April 16, 1929. R. A. WAITE ET AL 1,709,102

CONTROL SYSTEM FOR ELEVATORS

Original Filed Jan. 19, 1926 3 Sheets-Sheet 1

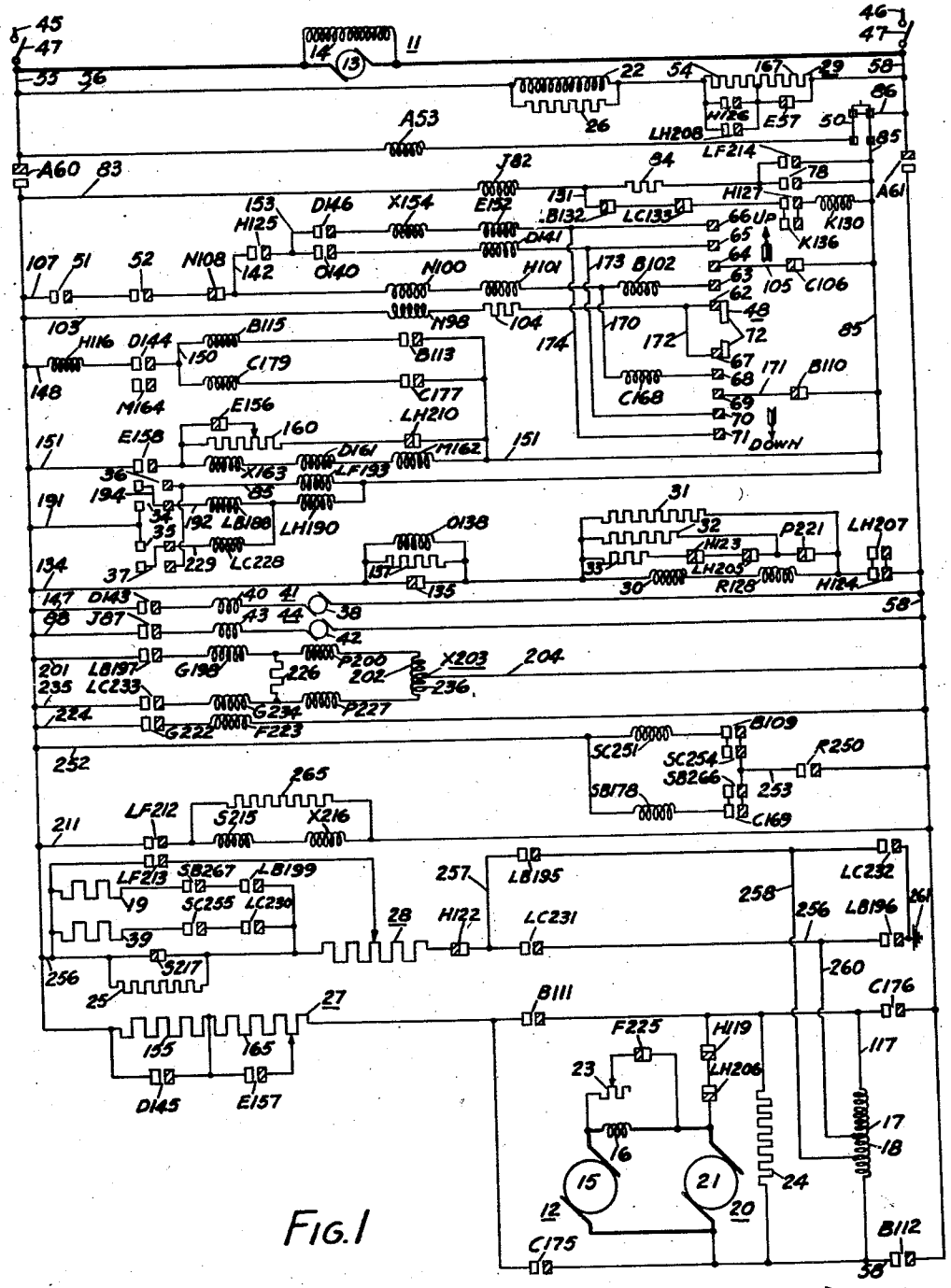


FIG. 1

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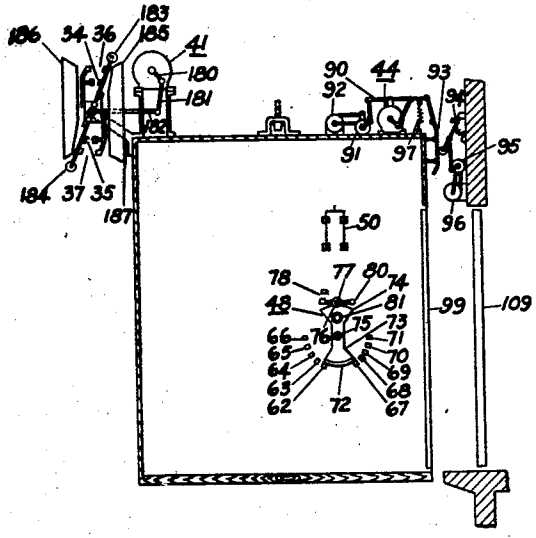


FIG. 2

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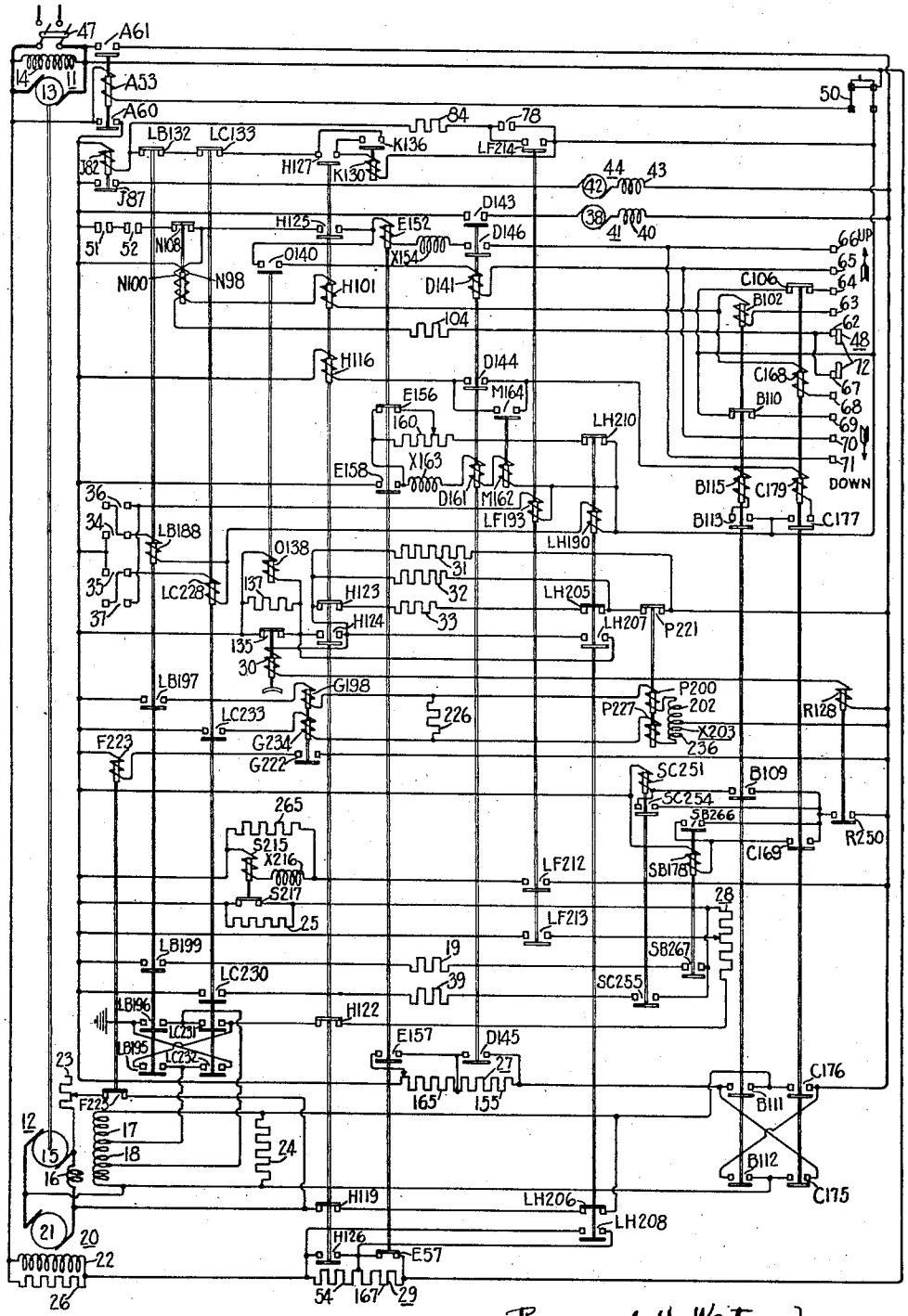


