United States Patent

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[54] **ZONED ELEVATOR CONTROL SYSTEM INCLUDING AN ARRANGEMENT FOR CONTROLLING THE OPERATION OF CARS IN RESPONSE TO THE LEVEL OF TRAFFIC IN THE ZONES**
7 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **187/29**
[51] **Int. Cl.** **B66b 1/20**
[50] **Field of Search** 187/29

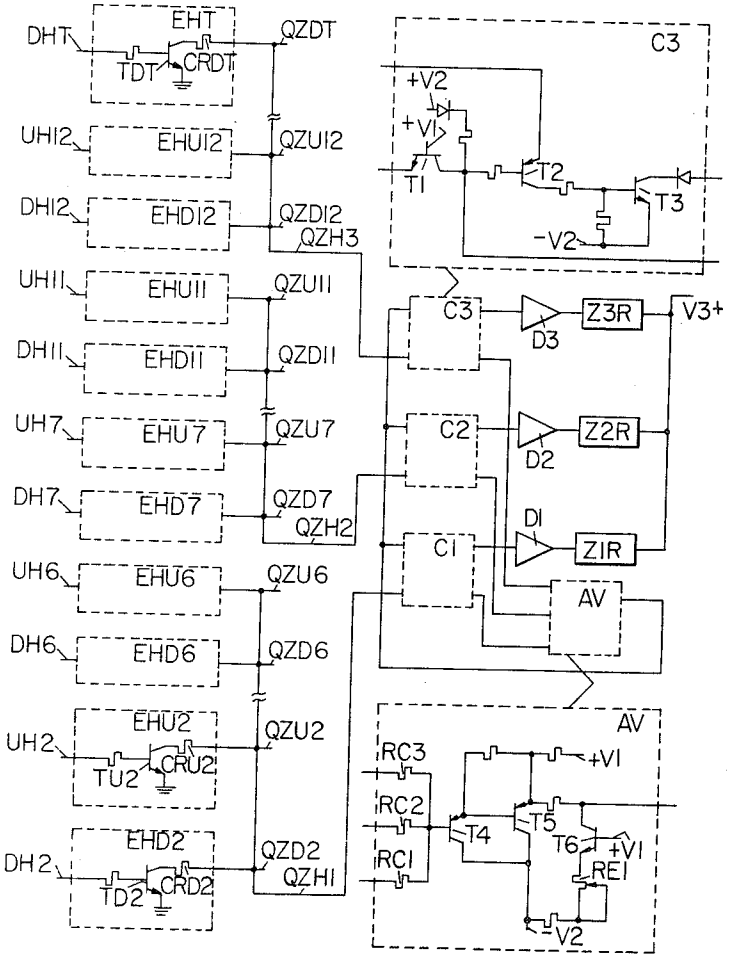
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ABSTRACT: A zoned elevator control system for a group of cars in which the cars are distributed on a predetermined apportioned basis into various zones of the building for assignment thereto, whereupon in the absence of calls each car is brought to a stop at a landing in a zone to which it is assigned. Thereafter in a zone to which a car is assigned the response to the first landing call is limited to a car assigned to that zone. A landing call in a zone to which no car is assigned starts a car assigned in the nearest lower zone. The level of traffic in each zone is measured individually and is a function of the number of landing calls in registration in the respective zone. An average of a number of landing calls in all zones is derived and a comparison is made between the number of landing calls in each individual zone and the average number of landing calls. Whenever the number in any zone exceeds the average by a predetermined amount it signifies that the zone is a heavy traffic zone. As a result the limitation on the response to landing calls to a car assigned to that zone is removed. This enables a car in the nearest lower zone to respond to landing calls in the heavy traffic zone notwithstanding another car is assigned to that zone. In addition while the heavy traffic demand continues any car in a zone which is in excess of the apportioned number of cars for that zone and therefore is not assigned to that zone is caused to travel toward the heavy traffic zone. All cars entering the heavy traffic zone while the heavy traffic demand continues are assigned to that zone and are thereby prevented from traveling to an unoccupied zone as they otherwise would.



