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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Multiple Zone Elevator Control System

We, OTIS ELEVATOR COMPANY, a corporation organized and existing under the laws of the State of New Jersey, United States of America, of 260 Eleventh Avenue, New York, New York, 10001, United States of America do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to elevators and particularly to automatic control systems for elevators.

The invention is directed to plural car elevator systems in which the starting and stopping of the cars under certain conditions is in response to the calls that are registered. Such systems effect the starting of one car in response to the registration of the first car in the system and bring one or more additional cars into operation as certain service demand conditions arise. Heretofore, under certain traffic conditions, these systems frequently caused the operation of less than a sufficient number of cars to provide fast and efficient service.

It is, therefore, an object of this invention to provide a system for rendering increased efficiency of elevator service under certain traffic conditions.

In a preferred embodiment of the invention the cars are changeably assigned to various zones of a building. These zones preferably consist of a main landing zone, which includes the building lobby landing and any basement and sub-basement landings; and one or more upper zones between which are divided the upper landings. Each zone is assigned the services of one of the cars which responds to the traffic demands arising in the zone to the exclusion of the remaining cars of the system. In addition, each car serves any landing of the building in response to calls registered on its car call registering circuits. While the assigned car operates within its assigned zone it normally cannot respond to landing calls registered at landings below its zone and all cars below its zone are prevented from responding to landing calls registered at landings in its zone. Any car, however, may enter any zone in response to its own car calls. Conversely, when an assigned car leaves its zone in response to a car call, a different car which is temporarily unassigned may enter the zone and become assigned thereto. If necessary, an assigned but idle car may leave its assigned zone to respond to landing calls in a temporarily unoccupied adjacent zone.

According to the invention there is provided an elevator control system for a plurality of cars operating in response to the operation of individual starting switch means to serve a plurality of landings including a main landing in a building by starting and stopping in response to calls registered in said cars and at said landings, said system being characterized both in that it segregates said landings into a plurality of groups of landing so as effectively to divide said building into a plurality of zones including a main landing zone and also by control means including zone assignment switch means individual to each car, each being effective upon its respective car occupying a zone in which it is the only car present to assume its actuated condition, and group zone relay means individual to each zone, each being effective upon a car occupying its respective zone to assume is actuated condition, each said group zone relay means when so actuated being effective to limit the response to landing calls registered in that zone to a car located therein, each said zone

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assignment switch means being effective when in its unactuated condition to cause the starting switch means of its respective car to cause movement of said car toward a zone whose group zone relay means is in its unactuated condition thereby causing said cars to distribute themselves into the various zones notwithstanding the absence of registered calls.

A more complete understanding of the preferred mode of carrying out the invention in an illustrated three car group and various features and advantages thereof will be gained from the following description and appended claims when considered in conjunction with the accompanying drawings, in which:

FIGURE 1 is a simplified schematic wiring diagram of power and control circuits for one elevator, these circuits being identical for all the elevators;

FIGURES 2, 3 and 4 taken together constitute a simplified schematic wiring diagram of the operating circuits for one of the elevators, certain circuits being common to all the elevators;

FIGURE 5 is a simplified schematic wiring diagram of the car call circuits for one of the elevators; and

FIGURE 6 is a simplified schematic ciring diagram of the hall call circuits for one of the elevators, certain circuits being common to all elevators.

To facilitate an understanding of an application of the invention, the illustrated control system has been considerably simplified from that which would be used in a complete commercial installation. It is to be understood that in applying the invention to various types of control systems, many changes may be made, especially in adapting it to the more complex arrangements, without departing from its intent and principles of operation.

The electromagnetic switches employed in the system illustrated are designated as follows:

ADV —Advanced Advancer Switch
ASR —Automatic Starting Switch
BLZ —Bottom Landing Zone Switch
BR —Brake Release Switch
C —Potential Switch
CBS —Car Button Switch
CC —Continuous Call Switch
CPR —Call Pickup Relay
D —Down Direction Switch
DG —Direction Holding Switch
DGD —Auxiliary Down Direction Switch
DGU —Auxiliary Up Direction Switch
DO —Door Open Switch
1E —First Speed Switch
2E —Second Speed Switch
ETS —Excitation Time Switch
FLC —False Call Switch
GH —Door Close Limit Switch
GUD —Group Up Dispatching Switch
H —Field and Brake Switch
HCR —Hall Call Relay
HG —Higher Car Call Switch
HJ —Higher Call Switch
HJX —Higher Hall Call Switch
HS —Hall Stop Switch
HR —Highest Call Reversal Switch
HRX —Auxiliary Highest Call Reversal Switch
LG —Lower Car Call Switch
LJ —Lower Call Switch
LJX —Lower Hall Call Switch
LR —Lowest Call Reversal Switch
MGP —MG Set Preference Switch
MGT —MG Set Time Relay
MGZ —Group Middle Zone Relay
MLGZ—Group Main Landing Zone Relay
MLU —Main Landing Up Switch
MLZ —Main Landing Zone Switch
MZ —Middle Zone Switch
NT —Door Hold Open Switch
PM —Pawl Magnet (on selector)
PMY —Pawl Magnet Relay
RUN —Running Relay
SC —Selection Switch
TGZ —Group Top Zone Relay
TLZ —Zone Top Landing Switch
TZ —Top Zone Switch
U —Up Direction Switch
XDO —MG Start and Door Open Switch