Fig. 3.

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UNITED STATES PATENT OFFICE.

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CONTROL SYSTEM FOR ELEVATORS.

Original application filed January 19, 1926, Serial No. 82,258. Divided and this application filed April 18, 1927. Serial No. 184,725.

The invention relates to control systems, and particularly to control systems for elevators.

This application is a division of application Serial No. 82,258, filed January 19, 1926.

In electric elevator systems in which the car is brought to a stop automatically at the landings, it is important that the speed of the car, during the final stopping operations, be reduced in a minimum of time to a value from which an accurate stop may be made. This is particularly true in systems in which push button control is employed for causing the automatic slow-down as well as the final stop and in those in which the starting of the car is under the control of an operator while the slow-down and stop is automatic.

It is advantageous in such systems to employ a variable voltage direct current generator for supplying power to the elevator motor. The control of the field strength must be such that the E. M. F. generated may be rapidly brought to a proper value to cause the elevator motor to run at a suitable speed from which an accurate stop may be made. The time constant of the generator field during the slow-down and stopping operations is an important factor, especially where a generator is used whose field has a large time constant.

Where power operated car gate and hatchway door mechanism is employed, or where the gate and door are manually operated, it is desirable to effect the movement of the gate and door into open positions by the time that the car has stopped at the floor. Such operation is advantageous particularly because of the amount of time which is saved. In high speed elevator systems, the time gained in making each stop is an important factor and, when the gain for a whole trip is considered, it may be seen that the operating efficiency of the whole system is raised considerably. In such an arrangement, however, the speed of the car might be accidentally increased during the gate and door opening operation or while the gate and door are open with a passenger in the act of stepping into or out of the car.

One feature of the invention resides in forcing the strength of the generator field to such a value as to insure an accurate stop under varying conditions of operation.

Another feature is the minimizing of the possibility of occurrence of excessive speeds during the period when the hatchway door, and car gate when used, might be partially or wholly open.

Other features and advantages will become apparent from the following description and appended claims.

While the invention is applicable to other elevator systems, particularly those in which automatic stopping is employed, it will be described, by way of illustration, as embodied in a self leveling elevator system.

In the drawings:

Figure 1 is a straight wiring diagram of an elevator control system;

Figure 2 is a schematic representation of the elevator car, showing the arrangement of the car switch and of mechanism suitable for effecting the leveling and car gate and hatchway door opening operation, and

Figure 3 is a schematic wiring diagram of the control system shown in Figure 1.

Referring to Figure 1, no attempt is made to show the coils and contacts of the various electromagnetic switches in their associated positions, a "straight" diagram being employed wherein the coils and contacts of the various switches are separated in such manner as to render the circuits involved relatively simple. Also the parts of other switches and apparatus are separated in the interest of simplifying the diagram. For a clearer understanding of the invention, the stationary contacts of the switches are illustrated in cross section. The relation of the coils and contacts of the various switches is shown in Fig. 3.

The motor generator set comprises a driving motor 11, illustrated for convenience of description as of the direct current type, and a variable voltage direct current generator 12. The armature of the driving motor is designated 13 and its field winding 14. The armature of the generator is designated 15, its series field winding 16, and its separately excited field winding 17. The elevator motor is designated as a whole by the numeral 20, its armature being designated 21 and its field winding 22. An adjustable resistance 23 is arranged in shunt to the genera-

tor series field winding. Discharge resistance 24 is provided for the generator separately excited field winding while discharge resistance 26 is provided for the elevator motor field winding 22. A resistance 27 is provided for controlling the strength of the generator field and therefore the voltage applied to the elevator motor armature during car switch operation. Another resistance 28 is provided for controlling the strength of the generator field during the leveling operation. 25 is a resistance employed for forcing a rapid reduction in the strength of the generator field upon the initiation of the leveling operation to continue the motion of the car to the landing in case of an underrun. 19 is the up field strengthening resistance and 39 is the down field strengthening resistance. A resistance 29 controls the strength of the elevator motor field during different conditions of operation. 30 is the release coil for the elevator motor electromagnetic brake. This coil is provided with discharge resistances 31, 32 and 33 for controlling the application of the brake under different conditions of operation. 34 and 35 are the up slow speed contacts and the down slow speed contacts respectively of the leveling switch, the leveling switch up and down fast speed contacts being designated 36 and 37 respectively. 38 is the armature and 40 is the field winding of the motor 41 for moving the rollers of the leveling switch into position to clear the leveling cams. 42 is the armature and 43 is the field winding of the door control motor 44. 45 and 46 are the direct current supply mains. 47 is a double pole knife switch for connecting the system to the supply mains. In order to suit the type of diagram employed, the blades of this switch are shown separated. The car switch is designated as a whole by the numeral 48. 50 is the safety switch in the car. The series of door contacts are indicated by a single set of contacts 51. The gate contacts are indicated as 52. The various safety, limit, stop and emergency switches are omitted in order to simplify the description.

The electromagnetic switches have been designated as follows:

A—potential switch,
B—up main direction switch,
C—down main direction switch,
D—first accelerating switch,
E—second accelerating switch,
F—series field switch,
G—series field relay,
H—main brake and field switch,
J—door control motor switch,
K—door control motor maintaining relay,
M—maintaining relay,
N—sequence relay,
O—accelerating relay,
P—hard brake switch,
R—retaining switch,
S—slow down switch,
LB—up leveling direction switch,
LC—down leveling direction switch,
LH—leveling brake and field switch,
LF—fast speed leveling relay,
SB—up field strengthening control switch,
SC—down field strengthening control switch,

Throughout the description which follows, these letters, in addition to the usual reference numerals, will be applied to the parts of the above enumerated switches. For example, contacts B111 are contacts on the up main direction switch, while actuating coil A53 is the coil that operates the potential switch. The electromagnetic switches are shown in their deenergized positions. Reactances are similarly designated by the character X.

