Sept. 21, 1965 A. O. LUND ETAL 3,207,265

ELEVATOR CONTROL SYSTEM

Filed Dec. 27, 1961 5 Sheets-Sheet 1

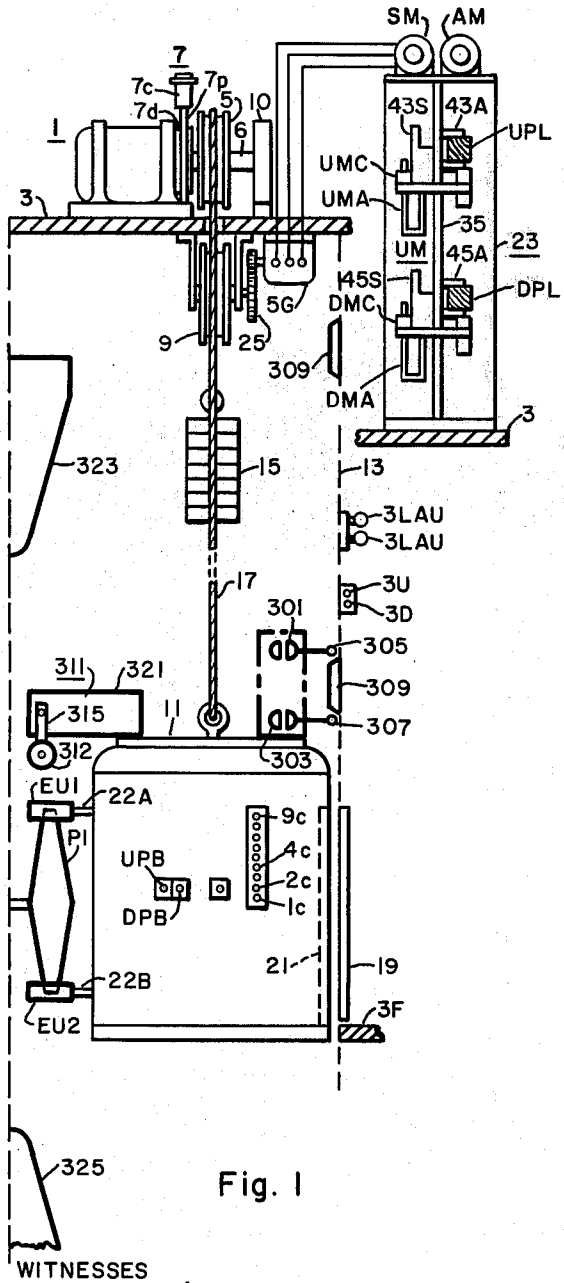


Fig. 1

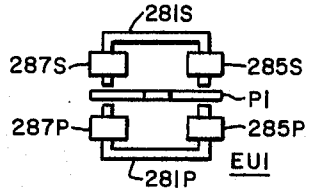


Fig. 2

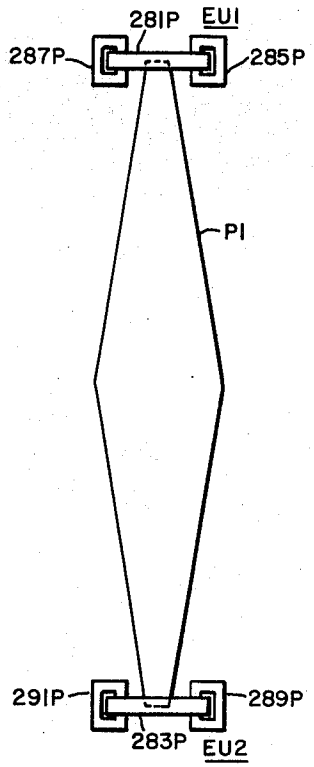


Fig. 3

WITNESSES

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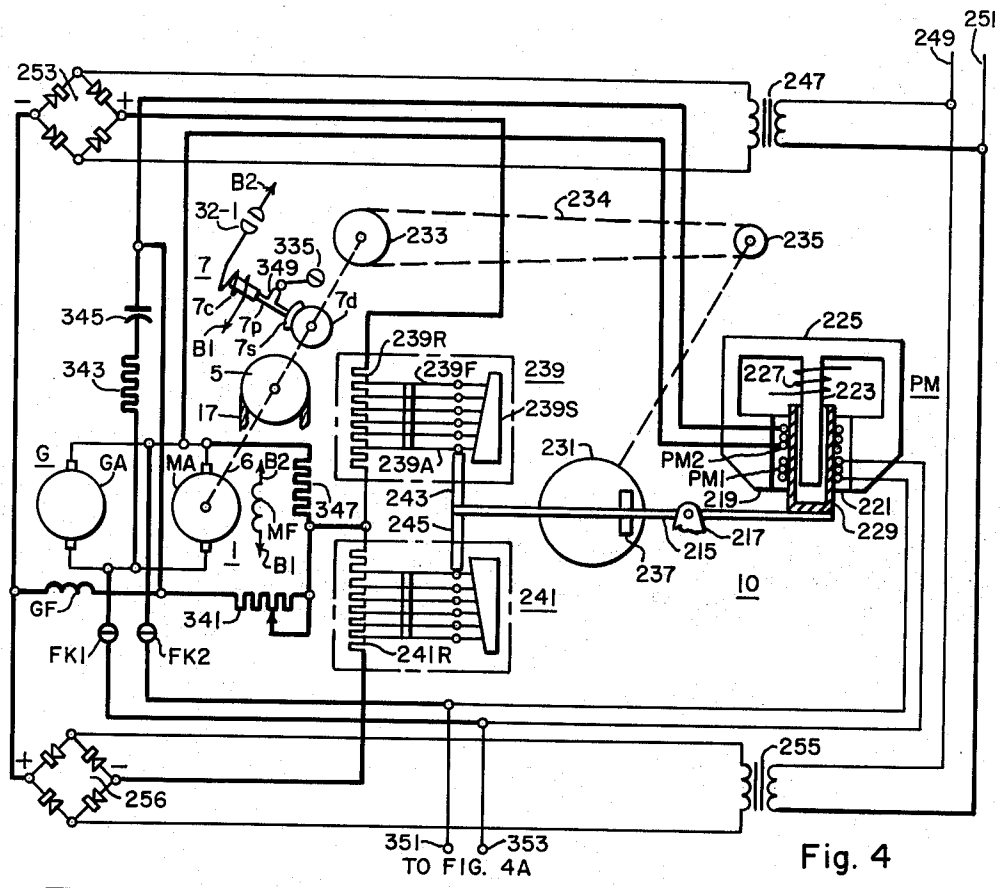

253
247
249
251
B2
32-1
234
233
235
335
349
7
7c
7d
7p
7s
B1
345
343
5
17
239R
239F
239
239S
239A
225
227
223
PM
231
PM2
PM1
219
221
229
217
215
237
10
G
GA
MA
6
B2
347
243
245
MF
B1
241
241R
GF
341
FK1
FK2
255
256
351
353
TO FIG. 4A