2 Sheets-Sheet 1

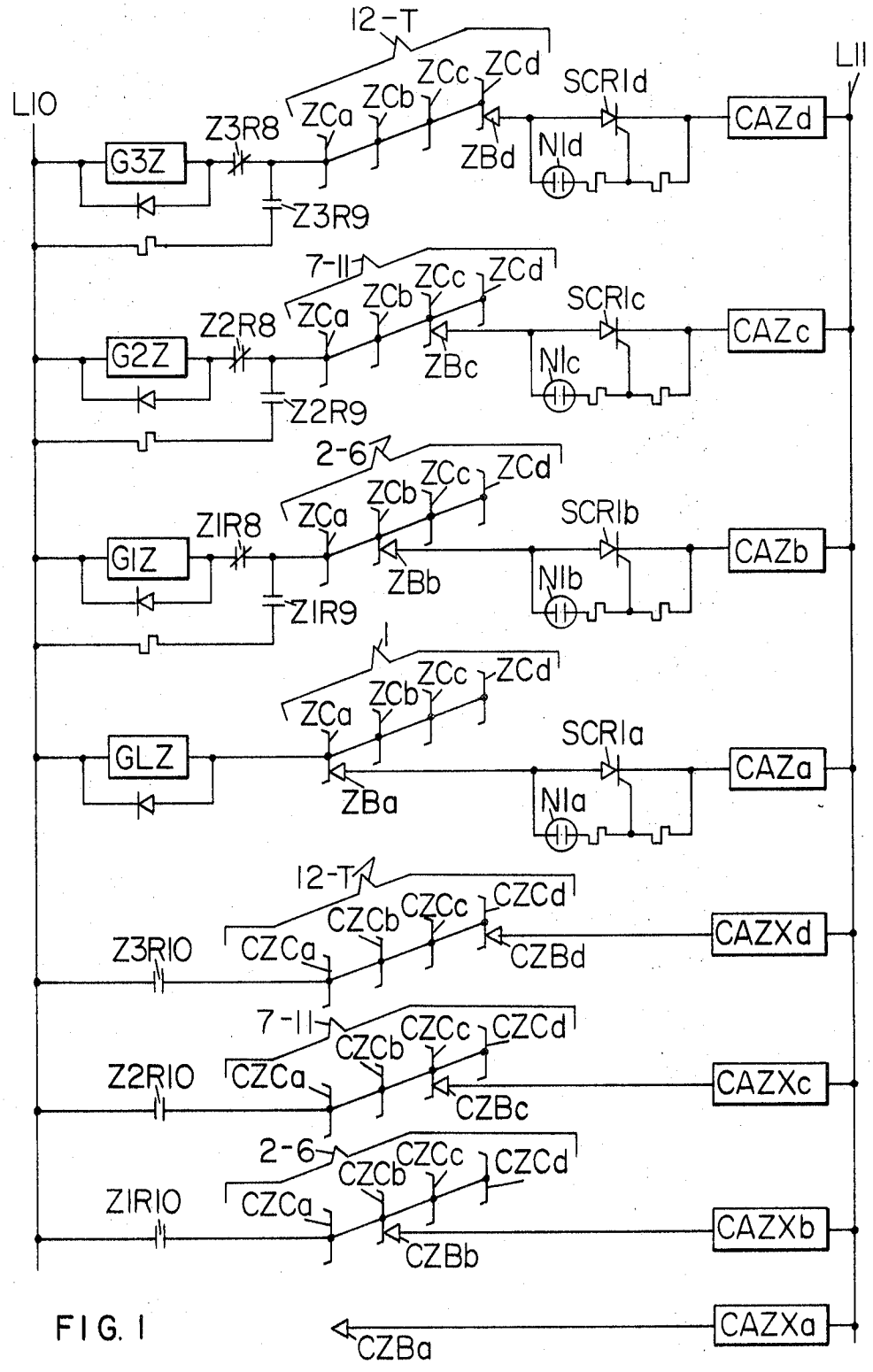


FIG. 1