Upon the closing of the knife switch 47, the driving motor 11, elevator motor field winding 22 and potential switch actuating coil A53 are energized, the circuit for coil A53 being through safety switch 50. The driving motor starts in operation, bringing the generator 12 up to full speed. The series field winding and starting means for the driving motor are omitted to simplify the description. With the elevator motor at rest, the current supplied to its field winding 22 is reduced by section 54 of resistance 29, providing what may be termed a "standing field". The circuit for the elevator motor field winding may be traced from the left-hand blade of switch 47, line 55, by way of line 56 through field winding 22, resistance section 54 and second accelerating switch contacts E57, line 58, to the right-hand blade of switch 47. It is not desired to apply full line voltage to the field winding 22 when the elevator motor is not in operation because of increased power consumption. On the other hand, it is not desired to have this field winding deenergized with the elevator motor at rest as a matter of safety and because of the time constant involved in building up. The potential switch, upon operation causes the engagement of contacts A60 and A61, preparing the circuit for the generator separately excited field winding, the electromagnetic brake release coil and the control circuits. The condition of the circuits so far described might be termed normal.

Referring briefly to Figure 2, the car switch 48 comprises a set of up contacts 62, 63, 64, 65 and 66 and a set of down contacts 67, 68, 69, 70 and 71. A contact segment 72 for bridging the contacts of each set is mounted on the segmental support 73 of insulating material. A cam 74 is formed on the support above the pivot point 75. The cam is formed with a centrally disposed de-

pression 76 into which the operating roller 77 of the gate and door switch 78 extends with the car switch in "neutral" or off position. The switch 78 is pivoted at 80 so that movement of the car switch in either direction causes the engagement of the switch contacts. The car switch is operated by means of a control handle 81. It is preferred to provide centering springs (not shown) on the car switch to cause it to be returned to off position when released by the operator.

Referring back to Figure 1, assume that the system is designed for an installation of several floors and that the car is at rest at the first floor with the gate and door open. In the starting operation, the operator first gives the car switch a slight initial movement to effect the closure of the gate and door switch 78. For convenience of description, this switch is arranged to complete a circuit for the door control motor switch actuating coil J82. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 83 through coil J82, resistance 84 and switch 78, line 85, switch 50, line 86, line 58, to the right-hand blade of switch 47. The door control motor switch, upon operation, causes the engagement of contacts J87, completing the circuit for the door control motor 44. This circuit may be traced from the left hand blade of switch 47, by way of line 55 through contacts A60, by way of line 88 through contacts J87, door control motor field winding 43 and armature 42, by way of line 58 through contacts A61, to the right-hand blade of switch 47.

Referring again to Figure 2, motor 44 operates pneumatic gate and door operating mechanism, as for example through linkage 90 to move valve 91 for gate engine 92 to gate closed position and to withdraw the retiring cam 93 from engagement with the roller provided on the end of the door engine valve lever 94. The lever 94 is operated by a spring to move valve 95 for the door engine 96 to door closed position. The gate and door engines operate through mechanism not shown to close the car gate 99 and hatchway door 109. It is to be understood that a door is provided in the hatchway at each landing.

Referring back to Figure 1, if the operator, after he has closed the gate and door, desires to open them, or if he desires to arrest their movement, he may do so by releasing the car switch to return to off position. This causes the opening of the gate and door switch 78 with the consequent deenergization of coil J82 and the separation of contacts J87. In this manner, the circuit for the motor 44 is broken. The spring 97, shown in Figure 2, operates upon the deenergization of motor 44 to move valve 91 and, through cam 93 and lever 94, valve 95 into positions to cause the reverse operations of the engines 92 and 96 to open the gate and door. Obviously other forms of power operated gate and door mechanisms, such as electric in lieu of pneumatic, may be employed without departing from the spirit of the present invention.

Assuming that the gate and doors are closed, the gate contacts 52 and door contacts 51 are in engagement. The operator may now move the car switch to full operated position to start the car in the up direction. It is to be noted that the gate and door switch 78 remains in closed position so long as the car switch is moved out of "neutral" position. Upon the engagement of contact segment 72 and contact 64, circuits are simultaneously completed for the oppositely wound coils N98 and N100 of the sequence relay, actuating coils H101 of the main brake and field switch and B102 of the up main direction switch being in the circuit for coil N100. The engagement of the contact segment and contacts 65 and 66 prepares circuits for the actuating coils of the accelerating switches.

The circuit for coil N98 of the sequence relay may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 103 through coil N98 and resistance 104, contacts 62 and 64 of the car switch, by way of line 105 through contacts C106 of the down main direction switch, line 85, to the right-hand blade of switch 47 as above traced. The circuit for coil N100 may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 107 through door contacts 51, gate contacts 52, sequence relay contacts N108, and coils N100, H101 and B102, contacts 63 and 64 of the car switch, to the right-hand blade of switch 47 as above traced. The purpose of the sequence relay N is to insure the closure of the gate and doors before starting the car. Coils N98 and N100, being differentially wound, oppose each other, when energized simultaneously, to prevent the operation of the relay. If either coil is energized ahead of the other, or if either coil alone is energized, contacts N108 separate, preventing the starting of the car. If either the gate contacts 52 or any of the door contacts 51 are separated at the time that car switch segment 72 engages contacts 64, coil N98 alone is energized, resulting in the separation of contacts N108. The separation of contacts N108 prevents the energization of coil N100, maintaining the sequence relay operated, and of coil B102, preventing the operation of the up main direction switch to effect the starting of the car. The gate and door switch 78, there-

fore, is closed by the initial movement of the car switch so that the gate and door contacts may be closed before the engagement of segment 72 and contact 64. However, if the car switch is moved into position where segment 72 engages contact 64 before the closure of the door and gate contacts, the sequence relay operates to prevent the starting of the car. Thus it is impossible to start the car on the door or gate contacts.

Assuming that the sequence relay has operated, in order to start the car the car switch is returned to a position with segment 72 disengaged from contact 64, deenergizing coil N98 to permit contacts N108 to reengage. If the gate and door are closed, the car switch may be returned immediately to full on position. Otherwise, closing of the gate and door must be effected before the car switch is moved into full on position.

It is preferred to provide the main direction switches with a mechanical interlock to prevent their simultaneous operation. Such an interlock may be of the form of a walking beam pivotally mounted for engaging catches on the armatures of these switches. Upon operation of the up main direction switch in response to the energization of its actuating coil B102, contacts B110 separate and contacts B109, B111, B112 and B113 engage. The separation of contacts B110 breaks the circuit leading from the car switch down feed contact 69, contacts B110 and the corresponding down direction switch contacts C106 serving as electrical interlocks as is well understood in the art. Contacts B109 will be referred to later. The engagement of contacts B113 prepares the circuit for the up main direction switch holding coil B115 and the main brake and field switch holding coil H116. The engagement of contacts B111 and B112 completes a circuit for the generator field winding 17. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, resistance 27 and contacts B111, by way of line 117 through field winding 17, by way of line 58 through contacts B112 and contacts A61, to the right-hand blade of switch 47.

The main brake and field switch H operates simultaneously with the main direction switch B. Switch H, upon operation, causes the separation of contacts H119, H122 and H123 and the engagement of contacts H124, H125, H126 and H127. The separation of contacts H119 disconnects the generator field winding from the generator armature. The purpose of this arrangement will be explained later. Contacts H122 are in the circuit for the resistances employed to control the generator field strength during leveling. The purpose of these contacts also will be explained later. The separation of contacts H123 disconnects resistance 33 from across the brake release coil 30. Resistance 33 being of low ohmic value, its disconnection before contacts H124 engage prevents excess power consumption from mains 45 and 46. The engagement of contacts H127 establishes a circuit for the door control motor maintaining relay actuating coil K130. This circuit may be traced from the left hand blade of switch 47, by way of line 55 through contacts A60, by way of line 83 through coil J82, by way of line 131 through up leveling direction switch contacts LB132, down leveling direction switch contacts LC133, contacts H127 and coil K130, line 85, to the right-hand blade of switch 47 as previously traced. The engagement of contacts H125 further prepares the circuits for the actuating coils of the accelerating switches. The engagement of contacts H126 short-circuits section 54 of the elevator motor field resistance 29, permitting the motor field to build up to its full strength. The engagement of contacts H124 completes the circuit for the brake release coil 30. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 134 through contacts 135 operated by the brake, brake release coil 30, retaining switch actuating coil R128 and contacts H124, by way of line 58 through contacts A61, to the right-hand blade of switch 47.