Fig. 4

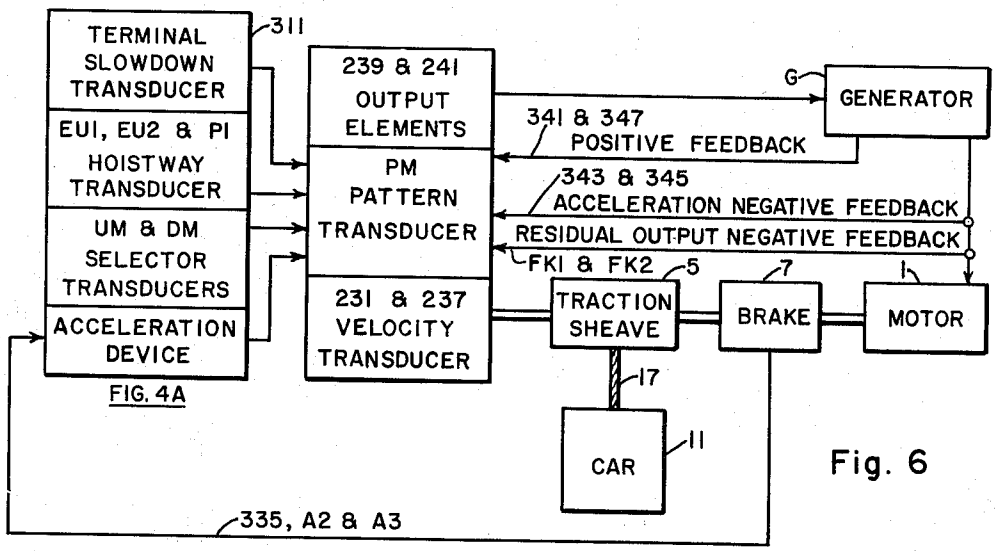

TERMINAL SLOWDOWN TRANSDUCER
EU1, EU2 & PI HOISTWAY TRANSDUCER
UM & DM SELECTOR TRANSDUCERS
ACCELERATION DEVICE
311
FIG. 4A
239 & 241 OUTPUT ELEMENTS
PM PATTERN TRANSDUCER
231 & 237 VELOCITY TRANSDUCER
G
GENERATOR
341 & 347 POSITIVE FEEDBACK
343 & 345 ACCELERATION NEGATIVE FEEDBACK
RESIDUAL OUTPUT NEGATIVE FEEDBACK
FK1 & FK2
5
7
1
TRACTION SHEAVE
BRAKE
MOTOR
17
CAR
11
335, A2 & A3

Fig. 6

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ELEVATOR CONTROL SYSTEM

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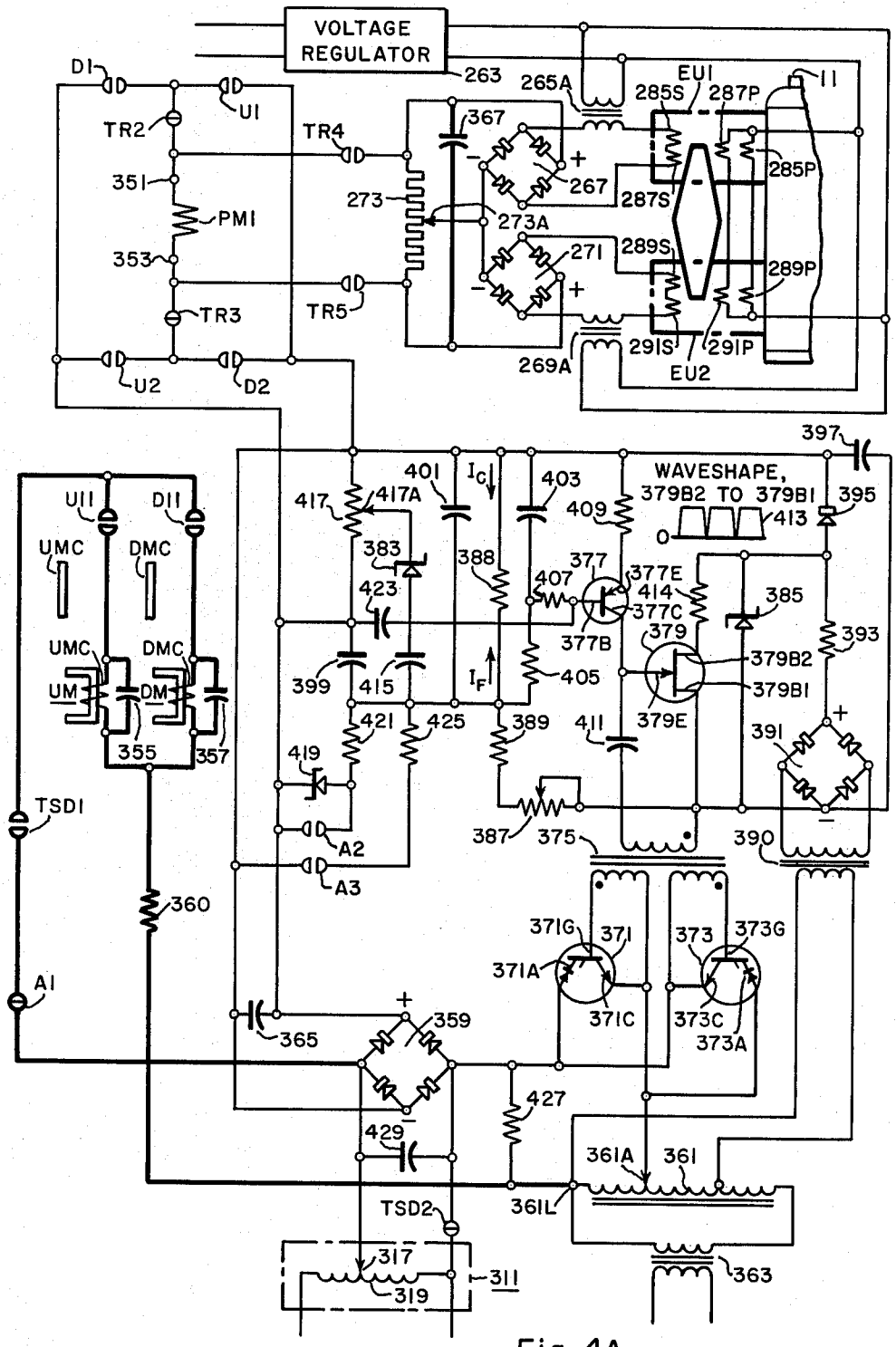