Throughout the description which follows, these letters will be applied to the above designated relays and switches and in some cases to their coils. With reference numerals appended thereto, these letters will also be applied to the contacts of these relays and switches. The circuits for the coils of all switches and relays which have group functions have been shown. For purposes of simplification, rather than show three separate sets of the circuits which perform functions peculiar to individual ones of the elevators, only a representative set of these circuits has been shown it being understood that a similar such set is provided for each of the cars. In some places in the drawing certain circuits associated with an individual elevator are shown to be interconnected with equipment associated with other elevators of the group. In those circuits, in order to differentiate between the equipment of the various elevators, the lower case letters "a", "b" and "c", indicative of the different elevators, have been appended to the reference characters used to designate the equipment. Throughout the description also, differentiation will be made between the components of the various elevators by appending the lower case letters "a", "b" and "c" to the reference characters designating those components.

The circuits in the drawing are presented in a simplified form wherein the coils and

contacts of the relays and switches are dissociated from one another and are grouped in series and series parallel circuits extending between positive and negative potential leads. The relationship between the coils and their associated contacts is indicated on the "spindle sheet" Figures 7 to 9. The switches are there arranged in alphabetical order of their reference designation and to each coil and contact a numerical reference is applied. Each contact has a pair of hyphened reference, the first of which indicates the number of the contact and the second indicates the drawing figure in which it is located. In the case of the coil, only a single reference indicating the drawing figure is displayed. Thus, a specific coil or contact can readily be located by aligning its "spindle sheet" figure in vertical correspondence with the drawing figure indicated for the element in question.

The electromagnetic switches are illustrated in deenergized condition. Switch DG is of the latching type and has an operating coil and a reset coil. Its contacts are shown for its reset condition. Switch HS has an operating coil and a holding coil. Switch GUD has two operating coils.

Referring now to the drawing, there is shown in Figure 1, an exciter having series and shunt fields ESF and EF, respectively, and an armature EA. The exciter forms a part of the usual motor-generator set and is connected to supply current to the various elevator control circuits. The generator of this set has its shunt field GF connected to the exciter armature through conventional direction controlling circuits and has its series field GSEF in the loop circuit containing its armature GA and the armature MA of the elevator drive motor. The elevator drive motor shunt field MF is connected across the exciter armature output terminals, as is brake release coil BR which is subject to contacts H2. Door motor armature DMA and its field DMF are connected through switching contacts to the exciter armature outputs to be energized for elevator door operation. A brush advancer motor has its armature BMA and fields BMF connected through switching contacts to the exciter armature output terminals for the purpose of controlling the operation of selector switches SLS1, SLS2, SLS3 and SLS4 through the positioning of the floor selector advancer panel. The floor selector and its advancer panel are both well known in their construction and operation and are therefore not shown in detail here. Various control switches and the circuits therefore which be further discussed hereinafter are also shown in FIGURE 1.

Figure 2 indicates the circuit connections for various control circuits having to do with starting and stoppng the car, and are individual to each car.

Figure 3 relates to the arrangement for determining control in response to the location of the call or calls with regard to the location of the car and with regard to the position of companion cars in the various zones. It is to be understood that zoning brushes RB, ZRB and ZSB are each individually provided for each car and are located on the advancer panel of their respective car's floor selector. Brushes ZRB and ZSB are so constructed as to engage the next succeeding landing contact (ZRC and ZSC, respectively) in the direction of travel before disengaging from the preceding stationary contact. When any of the cars is stopped at a floor, all brushes on its associated selector are in engagement with their cooperating stationary contacts corresponding to that floor or landing. The brushes on the selector advancer panel, as is well known, precede the synchronous indication of the car's location to provide an indication of its effective location. Among other functions, the advancer panel brushes latch by a pawl mechanism into engagement with the contacts for a floor where a stop is to be made and are maintained in that position as the car moves into registry with the landing.

Figure 4 indicates circuit details for the group dispatching and zoning arrangements.

Figure 5, showing the arrangement of the car call registering circuits, the call pickup and cancelling circuits and the circuits for indicating car calls as being either above or below the location of the car, is somewhat similar to the arrangement of Figure 6 with which it will be considered. The hall call pickup and cancelling brushes DHB and UHB, the car call pickup and cancelling brush CAB and the highest and lowest hall call brushes HHB and LHB are each physically located on the selector advancer panel as are switches HHS and LHS which although electrically insulated from brushes HHB and LHB are mechanically operated thereby. The highest and lowest car call brush HCB (Figure 5), the upper half of which is made of non-conducting material, is similarly located on that panel and in conjunction with the thyratron gas tubes XLG and XHG operates to indicate the presence or absence of car calls below or above the effective (not synchronous) location of the car.