The door control motor maintaining relay coil K130 in the circuit above traced is subject to the potential drop across resistance 84. The system is arranged so that the voltage thus applied to coil K130 is sufficient to effect the operation of the relay. Contacts K136 engage, upon the operation of the relay, to by-pass contacts H127. The purpose of this arrangement will be seen from later description. The operation of the retaining switch R in response to the energization of its actuating coil causes the engagement of contacts R250, to complete the circuit for the down field strengthening control switch actuating coil SC251, the circuit having been prepared by the previous engagement of up direction switch contacts B109. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 252 through coil SC251 and contacts B109, by way of line 253 through contacts R250, by way of line 58 through contacts A61, to the right-hand blade of switch 47. The down field strengthening control switch, upon operation, causes the engagement of contacts SC254 and SC255. The engagement of contacts SC255 prepares the circuit for down field strengthening resistance 39. Contacts SC254 by-pass contacts B109 so as to maintain coil SC251 energized until con-

tacts R250 separate. The purpose of this arrangement also will be seen from later description.

The brake release coil 30 being energized, the elevator motor field being connected directly to the mains 45 and 46 and current being supplied from the generator armature 15 to the elevator motor armature 21, due to the energization of the generator separately excited field winding, the elevator motor starts.

As the brake releases, the brake switch contacts 135 separate to insert cooling resistance 137 in series with the brake release coil. These brake switch contacts are preferably arranged to be separated at the end of the releasing operation. Separation of contacts 135 also breaks the short circuit around coil O138, permitting the operation of the accelerating relay O. This relay operates to cause the engagement of contacts O140, completing the circuit for the first accelerating switch actuating coil D141. The purpose of this arrangement is to utilize the time constant of the brake for timing the acceleration of the motor, more specifically, for timing the operation of the first accelerating switch. Although the brake release coil is energized at the same time that power is supplied to the motor, the brake shoes do not lift at once because of the inherent time constant of the brake magnet and because the brake shoes and lever arms represent considerable mass to be set in motion. The circuit for coil D141 completed by contacts O140 may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 107 through the door contacts 51, gate contacts 52 and contacts N108, by way of line 142 through contacts H125, contacts O140 and coil D141, contacts 65 and 64 of the car switch, to the right-hand blade of switch 47 as previously traced.

The operation of the first accelerating switch, in response to the energization of its actuating coil, causes the engagement of contacts D143, D144, D145 and D146. The engagement of contacts D143 completes the circuit for the leveling switch motor 41. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 147 through contacts D 143, field winding 40 and armature 38 of motor 41, by way of line 58 through contacts A61, to the right-hand blade of switch 47. The leveling switch motor, upon energization, acts to move the leveling switch operating rollers so as to clear the leveling cams during movement of the car. This operation will be explained later. The engagement of contacts D144 completes the circuit for holding coils B115 and H116. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 148 through coil H116 and contacts D144, by way of line 150 through coil B115 and contacts B113, line 151, line 85, to the right-hand blade of switch 47 as previously traced. The purpose of the energization of these holding coils will be seen from later description. The engagement of contacts D146 completes the circuit for the second accelerating switch actuating coil E152. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 107 through door contacts 51, gate contacts 52 and contacts N108, by way of line 142 through contacts H125, by way of line 153 through contacts D146, reactance X154 and coil E152, car switch contacts 66 and 64, to the right-hand blade of switch 47 as previously traced. The engagement of contacts D145 short-circuits section 155 of resistance 27, increasing the voltage applied to the generator field winding. Thus the generator E. M. F. is increased, increasing the speed of the motor.

The second accelerating switch E does not operate immediately the circuit for its actuating coil is completed, its action being delayed by the effect of reactance X154. Upon operation, contacts E156 and E57 separate and contacts E157 and E158 engage. The separation of contacts E156 removes the shunt circuit around a portion of resistance 160. The separation of contacts E156 before contacts E158 engage prevents excess power consumption from mains 45 and 46. The engagement of contacts E158 completes the circuit for the first accelerating switch holding coil D161 and the maintaining relay actuating coil M162. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 151 through contacts E158, reactance X163, coil D161 and coil M162, line 85, to the right-hand blade of switch 47 as previously traced. The maintaining relay contacts M164 are thus closed to by-pass contacts D144. The purpose of this arrangement will be described later. The engagement of contacts E157 short-circuits section 165 of resistance 27 to increase the voltage applied to the generator separately excited field winding. The E. M. F. of the generator, therefore, increases to its full value and the speed of the elevator motor increases. The separation of contacts E57 removes the short circuit for section 167 of resistance 29 in the elevator motor field winding circuit, bringing the elevator motor up to full speed.

The starting of the car in the down direction is accomplished in a similar manner and will be only briefly described. The operator first moves the car switch into posi-

tion to cause the closure of the gate and door and then into full on position where its contact segment 72 bridges contacts 67, 68, 69, 70 and 71. Thus the circuit is completed for the down main direction switch actuating coil C168. This circuit may be traced from the left-hand blade of switch 47, through coil H101 as previously traced, by way of line 170 through coil C168, car switch contacts 68 and 69, by way of line 171 through contacts B110, line 85, to the right-hand blade of switch 47 as previously traced. The circuit for coil N98 is by way of line 172. The circuit for coil D141 is by way of line 173. The circuit for coil E152 is by way of line 174. The down main direction switch, upon operation, causes the separation of contacts C106 and the engagement of contacts C169, C175, C176 and C177, these contacts corresponding with up main direction switch contacts B110, B109, B111, B112 and B113 respectively. Contacts C169 prepare a circuit for the up field strengthening control switch actuating coil SB178 to be completed by contacts R250. The holding coil of the down ~~main~~ direction switch is designated C179. Further than this, the operation of starting the car in the down direction is the same as described for starting it in the up direction.

Assume that the car is running in the up direction and that the operator centers the car switch between the second and third floors in order to stop at the third floor landing. Thus the contact segment 72 moves off contacts 66, 65, 64 and 63 and the circuits for the second accelerating switch actuating coil E152, first accelerating switch actuating coil D141, main brake and field switch actuating coil H101, up main direction switch actuating coil B102 and sequence relay coils N98 and N100 are broken. The second accelerating switch drops out immediately. The first accelerating switch, main brake and field switch and up main direction switch are maintained operated, however, by holding coils D161, H116 and B115 respectively. The deenergization of coils N98 and N100 is in preparation for the next starting operation. It is to be noted that switch 78 is opened by the centering of the car switch. The circuit for coil J82, however, is maintained through contacts H127 and K136 in parallel and coil K130.

The second accelerating switch, upon dropping out, causes the separation of contacts E157 and E158 and the reengagement of contacts E57 and and E156. The separation of contacts E157 reinserts section 165 of resistance 27 in series with the generator separately excited field winding to decrease the E. M. F. of the generator. The engagement of contacts E57 short-circuits section 167 of resistance 29, increasing the strength of the elevator motor field for the stopping operation. With the generator E. M. F. lowered and the strength of the elevator motor field increased, the speed of the elevator motor is decreased. The separation of contacts E158 breaks the circuit for holding coil D161 and coil M162. The first accelerating switch D and maintaining relay M do not drop out immediately, however, their action being delayed by the effect of reactance X163 in series with the coils and the discharge resistance 160 in parallel with the reactance and the coils. The engagement of contacts E156 to short-circuit a portion of resistance 160 is effective to prolong the time element of the switch and relay. The time element may be adjusted to the desired value by changing the amount of the resistance portion short-circuited. Relay M is preferably adjusted to hold in at a smaller current value than the accelerating switch D. This may be readily accomplished due to the fact that the relay is much smaller and therefore lighter in construction than the accelerating switch and requires less current to hold in.

