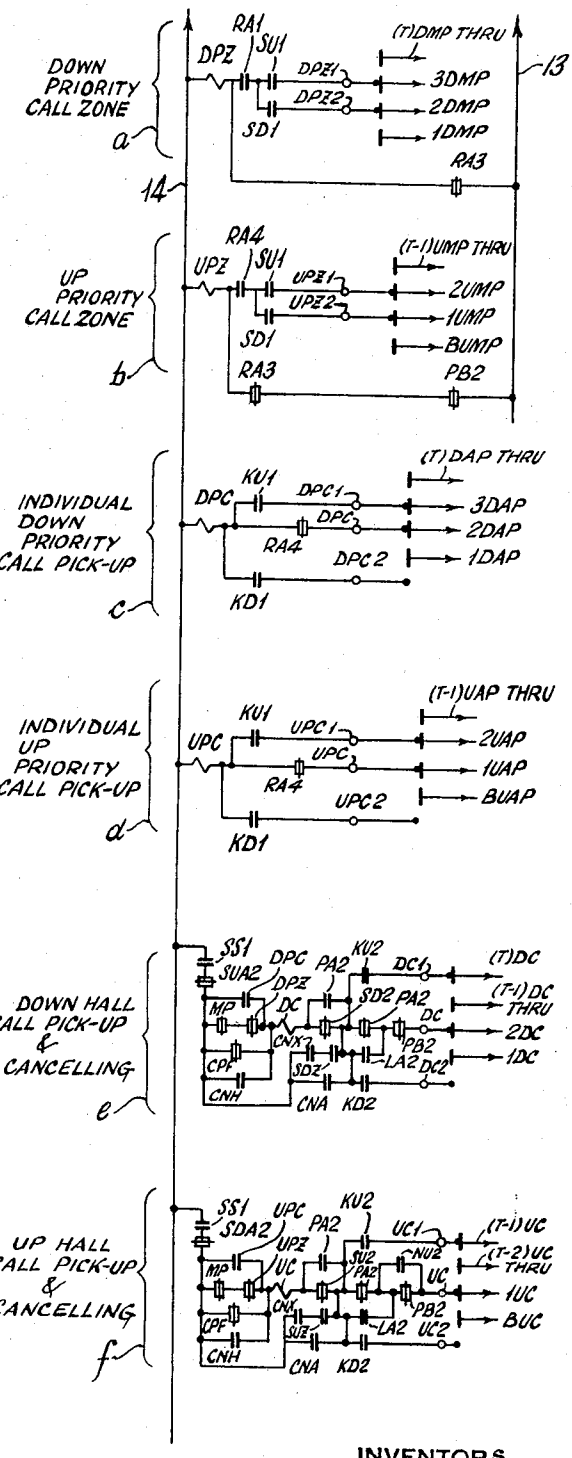


Fig. 6.



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ELEVATOR CONTROL SYSTEM WITH PRIORITY DISPATCHING CAPABILITY

The present invention relates generally to elevator control systems, and particularly to an elevator control system having the capability of assigning a car to respond to a specified priority call made for elevator service.

In practically all large office buildings and in many apartment dwellings, passenger service between floors or landings in the building is provided by elevator cars operating between those landings. The trend in recent years has been to control the operation of the elevator cars by automatic control systems in contrast to the manual systems under the control of operators riding in the individual cars. In most such automatic control systems the elevator car is operated in response to a call made for service either from a location at a landing, which is designated as a hall call, or by a demand for service made by pressing a floor select button located within the car itself, which is designated as a car call. The making of both hall and car calls are registered in suitable portions of the control system, and a car is then assigned to respond to that call. When the response to the call is completed, the call registration is cancelled.

To increase the efficiency of operation of automatic elevator control systems it has been proposed to assign certain cars to respond only to calls made within specified zones rather than having each car available to respond to calls made at any landing in the building. In such zone dispatching systems, the elevator car may be dispatched to either the highest or lowest landing at which a hall call is unanswered, or the elevator car may be dispatched to the landing at which a hall call is registered, which is the furthest distance from the present location of the car.

In most of the known automatic dispatching systems a timer operates to dispatch a car to respond to a hall call at a predetermined time after the call is registered. No distinction is made in this system of which of the registered hall calls was the first to be made, and the dispatched car stops at all registered hall calls in the direction of its travel without regard to the times at which those calls were made. As a result the person making a hall call at a landing which is outside the immediate zone of the dispatched car must often wait a considerable length of time for elevator service, since the car-dispatching system is not aware of the longest-waiting hall call, and moreover must answer all intermediate hall calls along its direction of travel. Moreover, the dispatching of cars in this manner often causes the cars to bunch or congregate at certain areas in the hatch rather than being uniformly spread out, thus reducing the ability of the cars to promptly respond to hall calls made in other sections in the building. In addition, the car assignment for response to hall calls in the known dispatching systems is often arbitrary and has no bearing on the proximity of the car to the floor at which the hall call is made.