Fig. 4A

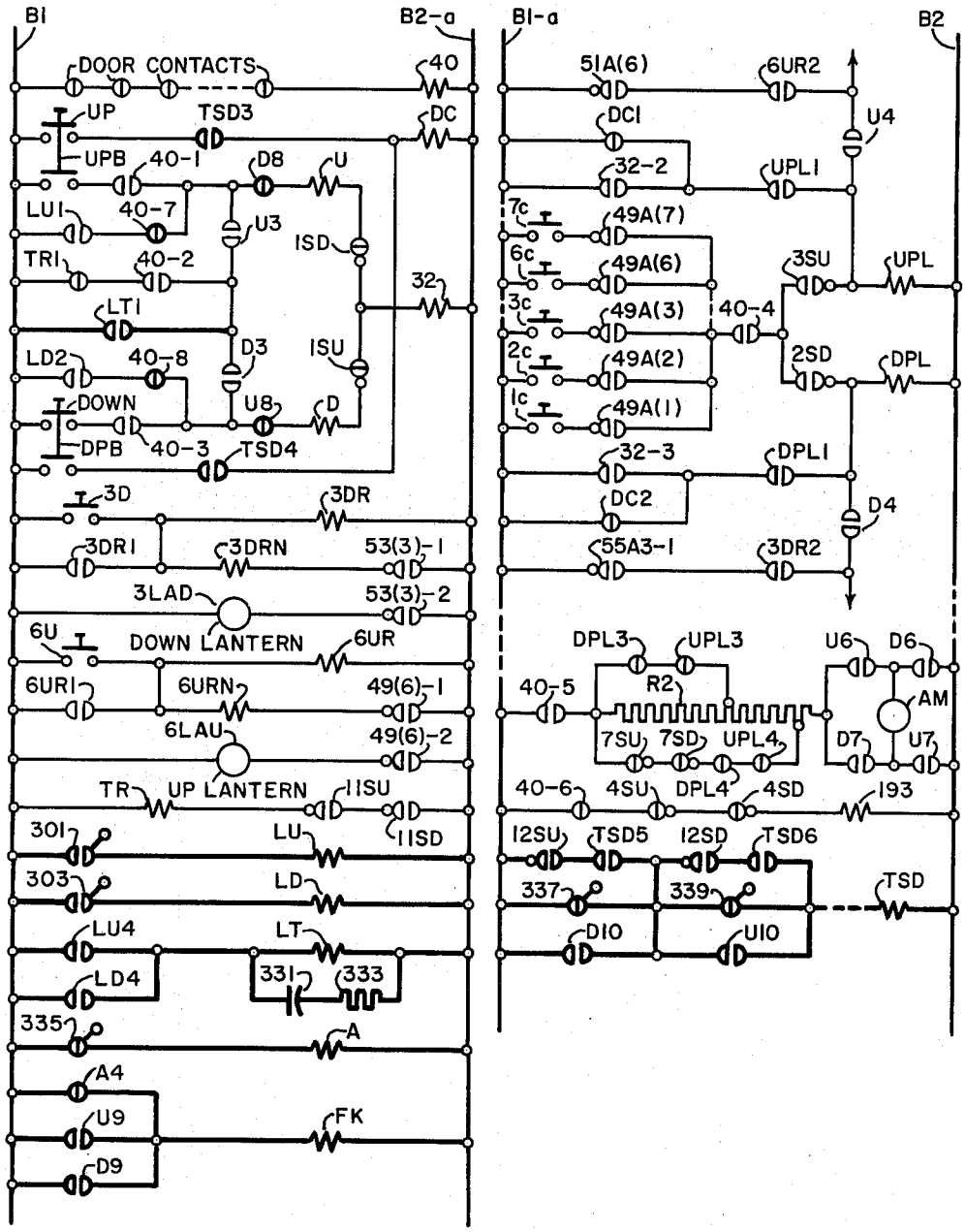

B1
B2-a
B1-a
B2
DOOR CONTACTS
40
UP
TSD3
DC
UPB
40-1
D8
U
LU1
40-7
U3
ISD
TR1
40-2
32
LT1
LD2
40-8
D3
ISU
DOWN
U8
D
DPB
40-3
TSD4
3D
3DR
3DR1
3DRN
53(3)-1
3LAD
53(3)-2
6U
DOWN LANTERN
6UR
6UR1
6URN
49(6)-1
6LAU
49(6)-2
TR
UP LANTERN
11SU
11SD
301
LU
303
LD
LU4
LT
LD4
331
333
335
A
A4
U9
FK
D9
51A(6)
6UR2
DC1
U4
32-2
UPL1
7c
49A(7)
6c
49A(6)
3SU
UPL
3c
49A(3)
40-4
2c
49A(2)
2SD
DPL
1c
49A(1)
32-3
DPL1
DC2
D4
55A3-1
3DR2
DPL3
UPL3
U6
D6
40-5
R2
AM
7SU
7SD
UPL4
D7
U7
40-6
4SU
DPL4
4SD
193
12SU
TSD5
12SD
TSD6
337
339
TSD
D10
U10

Fig. 5

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ELEVATOR CONTROL SYSTEM

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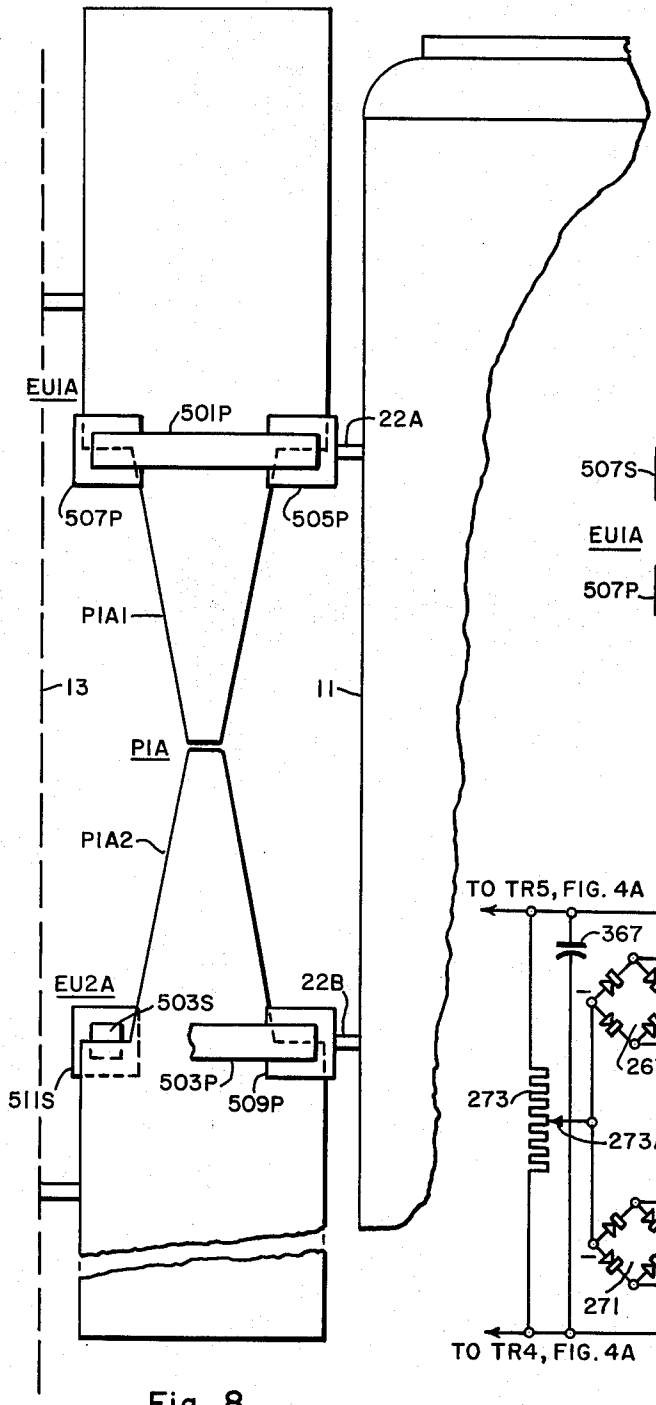


Fig. 8

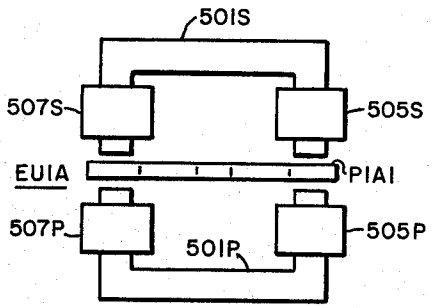


Fig. 7

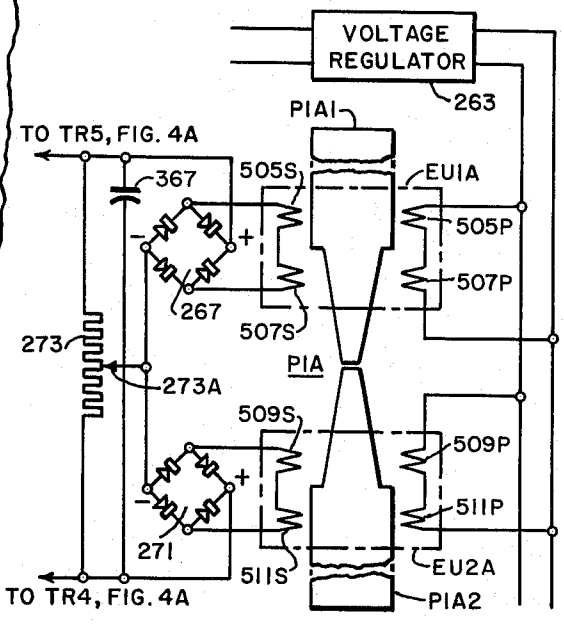


Fig. 9

United States Patent Office 3,207,265 Patented Sept. 21, 1965

3,207,265

ELEVATOR CONTROL SYSTEM

Alvin O. Lund, Little Falls, and William M. Ostrander, Hackensack, N.J., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Dec. 27, 1961, Ser. No. 162,478
46 Claims. (Cl. 187—29)

This invention relates to motor-control systems, and it has particular relation to mechanisms and systems for controlling the starting and stopping of elevator cars.