One set of car and hall call registering means are illustrated in Figures 5 and 6. In any installation, an individual set of car call means are provided for each car and a common set of hall call means are provided for the group. Each of the call registering means comprises a cold cathode gas tube (1U, 2D or 1C) which has a numerical designation indicating the landing with which it is associated and a letter suffix indicating direction of travel or location in the car. These are actuated through the capacity-to-ground coupling of a person that touches their

exterior electrode which also functions as the touch bottom TB (3U, Figure 6). Each tube has a load resistor (RUL, RDL, or RCL) in its anode circuit across which a signal potential appears as the tube conducts current in response to the registration of a call. This potential appears on selector contacts CAC and HCC for car calls and contacts UH, DH, HH and LH in the case of landing calls. Corresponding individual landing call selector contacts (i.e. UH, DH, HH and LH) are provided for each of the cars and are interconnected in the usual fashion, although for purposes of illustrative simplification such interconnections have been omitted. As is well known, voltage values of 135 volts from line B+ to line Bo, 150 volts R.M.S. from line Bo to the ground potential end of the secondary winding of transformer TF, 95 volts R.M.S. from line Bo to line AC1 and minus 45 volts from line B— to line Bo may suitably be used in conjunction with the cold cathode gas tubes.

Coil HCR (Figure 6) of the hall call relay is in series connection with the plate supply of the landing touch button cold cathode tubes and is adjusted to "pull in" or operate when a predetermined amperage, corresponding in magnitude to the combined currents in a predetermined number of conducting tubes, passes through the coil. Accordingingly, the relay operates as a detector when this minimum number of landing calls, irrespective of their direction, exists. Capacitor Q1 acts as a filter for short sharp induced current stages. Capacitor Q7 and thyratron tube XCC act as time measuring elements and serve to actuate continuous call switch CC when the predetermined number of registered landing calls have existed continuously for a predeterimned time. This measurement is useful for indicating the presence of traffic demands which are presently thought to be more suitably handled by a mode of operation other than the type provided by this invention. The agency of switch CC provides a ready means for switching over to a mode of operation more especially styled for the changed circumstances. Except where stated otherwise in the following explanation it will be assumed that calls are registered intermittently so that tube XCC is not conducting and switch CC is deenergized.

The operation of the system in controlling the starting and stopping of the cars in response to calls as well as the answering and resetting of such calls is known per se. Typical circuity which would be required by one car to perform these functions is shown in the drawing but any detailed descriptions of this circuitry would unnecessarily lengthen this specification and for that reason such descriptions have been omitted.

Turning now to the manner in which the movements of the cars influence one another and provide the desired services to the various zones, assume that car "a" is just arriving at the main or lobby landing after traveling therefrom the sixth landing in response to a lobby car call; that car "b" is at the second landing in the middle zone with its direction establishing and reversing means prepared for future up travel so that switch DGb is set up and that car "c" is at the main or lobby landing in the lobby zone with its direction establishing and reversing means also prepared for future up travel so that switch DGc is set. While car "b" is at the second landing, it is assigned to the middle zone because its middle zone switch MZb (corresponding to MZa, Figure 3, but not shown) is operated over a circuit including contacts MZ2a, MZ2c, coil MZb, selector contact ZSCb2 and advancer panel brush ZSBb. This causes actuation of group middle zone relay MGZ over the circuit including contact MZ3b and coil MGZ. As a result contacts MGZ1 and MGZ2 (Figure 6) of the middle zone isolation means are separated in the hall call above and the hall call below circuits.

Also, the main landing zone switch MLZc (not shown, but corresponding to MLZa) is actuated because the presence of car "c" at the main landing has brought brush ZSBc into engagement with selector contact ZSC1c. Contacts MLZ3c are closed in the circuit of coil MLGZ of the group main landing relay MLGZ energizing it and opening contacts MLGZ1 and MLGZ2.

Since no car is in the top zone contacts TZ3a, TZ3b and TZ3c in the circuit of coil TGZ are opened and contacts TGZ1 and TGZ2 (Figure 6) are both closed in the hall call above and the hall call below circuits. The engagement of contacts TGZ1 connects the hall call above circuits for the landings in the top zone to the corresponding circuits for the landings in the middle zone and car "b", the middle zone car, can respond to hall calls in the top zone as well as to those in the middle zone.

Before car "a" arrived at the main landing contacts LJ3a (Figure 3) closed completing the circuit for the energization of coil LRa of the lowest call reversal switch through contacts PMY5a, RUN2a, LJ3a and DGD1a, advancer panel brush ZRBa, selector floor bar contact ZRC1a and contacts MLGZ3 and DGD2a. Contacts LR1a closed to prepare a self-holding circuit for switch LRa and contacts LR2a closed preparing the circuit for energizing the set coil DGa of the direction holding switch. As the car comes to rest selector contacts SLS1a separate to deenergize coil Ha (Figure 1) of the field and brake switch and contacts H4a (Figure 2) in circuit with coil RUNa are separated. This closes contacts RUN3a in circuit with coil DGa of direction holding switch DGa set-