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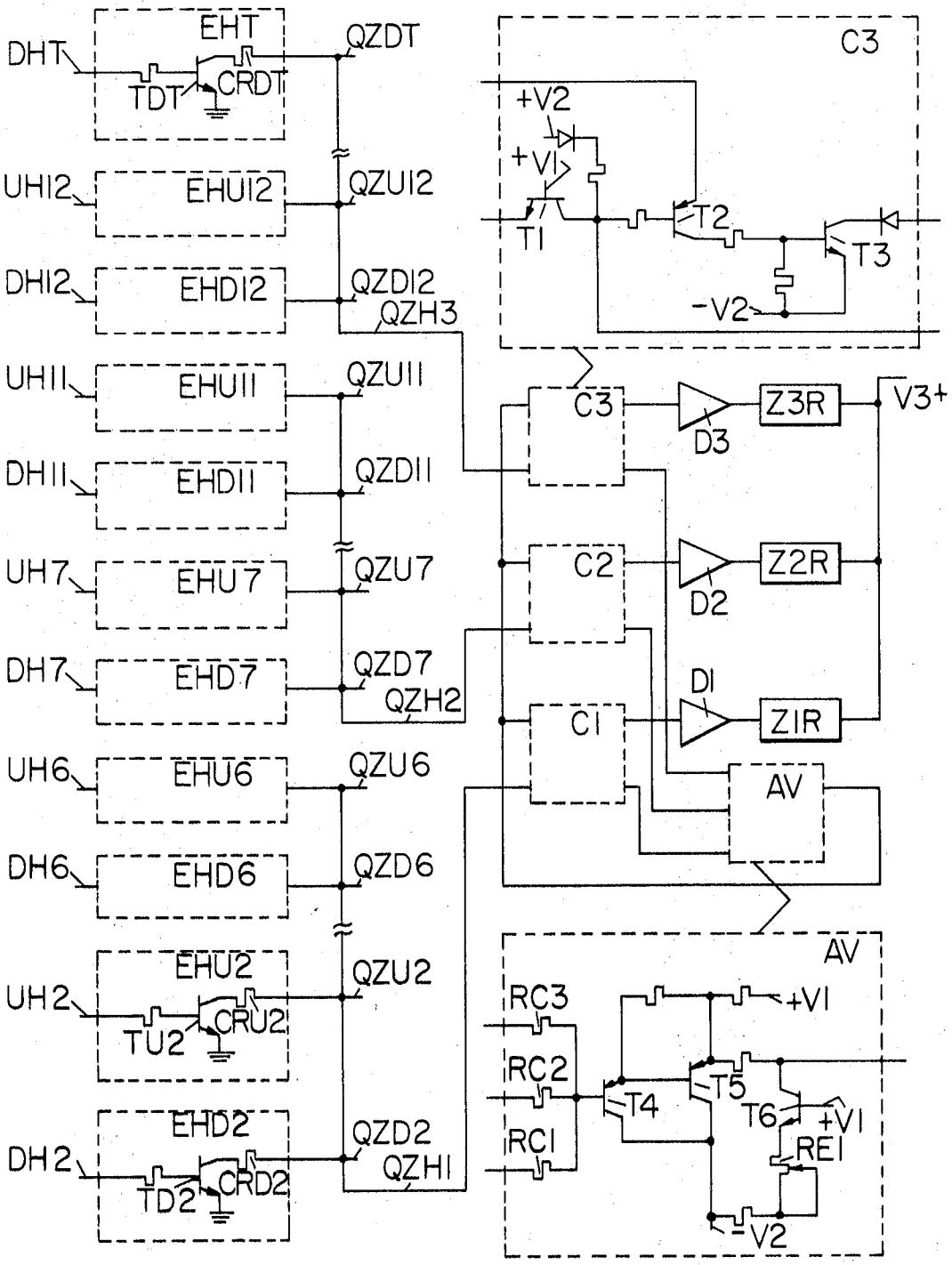