Although the invention may be employed in whole or in part with various types of motor-control systems, it is particularly suitable for elevator systems wherein an elevator car stops automatically in response to calls for service. The calls for service may be registered by means of car-call buttons positioned within the elevator car or by means of floor buttons operated by waiting passengers at the various floors served by the elevator car. The elevator system may be of the automatic type wherein an elevator car starts automatically in response to registration of a call for service. However, the invention also is suitable for an attendant-operated elevator system wherein an attendant in the elevator car must perform some function in order to permit the elevator car to start for the purpose of answering a call for service.

In an elevator system embodying the invention, the speed and position of an elevator car are controlled by a regulator in which the actual speed and position of the car are compared with a reference pattern. A variation between the actual speed and that called for by the pattern results in an adjustment for correcting the actual speed of the elevator car.

Apparatus for making such a comparison between actual speed and that called for by a reference pattern is disclosed in the Oplinger Patent 2,874,806 which was issued February 24, 1959, and which is assigned to the same assignee as the present application. In the apparatus of the Oplinger patent, the actual speed of the elevator car is determined by the control of an element or device such as a lever which is movable with respect to a supporting structure. The element is electromagnetically coupled to the elevator car motor for the purpose of applying a force acting between the element and the supporting structure which is dependent on the speed of the elevator car. A second force in opposition to the first force is applied between the element and the supporting structure to serve as a reference or pattern representing the desired motor speed. This second force is produced by a second electric or pattern motor which is energized in accordance with the desired speed and position.

The resultant movement or deflection of the element controls the energization of the elevator car motor and, as a result, the speed and position of the elevator car. Thus, the car motor may be of the direct-current type and may have its armature coupled to the armature of a direct-current generator to form a variable voltage or Ward Leonard control system. The resultant movement of the element is utilized to control the field excitation of the direct-current generator.

The element adjusts in opposite directions a pair of rheostats or variable resistors. In the aforesaid Oplinger patent, the regulator has an output circuit in which each of these rheostats is connected in series circuit relationship with the primary of a transformer to vary the voltage applied thereto, and thus to vary indirectly the secondary or output voltage of the transformer. The variable secondary voltages, in turn, are rectified, and the generator field is excited in accordance with the difference between the rectified voltages. Consequently,

the rheostats not only must control the power supplied to the generator field but also must handle the power loss in the associated transformers and rectifiers. As a practical matter, it has been found that the amount of power dissipated by the rheostats is more than twice that delivered to the generator shunt field. This places a substantial limitation upon operation of the circuit. In addition, for installations having a source of alternating energy whose voltage is relatively high, such as 440 volts, an additional transformer is required to reduce the voltage applied to the rheostat circuits.

It is, therefore, an object of the present invention to overcome the aforesaid limitations by providing an improved output circuit for the above-described regulator. In accordance with the invention, this is accomplished by first rectifying the transformer secondary voltages, which are maintained at a substantially constant value, and then by connecting the rheostats to control directly the outputs of the rectifiers and thus, in turn, to control directly the power supplied to the generator field according to the difference in the effective resistances of the rheostats.

The mechanical resistance of each of the rheostats to change in adjustment is a factor which tends to affect adversely the high speed regulation of the elevator motor and consequently of the elevator car by the above-described regulator.

Accordingly, it is another object of the invention to improve the high speed regulation of such regulator. For this purpose, means are provided for increasing the static gain or accuracy of the regulator. Conveniently, such means may take the form of positive feedback to the regulator in accordance with energization of the generator field. Such feedback tends to cause the pattern motor to exert a force on the elevator motor control element in aid of the aforesaid second or reference force representing the desired elevator car speed.

The energization of the pattern motor is controlled for the purpose of controlling the acceleration, slowdown and position of the elevator car. In the aforesaid Oplinger patent, an electromagnetic device having a continuously variable output controls the slowdown and position of the car.

A further object of the invention is to control the slowdown and position of the elevator car with improved accuracy and decreased sensitivity to ambient temperature changes. Thus, a magnetic plate is provided for each floor served by the elevator car and is positioned adjacent the path of travel of a pair of spaced electromagnetic units carried by the car. A control circuit including the electromagnetic units has an output which varies in magnitude with the displacement of the elevator car from a floor at which the car is stopped and has a directional property dependent upon the direction of such displacement. This circuit is employed both for effecting slowdown of the car and for stopping the car at a position of registration with each of the floors and for effecting the return of the car to such position of registration in the event of unintentional displacement of the car after such stopping. In one embodiment of the invention, the magnetic plate is substantially diamond-shaped, while in another embodiment the plate has a generally hourglass-shaped configuration.

In the event that the normal slowdown means provided for the elevator car fail to function properly, means may be provided which operate in response to such failure for continuously deenergizing the pattern motor to bring the car to a smooth stop at one or the other of the terminal floors served by the car.

It is also an object of the invention to provide a continuously-variable control device for energizing the pattern motor to accelerate the elevator car at a substan-

tially constant rate until the car attains its maximum velocity. In a preferred embodiment of the invention, this device includes a pair of controlled rectifiers whose conduction of current is regulated through control of their firing angles by a variable phase gate signal supplied by a pulse generator. Conveniently, the acceleration device may include means for shaping the acceleration reference pattern by decreasing the acceleration rate as the elevator car approaches its maximum velocity.

It is an additional object of the invention to control operation of the elevator car motor in response to the position of the elevator brake during its release and application. Thus, the aforementioned acceleration device is rendered operable to energize the pattern motor only after the brake has reached a predetermined position during its release. On the other hand, the brake is applied only when the elevator car has come to a complete stop at a landing. Moreover, when the brake arrives at a predetermined position during its application, the pattern motor is energized to reverse energization of the generator field in order to reduce the residual flux of the generator, thereby minimizing the circulating of current in the generator and elevator motor armature circuit.

Other objects of the invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a schematic view with parts shown in elevation, parts broken away and parts shown in cross section of an elevator system embodying the invention;

FIG. 2 is a view in top plan of leveling apparatus suitable for the system of FIG. 1;

FIG. 3 is a view in side elevation of the leveling apparatus shown in FIG. 2.

FIGS 4, 4A and 5 are schematic views showing control circiuts in straight line form suitable for the elevator system of FIG. 1;

FIG. 6 is a block diagram of components of the control circuits of FIGS. 4 and 4A;

FIG. 7 is a top plan view of a modified form of leveling apparatus suitable for the elevator system of FIG. 1;

FIG. 8 is a view in side elevation of the leveling apparatus shown in FIG. 7 associated with the elevator car of FIG. 1; and

FIG. 9 is a schematic view of a control circuit embodying the apparatus of FIGS. 7 and 8.

GENERAL SYSTEM

Although the invention may be employed in various types of elevator control systems, the system herein described is similar to that disclosed in the aforesaid Oplinger Patent 2,874,806. Thus, FIGS. 1, 4 and 5 of the present application respectively are based on FIGS. 1, 4 and 4A of the Oplinger patent, certain changes in and additions thereto being indicated in the present FIGS. 1, 4 and 5 by extra-heavy lines. Components in this specification which are similar to those in the Oplinger patent bear the same reference characters that are employed in such patent.

As is the case in said Oplinger patent, it will be assumed that the system of FIG. 1 is designed for what is known as "signal operation." Referring to FIGS. 1 and 4, an elevator motor **1** is secured to the upper surface of a floor **3**, which may be located in the penthouse of a building being served by the elevator system. The elevator motor **1** has a traction sheave **5** secured to its shaft **6**, and an elevator brake **7** is associated with the elevator motor and the traction sheave in a conventional manner. As will be pointed out below, the elevator brake has a shoe **7***s*, which is spring applied by means of a plunger **7***p* to a brake drum **7***d* secured to the shaft **6** to hold the traction sheave **5** stationary and is released in response to energization of a solenoid **7***c*. A secondary or idler sheave **9** is secured to the lower surface of the penthouse floor **3**. A control unit **10** is operated by the shaft **6** of the motor **1**. This control unit is employed in controlling the speed of the motor **1** and will be discussed below.