ting the switch and closing contacts DG8a (Figure 1) to complete the circuit for coil MLUa of main landing up switch MLUa through closed contacts PMY4a, ASR3a, DG8a, and engaged selector contact ZSC1a and advancer panel brush ZSBa. Energization of coil MLUa causes closing of contacts MLU3a which completes a circuit through closed contacts SC3a for the coil GUD of group up dispatching switch GUD. Contacts GUD4 (corresponding to GUD2 shown in the circuit of representative coil ASR, Figure 2) in the circuit of coil ASRc are separated. When switch ASRc drops out after its hold-in time expires contacts ASR3c open in the circuit of coil MLUc of the main landing up switch for car "c" (not shown, but similar to the circuit for the coil of switch MLUa) deenergizing the coil and causing the switch to drop out. As switch MLUc drops out it opens its contact MLU2c in the circuit of coil SCc of the selection switch for car "c" (not shown, but similar to the circuit for the coil of switch SCa, Figure 3). When switch SCc drops out elevator "c" loses its designation as the selected lobby zone car whereupon elevator "a" will become the selected lobby zone car when its selection switch is operated after energization of its coil SCa through closed contacts MLU2a, ETS4a, SC5b and SC5c. Also, contacts ASR2c (Figure 1) are closed in the circuit of coil PMc of the pawl magnet for car "c" to close contacts PM1c and provide a circuit through contacts DG9c, the brush motor armature BMAc and field BMFc to cause the brush motor to rotate. As the brush motor rotates, the advancer panel moves in the upward direction to close selector switches SLS1c, etc., and generator field GFc is energized to cause car "c" to move upwardly as a result of having been displaced by car "a". Elevator "c" will continue upwardly until it encounters any "up" hall call; or until it encounters a "down" hall call in a zone to which it becomes assigned, which is also the highest call in that zone or, if there are contiguous unoccupied zones adjacent the zone to which it is assigned, is the highest call in those zones; or it encounters an unoccupied zone with no call above it in a contiguous unoccupied zone. In the latter two cases the car stopping equipment will be operated because as will be described later the car's highest call reversal switch HRc will be energized through contacts PMY6c (Figure 3), RUN1c, HJ3c, DGU1c, coil HRc and one of the circuit branches which includes contacts MZ5c or TZ5c or brush ZBRc and top zone selector contacts ZRC5, etc., and DGU2c. Which of these circuit branches is effective depends upon the simultaneous positions of the cars.

If when the car "a" comes to rest at the main landing the excitation time switch ETSc of car "c" is in its released or unoperated condition the MG set of elevator "c" is shut down. Under such circumstances car "c" is not dispatched from the main landing because its automatic starting switch ASRc never releases to start the car. This is so because as contact GUD4 (not shown, but corresponding to contacts GUD2) open to start ference switch MGP (Figure 4) is operated the timing out of swkitch ASRc, MG set pre-through contacts MLU4a and ETS5a. This causes contacts MGP3 (not shown) but corresponding to contacts MGP1 in the circuit of coil SCa) to open in the circuit of coil SCc (not shown). Since contacts ETS4c (not shown, but corresponding to contacts ETS4a, Figure 3) are also open, owing to excitation time switch ETSc being in its unoperated condition, the circuit to coil SCc of the selection switch for car "c" is interrupted. This releases the switch causing contacts SC4c (Figure 1) to close in parallel with contacts GUD4 to once again complete the circuit for coil ASRc of the automatic start relay for elevator "c" thereby preventing it from timing out. Although under these circumstances elevator "c" is not dispatched, elevator "a" which just entered the main landing zone becomes the selected car and is so dispatched because of the energized condition of car "c" main landing up switch MLUc (not shown, but corresponding to MLUa, Figure 3). As the selection switch SCc releases it closes its contacts SC3c in series with closed contacts MLU3c in the circuit of coil GUD to maintain the group up dispatch relay energized and also closes its contacts SC5c to complete the circuit for coil SCa. This causes contacts SC4a to open in parallel with contacts GUD2 and permits automatic starting switch ASRa for elevator "a" to time out after the expiration of the door hold open time provided by door hold open switch NTa.

Assume, now, that car "c" is dispatched as car "a" arrives at the main landing and that as car "c" starts to run up a sixth landing down hall call is registered to cause tube 6D to conduct. The cathode potential of tube 6D is applied to the control grid of tube XHJb of car "b" through the circuit including rectifiers DR3 and DR4, contacts TGZ1, the interconnecting lines and rectifiers between the adjacent stationary contacts HHb, contact HH2b, (the assumption being that car "b" is at the second landing) advancer panel brush HHBb and resistor R7b. Upon tube XHJb conducting, coil HJXb of higher hall call switch HJXb in the tube plate circuit is energized and closes its contact HJX1b in the circuit of coil HJb (Figure 3) of higher call switch HJb. This opens contact HJ6b in the circuit of coil ASRb (Figure 2). When switch ASRb drops out the set coil PMb (Figure 1) of the pawl magnet on the selector associated with car "b" is energized

through contacts XDO6b, ASR2b and ADV2b causing the advancer panel to be started upward by the brush motor which is energized through closed contacts PM1b and DG9b. As the advancer panel moves the selector contacts SLS1b, etc. are closed and the car starts in the up direction to answer the sixth landing down hall call; and is ready to stop for any up hall call which it may encounter. As hereinbefore explained car "c" is also running up, but it is not responding to the 6D call since separated contacts MGZ1 (Figure 6) isolates the 6D call from the call above circuits of cars below the middle zone and prevents the application of the potential of the cathode of the 6D tube to the control grid of tube XHJc before the advancer panel brush HHBc reaches the second landing floor bar contact HH2c. Upon brush HHBc engaging contact HH2c the 6D call causes switch HJc to be operated in the same manner as switch HJb was operated. When switch HJc operates elevator "c" is also responsive to the 6D call.