The first accelerating switch, upon dropping out, causes the separation of contacts D143, D144, D145 and D146. The separation of contacts D144 is in preparation for the next starting operation, contacts M164 remaining in engagement to maintain holding coils H116 and B115 energized. The separation of contacts D146 also is in preparation for the next starting operation, the circuit for coil E152 having been broken by the movement of the car switch as above described. The separation of contacts D145 removes the short circuit for section 155 of resistance 27, decreasing the strength of the generator field. Thus the generator E. M. F. is again decreased and the speed of the elevator motor is reduced.

The separation of contacts D143 deenergizes the leveling switch motor 41. In this manner the operating rollers of the leveling switch are extended for engagement by the leveling cams. Referring briefly to Figure 2, the leveling switch motor is operatively connected to the leveling switch by means of an arm 180 on the motor shaft, a connecting link 181 and a lever 182. In the starting operation, the motor 41 being energized, arm 180 rotates, acting through link 181 and lever 182 to move the leveling switch as a whole about a pivot. In this manner the leveling switch operating rollers 183 and 184 are moved into position where they do not engage the leveling cams 185 and 186 during motion of the car, a stop being provided to determine the extent of the movement. It is to be understood that leveling cams are provided for each floor. The leveling switch is pivoted on a bracket 187 secured to the car frame. In the stopping operation, upon the deenergization of the lev-

eling switch motor, a spring (not shown) moves the lever 182 and therefore the leveling switch back into the first described position with the rollers 183 and 184 extended for engagement by the leveling cams. Each pair of leveling switch contacts 34, 35, 36 and 37 comprises a stationary contact and a movable contact operated by the engagement of its corresponding roller and leveling cam. The fast speed contacts 36 and 37 are arranged to separate before their corresponding slow speed contacts 34 and 35 in the leveling operation. Springs (not shown) are provided for causing the separation of the contacts of the pairs as the leveling operation is effected and stops are provided for determining the extent of movement of the rollers as they ride off the leveling cams.

It will be assumed that the car has not reached the landing and that the up leveling switch operating roller 183 moves onto the vertical surface of up leveling cam 185 before relay M drops out. The engagement of leveling switch up slow speed contacts 34 completes a circuit for the up leveling direction switch actuating coil LB188 and the leveling brake and field switch actuating coil LH190. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, line 191, leveling switch contacts 34, by way of line 192 through coil LB188 and coil LH190, line 85, to the right-hand blade of switch 47 as previously traced. The engagement of the leveling switch up fast speed contacts 36 completes the circuit for fast speed leveling relay actuating coil LF193. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, line 191, leveling switch contacts 34, line 194, leveling switch contacts 36, by way of line 85 through coil LF193, to the right-hand blade of switch 47 as previously traced. It is to be noted that, due to the fact that the circuit for coil LF193 is through leveling switch slow speed contacts 34, the circuit for coils LB188 and LH190 must be made in order that the circuit for coil LF193 may be completed.

The up leveling direction switch LB, upon operation, causes the separation of contacts LB132 and the engagement of contacts LB195, LB196, LB197 and LB199. The engagement of contacts LB199 has no particular effect at this time. Contacts LB132 will be referred to later. The engagement of contacts LB195 and LB196 prepares a circuit for portion 18 of the generator separately excited field winding. The engagement of contacts LB197 completes the circuit for up series field relay actuating coil G198 and up hard brake switch actuating coil P200. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 201 through contacts LB197, coil G198, coil P200, and portion 202 of reactance X203, line 204, by way of line 58 through contacts A61, to the right-hand blade of switch 47.

The leveling brake and field switch, operating simultaneously with the up leveling direction switch, causes the separation of contacts LH205, LH206 and LH210 and the engagement of contacts LH207 and LH208. Contacts LH205 are in the circuit for resistance 33 across the brake release coil. Contacts LH206 are in series with contacts H119 in the circuit for connecting the generator separately excited field winding to the generator armature. Contacts LH207 by-pass contact H124 in the circuit for the brake release coil. Contacts LH208 by-pass contacts H126 in the circuit for section 54 of the motor field resistance 29. The purpose of contacts LH205, LH206, LH207 and LH208 will be seen as the description proceeds. Contacts LH210 break the shunt circuit comprising resistance 160 for coils D161 and M162.

The fast speed leveling relay, upon operation, causes the engagement of contacts LF212, LF213 and LF214. The engagement of contacts LF213 short-circuits a portion of resistance 28, the purpose of which will be seen as the description proceeds. The engagement of contacts LF214 by-passes contacts LB132, LC133, H127 and K136, coil K130 and switch 78 through resistance 84 in a circuit for coil J82 of the door control motor switch. Since the engagement of contacts LF214 generally occurs substantially simultaneously with the separation of contacts LB132, the switch J does not drop out. Even if switch J should drop out, the immediate reenergization of coil J82 upon the engagement of contacts LF214 would prevent the operation of the gate and door operating mechanism due to the time required for the mechanism to start in operation. The circuit for the door control motor maintaining relay coil K130, however, is broken by the separation of contacts LB132. The engagement of contacts LF212 completes the circuit for the slow-down switch actuating coil S215. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 211 through contacts LF212, coil S215 and reactance X216, by way of line 58 through contacts A61, to the right-hand blade of switch 47. The slow-down switch S, upon operation, causes the separation of contacts S217 to remove the short circuit for resistance 25. The purpose of this arrangement will be seen from later description.

The separation of contacts LH210 to break the circuit for resistance 160 as above set forth causes relay M to drop out and separate contacts M164. As a result the circuit

for holding coils B115 and H116 is broken, permitting the up main direction switch and main brake and field switch to drop out. Switch B, upon dropping out, causes the separation of contacts B109, B111, B112 and B113 and the engagement of contacts B110. The separation of contacts B113 and the engagement of contacts B110 is in preparation for the next starting operation. The separation of contacts B109 is without effect as they are by-passed by contacts SC254 to maintain the energization for the down field strengthening control switch actuating coil SC251. The separation of contacts B111 and B112 breaks the circuit for the generator field winding 17. However, portion 18 of the field winding is simultaneously connected to one of the lines and neutral by contacts H122 of the main brake and field switch as set forth below. It is to be noted that the source of supply illustrated is direct current and it is preferred that it be a three wire system having the neutral grounded. The neutral is indicated by the reference character 261. In the event that only alternating current is available, it is to be understood that a three wire exciter, driven by an alternating current motor, may be employed to supply the field windings and the control circuits. The switch H, upon dropping out, causes the separation of contacts H124, H125, H126 and H127 and the engagement of contacts H119, H122 and H123. The separation of contacts H125 and H127 is in preparation for the next starting operation. The separation of contacts H124 and H126 is without effect, the circuit for the brake release coil 30 being maintained by contacts LH207 and section 54 of resistance 29 remaining short-circuited by contacts LH208. The engagement of contacts H119 and H123 also is without effect as the circuit for reconnecting the generator separately excited field winding to the generator armature is maintained broken by contacts LH206 and the shunt circuit for the brake release coil 30 comprising resistance 33 is maintained broken by contacts LH205. The engagement of contacts H122, however, completes the circuit for portion 18 of the generator field winding. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 256 through contacts LF213, the remaining portion of resistance 28 and contacts H122, by way of line 257 through contacts LB195, line 258, portion 18 of field winding 17, line 260, back to line 256, through contacts LB196, to neutral 261. With contacts LF213 in engagement, short-circuiting a portion of resistance 28 and with portion 18 of the generator field winding connected to the mains, an E. M. F. is generated which causes the elevator motor to run at a suitable fast leveling speed. Discharge resistance 24 acts not only to smooth out the changes in generator E. M. F. due to the reinsertion of resistance 27 in circuit with the separately excited field winding in steps but also acts to prevent a sudden drop in value of the E. M. F. upon the changing over of the connections for the separately excited field winding. It is to be understood that resistance 27 may be controlled in any number of steps, two being shown merely for convenience of description.