Thus in the known elevator-dispatching systems a passenger making a hall call is frequently required to wait for elevator service for an unnecessarily, and often intolerably, long time. Moreover, the frequent bunching of the cars in the hatch produces inefficiencies in system operation since the cars are often positioned at great distances from certain floors in the building. Optimum usage of all the cars to answer hall calls in an automatic elevator control system remains a goal, to which the successful solution has as yet eluded the art.

It is, therefore, an object of this invention to provide an automatic elevator-dispatching system in which the longest-waiting call is assigned priority status, and which reduces the time required for a passenger to wait for elevator car service.

It is a more general object of the present invention to provide an automatic elevator control and dispatching system in which more effective use is made of the cars in that system.

It is another object of the present invention to provide an improved elevator-dispatching system of the type described, which is completely automatic in operation and which is reliable in operation over long periods of service.

In the dispatching system of the present invention a hall call that has been waiting the longest is designated as a priority call, and a suitable registration of that call is made. Basically there can be only one priority call registered at a given time except for calls made in the priority zone. If only one hall call is registered it automatically becomes a priority call.

The nearest available car, that is, the car that has completed its car calls and assigned priority calls and is located at a landing nearest that at which the priority call is made, is assigned to respond to the priority hall call. Once that car has been assigned to the priority hall call it bypasses all other hall calls that may be subsequently made and proceeds directly to its assigned priority call at the landing at which the priority call is made.

Once a priority call is registered a zone of priority calls may be established which zone is one or two floors either above or below the priority call landing. Hall calls made at these landings may also become priority calls and will be answered by the assigned car so long as they are in the same direction of travel as the initially registered priority call.

The priority call that has been assigned to a particular car is defined as an assigned priority call. This call is specifically assigned to one car and will normally not be answered by any other car. Once a priority call is registered it prevents all other hall calls from being designated as priority calls except for those calls made in the priority call zone. Once the assigned priority call is removed from the priority call system and transferred to the assigned car, the system is then permitted to select another priority call based on the then longest waiting hall call, and to assign another car to the newly registered priority call if one is available. The latter assigned car will be, as before, the nearest available car to the landing at which the new priority call is registered.

To the accomplishment of the above and to such further objects as may hereinafter appear, the present invention relates to an automatic elevator-dispatching system as defined in the appended claims and as described in the following specification taken together with the accompanying drawings in which:

FIG. 1 is a schematic diagram of the priority call selection and registering circuits for the various landings in a building in accordance with a preferred embodiment of the control and dispatching system of the present invention;

FIG. 2 is a schematic diagram of the nearest car select circuitry for a four-car system for use in the system of the present invention;

FIG. 3 is a relay logic diagram of the nearest car select circuit of the system of the invention;

FIG. 4 is a logic circuit of the up-and-down master priority assigned call circuit of the system;

FIG. 5 is a relay logic diagram of the up-and-down assigned priority call-initiating circuits; and

FIGS. 6 *a–f* are respectively schematic logic relay diagrams of the up-and-down priority call zone circuits, the up-and-down priority call pickup circuits, and the up-and-down call pickup and call-cancelling circuits, of the system of the present invention.

The automatic control and dispatching system of the invention is herein described with reference to an elevator system comprising a number of elevator cars capable of responding to a call made at any one of the landings in a building. The system senses which of these hall calls has been waiting the longest for service, to wit, the longest-unanswered hall call. That call is designated as a priority call. The system then assigns the nearest available car that is, a car that has completed its car calls and assigned priority calls to respond to the priority call or to hall calls made within a priority call zone consisting of the landing at which the priority call is registered, and one or two floors above or below that landing depending on the direction (i.e., up or down) of the hall call.

In the following specification and in the drawings, the relay contacts and energizing coils employed in the system are given the following functional designations.

Relay	Function

CNA	Hall Call Canceling
CNH	Call Cancel Hall
CNX	Hall Call Canceling, Floor line
CPFL	Common Power Failure Indication
DC	Down Hall Call Pickup
DP	Down Priority Call
DPC	Down Priority Call Pickup
DPA	Down Assigned Priority Call Row, Up Direction
DPB	Down Assigned Priority Call Row, Down Direction
DPZ	Down Priority Call Zone
KD	Intermediate Speed Down Ind.
KU	Intermediate Speed Up Ind.
LA	Leveling Slow Speed
MP	Master Priority Call Ind.
NU	Next Up Indication
NS	Next Available Car Ind.
NSB	Next Available Back Up Car
NSBM	Next Available Back Up Car Master
PA	Potential Switch Ind.
PB	In service At Bottom Terminal INd.
PBA	In Service At Bottom Terminal—Common Panel Ind.
RA	Releveling Indication
SDA	Signal for Down Direction
SD	Start Down Direction
SUA	Signal for Up Direction
SU	Start Up Indication
SS	In Service Indication
SSA	In Service Indication—Common Panel
UC	Up Hall Call Pickup
UP	Up Priority Call
UPC	Up Priority Call Pickup
UPA	Up Assigned Priority Call Row, Up Direction
UPB	Up Assigned Priority Call Row, Down Direction
UPZ	Up Priority Call Pickup
BUAP	Bsmt. Up Assigned Priority Call
1UAP thru (T-1)UAP	1st Floor Up Assigned Priority Call Floor Below Top Floor Up Assigned Priority Call
1DAP	1st floor Down Assigned Floor Call
2DAP thru (T)DAP	2nd Floor Down Assigned Priority Call Top Floor Down Assigned Priority Call

The priority call registering circuitry is preferably contained on a plurality of printed circuit cards each generally designated **10**, there being one such card for each landing in the building in which the elevator system is installed. The cards for each landing, except for the top floor (T) and the bottom floor (B), each contain two substantially identical circuit, one for registering a down hall call at that landing, and the other for registering an up hall call made from that landing. Conveniently the top and bottom priority call circuits **10**(T) and **10**(B) may be combined on a single common printed circuit card.