Assume elevator "b" leaves the middle zone before elevator "c". Its advancer brush ZSBb leaves contact ZSC4b so that middle zone switch MZb drops out. Contacts MZ2b (not shown, but corresponding to contacts MZ1b, Figure 3) in the circuit of coil MZc (not shown, but similar to the circuit of coil MZa, Figure 3) of the middle zone switch for car "c" thereupon closes and completes the circuit for that coil through brush ZSBc and the ZSCc contact it is then engaging. Upon switch MZc operating car "c" is assigned as the middle zone car.

Continued upward travel of elevator "b" causes brush ZSBb to engage contact ZSC5b completing the circuit for the coil TZb (not shown, but similar to the circuit for coil TZa, Figure 3) of the top zone switch for car "b" assigning car "b" to the top zone and closing contacts TZ3b in the circuit for coil TGZ of group top zone relay TGZ. Relay TGZ opens its contact TGZ1 in the interconnecting circuit for the HH contacts below the bottom floor of the top zone. This causes the 6D call to be isolated from the call above circuits for cars below the top zone and permits only car "b", now the top zone car, to respond to it. Car "c", the middle zone car, can no longer respond to this call since contacts TGZ1 have interrupted the call above circuit. There being no calls registered in the middle zone car "c" is stopped at the next floor it comes to in that zone. The stop for car "c" is initiated by operation of its highest call reversal switch caused by the release of switch HJXc and HJc and the energization of coil HRc through the circuit comprising contacts PMY6c, RUN1c, HJ3c, DGU1c and MZ5c. Contacts HR3c close upon operation of highest call reversal switch HRc and complete the circuit for the reset coil PMc of the pawl magnet. This resets the pawl magnet of the selector to cause the advancer panel to stop its upward travel and initiates the stopping operation for car "c". Car "c" was not stopped in response to a call and therefore its door operating apparatus is rendered ineffective and its doors are not opened when it stops. This occurs because switch CPRc is not operated and its contacts CPR2c in switch DOc circuit thereby remain open.

Car "b", in the meantime, continues in the up direction until its stop is initiated when the contacts of advancer panel switch HHSb open as brush HHBb engages stationary contact HH6b. This removes the cathode potential of tube 6D from the control grid of tube XHJb preventing the tube from again conducting after the next negative half cycle of the a.c. potential applied across its cathode-anode circuit and permits higher hall call switch HJXb to release. When switch HJXb releases contacts HJX1b open in the circuit of coil HJb of higher coil switch HJb which closes contact HJ3b in the circuit for coil HRb of highest call reversal switch HRb. This circuit includes contacts PMY6b, RUN1b, HJ3b, DGU1b and TZ5b. Contacts HR4b open in the circuit of coil HRXb of auxiliary highest call reversal switch HRXb. Contacts HR3b close completing the circuit for the reset coil PMb of the pawl magnet on the selector associated with car "b". The pawl magnet upon resetting causes the advancer panel to stop by deenergizing the brush motor armature and fields and by causing the pawls to engage the stopping lug for the sixth landing to hold the advancer panel at that position. With the stopping of the advancer panel elevator "b" is caused to stop at the sixth landing. The 6D hall call is reset, in the manner known per se by application of the cathode potential of tube XHSb to the cathode of the 6D tube. Also switch HRb is self-held through its HR1b contacts until contacts RUN3b and U4b engage so that switch DGb is reset and the direction of travel is reversed.

As the stop took place switch HSb was operated by energization of its pull-in coil HSb in preparation for the resetting of the 6D hall call. Contacts HS2b closed in the circuit of coil CPRb (Figure 2) and call pickup relay CPRb operated. This closed contacts CRP2b in the coil circuit of door open switch DOb and as the stop is completed car "b" opens its doors, in the manner known per se, to enable the intending passenger at the sixth landing to enter the car.

To demonstrate the operation when a car leaves the zone to which it has been assigned and terminates in an occupied zone other than the main landing zone assume that the entering passenger at the sixth landing registers a third landing car call. The con-

duction of tube 3Cb causes tube XLGb to conduct and energizes coil LGb of lower car call switch LGb. Contacts LG1b (Figure 3) engage causing switch LJb to operate opening its contacts LJ4b in the circuit of coil ASRb of automatic starting switch ASRb. When switch ASRb times out, the pawl magnet PMb is set through the circuit including contacts ASR2b and causes the advancer panel to be advanced downward. After the doors close and lock, car "b" starts down to the third landing answering all down hall calls it encounters on the way.