Relay G and switch P do not operate immediately their actuating coils are energized, their action being delayed by reactance X203. Switch P, however, is adjusted to operate almost immediately and, upon operation, causes the separation of contacts P221, disconnecting resistance 32 from across the brake release coil 30. Relay G, upon operation, causes the engagement of contacts G222, completing the circuit for the series field switch actuating coil F223. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 224 through contacts G222 and coil F223, by way of line 58 through contacts A61, to the right-hand blade of switch 47. Switch F, upon operation, causes the separation of contacts F225, breaking the circuit including resistance 23 in shunt to the generator series field winding 16. The generator series field is so wound that, without the parallel resistance 23, it would have too great an effect for proper operation of the car. The desired compounding is obtained by employing the low resistance shunt. Upon separation of contacts F225, the strength of the series field is increased for the leveling operation so as to aid in bringing the motor to a stop. The short delay in the action of relay G, and therefore switch F, upon the initiation of the leveling operation, is desirable in order that the current in the generator armature-elevator motor armature circuit may adjust itself to such a value that proper series field strength during the leveling operation may be obtained.

As the car nears the third floor landing, roller 183 rides off the vertical surface onto the oblique surface of cam 185. This results in the separation of leveling switch up fast speed contacts 36, deenergizing fast speed leveling relay coil LF193. Relay LF, upon dropping out, causes the separation of contacts LF212, LF213 and LF214. The separation of contacts LF213 removes the short circuit for the portion of resistance 28 and for resistance 25. The separation of contacts LF212 breaks the circuit for the slow-down switch actuating coil S215. The switch S does not drop out immediately, however, being delayed by the action of reactance X216 and discharge resistance 265. As will be explained later, by this arrange-

ment the generator E. M. F. is so controlled as to cause the speed of the elevator motor to be reduced to a value from which an accurate stop may be made. The separation of contacts LF214 breaks the circuit for the door control motor switch coil J82. Switch J, upon dropping out, causes the separation of contacts J87 to deenergize the motor 44, thus effecting the automatic gate and door opening operation. The gate and door operating mechanism functions in the same manner as described for opening the gate and door in response to centering the car switch. In this manner the automatic gate and door opening operation is timed so that the gate and door open as the car stops at the landing. It is to be noted, however, that the automatic gate and door opening operation can not take place until the leveling switch fast speed contacts separate.

Shortly before the car reaches the exact level with the landing, the roller 183 rides off the oblique surface of cam 185, thereby separating the leveling switch up slow speed contacts 34. The circuit for coils LB188 and LH190 is thus broken. Switch LH drops out, causing the separation of contacts LH207 and LH208 and the reengagement of contacts LH205, LH206, and LH210. The engagement of contacts LH210 is in preparation for the next starting operation. The separation of contacts LH207 breaks the circuit for the brake release coil 30, effecting the application of the brake. The separation of contacts LH207 also breaks the circuit for the accelerating relay coil O138 and the retaining switch coil R128. The accelerating relay O drops out, separating contacts O140 in preparation for the next starting operation. The action of the retaining switch will be explained later. The separation of contacts LH208 reinserts section 54 of resistance 29 in series with the elevator motor field winding, reducing the current therein to a "standing field" value. The reengagement of contacts LH206 reconnects the generator separately excited field winding to the generator armature. The polarity of this connection is such that the generator sends current through the field winding in such manner as to oppose the flux which produces the generator E. M. F., thus tending to destroy the residual flux of the generator field.

Up leveling direction switch LB, dropping out simultaneously with switch LH, causes the separation of contacts LB195, LB196, LB197 and LB199 and the engagement of contacts LB132. The separation of contacts LB199 and the engagement of contacts LB132 is in preparation for the next starting operation. The separation of contacts LB195 and LB196 disconnects portion 18 of the generator separately excited field winding from the mains, the winding being simultaneously connected to the generator armature by contacts LH206 as set forth above. The separation of contacts LB197 breaks the circuit for coils G198 and P200. The relay G drops out immediately but the dropping out of switch P is delayed slightly due to the effect of the reactance X203 and discharge resistance 226. It is to be noted that the discharge current for up coil P200 and the reactance passes through down coil P227 in such direction as to cause coil P227 to assist coil P200 in maintaining switch P in operated condition. Relay G, upon dropping out, causes the separation of contacts G222 to deenergize coil F223, switch F dropping out in turn to cause the engagement of contacts F225. The engagement of contacts F225 reconnects resistance 23 in parallel with the generator series field winding 16. Switch P, upon dropping out, causes the engagement of contacts P221.

Thus the brake being applied and the generator separately excited field winding being disconnected from the mains, the car is brought to rest level with the third floor landing. Since the engagement of contacts P221 is delayed, the brake release coil 30 discharges only into resistance 31 of relatively high ohmic value and a "hard" application of the brake is obtained. In this manner a positive stop at the landing is assured. The car may come to the floor and the leveling direction switch LB open and the brake apply before the slow-down switch S drops out. If the car has not come to the floor when switch S drops out, contacts S217 engage to short-circuit resistance 25, assuring that the car does not stall. The operation and purpose of this arrangement will be explained more in detail later.

With the sequence of operation as above described the car will be slowed down and stopped level with the desired landing without sacrifice of smoothness. However, should the car switch be centered with the car at a greater distance from the landing, the maintaining relay would hold in to effect, through its contacts M164, the retention of the main direction switch and main brake and field switch in operated condition. Should relay M drop out before the leveling switch contacts engage, the subsequent engagement of the leveling switch contacts as the leveling switch roller rides onto the cam would cause the operation of switches LB and LH and relay LF to bring the car to a level with the floor. In the event that the car switch is centered late in the stopping operation, as for example when the leveling switch operating roller strikes the leveling cam upon the dropping out of the first accelerating switch D, the immediate separation of contacts LH210 forces the dropping out of the main direction switch and the main brake and field switch to permit the

immediate change of the field winding connections and thus slow down the elevator motor more rapidly. In this manner the tendency for the car to overrun the floor is reduced.