FIG. 2

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ZONED ELEVATOR CONTROL SYSTEM INCLUDING AN ARRANGEMENT FOR CONTROLLING THE OPERATION OF CARS IN RESPONSE TO THE LEVEL OF TRAFFIC IN THE ZONES

This is an invention relating to a supervisory control system for a group of elevator cars located in a multistory building.

A recent development in supervisory control for a group of elevators, the so-called zoned elevator control system, has proven itself to be an outstanding arrangement for controlling a group of elevator cars to provide efficient service. Such systems operate to divide the buildings they serve into a predetermined number of zones, each containing a predetermined number of landings. Each of the zones in a building is assigned the services of a predetermined number of cars provided they are located therein. Unless responding to calls, a car which is not assigned to the zone it is in is caused to travel until it is ultimately located in a zone to which it becomes assigned. In this way in the absence of calls the cars are distributed on an apportioned basis into the various zones of the building. A landing call registered in a zone which is not occupied by a car causes a car located in the nearest lower occupied zone to respond thereto; whereas, the occupation of a zone by a car limits the response to landing calls to a car located in that zone.

This last-mentioned operation is highly desirable under most circumstances because it frees cars in other zones from the necessity of traveling in an attempt to respond to landing calls in an already occupied zone and, consequently, enables them to respond more quickly to calls in their own zones. Even so it is desirable to remove the limitation on the response to landing calls notwithstanding there is a car occupying a zone in order to provide additional service to that zone should a heavy traffic demand arise in it. Previous arrangements have been devised which accomplish this. They provide additional service to a zone when a predetermined traffic demand occurs therein without regard to the traffic demands existing in the other zones in the building.

It is an object of this invention to provide a zoned elevator control system with apparatus to enable it to provide additional service to one of the zones in the building under circumstances in which the traffic level in that zone becomes heavy in relation to the traffic demands in the other zones in the building.

It is a further object of this invention to provide a zoned elevator control system with apparatus to enable it to assign all cars entering a heavy traffic zone to that zone in order to have them operate in the same manner as the predetermined apportioned number of cars otherwise assigned to that zone.

As a feature of the invention the level of traffic in each zone is measured individually as a function of the number of landing calls in registration in each respective zone. An average of the number of landing calls in all zones is derived and compared with the number of landing calls in each individual zone. A heavy traffic zone status is signified whenever the number of calls in any zone exceeds the average by a predetermined amount.

In carrying out the invention according to the disclosed preferred embodiment there is provided an elevator control system for a plurality of elevator cars in which the cars serve a plurality of landings in a building by starting in response to the operation of individual starting switches and by stopping in response to calls registered in the car and at the landings. Landing calls include both up and down landing calls. These and car calls are both cancelled when a car stops in response to them. The system segregates the landings into a plurality of groups of landings and effectively divides the building into a plurality of zones. Furthermore, the system comprise control means which includes assignment switch equipment individual to each car. The assignment switch equipment of each car is capable of being actuated when its respective car is the only car located in a zone. The control means also includes zone switching equipment individual to each zOne. The zone switching equipment for an individual zone is capable of being actuated when any of the cars is located in its respective zone. Upon being actuated the zone switching equipment limits the response to landing calls registered in its zone to a car that is located therein.

Unactuated assignment switch equipment operates the starting switch of its respective car to cause it to move toward a zone whose zone switching equipment is unactuated. This causes the cars to distribute themselves into the various zones on a predetermined apportioned basis.