As the upper non-conducting portion of cam HCBb engages hook switch HCC3b, in preparation of the stop at the third landing the potential of the cathode of tube 3Cb is no longer applied to the control grid of tube XLGb and the tube is extinguished during the next negative half cycle of the a.c. potential applied across its cathode-anode circuit. This releases switch LGb and opens contacts LG1b to release switch LJb. Contacts LJ3b close to energize the coil of switch LRb which becomes self-holding through the circuit including its own contacts LR1b, contacts DGD1b, advancer panel brush ZRBb, stationary contact ZRC3b, and closed contacts DGD2b and MLGZ5 (not shown, but corresponding to contact MLGZ3 shown in the representative circuit for coil HR and LR). Contacts MLGZ5 are closed because car "a" is occupying the main landing zone. Switch LRb of the direction establishing and reversing switch means is self-held until car "b" is stopped in order to maintain contacts LR2b closed in the set coil circuit of switch DGb until contacts RUN3b and D4b are closed to set the direction holding switch DGb for travel to the top zone which is now unoccupied. However, if a car not not located at the main landing such a reversal would not take place since contact MLGZ5 would be open and relay LRb would not be operated. This would permit car "b" to continue down to the main landing zone to provide a car for future intending passengers at the main landing. In any case, car "c" middle zone switch MZc is in its energized condition and maintains contacts MZ2c open in the circuit of coil MZb (not shown, but corresponding to that of coil MZa, Figure 3) to prevent car "b" middle zone switch MZb from operating. This prevents automatic start relay ASRb from remaining energized beyond its time delay after contacts NT3 open and causes car "b" to travel out of the middle zone.

In addition to returning automatically an unassigned car to the unoccupied main landing zone, a main landing hall call causes a car in the adjacent occupied zone to travel down to the unoccupied main landing zone. Breaking contacts MLGZ2 in the lower hall call or LH contact circuit between the first and second landings (i.e. between the main landing zone and the middle zone) and breaking contacts MLGZ1 and MGZ2 in the LH contact circuit between the fourth and fifth landings (i.e. between the middle and top zones) provides a circuit for a main landing hall call to the XLJ tube circuit of a car in the next adjacent occupied zone to cause the car to travel down. This provides a car for intending passengers at the main landing without requiring them to wait for an unassigned car to return to that zone. In addition when the main landing zone becomes unoccupied contacts MLGZ4 in the circuit of coil FLC of the false call switch are separated. Coil FLC is deenergized when the charge in its timing circuit is dissipated and the false call switch releases to close contacts FLC1 of the preferential service circuit to place a call indication through contacts MLGZ2 on contact LH2. This causes a car in the next adjacent occupied zone to come to the main landing, thus providing preferential service for that landing. In contrast to the operation at other landings, when a car arrives at the main landing it opens its doors even though it is not responding to a registered call. This occurs as a result of the engagement of contacts MLZ4 in the coil circuit of its associated call pickup relay CPR as the car approaches the landing.

From the foregoing description it can be seen that while calls are being registered intermittently, a car entering a zone which does not have a car assigned to it is assigned as the zone car for that zone and prevents any hall call in the zone from calling another car into the zone. A zone car responds to all registered hall calls in its zone. It stops when traveling in the up direction at floors for which its own car calls are registered and at floors for which up landing calls are registered. During downward travel of a zone car in its zone, stops are made in response to its own car calls and to down landing calls. Under circumstances where a hall call in a zone for the opposite direction to that in which the zone car is traveling in that zone is the last hall call in that zone and the zone car is not responding to any call beyond such opposite direction hall call, the zone car also stops for such opposite direction hall call. Stops are made in the natural order in which the floors are reached regardless of the order in which the calls are registered. A car assigned to a zone only moves in response to a car call registered for a floor out of its zone or for a hall call registered at a landing in its zone provided the zones next adjacent its zone also have cars assigned to them. Under such circumstances, the assigned car stops at a landing in its zone in the absence of calls. If the zone above that to which a car is assigned has no car assigned to it the assigned car is enabled to leave its assigned zone in response to hall calls in such zone

above. A zone car will also leave its zone to travel to the unoccupied main landing from the adjacent occupied zone if a main landing hall call is registered or if the main landing zone has been unoccupied for a predetermined period of time.

Upon leaving its zone a car loses its designation or assignment as that zone car and responds to all hall calls for the direction in which it is traveling and any other car call which may be registered. After losing its zone car designation a car entering an occupied zone, which is not the main landing zone, continues to run answering all calls it may encounter for its direction of travel. A car entering the main landing zone causes a car which may be present in the main landing zone with its MG set running to leave the main landing and travel up, as an unassigned car. If the MG set of the car in the main landing zone is not running a subsequently entering car is forced to leave and travel up, as an unassigned car whereupon it answers all calls it may encounter for its direction of travel until it reaches an unoccupied zone and becomes assigned to that zone. If it is not further required to respond to a registered demand for service it stops and parks at one of the floors in its zone. A selected car at the main landing is caused to leave the main landing upon the registration of a car call or a hall call in an adjacent unoccupied zone.