The plurality of priority calls circuits are all connected to a priority call bias board **12** which contains a first Darlington pair **T1** comprising transistors **Q1** and **Q2**, and a second Darlington pair **T2** comprising transistors **Q3** and **Q4**. The cards are interconnected to one another in a manner more completely described below and each card, has terminals connected to a 110-volt supply line **13**, and a ground line **14**.

When no hall call is made, none of the U or D relay contacts are closed so that there is no significant voltage at point A on card **12**. Point A is connected through a resistive voltage divider comprising resistors **R1** and **R2** to the input base of Darlington pair **T1** so that the latter is in the nonconductive state and output point B of Darlington pair **T1** is at a high level. Point B is connected by a line **16** to point C of each up hall call circuit and to point D of each down hall call circuit. Points C and D on all cards **10** are thus also at a high potential level at this time.

Point A is also connected through a pair of series connected diodes **D1** and **D2** and a variable resistor **R3** to the input of Darlington pair **T2**. Resistor **R4** defines a resistive voltage divider with resistor **R3** to limit the potential at that input. With point A at its low level, Darlington pair **T2** is also nonconductive and its output point E connected by a line **18** to point F on all the up hall call circuits, and points G on all the down hall call circuits is at a high level.

In the following description it will be assumed that a down hall call is made at landing (**T–1**), that is, the landing immediately below the top floor T, it being understood that this description is equally applicable to any up or down hall call made at any other landing.

When a hall call is made by the operation of a suitable member located at landing (**T–1**), relay (**T–1**) **D** is energized in a known manner, its contacts are closed, and the anode of SCR **Q5** in the (**T–1**)**D** circuit is connected through these contacts to line **13**. Line **13** is also connected through these contacts and by resistors **R5** and **R6** and diode **D3** to apply a suitable voltage to a trigger diode TP causing the latter to conduct, thereby producing a pulse at the gate of SCR **Q5**. This pulse causes energizing current to flow through the anode-cathode circuit of SCR **Q5**, resistor **R7**, diode **D4** and the coil of relay (**T–1**)**DP**, the priority call relay for a down hall call made at landing (**T–1**). In this manner a priority call is registered for the hall call made at that landing signifying that that call is the longest-waiting unanswered hall call, or priority call.

The coil of relay (**T–1**)**DP** is connected through the normally closed (**T–1**)**DMP** contacts and a line **20** to point A. That point thus becomes charged to a relatively low potential upon the conduction of SCR **Q5** and the ensuing energization of the (**T–1**)**DP** relay. That low potential is reflected at the input of Darlington pair **T1** and is sufficiently low to cause Darlington pair **T1** to turn on, which in turn causes point B on card **12** to go to substantially ground potential. When this occurs, points C and D in all the priority call circuits are also tied to ground. If a hall call were then made, for example, an up hall call at the first floor, the **1U** relay contact would close to connect the anode of the SCR in the first floor up call circuit to the 110-volt line. However, a capacitor CT in that circuit would charge through a resistor **R8** to a level determined by the voltage division effected by a voltage divider comprising resistors **R8** and **R9**, the latter being connected to ground at point D through a then-conducting diode **D5**. The value of resistor **R6** is chosen so that its effect on the charging of capacitor CT compared to that of resistors **R8** and **R9** is negligible.

Resistors **R8** and **R9** normally limit the maximum voltage to which capacitor CT may charge to a level below the breakdown voltage of trigger diode TP and thus prevent the actuation of the SCR in that circuit. The subsequent making of a hall call after the initial registration of a priority hall call is therefore prevented as desired.

In some applications of the dispatching system of the invention, it may be desired to establish a priority zone comprising the priority call landing and one or perhaps two adjacent landings in the same direction as the priority call with respect to that landing. To this end each capacitor CT has its lower side connected through a resistor **R10** and a resistor **R11**. The latter resistor is connected in series to similar junction points and resistors located in all other up hall call registration circuits. A similar series resistor chain is formed of resistors **R12** arranged in all the down hall call registration circuits. Each series resistor chain is connected at either end to ground in circuit board **12**, resistors **R13** and **R14** respectively being connected to ground and to the two ends of the series resistors **R12**, and resistors **R15** and **R16** serving the same function for the series chain of resistors **R11**.

For the priority call circuit for which a down hall call is initially registered, this call being the priority call, the SCR **Q5** in that circuit is actuated, and point **22** in that circuit, connected to the cathode of SCR **Q5** through a diode **D6**, is raised to a relatively high potential, as are points H and I (points J and K for an up call circuit). That high potential increases the voltage at the lower end of capacitor CT and may be sufficient to allow that capacitor to charge to a voltage above the breakdown voltage of trigger diode TP.