An elevator car **11** is mounted for movement in a hoistway **13** to serve the various floors or landings of the building associated therewith. The elevator car is connected to a counterweight **15** by means of one or more ropes or cables **17**, which pass around the traction sheave **5** and the secondary sheave **9** in a conventional manner.

At each floor served by the elevator car, a hoistway or floor door **19** is provided. In addition, the elevator car has a gate **21**, which registers with the hoistway door at any floor at which the elevator car is stopped. The doors and the gate may be of conventional construction and may be operated automatically in any conventional way. However, for present purposes, it will be assumed that the gate and doors are opened and closed by an elevator car attendant.

In order to register calls for floors desired by passengers traveling in the elevator car, a plurality of car call buttons **1***c* through **9***c* are provided. It is assumed that the building served by the elevator car has nine floors requiring service. The elevator car also contains an up push button UPB and a down push button DPB, which are operated by the car attendant in order to condition the elevator car for up travel or down travel.

As is illustrated in FIG. 1, an up push button **3U** is provided at the third floor **3F** for operation by a person desiring transportation in the up direction. A similar push button would be provided at each of the floors from which a person may desire to travel in the up direction. Hereinafter, each such push button will be identified by the reference character U preceded by a number corresponding to the floor at which the button is located. In a similar manner, FIG. 1 shows a down push button **3D**, which may be operated by a person desiring to travel in the down direction. A similar push button would be located at each floor from which a person may desire transportation in the down direction.

In order to signal the approach and direction of travel of the elevator car to an intending passenger, suitable floor signals such as lanterns may be provided. Thus, in FIG. 1, an up floor lantern **3LAU** and a down floor lantern **3LAD** are illustrated. Similar lanterns may be provided at each floor requiring such signals.

As the elevator car approaches a floor at which it is to stop, it is desired that it stop automatically and accurately in registration with such floor. To this end, position-responsive mechanism is provided in the hoistway and on the elevator car. Thus, FIG. 1 shows a hoistway transducer comprising a pair of electromagnetic units **EU1** and **EU2** respectively mounted on brackets **22A** and **22B**, which are secured to the elevator car. A separate inductor plate or vane **P1** constructed of magnetic material such as steel is located in the hoistway adjacent each of the floors served by the elevator car. Preferably, the length of the plate **P1** is substantially less than the distance between successive floors. Such distance generally will be a minimum of approximately eight feet, and, consequently the plate **P1** preferably is substantially less than eight feet in length. In the present instance, it will be assumed that the plate has an overall length of approximately twenty inches. When the car is stopped accurately at a floor, the units **EU1** and **EU2** are associated with the plate **P1** for such floor in the manner illustrated in FIG. 1. It will be appreciated that the length of the plate and the distance between the units **EU1** and **EU2** are exaggerated in FIG. 1 for the purpose of clarity.

To facilitate leveling of the elevator car, each of the units **EU1** and **EU2** has an electrical output, the magnitude of which is dependent upon the displacement of the car from registry with a landing or floor at which the car is to be stopped.

The construction of the units **EU1** and **EU2** and of the plate **P1** is shown more clearly in FIGS. 2 and 3, while a schematic representation of same is illustrated in the

upper right-hand portion of FIG. 4A. The unit EU1 includes a pair of soft magnetic cores 281P and 281S, which are C-shaped and which have pole faces adjacent each other to define a rectangular magnetic path. Similarly, the unit EU2 includes a pair of soft magnetic cores 283P and 283S (not shown), which also are C-shaped and which have pole faces adjacent each other to define a rectangular magnetic path. It will be noted that the pole faces of the cores of each of the units are spaced to provide air gaps through which the plate P1 may pass.

The core 281P is provided with primary windings 285P and 287P, which are connected to direct magnetic flux in the same direction around the associated magnetic path. The magnetic core 281S has secondary windings 285S and 287S, which have voltages induced therein by fluxes passing through the associated magnetic path. Likewise, the core 283P is provided with primary windings 289P and 291P, which are connected to direct magnetic flux in the same direction around the associated magnetic path, while the magnetic core 283S has secondary windings 289S and 291S, which have voltages induced therein by fluxes passing through the associated magnetic path.

It will be observed that the plate P1 is generally diamond-shaped, that is, it has double tapered configuration, and that it is so mounted that the pole faces of the magnetic cores pass closely adjacent the plate as the elevator car approaches the associated floor. The magnitude of voltage induced in each of the secondary windings 285S, 287S, 289S and 291S depends upon the position of the plate P1 with respect to their associated magnetic cores. When the units EU1 and EU2 are displaced vertically from the plate P1, maximum voltage is induced in each of the secondary windings, as a result of the relatively low reluctance path for flux in each of the cores and its associated air gaps. When the plate P1 is located between the magnetic cores, it tends to shield the secondary windings from the magnetic flux produced by the primary windings. The extent of the shielding depends upon the position of the plate with respect to the magnetic cores. Maximum shielding is obtained when the magnetic cores of a unit are adjacent the middle or widest portion of the plate P1; the shielding decreases as the magnetic cores approach either end of the plate going away from the mid portion.

Assume that the elevator car is approaching the third floor while traveling in the up direction and that the primary windings of the units EU1 and EU2 are energized. When the units EU1 and EU2 both are displaced downwardly from the plate P1, maximum voltage is induced in each of the respective secondary windings, as aforesaid. When the unit EU1 is located adjacent the lower end of the plate P1, the plate slightly shields the secondary windings 285S and 287S from magnetic flux produced by the primary windings 285P and 287P. Due to the tapered configuration of the lower portion of the plate P1, the shielding between the pole faces of the cores 281P and 281S continues to increase as the car proceeds upwardly, and correspondingly decreasing voltage is induced in each of the secondary windings 285S and 287S. Such voltage reaches a minimum when the pole faces are adjacent the widest part of the plate P1, since at that point the shielding therebetween is maximum.

Further upward travel of the car results in gradually decreasing shielding between the pole faces of the cores 281P and 281S as a result of the tapered configuration of the upper portion of the plate P1, and the voltages induced in the secondary windings 285S and 287S consequently continuously increase. When the elevator car reaches the position illustrated in FIG. 1 adjacent the third floor, close to maximum voltage is induced in each of the secondary windings 285S, 287S, 289S and 291S, since the units EU1 and EU2 are adjacent the upper and lower ends, respectively, of the plate P1. As the car continues to move upwardly, the voltages induced in the secondary windings 285S and 287S become and remain at maximum while the voltages induced in the secondary windings 289S and 291S first decrease and then increase in a manner which will be apparent from the preceding discussion of the changing voltages induced in the secondary windings 285S and 287S.

The induced voltage-distance relationships for downward travel of the elevator car will be apparent from the foregoing discussion of upward travel thereof. Thus, it will be appreciated that the voltage induced in each of the secondary windings 285S, 287S, 289S and 291S is dependent upon the vertical positions of the units EU1 and EU2 with respect to the plate P1.

It is desirable to provide a relatively steep output voltage-versus-floor distance relationship of the secondary windings around floor level to insure precise leveling of the elevator car. The distance over which this steep characteristic is obtained and its steepness are controlled by the length of the plate P1 and the width of its blunted ends, respectively. The application of the units EU1 and EU2 will be discussed further in connection with FIGS. 4, 4A and 5 below.

Referring to FIG. 1, the elevator control system also includes a pair of switches 301 and 303, which have cam followers 305 and 307, respectively. These switches are secured to the elevator car by any suitable means and are operated by a cam 309 located in the hoistway adjacent each of the floors served by the car. When the car is stopped accurately at a floor, the switches 301 and 303 are associated with the cam 309 for such floor in the manner illustrated in FIG. 1, and both of the switches are open.