In addition, the control system includes zone traffic signifying means individual to each zone each of which operates in response to the number of landing calls registered in its zone to produce a signal characteristic of the level of traffic in its respective zone. The traffic level signal of each zone is transmitted to an averaging means which in response thereto produces a signal characteristic of the average traffic level in all zones. A comparison means includes a comparator switching circuit individual to each zone, each of which operates in response to the average signal and the traffic level signal of its respective zone to actuate a heavy traffic switch associated with its zone whenever a predetermined relationship exists between the average signal and the traffic level signal of its associated zone. An actuated heavy traffic switch for a particular zone controls the operation of the cars by removing the limitation on the response to landing calls provided by the zone switching equipment for that particular zone. This enables a car outside that zone to respond to landing calls registered therein notwithstanding a car is located in that zone. Specifically the actuation of the heavy traffic switch for a particular zone enables the starting switch of a car in the next occupied zone below that particular zone to start its car in response to landing calls in that particular zone.

Moreover an actuated heavy traffic switch enables the assignment switch equipment of any car entering the heavy traffic zone to assign its car to that zone in order to prevent it from moving toward a zone whose zone switching equipment is unactuated. The actuated heavy traffic switch for a particular zone also operates the starting switch of a car whose assignment switch equipment is unactuated to cause movement of the car toward that particular zone.

Other objects and features as well as advantages of the invention will be apparent to those skilled in the elevator art from the foregoing and from the following description and appended claims when considered in conjunction with the accompanying drawing in which,

FIG. 1 is a four-car wiring diagram of the zone switching equipment for a four-car elevator group together with the assignment switch equipment individual to each car of the group; and

FIG. 2 is a schematic wiring diagram of zone traffic signifying means individual to specific zones together with averaging means, a comparison means, and a group of heavy traffic switches, a different one for each of the specific zones of the disclosed system.

To facilitate describing the invention with sufficient particularity to enable anyone skilled in the art to practice and to understand it, it is disclosed in an arrangement which is much more simplified than that which would be provided in a commercial installation, it being understood that in applying the invention to control systems used commercially many modifications may be made. In addition, while the traffic signifying means, the averaging means and the comparison means of FIG. 2 have been employed in a constructed embodiment comprising solid-state equipment of the semiconductor variety for simplification purposes they are disclosed herein as controlling well-known relay control circuits. A complete understanding of how these relay circuits are employed in an operative elevator system may be had by referring to U.S. Pat. application "Zoned Elevator Control System Including An Arrangement For Increasing The Number Of Cars Which Can Respond To Landing Calls In Any Of The Zones," Ser. No. 818,917, of Alfred John Probert and John Joseph Faup, filed Apr. 24, 1969, and assigned to the assignee of this application.

Differentiation between the respective four-cars and their individual equipment is provided in the following description and in the drawing by appending the lower case letters *a*, *b*, *c* and *d*, a different one for each car, to the reference characters for the disclosed equipment. The elevator group serves 16 landings L1 to LT, which are segregated into four zones including a main landing zone, and first, second and third zones. The main landing zone includes the main landing L1, the first zone landings L2 to L6, the second zone landings L7 to L11, and the third zone landings L12 to LT. To simplify the drawing, equipment associated with landings 3, 4, 5, 8, 9, 10, 13, 14 and 15 has been eliminated These are the intermediate landings of the first, second and third zones, respectively, and it will be apparent from the description and drawing how this equipment is connected into the system. Referring now to the drawing, in FIG. 1 each of zoning brushes ZB_a, ZB_b, ZB_c and ZB_d is carried on its respective car's landing selector. Each engages its respective zoning contacts ZC_a, ZC_b, ZC_c and ZC_d of the main landing zone and the first, second and third zones to complete an electrical connection therewith when its car is located at one of the landings in each respective zone. Zoning contacts 1ZC_a, etc., 2—6 ZC_a, etc., 7—11 ZC_a, etc. and 12—T ZC_a, etc. are long enough to span all positions on the selectors corresponding to landings in their respective zones. The zoning contacts associated with each car for each of the four separate zones are interconnected so that the circuits for the coils of zoning switches GLZ, G1Z, G2Z and G3Z of the zone switching equipment are capable of being completed in response to the location of any car in their respective zones. Any zoning switch, therefore, is actuatable upon the zoning brush of any car engaging its zoning contact for the corresponding zone. For example, the first car whose brush ZB engages its contact 2—6 ZC causes the potential of line L10 to appear at that brush by way of the circuit established through contacts Z1R8 or Z1 R9. This potential causes the associated neon tube N1 to conduct.