Should an overrun occur, however, the system is arranged so that the operation of the switches is modified. Assuming in the above example that the car overruns the third floor landing to the extent of causing the engagement of leveling switch down slow speed contacts 36, a circuit is completed for down leveling direction switch actuating coil LC228 and coil LH190. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, line 191, contacts 35, by way of line 229 through coil LC228, by way of line 192 through coil LH190, line 85, to the right-hand blade of switch 47 as previously traced. Contacts LH205, LH206 and LH210 are separated and contacts LH207 and LH208 are engaged so that the circuit for resistance 33 across the brake release coil is broken, the generator separately excited field winding is disconnected from the generator armature, the brake release coil is energized and resistance section 54 for the elevator motor field winding is short-circuited. Contacts LH210 insure the dropping out of the main direction switch. The switch LC operates to cause the separation of contacts LC133 and the engagement of contacts LC230, LC231, LC232 and LC233. The separation of contacts LC133 is without particular effect at this time. The switch R is maintained in operated condition, should there be an interval that the brake release coil 30 and coil R128 are disconnected from the mains as is being assumed, by the brake release coil discharge current. Thus coil SC251 remains energized and contacts SC255 are maintained in engagement. The engagement of contacts LC230, therefore, completes the connection of down field strengthening resistance 39 to line 256. This operation serves no particular purpose so long as the car has not overrun into the fast speed leveling zone. The engagement of contacts LC231 and LC232 connects portion 18 of the generator separately excited field winding to one of the mains and grounded neutral. Due to the reversal of the direction of the current through field winding portion 18 from that during the leveling operation with the car approaching the floor in the up direction, the car is caused to start in the down direction. Since relay LF is not operated, contacts LF212 are separated and therefore contacts S217 are in engagement short-circuiting resistance 25 and contacts LF213 are separated so that resistance 28 is included in circuit with field winding portion 18, causing the motor to run at slow leveling speed.

The engagement of contacts LC233 completed a circuit for the down series field relay actuating coil G234 and the down hard brake switch actuating coil P227. This circuit may be traced from the left-hand blade of switch 47, by way of line 55 through contacts A60, by way of line 235 through contacts LC233, coil G234, coil P227 and portion 236 of reactance X203, line 204, by way of line 58 through contacts A61, to the right-hand blade of switch 47. Relay G and switch P do not operate immediately upon the engagement of contacts LC233. When approaching the floor in the up direction, the current flowing through reactance portion 202 caused a flux to be built up in the reactance X203 in one direction. Upon the separation of contacts LB197, the current in the reactance and coil P200 discharged into resistance 226 tending to maintain the flux built up and, as previously explained, switch P in operated condition. Upon the engagement of contacts LC233 on the overrun, the current supplied to coils G234 and P227 must reverse the flux in the reactance, thus taking a longer time to build up to a value sufficient to cause the operation of relay G and switch P. Thus contacts F225, depending for their operation upon the operation of relay G, remain closed temporarily to insure that the current in the generator armature-motor armature circuit has fallen to a low value. Since the current in the series field winding may be flowing in a direction such as to cause the generation of an E. M. F. which is of proper polarity for operating the car in the down direction, immediate increase in the strength of the series field might result in another overrun, i. e., an overrun in the down direction. As the car returns to the floor, it is stopped by the separation of the leveling switch slow speed contacts 35 in a manner similar to that described for approaching the floor in the up direction.

If the overrun is great enough to cause the engagement of the leveling switch down fast speed contacts 37 as well as the leveling switch down slow speed contacts 35, coil LF193 is energized. As previously described, relay LF causes the engagement of contacts LF212, LF213 and LF214. Contacts LF213 short-circuit the portion of resistance 28. Contacts LF212 complete the circuit for coil S215 causing the operation of the slow-down switch S and the consequent separation of contacts S217, removing the short circuit for resistance 25. Resistance 25, however, is short-circuited by contacts LF213. Thus the elevator motor is caused to run at its fast leveling speed. The engagement of contacts LF214 causes coil J82 to be energized again in the event that it has become deenergized. As the car moves back into the slow speed leveling zone, relay

LF drops out, causing the separation of contacts LF212, LF213 and LF214. As previously described, the separation of contacts LF214 initiates the operation of the automatic gate and door opening mechanism; the separation of contacts LF212 breaks the circuit for coil S215, the slow-down switch being maintained in operated condition by the action of reactance X216 and discharge resistance 265; and the separation of contacts LF213 removes the short circuit for the portion of resistance 28 and for resistance 25. It is to be noted that down field strengthening resistance 39 is connected in parallel with resistance 25 during this operation due to the engagement of contacts SC255 and LC230, as above set forth. By means of this arrangement, as will be explained later, proper slow leveling speed is obtained for bringing the car to the floor, where it is stopped as above described. Similar operation is had in the event of an overrun with the car moving in the down direction, the holding circuit for up field strengthening control switch coil SB178 being established by contacts SB266 and the circuit for resistance 19 being prepared by contacts SB267. The circuit for resistance 19 is completed by the up leveling direction switch contacts LB199.

It is to be understood that the operator may control both the acceleration and retardation of the car by moving the car switch in steps. Should the operator suddenly move the car switch from one position into the other, for example from up into down position, injury to the system is prevented by contacts B110 which remain separated until the up direction switch drops out. It is to be noted that, when the car is stopped between floors, the switch P is not operated. Thus contacts P221 are in engagement and a "soft" application of the brake is obtained.

When generators, suitable for supplying power to an elevator motor for high speed installation, are employed also to supply power to the motor during the leveling period as in the system above described, variations in the leveling operation are likely to occur due to the slowness with which the strength of the generator field reduces to a value suitable for obtaining the desired slow leveling speed of the elevator motor. Consistent results may be obtained under such conditions by forcing the generator field strength down to such a value that a slow leveling speed of the elevator motor, from which an accurate stop may be made, is assured. This may be accomplished by initially and momentarily inserting a resistance of relatively high ohmic value in circuit with the generator field winding as the change in connections for obtaining slow leveling speed is made. This resistance acts to reduce the current supplied to the generator field winding to a very low value and thus causes a more rapid decrease in the strength of the generator field. In some installations, the value of such a resistance may be infinite so that the decrease in generator field strength is governed entirely by the action of the current in the field winding discharge circuit. In the control system described, this resistance has been designated 25. This resistance may be inserted in a circuit connected across mains 45 and 46 and including the whole field winding. But in order to afford protection against the occurrence of excessive speeds, as will be pointed out later, it is preferred to employ only a portion of the field winding connected to one supply main and a grounded neutral. In accordance with the preferred arrangement, therefore, resistance 25 is inserted in circuit with only the portion 18 of the field winding, the insertion being governed by the operation of the fast speed leveling relay LF and the slow-down switch S. In a brief résumé of the operation, as the car enters the slow speed leveling zone, the fast speed leveling relay drops out, causing the separation of contacts LF212 and LF213. The separation of contacts LF212 breaks the circuit for the slow-down switch actuating coil S215, the slow-down switch being maintained operated by the action of reactance X216 and discharge resistance 265. Contacts S217, therefore, remain separated so that the separation of contacts LF213, instead of inserting only the remainder of resistance 28 in circuit with portion 18 of the generator field winding, inserts in addition resistance 25. Were resistance 25 permitted to remain in circuit with the field winding portion for too long a period, it would cause such a reduction in the generator field strength, and therefore generator E. M. F., as might result in stalling the elevator motor regardless of whether the car had reached the landing. Such a situation might result under certain conditions of operation as where the car is slow in coming to the floor. The stalling of the car is prevented, however, by the action of the slowdown switch S, this switch, as above described, being maintained in operated condition for a certain time interval by the action of reactance X216 and discharge resistance 265. Thus the car may come to the floor and the leveling direction switch drop out before switch S drops out to cause the reengagement of its contacts S217. Should the car not reach the landing within the time interval for switch S, however, the dropping out of this switch and engagement of its contacts S217 short-circuits resistance 25, leaving only resistance 28 in circuit with the generator field winding. The value of resistance 28 is so chosen that the generation of an E. M. F. of sufficient value to cause the

continued operation of the motor to move the car to a level with the landing is assured. The value of resistance 25 is so chosen and the timing of the slow-down switch is so adjusted as to give proper operation for the particular installation when the car is being stopped as it approaches the floor.