It will be noticed that the potential at point **22** is highest at the circuit in which the initial hall call is registered, and is next

highest at the circuit for the landing adjacent the priority call landing due to the voltage drop in resistor R11 (or R12) in the former circuit. That voltage decreases rapidly through the other series-connected resistors R11 or R12 for landings further removed from the initial priority call landing. By the proper selection of resistors R11 (and R12) a subsequently made hall call at a landing adjacent or even once removed from the initial priority call landing can also become a priority call if the later-made calls are in the same direction (up or down) as the initial priority call.

After each priority call is registered by the energization of the corresponding DP or UP relay in the priority call circuit, the positive potential at point A is incrementally increased. After a predetermined number of priority calls (e.g., one or two) the potential at point 21 becomes sufficient to turn on Darlington pair T2, that number being determined by the adjustment of variable resistor R3. When Darlington pair T2 is turned on in this manner points F and G on all priority call circuits are tied to ground and the lower end of all capacitors CT are connected to ground at line 18 through the then conducting diode D7. The clamping of the charging capacitors CT thereafter prevents the registering of any subsequent priority calls since the trigger diodes TP in all circuits can no longer be triggered, and the SCR's in those circuits can thus not be actuated.

As will be more completely described below, an available car, that is an elevator car that has cleared all of its car calls and previously assigned priority calls, is selected to respond to the registered priority call. This car selection causes one of the N-a–N-d relays to be energized (FIG. 3) depending on which of the four elevator cars *a*, *b*, *c* or *d* is thus selected. The simultaneous energization of the N relay and the associated DP or UP priority relay causes the energization of the DAP or UAP relay (FIG. 5), which in turn causes the energization of the associated DMP or UMP relay (FIG. 4).

Referring again to FIG. 1, the actuation of the DMP or UMP relay upon the assignment of a car to respond to the registered priority call causes its contacts to open and thus opens the return path of the DP or UP relay and SCR Q5 causing the latter to be turned off. As a result the voltage at point A is gradually removed causing first Darlington pair T2, and then Darlington pair T1 to become nonconductive. Prior to this time, however, hall calls were being registered and capacitor CT in the associated priority call circuits were gradually charging to a level which was, however, limited by the clamping effect of Darlington pair T2, that is below the breakdown voltage of triggering diode TD.

However, when point E rises as a result of the turning off of Darlington pair T2, the charging capacitors CT are no longer clamped to ground. The priority landing select circuit 10 having the greatest charge on its capacitor CT will thus have its trigger diode TP triggered into conduction and its SCR Q5 operated. The priority call selection and car assignment for that hall call is then repeated in the manner described above for the next hall call having the longest waiting time.

The charge on the capacitor CT of the priority call circuit for the initial priority hall call to which an available car has been assigned is not, however, removed, until the hall call relay D or U, is deenergized to disconnect that capacitor from the 110-volt line. That relay is in turn deenergized in a known manner such as when the selected car responds to that priority call, or when a car stops for a car call at a landing at which any type of hall call (priority or nonpriority) is registered. Capacitor CT then discharges rapidly through diode D8 and resistor R16.

To complete the priority cal registering circuit, a capacitor C1 and a resistor R17 are connected in parallel between the gate and cathode of SCR Q5 to ensure reliable switching operation of that device. A capacitor C2 is connected in shunt across the coil of the priority call relay DP or UP, to offset the inductance effect of the coil on the SCR to permit the latter to turn on quickly, and to rapidly apply a voltage to point A on priority call bias card 12, thereby to avoid erroneous multiple priority call indications.

The system of the present invention further contains means for assigning the nearest available car to respond to the priority call in the manner described above, if there are several cars available. To this effect, the available car located in the hatch at a landing nearest to the landing at which the priority call is made will be the car assigned to respond to that call. FIGS. 2 and 3 illustrate the logic and switching circuitry which perform this function in the system. In the following description, it will be assumed that the elevator system consists of four cars designated *a*, *b*, *C* and *d*, each of which may, if available, be assigned to respond to a priority call.

In FIG. 3, the circuit of FIG. 2 is enclosed in rectangle 24 and correspondingly designated terminals in FIGS. 2 and 3 are connected to one another. The circuit of FIG. 2 comprises four Darlington pairs T3–T6, one pair being provided for each of the elevator cars *a–d*. The emitters of these Darlington pairs are respectively connected through diodes D9–D12 to a common line 26, and their bases are respectively connected through resistors R18–R21 to circuit output terminals L, M, N and O. A control Darlington pair T7 has its collector connected through a resistor R22 to line 26 at a point 28. A capacitor C3 is connected between point 28 and the grounded emitter of Darlington pair T7.

A diode D13 is connected in parallel with resistor R22, and the base of Darlington pair T7 is connected through a resistor R23 to a point 30 to which the cathodes of diodes D14 and D15 are connected. The anodes of these diodes are respectively connected to terminals P and Q.