It will be assumed that the cam followers 305 and 307 and each of the cams 309 are designed and located so that the switch 303 is actuated to close upon upward movement of the elevator car away from a position of registration with a floor by a distance of one-quarter inch and likewise that the switch 301 is actuated to close upon downward movement of the car away from a position of registration with a floor by a distance of one-quarter inch. It the present instance, it also will be assumed that the left side of each of the cams 309, as viewed in FIG. 1, has a length of approximately 22 inches, or 11 inches from each side of the horizontal centerline of the cam. Consequently, as the elevator car leaves a floor in the up direction, the switch 303 closes when the car is ¼ inch from the floor and opens when the car is approximately 22¼ inches above the floor; and as the car leaves a floor in the down direction the switch 301 closes when the car is ¼ inch from the floor and opens when the car is 22¼ inches below the floor. In addition, during down travel of the elevator car, the switch 303 closes when the car arrives at a distance of 22¼ inches from each floor and remains closed until the car is within ¼ inch of a position of registration with such floor; and during up travel, the switch 301 closes when the car arrives at a distance of 22¼ inches from each floor and also remains closed until the car is within ¼ inch of a position of registration with such floor.

Operation of the elevator car also is controlled by a terminal slowdown transducer 311. Referring to FIG. 1 and the bottom of FIG. 4A, this transducer includes a roller or cam follower 313, which is mounted for rotation about its axis on an arm 315. This arm controls a suitable device having a variable output voltage. Thus, for illustrative purposes, the arm 315 may be mounted for rotation to actuate a movable contact 317 of a variable voltage autotransformer 319. Such an autotransformer is well known in the art, and it appears unnecessary to describe it further. The autotransformer is suitably mounted within an inclosure 321 secured to the elevator car.

Disposed in the hoistway at the upper and lower ends thereof is a pair of cams 323 and 325, respectively. The cam 323 is configured and positioned to contact the roller 313 and thus to rotate the arm 315 in a counterclockwise direction as viewed in FIG. 1, gradually through an angle

of approximately 90° as the elevator car during up travel approaches the ninth or upper terminal floor. Likewise, the cam **325** is configured and positioned to contact the roller **313** and thus to rotate the arm **315** in a counterclockwise direction gradually through an angle of approximately 90° as the elevator car during down travel approaches the first or lower terminal floor. The roller and arm may be suitably weighted so that they are rotated gradually by the force of gravity in a clockwise direction to return to the position illustrated in FIG. 1 as the elevator car travels in the opposite direction from each of the terminal floors and the roller finally loses contact with the associated cam.

Thus, when the roller is out of contact with both of the cams, the movable contact **317** of the autotransformer **319** is in the position illustrated in FIG. 4A, and the autotransformer produces maximum output voltage. As the car approaches either of the terminal floors, the contact **317** gradually is moved toward the right, as viewed in FIG. 4A, until the output voltage of the autotransformer becomes zero when the car has substantially arrived at such floor. For the purpose if illustration, it will be assumed that the length of each of the cams **323** and **325** is such that variation in autotransformer output voltage between maximum and zero occurs through a distance of approximately 19 feet.

Control of the operation of the elevator car also is provided by a floor selector **23** (FIG. 1) which conveniently may be mounted on the penthouse floor **3**. This floor selector has two drive inputs supplied thereto. One is a drive input by an advance motor AM located on the top of the floor selector. The second drive input is supplied for the purpose of driving the floor selector in accordance with movement of the elevator car. Such a drive input may be provided in any desired manner. For example, a drive tape may be provided in a known manner for mechanically driving the selector unit in accordance with movement of the elevator car. However, in FIG. 1, a preferred drive is provided of the self-synchronous type. Such a drive includes a transmitter or generator SG, which is electrically connected to a receiver or motor SM. The transmitter or generator SG is coupled to the secondary sheave **9** through suitable gearing **25**.

The floor selector **23** may be of any suitable type. Conveniently, it may be similar to the floor selector described in the aforesaid Oplinger patent, and such a floor selector is here illustrated generally in FIG. 1.

To facilitate consideration of the selector, the following components thereof in FIG. 1 are listed which are identical with components bearing the same reference characters in the aforesaid Oplinger patent:

AM—advance motor
SM—motor of self-synchronous drive
35—guide rail
43S, 45S—synchronous carriages
43A, 45A—advance carriages
UPL—up pawl relay
DPL—down pawl relay
UM—up solenoid control unit
UMC—coil for unit UM
UMA—magnetic armature for unit UM
DM—down solenoid control unit
DMC—coil for unit DM
DMA—magnetic armature for unit DM

For a complete understanding of the floor selector, reference may be made to the aforesaid Oplinger patent and to the Savage Patent 2,657,765, which is referred to in the Oplinger patent.

ELEVATOR CONTROL SYSTEM

As previously pointed out, the invention may be employed with various types of elevator control systems. In order to illustrate the application of the invention to a suitable elevator control system, reference will be made to the circuits shown in FIGS. 4, 4A, and 5; FIGS. 4 and 5, as has been noted, being based on FIGS. 4 and 4A of the aforesaid Oplinger patent. In these circuits, a number of electromagnetic relays and switches are illustrated. These relays and switches may have contacts of the make type, which are closed when the relay or switch is energized or picked up, and which are opened when the relay is deenergized or dropped out. Alternatively, the relays or switches may have break contacts, which are opened when the relay or switch is energized or picked up and which are closed when the relay or switch is deenergized or dropped out. Each of the relays and switches will be designated by a suitable reference character, and each set of contacts thereof will be designated by such reference character followed by an appropriate suffix in the form of a numeral. For example, the expression **U1** designates the first set of contacts for the up switch U, whereas the expression **U3** designates the third set of contacts for the up switch U.

In order to facilitate consideration of the control system, the following components of FIG. 5 are listed which are identical with components bearing the same reference characters in the aforesaid Oplinger patent:

B1, B2, B1–*a*, B2–*a*—direct-current buses
40—door relay
UPB—up push button
DPB—down push button
DC—door closing relay
U—up switch
D—down switch
32—car running relay
2D, etc.—down floor call push buttons
2DR, etc.—down floor call registering relays
2DRN, etc.—down floor call canceling coils
2LAD, etc.—down lanterns
1U, etc.—up floor call push buttons
1UR, etc.—up floor call registering relays
1URN, etc. up floor call canceling coils
1LAU, etc.—up lanterns
TR—transfer relay
1c, etc.—car call push buttons
UPL—up pawl relay
DPL—down pawl relay
AM—advance motor
R2—advance motor speed control resistor
193—sprocket wheel release coil
1SU, 1SD, 3SU, 3SD, 4SU, 4SD, 7SU, 7SD, 11SU, 11SD—pile-up switches
49, 49A, 51A, 53, 55A—pile-up switches of floor-stop units

For a complete understanding of the above-listed components, reference may be made to the aforesaid Oplinger patent. In addition to these components, the present FIG. 5 includes the following new components:

LU—up leveling relay
LD—down leveling relay
LT—landing time relay
A—acceleration relay
FK—field control relay
TSD—terminal slowdown relay

It should be noted that the electromagnetic relays and switches of FIG. 5 are illustrated in their deenergized and dropped out conditions.

As in the aforesaid Oplinger patent, the direction of travel of the elevator car is determined by operation of the up push button UPB or the down push button DPB by the attendant in the elevator car. Assuming that the direct-current buses **B1**, **B2**, **B1–*a*** and **B2–*a*** are energized, operation of one of these buttons energizes the door closing relay DC and under suitable conditions completes an energizing circuit for the car running relay **32** and either the up switch U or the down switch D. The switches U and D determine the direction of travel

of the elevator car. Operation of those portions of the energizing circuits for the switches U and D and the car running relay **32** indicated in FIG. 5 by extra-heavy lines, which serve to designate modifications in the circuits of the Oplinger patent, will be discussed below.

Energization of the up leveling relay LU is controlled by the cam-operated switch **301**. It will be recalled that operation of the switch **301** has been discussed in connection with FIG. 1. Thus, when the elevator car moves a distance of between ¼ inch and 22¼ inches downwardly from any landing, the switch **301** is closed to energize and pick up the relay LU, and as the car approaches a landing in the up direction of travel, the switch **301** is closed to pick up the relay LU when the car is between 22¼ inches and ¼ inch from such landing. For any other position of the elevator car, the switch **303** is open to deenergize and drop out the relay LU.