Consequently, a signal is applied to the gate of the associated silicon controlled rectifier SCR1 to cause it to conduct. This enables sufficient current to flow through the coil of its associated car assignment switch CAZ to actuate the switch. Also with contacts Z1R8 closed sufficient current flows through the coil of first zone switch G1Z to cause the actuation of that switch. Under these circumstances, upon conduction of rectifier SCR1 associated with the first car to enter the first zone, the potential on the 2—6 ZC contacts of all cars is reduced to a value sufficiently below that of line L10 to prevent the conduction of neon tube N1 of any other car which may enter the first zone while the first car to enter remains in that zone. This prevents the actuation of car assignment switch CAZ of any other car.

Auxiliary zoning brushes CZB_a, CZB_b, CZB_c and CZB_d are similar to zoning brushes ZB_a, etc. and are carried on their respective cars' landing selectors to operate in a similar fashion. Zoning contacts CZC_a, CZC_b, CZC_c and CZC_d are mounted on their respective cars' landing selectors to provide an electrical circuit for their respective brushes CZB_a, etc. in the same fashion as contacts ZC_a, etc. whenever electrical connections for their respective brushes ZB_a, etc.

In FIG. 2, lines DH2, UH2, etc., to DHT are connected to associated typical landing call registration devices for registering down and up landing calls for the second, sixth, seventh, eleventh, twelfth and top landings. Identical circuits are also provided for each of the other landings of the building above the main landing but as previously mentioned these are not shown for reasons of simplification. Each landing call registration device is capable of producing a signal suitable to saturate the base of its associated transistor TD2, TU2, etc., whenever a passenger registers a corresponding landing call. Each of these signals causes its respective transistor to conduct thus providing a circuit to ground from output line QZD2 or QZU2, etc. through its corresponding collector resistor CRD2 or CRU2, etc. Output lines QZD2, QZU2, etc., to QZDT for the landing call registration devices in each zone are connected together to zone output lines QZH1, QZH2 and QZH3. As a result, the resistance circuit to ground from each zone output line decreases as a function of the number of landing calls in registration in its respective zone.

The zone output lines QZH1, QZH2, and QZH3 are connected to comparison means comprising individual comparator switching circuits C1, C2 and C3, one for each line. One output from each comparator switching circuit is connected to an averaging means AV. The output of the latter device is connected in a feed back arrangement to a second input of each comparator switching circuit. A second output from each comparator switching circuit is connected to an associated heavy traffic switch Z1R, Z2R, or Z3R.

Each comparator switching circuit includes three transistors T1, T2 and T3. The base of each transistor T1 is connected permanently to a voltage source + V1. Its emitter is connected to its associated zone output line QZH1, QZH2 or QZH3 and its collector is connected through a resistor and rectifier to a source of voltage + V2. As a result, the amount of current flowing through its collector-emitter circuit is a function of the resistance circuit to ground of its associated zone output line QZH1, QZH2, or QZH3. Since, as explained, the resistance of each of these circuits decreases as a function of the number of landing calls in registration in its respective zone, the voltage at the collector of each transistor T1 also decreases as a function of the number of landing calls in its respective zone. Each of these collector voltages is applied to both the base of its associated transistor T2 and to an associated input circuit of averaging means AV.