The emitters of Darlington pairs T3–T6 are respectively connected through resistors R24–R27 to the bases of transistors Q6–Q9, the emitters of which are connected in common to ground. The collector of transistor Q6 is respectively connected to the bases of Darlington pairs T4, T5 and T6 through diodes D16, D17 and D18; the collector of transistor Q7 is respectively connected to the bases of Darlington pairs T3, T5 and T6 through diodes D19, D20 and D21; the collector of transistor Q8 is respectively connected to the bases of Darlington pairs T3, T4 and T6 through diodes D22, D23 and D24; and the collector of transistor Q9 is respectively connected to the bases of Darlington pairs T3, T4 and T5 through diodes D25, D26 and D27.

The collectors of Darlington pairs T3–T6 are respectively connected through diodes D27–D30 to a line 32 which in turn is connected to a terminal R, and through a resistor R28 to a terminal S. The collector of Darlington pair T7 is connected to terminal T, and the collectors of Darlington pairs T3–T6 are respectively connected to terminals U, V, X and Y. As shown in FIG. 3, a resistor R2*a* is connected across terminals R and T, and terminal R is connected to the 110-volt line 13.

The nearest car select circuit comprises a chain 34 of series-connected resistors RBN–R(T)N, there being one such resistor for each landing in the building. That resistor chain is connected between terminals P and Q of nearest car select circuit 24. The normally open contacts of the up-and-down priority relays DP and UP are connected between spaced points defined along resistor chain 34 and a line 36, there being one such connection above the top landing resistor R(T)N and one such connection below the bottom landing resistor RBN, through the contacts of relay (T)DP and BUP respectively. For the other landings, such as landing (T–1), there are two such contact connections provided above the corresponding landing select resistor, such as resistor R(T–1)N.

Also connected at spaced points along resistor chain 34 at locations between the landing select resistors, are selector segments BN–(T)N, there being one segment provided for each landing. Each elevator car has associated therewith a brush connected to a landing-sensing circuit 38*a*–38*d*, each of which comprises parallel connected normally open contacts of the corresponding N and NS relays, the latter being energized to close its contacts when its associated car is available, that is, it is not running, has no registered car calls, and its doors are closed. That parallel circuit is series connected with the parallel NSBM, PB2 and NSB contacts, the first two of which are normally closed, and the last of which is normally opened. The

parallel combination of the NSBM and NSB relay contacts provides preference for the nonselected car at the lobby landing. When a car is at a particular landing, its brush, input point **40**, is connected to the segment at that landing and through that connection to the corresponding point on resistor chain **34**. Circuit **38***a* of car a is shown in FIG. **3** as being at landing (T–**1**) so that point **40** of that circuit is connected to resistor chain **34** at a point intermediate resistors R(T–**1**) N and R(T)N. The output points of circuits **38***a*–**38***b* are respectively connected to terminals L, M, N and O of car select circuit **24**. Terminal S of circuit **24** is directly connected by a line **42** to line **36** at point **44**, and through resistor **R28** to terminal R. Terminal R is in turn connected by a line **46** to the 110-volt line **13**. Point **44** and thus line **36** is tied to the voltage supply line through resistor **28**.

When there is no registered priority call, the various UP and DP relay contacts are all open, line **36** is not connected to resistor chain **34** and terminals P and Q, so that there is no high voltage at these terminals. As a result Darlington pair **T7** is in the off condition and point **28** is high since the collector of Darlington pair **T7** is connected to terminal T and through resistor **R2***a* to the voltage supply line. Capacitor **C3** is thus charged to practically 110 volts at this time, and diodes **D9–D12** are all reverse biased.

When a priority call is registered, one of the priority relays is energized, its contacts are closed, and line **36** is thereby connected through those closed contacts at a corresponding junction point on resistor chain **34**. Thus if the priority hall is an up hall made at landing (T–**1**), the (T–**1**) UP relay contacts are closed and the point on resistor chain **34** intermediate resistors R(T–**1**)N and R(T)N is connected to line **36** and thus to the 110-volt line. It is to be recalled that each of circuits **38***a*–**38** is connected at various points along resistor **36** depending on their respective location. The voltage level at these points is a function of the distance of those landings from the priority call landing as a result of the potential drops across the landing select resistors in resistor chain **34**. In this example, the potential is highest at the (T–**1**)N brush connection and decreases with increasing distance from that connection. As a result the potential at terminals L, M, N and O, assuming that all cars *a–d* are available, is highest for the car nearest the landing at which the priority call is registered.

In FIG. **3** car a is closest to the (T–**1**) landing, so that its circuit **38***a* is connected to the highest voltage point on resistor chain **34**, and terminal L is the highest of terminals L–O. If car *b*, *c* or *d*, were located nearest the landing at which the priority call is registered, terminal M, N or O respectively would then be at the highest relative voltage with respect to the other terminals.

The closing of the priority relay contacts establishes a voltage along resistor chain **34** as described above and thus produces a potential drop across its end terminals P and Q. This potential drop is reflected at the base of Darlington pair **T7** and has the effect of turning Darlington pair **T7** on. Capacitor **C3** then begins to discharge through resistor **R22** and the collector-emitter circuit of Darlington pair **T7**.