Similarly, energization of the down leveling relay LD is controlled by operation of the cam-operated switch **301**, which also was discussed above in the description of the apparatus illustrated in FIG. 1. Consequently, if the elevator car moves a distance of between ¼ inch and 22¼ inches upwardly from any landing, the switch **301** is closed to energize and pick up the relay LD, and as the car approaches a landing in the down direction of travel, the switch **303** is closed to pick up the relay LD when the car is between 22¼ inches and ¼ inch from such landing. For any other position of the elevator car, the switch **301** is open, and the relay LD is deenergized and dropped out.

Closure of either of the make contacts LU4 or LD4 upon pickup of the respective leveling relays results in energization and pickup of the landing time relay LT. When both of the leveling relays are dropped out, the contacts LU4 and LD4 are open to deenergize the relay LT. However, this relay has a substantial time delay in dropout. This delay may be provided in any suitable manner, as by connecting a capacitor **331** and a resistor **333** in series across the relay coil. The relay LT controls application of the elevator brake, and its time delay in dropout is selected to be sufficient to permit the elevator car to come to a complete stop at each landing before the relay drops out to effect application of the brake.

The acceleration relay A is controlled by a cam-operated switch **335**. This switch is closed to energize and pickup the relay A when the elevator brake is applied and is opened to drop out the relay when the brake is released. The relay A has contacts which control the initiation of acceleration of the elevator car. Operation of the switch **335** will be discussed further in connection with FIG. 4 below.

Pickup of the relay A is accompanied by opening of its break contacts A4 to deenergize and drop out the field control relay FK, provided that make contacts U9 of the up switch U and make contacts D9 of the down switch D also are open.

The terminal slowdown relay TSD is connected across the direct current buses B1–*a* and B2 through at least two serially connected sets of contacts, each set comprising three parallel arms. One arm of each of the sets includes a floor selector switch. Thus, the switches 12SU and 12SD are operated by relative movement between the floor selector advance and synchronous carriages in a manner such that the switch 12SU is closed only if the elevator car, while traveling in the up direction, is within a first predetermined distance of a position of registry with each floor, such as twenty feet. Likewise, the switch 12SD is closed only if the elevator car, while traveling down, is within the same distance of each floor. A second arm of each of the aforementioned sets of contacts comprises a cam-operated switch which is secured to the elevator car and which is operated by a cam located in the hoistway adjacent one of the terminal floors. Thus, the switch **337** is opened by its associated cam only if the elevator car is within a second predetermined distance of the ninth or upper terminal floor which is slightly less than the aforementioned first predetermined distance, such as 19 feet. Similarly, the switch **339** is opened by its associated cam only if the elevator car is within the same distance of the first or lower terminal floor. These switches are closed for all other positions of the elevator car. Such switches and cams are well known in the art.

Finally, the third arm of each of the sets of contacts in the circuit of the terminal slowdown relay TSD includes make contacts of one of the up and down switches. For example, the third arm of the set of contacts associated with the upper terminal floor comprises make contacts D10 of the down switch D; while the third arm of the set of contacts associated with the lower terminal floor comprises make contacts U10 of the up switch U. Pickup of the relay TSD is accompanied by closure of its holding make contacts TSD5 and TSD6. The relay TSD will be discussed in greater detail below in the section entitled "Operation".

Referring now to FIG. 4, which, as has been indicated is based on FIG. 4 of the aforesaid Oplinger patent, material variations from the latter are indicated by the extra-heavy lines in the present FIG. 4. Consequently, with the exception of these modifications, reference may be made to the Oplinger patent for a complete understanding of the components of FIG. 4. To facilitate consideration of FIG. 4, the following components thereof are listed which are identical with components bearing the same reference characters in the aforesaid Oplinger patent:

1—elevator car motor
MA—motor armature
MF—motor field
G—generator
GA—generator armature
10—control unit
PM—pattern motor
PM1, PM2, 227—pattern motor windings
215—pattern motor lever
231—electroconductive disk
237—permanent magnet
239, 241—rheostats
247, 255—generator field transformers

Briefly, the winding PM1 of the pattern motor or transducer PM is energized from a direct-current source of energy for applying a force or torque to the lever **215**. As in the Oplinger patent, the winding PM2 is employed to minimize hunting. In the present embodiment of the invention, the winding PM2 also is utilized for increasing high speed regulation. This winding will be discussed in greater detail below.

A second force or torque is applied to the lever **215** which acts in opposition to the force or torque applied to the lever by the motor PM and which is dependent upon the rate of rotation of the motor **1**. For this purpose, the armature MA of the motor **1** is coupled to the disk **231** to rotate the disk about its axis within a magnetic field produced by the permanent magnet **237**, which is mounted on the lever **215**.

Because of the electromagnetic coupling between the permanent magnet **237** and the disk **231**, the rotation of the disk applies torque to the lever **215** having a magnitude dependent upon the rate of rotation of the motor armature MA and having a direction dependent upon the direction of rotation of the armature MA. Thus, the combination of the disk **231** and the magnet **237** may be designated a velocity transducer.

Deflection of the lever **215** about its pivot **217** is utilized to control the excitation of the generator G. Thus, movement of the lever controls the adjustment of a pair of output elements comprising two adjustable resistors or rheostats **239** and **241**. The rheostat **239** includes the resistor **239R** having a plurality of parallel adjacent leaf springs **239A** through **239F** connected to taps on the resistor. The leaf springs are biased against astop **239S**, which is shaped to keep the springs slightly spaced from

each other. The lever **215** carries a pusher arm **243**, which engages the leaf spring **239A**. When the lever is actuated in a clockwise direction as viewed in FIG. 4, the pusher arm **243** forces certain or all of the springs **239A** through **239F** to electrical engagement with each other to shunt a portion or all of the resistor. The extent of movement of the lever **215** determines the effective resistance of the resistor **239R**.

The rheostat **241** is operated similarly by a pusher arm **245** mounted on the lever **215**. By inspection of FIG. 4, it will be noted that movement of the lever arm operates the rheostats in opposite directions. Consequently, clockwise rotation of the lever **215** decreases the effective resistance of the resistor **239R**, whereas counterclockwise rotation of the lever **215** decreases the effective resistance of the resistor **241R**.

The primary windings of the two similar generator field transformers **247** and **255** are connected across two conductors **249** and **251**, which are coupled to a suitable source of alternating current (not shown) which may have a frequency of the order of 60 cycles per second. The equal output voltages of the secondary windings of these transformers are rectified by full-wave rectifiers **253** and **256**, respectively, the direct current outputs of these rectifiers having the polarities indicated in FIG. 4.

It will be noted that the negative output terminal of the rectifier **253** is connected to the positive output terminal to the rectifier **256**. It also will be observed that these rectifiers form two arms of a bridge, the other two arms of which comprise the rheostats **239** and **241**. Serially connected generator field winding GF and rheostat **341** are connected across the junction of the rectifiers **253** and **256** and the junction of the resistors **239R** and **241R**. Thus, the generator G is excited in accordance with the difference between the effective resistances of the resistors **239R** and **241R**. For example, when the lever **215** is in the position illustrated in FIG. 4, i.e., in its neutral position, current flow through the generator field winding GF is zero. Rotation of the lever **215** in a clockwise direction to decrease the effective resistance of the resistor **239R** will cause current flow through the winding GF and the rheostat **341**, from right to left, as viewed in FIG. 4. It will be assumed that such excitation of the generator is in the proper direction for down travel of the elevator car. Similarly, rotation of the lever **215** in a counterclockwise direction to decrease the effective resistance of the resistor **241R** will cause current flow through the winding GF and the rheostat **341** from left to right. It will be assumed that this excitation of the generator produces up travel of the elevator car.