The circuit from transistor T1 of each comparator switching circuit to averaging means AV is connected through an identical resistor RC1, RC2, RC3 to the base of transistor T4. By selecting small resistance values for resistors RC1, RC2 and RC3 in relation to the input impedance of transistor T4 it will be understood that the magnitude of the composite input signal to the base of transistor T4 is equal to the average magnitude of the individual input signals of comparator switching circuits C1, C2 and C3. With the circuit configuration shown for transistors T4 and T5, they operate as amplifiers to generate a voltage at the emitter of transistor T5 which is a function of the average of the number of landing calls in registration in each of the zones. As this average increases, the magnitude of this emitter voltage decreases. Transistor T6 operates to decrease the voltage produced at the emitter of transistor T5 a predetermined amount depending upon the magnitude of the resistance of rheostat RE1 in its emitter circuit. This produces a threshold voltage at the output of averaging means AV which is a function of the average of the number of hall calls in registration in each of the zones plus some predetermined number of landing calls which as will be understood can be a whole integer or some fractional part thereof.

The threshold voltage at the output of averaging means AV is transmitted back to a second input circuit of each of the comparator switching circuits C1, C2 and C3. In each it is applied to the emitter of its associated transistor T2. The base of each of these transistors as mentioned before is connected to the collector of its associated transistor T1 whose voltage is an inverse function of the number of landing calls in its respective zone. Thus, if the number of landing calls in a particular zone, say the second zone, is greater by the forementioned predetermined number than the average number of landing calls, the base of transistor T2 is at a lower potential than its emitter, enabling it to conduct. This applies a signal from its collector to the base of transistor T3 enabling it also to conduct. As a result the comparator switching circuit C2 presents a virtual ground to relay driver D2 enabling the energization of the coil of second zone heavy traffic switch Z2R. This operates switch Z2R to its actuated condition opening contacts Z2R8 and closing contacts Z2R9 and Z2R10.

In order to more fully appreciate the significance of this invention, assume car *c* is located in the second zone and car *b* is located in the first zone, when second zone heavy traffic

switch Z2R is operated to its actuated condition. Upon opening, contacts Z2R8 interrupt the circuit for the coil of second zone switch G2Z releasing it to its unactuated condition. Prior thereto, however, contacts Z2R9 close to maintain car assignment switch CAZ_c in its actuated condition and car *c* remains assigned to the second zone. In accordance with the well-known operation of a zoned elevator control system, the release of second zone switch G2Z removes the limitation on the response to landing calls registered in its zone and cars in the next lower occupied zone below the second zone, which in the assumed circumstances is the first zone, are enabled to respond to landing calls in the second zone. Consequently, car *b*, the car located in the first zone, is enabled to respond to landing calls in the second zone.

Assuming car *b* starts toward the second zone in response to landing calls registered therein. Upon entering that zone, zoning brush ZB_b engages zoning contact 7—11 ZC_b without effect since the voltage on this contact is below the firing voltage of neon tube $N1_b$. At the same time, auxiliary zoning brush CZB_b engages auxiliary zoning contact 7—11 CZC_b without effect since the voltage on this contact is below the firing voltage of neon tube $N1_b$. At the same time, auxiliary zoning brush CZB_b engages auxiliary zoning contact 7—11 CZC_b completing a circuit for the coil of auxiliary car assignment switch $CAZX_b$ through engaged contact Z2R10. Those skilled in the art will realize how to employ this switch in a manner similar to car assignment switch CAZ_b in order to assign car *b* to the second zone notwithstanding car *c* is already assigned thereto through the actuation of car assignment switch CAZ_c. Furthermore, it will be understood that any car entering the second zone while the heavy demand status continues will have its auxiliary car assignment switch CAZX operated to its actuated condition to assign that car to the second zone also.