As capacitor **C3** discharges, one of the Darlington pairs **T3–T6** having the highest potential at its base will begin to conduct, since its base will be the first to become sufficiently positive with respect to its emitter, which is tied to the high end of the discharging capacitor **C3**.

Upon the conduction of that Darlington pair, its initially high output terminal U, V, X or Y is grounded. If we continue the assumption that car a is the nearest available car to the priority call landing, the voltage at terminal L is the highest, Darlington pair **T3** is turned on, and the potential at terminal U decreases toward ground.

Referring again to FIG. **3**, it is seen that the coils of relays N-*a*, N-*b*, N-*c* and N-*d* are respectively connected between line !**13** and terminals U, V, X and Y. Assuming that the corresponding SSA relay is actuated, when one of these terminals is at a reduced or ground level, current is caused to flow between line **13** and the reduced voltage terminal, to bring about the energization of the corresponding relay. Thus, if as in the example given, when terminal U is at a reduced voltage, relay N-*a* is energized to bring about the selection of car *a* to respond to the registered priority call at landing (T–**1**). Thus as desired, the nearest available car to the priority call landing is assigned to respond to the registered priority call.

Moreover, upon the conduction of one of the select Darlington pairs **T3–T6**, the transistor **Q6–Q9** respectively connected thereto is caused to conduct and the inputs of all other Darlington pairs become clamped to ground through the diodes and the collector-emitter circuit of that transistor, thereby preventing the energization of the other Darlington pairs and the assigning of any other car to respond the registered priority call. If, for example, Darlington pair **T3** is the first to conduct current flows in the base circuit of transistor **Q6** turning that transistor on. Since a positive potential exists at terminals M, N and O, diodes **D16, D17** and **D18**, are forward biased and the bases of Darlington pairs **T4–T6** are respectively connected to ground through those diodes and the collector-emitter circuit of transistor **Q6**. Referring again to FIG. **1** it will be seen that contacts of relays N-*a* to N-*d* are connected in parallel between line **13** to terminal Z on circuit board **12**. Terminal Z is in turn connected to a resistor **R30** and through resistor **R1** to the base of transistor **Q1** of Darlington **T1**, and through diodes **D1, D2** and resistor **R3** to the base of transistor **Q3** of Darlington pair **T2**. When one of the cars is assigned as described above, one of contacts Na–Nd is closed and a positive voltage is applied to the input bases of Darlington pairs **T1** and **T2**. These Darlington pairs are thus maintained in their on state and thereafter prevent any other hall calls from becoming registered as priority calls, and also prevent the selected car from receiving more than its designated priority calls.

FIG. **5** illustrates the assigned priority call initiating circuit for a typical one of cars *a–d*. When the car select N relay, which may be any one of relays Na–Nd, is energized along with a priority call relay UP or DP for any landing, the corresponding UAP or DAP relay is energized. Thus, if as shown in FIG. **1**, the (T–**1**)DP relay is closed the third line in FIG. **5** is closed and the (T–**1**)DAP assigned relay is energized. The assigned car is then sent to respond to a down hall call at the (T–**1**) landing and will bypass all other hall calls as it travels toward its thus assigned priority call.

FIG. **4** illustrates the energizing circuit for the DMP and UMP relays upon the energization of the corresponding DAP or UAP relay. When the (T–**1**)DAP relay, for example, is energized, its contacts are closed and, as shown in FIG. **4**, the (T–**1**)DMP relay is energized. Referring to FIG. **1**, the energization of this relay opens the normally closed (T–**1**)DP contacts. The priority call having been registered and then assigned to an available car is, in this manner, unregistered.

Once the DAP or UAP relay is energized it remains energized even after the corresponding DP or UP relay is deenergized by the operation of the corresponding UMP or DMP relay, by the operation of the assigned priority call hold circuit shown in FIG. **5**. As can be seen in that circuit, the DAP or UAP relay coil, once energized, remains energized until the original hall call that initiated the priority call registration is answered, and the corresponding relay, e.g., (T–**1**)D, is deenergized.

FIG. **5** also illustrates the circuits for the priority call indicating relays UPA, UPB, DPA and DPB, which are normally energized when no assigned priority call is in registration. Relay UPA, or UPB, or DPA, or DPB is deenergized in response to the energization of the priority UP or DP relay depending on the direction of the priority call, and the landing location of the assigned car as indicated by the brush contacts shown in FIG. **5**.

The UPA relay when deenergized indicates an up priority call at a location above the location of the assigned car, and the UPB relay when deenergized indicates an up priority call at a landing below the location of that car. Similarly, the DPA and DPB relays when selectively deenergized, respectively in-

dicate down priority calls made at landings above and below the landing at which the assigned car is located.

The normally closed contacts of the BUP–(T–1)UP relays are connected in series between the UPA and UPB energizing circuits. At points between each adjacent pair of contacts a connection is made to a selector terminal which makes connection with the brush at the landing at which the car is located. For an up priority call one of the UP contacts for the assigned landing is opened to open the circuit path between the connected brush and one of the UPA or UPB circuits. The relay coil UPA or UPB is deenergized depending on whether the single open up contact is open above or below the brush contact. For example, if the car is at the third landing, and the 2UP contact is opened, the voltage is removed by the open 2UP series contact to deenergize UPB relay coil.