The arrangement described may also be employed to handle traffic conditions other than those in which calls are registered intermittently. For example, assume the system is provided with any one of the down direction traffic measuring devices that are known per se. Such a device could be either a switch similar to continuous call switch CC which operates upon a predetermined number of down halls calls being in registration for a predetermined period or a load weighing switch which operates upon a predetermined load being measured in a down traveling car or cars. Further assume that the down traffic increases sufficiently to cause the traffic measuring device to operate and energize the coil of a down traffic relay (not shown). This causes all pairs of making contacts on the relay to engage and all pairs of breaking contacts to separate. A pair of making contacts of the down traffic relay connected from line L10 to one of the operating coils of the group up dispatch switch GUD (Figure 4) maintains that switch in the operated condition as long as the down traffic relay remains operated. Furthermore, a pair of breaking contacts of the down traffic relay connected in series between each of the respective ZRC4 selector contacts and the pair of making contacts of the Group Top Zone Relay TGZ (corresponding to the pair of contacts TGZ3 in the respresentative circuit shown in Figure 3) prevents the respective highest call reversal switches HRa, etc. from operating to reverse unassigned cars traveling in the up direction until they reach at least the lowest landing in the top zone.

In these circumstances, the continuous operation of group up dispatch switch GUD causes all cars stopped at or thereafter stopping at the main or principal landing to be dispatched upwardly therefrom in the manner previously described for car "c". In traveling up each of the cars seeks an unoccupied zone, i.e. a zone which at the time has no car assigned to it. This is accomplished in the manner previously described for cars "b" and "c". In so traveling each of the cars answer its own car calls and any up hall calls it encounters. As mentioned, all unassigned cars in traveling up are prevented from reversing before they reach at least the lowest floor in the top zone notwithstanding there is no call registered above the cars. Reversals which otherwise might occur are prevented by the separation of the breaking contacts of the down traffic relay in series with the respective ZRC4 selector contact. Upon entering the top zone, all cars, whether they become assigned thereto or not, answer all their own car calls and any up hall calls they encounter and are permitted to reverse at the highest down hall call provided there is no car or up hall call above it. This reversal takes place in the same manner previously described with respect to the answering of the down hall call at the sixth landing by car "b".

If no car or landing calls are registered for any of the landing in the top zone when the cars enter it and another car is assigned thereto, the entering cars travel to the upper terminal before reversing because no holding circuit for their respective highest call reversal switches HRa, etc. is established until their respective zone top landing switches TLZa, etc. are energized. Upon reversing, the cars are made to leave the top zone as unassigned cars and run down to answer their own car calls and any down hall calls they might encounter.

Cars which become assigned to the middle and top zones in these circumstances operate in the same manner as previously described. Thus even though a car is assigned to the middle zone, until it establishes a down direction of travel and is required to travel down in response to a call below it, it is at liberty to provide service to intending passengers in the top zone should the top zone not have a car assigned to it. This is accomplished in the manner previously described for car "b".

From this it should be understood that the invention can provide increased service for passengers desiring to travel down by operating a down traffic measuring device whenever the down traffic reaches a predetermined

condition and by using this device when operated, first, to prevent cars which may be stopped at or may thereafter stop at the main landing from remaining in the main landing zone as they otherwise would in the absence of registered calls to which they can respond and, second, to prevent up traveling unassigned cars from reversing before they enter the top zone.

While the invention has been described as applied to a system having "without attendant" operation, it is applicable to systems arranged only for "with attendant" operation or to systems arranged for "with attendant" and "without attendant" operation. While a three car, seven floor installation has been described, it is to be understood that the invention is applicable to installations having other numbers of cars, and other numbers of floors including one or more basements. With installations having one or more basements, the basement floors may be considered as floors within the main landing zone and thereby serviceable by the main landing zone car. Landing calls to which cars are subject may vary. For example, where as it has been described that an unassigned car in an occupied zone responds to hall calls in the occupied zone for its direction of travel it may be arranged to have such unassigned car non-responsive to such calls.

WHAT WE CLAIM IS:—

1. An elevator control system for a plurality of cars operating in response to the operation of individual starting switch means to serve a plurality of landings including a main landing in a building by starting and stopping in response to calls registered in said cars and at said landing, said system being characterized both in that it segregates said landings into a plurality of groups of landings so as effectively to divide said building into a plurality of zones including a main landing zone and also by control means including zone assignment switch means individual to each car, each being effective upon its respective car occupying a zone in which it is the only car present to assume its actuated condition, and group zone relay means individual to each zone, each being effective upon a car occupying its respective zone to assume its actuated condition, each said group zone relay means when so actuated being effective to limit the response to landing calls registered in that zone to a car located therein, each said zone assignment switch means being effective when in its unactuated condition to cause the starting switch means of its respective car to cause movement of said car toward a zone whose group zone relay means is in its unactuated condition thereby causing said cars to distribute themselves into the various zones notwithstanding the absence of registered calls.

2. An elevator control system according to claim 1 characterized in that traffic measuring means are actuated in response to a predetermined traffic condition and while actuated operate to cause each car to resume movement after a stop at any landing in a terminal zone regardless of whether there is a call in registration at any landing of said zone.

3. An elevator control system according to claim 1 or claim 2 characterized in that each said group zone relay means includes individual isolation switching means, each of which operates when the group zone relay means for its respective zone is actuated to enable a car located in a predetermined direction from its respective zone to respond to landing calls registered in that zone.