In addition, those skilled in the art will understand how the existence of a heavy demand in a zone can be employed to cause unassigned cars to move toward that zone. In the forementioned Probert and Faup application this is accomplished by an arrangement which simultaneously prevents any unassigned car from starting toward an unoccupied zone. This same operation could be obtained with the arrangement of this invention but since a heavy demand in a zone releases the associated zone switch to its unactuated condition it is also possible to cause unassigned cars to travel to the heavy demand zone while not preventing them from being started toward unoccupied zones.

Other operations are also possible. For example, it may be desirable in some installations to provide more or less priority to one or more calls in a zone in relation to calls from other landings in that zone or in all zones. This can readily be accomplished by varying the resistive magnitude of the collector resistors CRD2, CRU2, etc., for these calls. In addition, it may also be desirable to provide more or less priority to one or more zones in relation to the other zones in a building. This is readily accomplishable by varying the resistive magnitude of the zone output line resistors RC1, RC2, etc., of these zones.

Other modifications to the above described arrangement are possible without departing in any way from the spirit of the invention. It is intended therefore that the embodiment specifically described not be considered exclusive or in any sense limited.

We claim:

1. An elevator control system for a plurality of cars operating to serve a plurality of landings in a building by starting in response to the operation of individual starting switch means and stopping in response to calls registered in said cars and at said landings, said system segregating said landings into a plurality of groups of landings so as effectively to divide the building into a plurality of zones and comprising control means including assignment switch means individual to each car, each being actuatable upon its respective car being located in a zone in which it is the only car present, zone switching means individual to each zone, each being actuatable upon a car being located in its respective zone, each said zone switching means when actuated being operable to limit the response to landing calls registered in that zone to a car located therein, each said unactuated assignment switch means being operable to cause the starting switch means of its respective car to cause movement of the car toward a zone whose zone switching means is unactuated, thus causing said cars to distribute themselves into the various zones, wherein the improvement comprises zone traffic signifying means individual to specific zones, each producing a signal characteristic of the level of traffic in its associated zone, averaging means operating in response to said traffic level signals and producing a signal characteristic of the average of said signals, and comparison means operating in response to said average signal and each of said traffic level signals to control the operation of said cars whenever a predetermined relationship exists between said average signal and any of said traffic level signals.

2. An elevator control system according to claim 1, wherein said comparison means includes a comparator switching circuit individual to each zone, each comparator switching circuit operating individually to control the operation of said cars whenever said predetermined relationship exists between said average signal and the traffic level signal of the zone associated with said operated comparator switching circuit.

3. An elevator control system according to claim 1, wherein each comparator switching circuit operates to cause the unactuation of the zone switching means associated with its zone notwithstanding a car is located in said zone whereby a car outside said zone is enabled to respond to landing calls registered therein.

4. An elevator control system according to claim 3, wherein each operated comparator switching circuit causes the actuation of the assignment switch means of each car located in its associated zone.

5. An elevator control system according to claim 4, wherein the traffic level signal produced by the traffic signifying means associated with each zone is characteristic of the number of landing calls in registration in its associated zone.

6. An elevator control system according to claim 5, wherein each comparator switching circuit operates when the number of landing calls in registration in its associated zone exceeds the average number of landing calls in all zones by a predetermined amount.

7. An elevator control system for a plurality of cars operating to serve a plurality of landings in a building by starting in response to the operation of individual starting switch means and stopping in response to calls registered in said cars and at said landings, said system segregating said landings into a plurality of groups of landings, wherein the improvement comprises traffic signifying means individual to at least specific ones of said groups of landings, each operating solely in response to the landing calls in registration in the area of said building comprising its associated group of landings and producing a traffic level signal characteristic of the number of landing calls in registration in its associated area, averaging means operating in response to said traffic level signals and producing a signal characteristic of the average of said signals, and comparison means operating in response to said average signal and each of said traffic level signals to control the operation of said cars whenever a predetermined relationship exists between said average signal and any of said traffic level signals.