The down priority call contacts DP–(T)DP are likewise series connected between the DPA and DPB circuits, and are selectively deenergized upon the operation of one of the DP relays in a manner similar to that described above.

Also as shown in FIG. 5, the MP, master priority relay is deenergized at all times except when one of the UPA, UPB, DPA or DPB relays are deenergized thus indicating that priority service is available in the system. The energization of the MP relay prevents, as will be described below with reference to the UC and DC relays, a car having assigned priority calls from stopping at normal, that is, nonpriority hall calls or unassigned priority calls.

The control system of the invention also contains the relay-energizing circuits illustrated in FIG. 6. As shown in FIGS. *6a* and *6b* the UPZ (and DPZ) relays are energized when the UMP (or DMP) relay is energized and an unassigned car reaches the slowdown point at the floor at which the assigned priority call is made. This prevents the unassigned car from responding to a priority call to which a different car has been assigned.

As shown in FIGS. *6c* and *6d*, the UPC (and DPC) relays are energized when the UAP (or DAP) relay is energized and the assigned car has reached the slowdown point at the priority call landing. This energization of this relay permits the car to stop at its assigned priority call.

FIGS. *6e* and *6f* illustrate the energization circuits of the DC and UC relays, these relays when energized being effective to stop the assigned car at the assigned priority landing. The energization of the UPZ (or DPZ) or MP relay in the UC (or DC) energizing circuits opens their associated contacts, and thus prevents the energization of the UC (or DC) relay. However, the subsequent energization of the UPC (or DPC) relays closes its associated contacts and bypasses the open UPZ (or DPZ) contacts to thereby energize the UC (or DC) relay and bring the assigned car to a halt at the priority call landing. The energization of either the UC or DC relay energizes the advance call cancel relay (not shown) which cancels the hall call that had initiated the priority call registration, assignment and dispatching operation described herein.

It may be desired to cancel a priority call when an unassigned car stops at an assigned priority landing in response to a car call made in that car for a stop at that landing. To that end the UC and DC circuits may be provided with a CNH contact connected in parallel with the UPC (and DPC) contacts. The CNH relay is picked up when the car responds to a car call at the priority call landing, and is then effective to energize the UC (or DC) relay and thus cancel the priority hall call made at that landing.

The elevator control system of the invention thus provides improved operation of a multicar system by sensing the longest-waiting hall call made for elevator service, assigning a priority status to that hall call, and then dispatching an available car, which is preferably the available car nearest the landing at which that call is made, to respond to that call.

The operation of the system reduces the average time required for response to a hall call, and makes substantially better and more efficient use of the elevator cars by more effectively spreading the cars in the shaft. The circuitry for performing these priority call sensing, registering, and dispatching functions is relatively inexpensive and is highly reliable, and can be readily incorporated into existing control systems to provide those systems with the additional capabilities described herein.

While only a single embodiment of the invention has been specifically described herein it will be apparent that many modifications may be made therein without departing from the spirit and scope of the invention.

We claim:

1. A control system for a plurality of elevator cars operating in two directions of travel to serve a plurality of landings, said system comprising means at each of said landings for registering up and down direction calls requiring bidirectional elevator service from said landings, means for initially selecting the first registration of said up and down calls and for subsequently selecting said up and down landing call which has been waiting the longest time for service, and means responsive to said selecting means for assigning one of said elevator cars to selectively respond bidirectionally in accordance with the location of said car with respect to said selected call for servicing said call.

2. A control system for a plurality of elevator cars operating in two directions of travel to serve a plurality of landings, said system comprising means at each of said landings for registering calls fro elevator service, means for determining which of said landing calls has been waiting the longest time for service, means responsive to said determining means for sensing which of said cars is located nearest the landing at which said longest-waiting call is made, and means for dispatching said nearest car to respond to said longest-waiting landing call.

3. The control system of claim 2, in which said car-assigning means includes means for permitting said assigned car to respond to a call made subsequent to said longest-waiting call at a landing adjacent the landing at which said longest-waiting call is registered.

4. The control system of claim 3, in which said registering means comprises switch means, and trigger means operatively connected to said switch means, actuated when a predetermined signal is applied thereto, and effective when so actuated to operate said switch means.

5. The control system of claim 4, in which there are one of said switch means and one of said trigger means for each of said landings, and further comprising charging means operatively connected to said trigger means for establishing a signal level thereat, and second switch means operated upon the operation of one of said first-mentioned switch means and effective when operated to limit the voltage developed at said charging means to below said predetermined level, thereby to prevent the operation of predetermined others of said first switch means.

6. The control system of claim 5, and including a limiting means having a plurality of series-connected resistors operatively connected to said first switch means and said charging means and effective to establish progressively decreasing voltages at said charging means associated with landings progressively more distant from the landing at which said longest-waiting call is made.

7. The control system of claim 5, further comprising third switch means actuated after a predetermined number of said first switch means are operated, and effective when so actuated to prevent the subsequent actuation of all unactuated ones of said first switch means.