Upon the energization of the generator field winding to return the car to the floor after an overrun, the generator field assumes an entirely different state magnetically, due primarily to the effect of the hysteresis of the iron and the fact that the field strength is being built up rather than reduced. Thus to insert resistance 25 in the circuit for field winding portion 18 upon the separation of contacts LF213 would cause too great a reduction in the strength of the generator field, resulting in the car being brought to a premature stop before the landing is reached and then being started again as resistance 25 was short-circuited by the subsequent engagement of contacts S217. It is preferred to overcome such a condition by paralleling resistance 25 by a resistance of relatively low ohmic value during the operation of returning the car to the floor after an overrun. Resistances 19 and 39, in conjunction with the field strengthening control switches SB and SC, the retaining switch R and the leveling direction switches LB and LC are employed for this purpose. As has previously been explained, contacts SC255 are caused to engage during up car travel and contacts SB267 during down car travel, these contacts being maintained in engagement during an overrun by the action of the retaining switch R. Thus the engagement of contacts LC230, upon the return of the car to the floor after an overrun in the up direction, connects resistance 39 in parallel with resistance 25, and the engagement of contacts LB199, upon the return of the car to the floor after an overrun in the down direction, connects resistance 19 in parallel with resistance 25. Upon the separation of contacts S217, therefore, the reduction in the current supplied to field winding portion 18 is only sufficient to cause a reduction in the speed of the elevator motor to the desired value.

It is preferred to employ two field strengthening resistances 19 and 39 to obtain the above described operation since each may be separately adjusted to suit the requirements of the particular installation. It is to be understood, however, that only one field strengthening resistance may be employed with two parallel circuits connected in series therewith, one parallel circuit including contacts SC255 and contacts LC230 arranged in series relation and the other including contacts SB267 and contacts LB199 arranged in series relation.

This arrangement for the control of the strength of the generator field aids in guarding against the occurrence of excessive speed of the elevator car during the leveling period, being particularly effective to prevent such occurrence in the event of the grounding of certain parts of the system. The automatic opening of the gate and door during the leveling period renders the feature of particular importance. In systems such as those employing resistance in series with the elevator motor armature to control the speed of the motor during leveling, or wherein the voltage applied to the armature of the elevator motor during leveling is controlled by means of resistance in series with the whole of the separately excited field winding of the generator, there is always the possibility of the grounding of the whole or a part of such resistances, causing the speed of the elevator motor to increase. If mechanism were employed, as in the present system, to effect the automatic opening of the gate and door during the leveling period, the sudden increase in the speed might occur while the gate and door were being opened, or after the gate and door were open when the leveling arrangement is slow in bringing the car to a level with the landing. In the present system, the possibility of occurrence of excessive speed from any cause, during the leveling period, and, therefore, during the opening of the gate and door or while the gate and door are open, is minimized, with such occurrence as the result of grounds prevented. Due to the fact that the circuit including resistance 27 for connecting the generator field winding to the source is broken by the main direction switch contacts, the accidental short-circuiting of resistance 27 during the leveling operation cannot effect an increase in the speed of the elevator car. Also the connections for the leveling operation must be made in order to effect the automatic gate and door opening operation, since contacts on the leveling direction switches control the circuit for the door control motor maintaining relay actuating coil K130. As previously set forth, the circuit for the field winding portion 18, employed during leveling, continues to the grounded neutral 261. Thus the maximum voltage which can be applied to field winding portion 18 is reduced to half the value of that which can be applied to the whole field winding during car switch operation. Also by completing the circuit for the field winding portion 18 through the grounded neutral, the occurrence of a ground in any part of this circuit results in short-circuiting all or a part of the field winding portion 18, causing a decrease rather than an increase in the generator field strength. Assuming that the circuit for field winding portion 18 is completed by contacts LB195

and LB196, the occurrence of a ground in the portion of winding 17, illustrated as above portion 18, would have no effect as the circuit from the upper junction point of winding portion 18 to ground is direct. In the case of the grounding of the field winding portion illustrated below portion 18, the tendency for an increase in total field strength is compensated for by a decrease in the field strength due to portion 18. Similar protection is afforded in the event that the circuit for field winding portion 18 is completed by contacts LC231 and LC232.

It is preferred to employ one of the intermediate poles, as for example the second or third pole of a four pole generator, for field winding portion 18 as illustrated. The remaining portions of the field winding then serve as protecting resistances between the grounded neutral and main 46 in the event that the main and leveling direction switches are closed simultaneously. It is to be understood that several types of generators may be employed and that they may be of other numbers of poles. It is to be further understood that field winding portion 18 may include more than one pole.

As many changes could be made in the above arrangements and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an elevator system, a car, hatchway doors for each of a plurality of landings, mechanism for opening and closing each door, means for causing the operation of said mechanisms, said means being biased to door opening position, means for bringing the car to a level with a desired landing in stopping, said second named means comprising means for causing the car to move at a fast leveling speed when beyond a certain distance from said landing and means for causing the car to move at a slow leveling speed upon arriving at said certain distance from said landing, and means for preventing the operation of said first named means to cause the opening of the door for said landing so long as the car is beyond said certain distance from the landing.

2. In an elevator system, a car, hatchway doors for the landings, mechanism for opening and closing said doors, electromagnetic means for causing, upon energization, the operation of said mechanism to close the door for the landing at which the car is positioned, a controller switch having contacts for causing the energization of said electromagnetic means, means for causing the car to level with a desired landing in stopping, said second named means comprising a two speed leveling switch having fast speed contacts and slow speed contacts, and means for preventing the operation of said mechanism to open the door for said desired landing until the final assumption of control of the car by the leveling switch slow speed contacts, said last named means comprising a switch operable in response to the engagement of the leveling switch fast speed contacts to by-pass the controller switch contacts.

3. In an elevator system, an elevator car, a plurality of landings, each landing having fast and slow speed leveling zones, a hatchway door for each of said landings, means for causing the opening and closing of said doors, means for causing the car, in stopping at any one of said landings, to be brought to a level therewith, said second named means being adapted to cause the car to run at a fast leveling speed when in the fast speed leveling zone for such landing and at a slow leveling speed when in the slow speed leveling zone for such landing, means for causing the operation of the first named means to effect the opening of the door for such landing to be initiated upon the arrival of the car in the slow speed leveling zone for such landing, and means for rendering the first named means ineffective to cause the opening of such door when the car is in the fast speed leveling zone for such landing, regardless of whether the leveling means first assumes control for fast leveling speed or assumes control for fast leveling speed after having had control for slow leveling speed.

4. In an elevator system, an elevator car, a plurality of landings, each landing having fast and slow speed leveling zones, a hatchway door for each of said landings, mechanism for opening and closing said doors, electromagnetic means for causing, upon energization, the operation of said mechanism to close the door for the landing at which the car is positioned, a switch in the car operable upon movement out of off position to cause the starting of the car and upon return to off position to cause the stopping of the car, said switch having contacts rendered effective upon movement of the switch out of off position to cause the energization of said electromagnetic means, means for maintaining said electromagnetic means energized during the slowing down of the car after the return of said switch to off position to cause the stopping of the car, means for causing the car, in stopping at any one of said landings, to be brought to a level therewith, regardless of whether it underruns or overruns such landing, said leveling means comprising a two speed leveling switch having contacts for causing the car to run at a fast leveling speed and contacts for causing the car to run at a slow leveling

speed, means responsive to the engagement of slow speed contacts of the leveling switch for causing the deenergization of said electromagnetic means to effect the operation of said mechanism to open the door for such landing, and means responsive to the engagement of fast speed contacts of the leveling switch for causing said electromagnetic means to be energized, thus preventing the opening of the door for such landing until the final assumption of control by slow speed contacts of the leveling switch.

In testimony whereof, we have signed our names to this specification.

RAYMOND A. WAITE.
FRANK L. MORRIS.