4. An elevator control system according to claim 3 characterized in that a preferential service circuit is provided for said main landing zone which operates to cause a car located in said predetermined direction therefrom to move toward said zone a predetermined period of time after said isolation switching means associated with said main landing zone is operated.

5. An elevator control system according to any of the preceding claims characterized in that each of the cars has door operating apparatus effective to open the door of its car incident to the stopping of the car at a landing outside the main landing zone in response to a registered call for that landing or to the stopping of the car at the main landing, said door operating apparatus being rendered ineffective to open the doors of its respective car upon the car stopping at a landing other than at the main landing in the absence of a call being registered for the landing at which it is stopping.

6. An elevator control system according to any of the preceding claims characterized in that individual direction establishing and reversing switch means is provided for each car, each of which operates to reverse the established direction of travel of its respective car provided the car stops in response to the last call causing it to travel in that direction and the group zone relay means for each of the zones in said established direction from the car is actuated.

7. An elevator control system according to any of the preceding claims characterized in that an individual motor generator set is provided for each of said cars, each of which operates to provide power for the operation of its respective car and an individual main landing up switch is provided for each car, each of which is actuatable upon its respective car stopping at said main landing, the actuated main landing up switch of a car located at the main landing causing a car subsequently stopping at the main landing to leave the main landing zone if the motor

condition and by using this device when operated, first, to prevent cars which may be stopped at or may thereafter stop at the main landing from remaining in the main landing zone as they otherwise would in the absence of registered calls to which they can respond and, second, to prevent up traveling unassigned cars from reversing before they enter the top zone.

While the invention has been described as applied to a system having "without attendant" operation, it is applicable to systems arranged only for "with attendant" operation or to systems arranged for "with attendant" and "without attendant" operation. While a three car, seven floor installation has been described, it is to be understood that the invention is applicable to installations having other numbers of cars, and other numbers of floors including one or more basements. With installations having one or more basements, the basement floors may be considered as floors within the main landing zone and thereby serviceable by the main landing zone car. Landing calls to which cars are subject may vary. For example, where as it has been described that an unassigned car in an occupied zone responds to hall calls in the occupied zone for its direction of travel it may be arranged to have such unassigned car non-responsive to such calls.

WHAT WE CLAIM IS:—

1. An elevator control system for a plurality of cars operating in response to the operation of individual starting switch means to serve a plurality of landings including a main landing in a building by starting and stopping in response to calls registered in said cars and at said landing, said system being characterized both in that it segregates said landings into a plurality of groups of landings so as effectively to divide said building into a plurality of zones including a main landing zone and also by control means including zone assignment switch means individual to each car, each being effective upon its respective car occupying a zone in which it is the only car present to assume its actuated condition, and group zone relay means individual to each zone, each being effective upon a car occupying its respective zone to assume its actuated condition, each said group zone relay means when so actuated being effective to limit the response to landing calls registered in that zone to a car located therein, each said zone assignment switch means being effective when in its unactuated condition to cause the starting switch means of its respective car to cause movement of said car toward a zone whose group zone relay means is in its unactuated condition thereby causing said cars to distribute themselves into the various zones notwithstanding the absence of registered calls.

2. An elevator control system according to claim 1 characterized in that traffic measuring means are actuated in response to a predetermined traffic condition and while actuated operate to cause each car to resume movement after a stop at any landing in a terminal zone regardless of whether there is a call in registration at any landing of said zone.

3. An elevator control system according to claim 1 or claim 2 characterized in that each said group zone relay means includes individual isolation switching means, each of which operates when the group zone relay means for its respective zone is actuated to enable a car located in a predetermined direction from its respective zone to respond to landing calls registered in that zone.

4. An elevator control system according to claim 3 characterized in that a preferential service circuit is provided for said main landing zone which operates to cause a car located in said predetermined direction therefrom to move toward said zone a predetermined period of time after said isolation switching means associated with said main landing zone is operated.

5. An elevator control system according to any of the preceding claims characterized in that each of the cars has door operating apparatus effective to open the door of its car incident to the stopping of the car at a landing outside the main landing zone in response to a registered call for that landing or to the stopping of the car at the main landing, said door operating apparatus being rendered ineffective to open the doors of its respective car upon the car stopping at a landing other than at the main landing in the absence of a call being registered for the landing at which it is stopping.

6. An elevator control system according to any of the preceding claims characterized in that individual direction establishing and reversing switch means is provided for each car, each of which operates to reverse the established direction of travel of its respective car provided the car stops in response to the last call causing it to travel in that direction and the group zone relay means for each of the zones in said established direction from the car is actuated.

7. An elevator control system according to any of the preceding claims characterized in that an individual motor generator set is provided for each of said cars, each of which operates to provide power for the operation of its respective car and an individual main landing up switch is provided for each car, each of which is actuatable upon its respective car stopping at said main landing, the actuated main landing up switch of a car located at the main landing causing a car subsequently stopping at the main landing to leave the main landing zone if the motor

generator set of the previously arrived car is not operated whereas if its motor generator set is operating, the actuated main landing up switch of the subsequently entering car causes the previously arrived car to so leave.

8. An elevator control system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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