8. The control system of claim 3, in which said nearest car sensing means comprises a second plurality of series connected resistors, a junction point being defined between each adjacent pair of said second plurality of resistors, and means responsive to the operation of said first switch means for applying a supply voltage at a selected one of said junction points, thereby to establish a maximum potential at said one of said junction points and progressively decreasing potentials at junction points progressively removed therefrom.

9. The control system of claim 8, in which said nearest car sensing means further comprises a plurality of fourth switch means, there being one of said fourth switch means for each of said cars, means respectively operatively connecting said fourth switch means to certain ones of said junction points depending on the respective landing locations of said cars, and means for operating one of said fourth switch means operatively connected to a junction point having a higher potential thereat as compared to the junction points operatively connected to the other of said fourth switch means.

10. The control system of claim 9, further comprising means operatively connected to said fourth switch means for preventing the operation of the others of said fourth switch means after the operation of said one of said fourth switch means.

11. The control system of claim 1, further comprising means for preventing cars other than said one of said cars from being assigned to said longest-waiting call.

12. The control system of claim 2, further comprising means for preventing cars other than said one of said cars from being assigned to said longest-waiting call.

13. The control system of claim 1, in which said registering means comprises switch means, and trigger means operatively connected to said switch means, actuated when a predetermined signal is applied thereto, and effective when so actuated to operate said switch means.

14. A control system for a plurality of elevator cars operating in two directions of travel to serve a plurality of landings, said system comprising registering means having a switch means actuated by a predetermined signal through a trigger means for each of said landings for registering calls for elevator service and further including charging means operatively connected to said trigger means for establishing a signal level thereat, a second switch means operated upon the operation of one of said first-mentioned switch means to limit the voltage developed at said charging means to below said predetermined level for preventing the operation of predetermined others of said first switch means, means for determining which of said landing calls has been waiting the longest time for service, and means responsive to said determining means for assigning one of said elevator cars to respond to said longest-waiting call.

15. The control system of claim 14, and including a limiting means having a plurality of series-connected resistors operatively connected to said first switch means and said charging means and effective to establish progressively decreasing voltages at said charging means associated with landings progressively more distant from the landing at which said longest waiting call is made.

16. The control system of claim 14, further comprising third switch means actuated after a predetermined number of said first switch means are operated, and effective when so actuated to prevent the subsequent actuation of all unactuated ones of said first switch means.

17. The control system of claim 1, further comprising means for preventing the assigning of a car to respond to a landing call made subsequent to the registration of said longest-waiting landing call, until said one of said cars is assigned to said longest-waiting landing call.

18. The control system of claim 2, further comprising means for preventing the assigning of a car to respond to a landing call made subsequent to the registration of said longest-waiting landing call, until said one of said cars is assigned to said longest-waiting landing call.

19. The control system of claim 3, further comprising means for preventing the assigning of a car to respond to a landing call made subsequent to the registration of said longest-waiting landing call, until said one of said cars is assigned to said longest-waiting landing call.

20. The system of claim 1, further comprising means for preventing said assigned car from stopping at call registrations other than said longest-waiting landing call, and means for preventing assignment of more than one car to said longest-waiting landing call.

21. The system of claim 2, further comprising means for preventing said assigned car from stopping at call registrations other than said longest-waiting landing call, and means for preventing assignment of more than one car to said longest-waiting landing call.

22. An elevator control system having an elevator car serving a plurality of landings in a building, said system comprising means for making up and down direction calls requiring bidirectional elevator service at each of said landings, means for timing said service calls to select a first unanswered of said calls which has been waiting for service for the longest time and to continue timing of subsequently registered calls to continually select the longest-waiting call for service, and means for assigning said car to respond bidirectionally in accordance with the location of said car with respect to said longest-waiting landing call and for bypassing any subsequently made landing service call.

23. A method of operating an elevator system of the type comprising a plurality of cars serving a plurality of landings, said method comprising the steps of timing the registration of calls at said landings, selecting initially the landing at which a call for service has been registered and selecting subsequently in order the calls remaining unanswered for the longest time, and assigning, after said selecting, one of said cars to respond to said selected landing call.

24. A method of operating an elevator system of the type comprising a plurality of cars serving a plurality of landings, said method comprising the steps of sensing the landing at which a call for service has remained unanswered for the longest time, determining which of said cars is available and located nearest said landing at which said longest-waiting call is made, and assigning said nearest car to respond to said longest-waiting call.

25. A control system for a plurality of elevator cars operating in two directions of travel to serve a plurality of landings, said system comprising means at each of said landings for registering up and down direction calls requiring bidirectional elevator service from said landings, means for selecting the first registration of said up and down landing calls remaining unanswered, and means responsive to said selecting means for assigning one of said elevator cars to selectively respond bidirectionally in accordance with the location of said car with respect to said first registration and service said selected call.

26. An elevator control system having an elevator car serving a plurality of landings in a building, said system comprising means for making a call for service at each of said landings, means for timing said service calls to select a first unanswered of said calls which has been waiting for service for the longest time and to continue timing of subsequently registered calls to continually select the longest-waiting call for service, and means for assigning said car to respond to said longest-waiting landing call.

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