The connections of the resistors **239R** and **241R** and their associated components as described in the preceding paragraph overcome the power handling and supply voltage limitations of the Oplinger patent noted in the introduction of this specification. Moreover, an additional advantage results. The L/R time constant of the circuit including the generator field winding GF is variable in accordance with the effective resistances of the resistors **239R** and **214R**. Consequently, the speed of response of the circuit is greater at relatively low elevator car speeds, i.e., when the fastest response is most desirable.

It will be recalled that the pattern motor winding PM2 is energized to minimize hunting of the motor **1**. In the aforesaid Oplinger patent, the winding PM2 is coupled to a generator field winding for this purpose. In the present FIG. 4, however, this is accomplished by means of a resistor **343** and a capacitor **345**, which are connected in series with the winding PM2 across the output terminals of the generator armature GA. Any variation in output voltage of the generator due to a change in its field excitation, with the attendant change in speed of the motor **1**, thus results in energization of winding PM2 through the resistor **343** and the capacitor **345**. The winding PM2, when energized in this manner, effects the application of force or torque to the lever **215** acting in a direction tending to oppose the change in excitation of the generator field winding GF. It will be recognized that such operation is a form of acceleration negative feedback. The values of resistance of the resistor **343** and capacitance of the capacitor **345** are selected for critical damping or slightly less for best system performance.

The sensitivity of the speed regulating system is dependent upon the force required for deflection of the leaf springs associated with the resistors **239R** and **241R**. The rheostat **341** in series with the generator field winding GF is employed for the purpose of increasing such sensitivity by minimizing the effect of such spring force. Thus, when the leaf springs associated with the resistor **239R** or the resistor **241R** are operated as explained heretofore to cause current to flow in the generator field winding, a voltage drop appears across the effective resistance of the rheostat **341** in series therewith. This voltage is fed back positively to the pattern motor winding PM2 through a decoupling resistor **347**. Consequently, when so energized, the winding PM2 effects the application of force or torque to the lever **215** acting in a direction tending to aid the change in excitation of the generator field winding.

The rheostat **341** is selected so that the maximum effective resistance to which it is adjustable is of a relatively low value, such as two ohms, in order to minimize its effect upon the magnitude of generator field current. In practice, the rheostat may be adjusted as follows: With the pattern motor winding PM1 deenergized the lever **215** is deflected manually to energize the generator field winding GF. When the lever is released it will tend to maintain its position due to the positive feedback to the winding PM2 from the rheostat **341**. The rheostat is adjusted so that when the lever is released from any position, it does not move in the direction in which it was manually deflected but returns slowly toward its neutral position. Such adjustment results in increased static gain and substantially improves the high speed regulation of the system and the accuracy with which the elevator car is positioned at each floor.

It will be observed that break contacts FK1 and FK2 control energization of the pattern motor winding PM1. These contacts are open as long as the elevator car is being moved by the motor **1**. When the car is stopped in a position of registration with a landing, however, the contacts FK1 and FK2 close so that the residual output voltage of the generator G is fed back negatively across the winding PM1 through the contacts. When the winding PM1 is energized in this manner, it effects the application of force or torque to the lever **215** acting in a direction opposite to that applied to the lever as the elevator car approached the last-named landing in order to reduce substantially the residual flux of the generator and thus to minimize the circulating current in the generator and motor armature loop circuit.

As mentioned heretofore, operation of the motor **1** also is responsive to the position of the elevator brake **7** during its application and release. To this end, a cam **349** may be secured to the brake plunger *7p* to actuate the cam follower of the switch **335**. Thus, when the plunger *7p* is practically at the end of its travel in the direction of application of the brake shoe *7s* to its assoicated drum *7d*, the cam **249** effects closure of the switch contacts. As power is applied to the brake solenoid *7c* to release the brake shoe from the drum, the cam disengages the cam follower, and the switch contacts open. The application of the switch **335** will be discussed further below.

It will be noted that the pattern motor winding PM1 is connected to a pair of terminals **351** and **353**. Referring to FIG. 4A, these terminals are connected for energization by the circuits shown therein. For convenience, the winding PM1 is reproduced schematically in FIG. 4A across the terminals **351** and **353**.

As in the aforesaid Oplinger patent, a pair of floor selector transducers comprising solenoid control units UM

and DM are employed for controlling deceleration of the elevator car. Referring for a moment to FIG. 1, the unit UM includes a coil UMC, which is mounted on the advance carriage 43A, and a soft magnetic armature UMA, which is mounted on the synchronous carriage 43S of the floor selector 23. The magnetic armature UMA is positioned within the coil UMC when the elevator car is positioned accurately at a floor to provide maximum impedance of the coil. Consequently, relative movement of the advance and synchronous carriage results in movement of the armature relative to the coil UMC for the purpose of varying the impedance thereof. In a similar manner, the solenoid control unit DM includes a coil DMC, which is mounted on the advance carriage 45A, and a soft magnetic armature DMA is mounted on the synchronous carriage 45S. Thus, relative movement of the carriages 45A and 45S results in variation in the impedance of the unit DM. The respective armatures and coils may be configured to provide any desired pattern of variation of coil impedance in response to relative movement of the coils and their armatures.

Returning to FIG. 4A, it will be noted that a capacitor 355 is connected across the coil UMC, while a capacitor 357 is connected across the coil DMC. It will be assumed that the design of each of the coils and armatures is such that the variation in total impedance of each coil and its associated parallel capacitor effects a substantially constant rate of deceleration of the elevator car as the associated armature is inserted into the coil. For convenience, the armatures UMA and DMA are illustrated schematically in FIG. 4A for movement alongside the respective coils UMC and DMC rather than within the coils, as is the actual case.

The coil UMC and its associated capacitor 355 are connected through make contacts U11 of the up switch, make contacts TSD1 of the terminal slowdown relay and break contacts A1 of the acceleration relay to an input terminal of a full-wave pattern rectifier 359. The opposite ends of this coil and capacitor are connected through a resistor 360, which has a relatively low resistance, to a terminal 361L of an autotransformer 361. The transformer 361 is energized from the secondary winding of a votlage regulating transformer 363, which maintains a substantially constant alternating voltage across the transformer 361. The primary winding of the transformer 363 is energized from a suitable source of alternating current (not shown). The solenoid coil DMC and its associated parallel capacitor 357 are connected similarly to the pattern rectifier 359 and to the autotransformer 361 through make contacts D11 of the down switch D.

It will be observed that the variable voltage autotransformer 319 of the terminal slowdown transducer 311 has its movable contact 317 connected to one input terminal of the pattern rectifier 359. An end terminal of the autotransformer 319 is connected to the other input terminal of the rectifier 359 through break contacts TSD2, the autotransformer being energized from a suitable source of alternating current (not shown). If desired, a suitable filter capacitor 365 may be connected across the ouput or direct-current terminals of the rectifier 359.

Referring to the upper portion of FIG. 4A, in the interest of accuracy the electromagnetic units EU1 and EU2, which replace the electromagnetic unit EU of the aforesaid Oplinger patent, are brought into operation during the last stage of the approach of the elevator car to a floor at which it is to stop, in order to terminate movement of the car accurately at the floor and to maintain it level with the desired floor. Thus, as the elevator car reaches the desired zone, the transfer relay TR opens its break contacts TR2 and TR3 and closes its make contacts TR4 and TR5 to render the electromagnetic units EU1 and EU2 effective for controlling the elevator car.

It will be noted that the primary winding 285P of the unit EU1 and the primary winding 289P of the unit EU2 are connected in series across the output terminals of a suitable voltage regulator 263, while the primary winding 287P of the unit EU1 and the primary winding 291P of the unit EU2 are connected in series across the output terminals of the voltage regulator. The voltage regulator maintains a substantially constant alternating voltage across its output terminals.

The secondary winding 285S and 287S of the electromagnetic unit EU1 are connected in series aiding with the secondary winding of a transformer 265A across the input terminals of a full-wave rectifier 267. Similarly, the secondary windings 289S and 291S of the electromagnetic unit EU2 are connected in series aiding with the secondary winding of a transformer 269A across the input terminals of a full-wave rectifier 271. The primary windings of the transformers 265A and 269A are connected to the output terminals of the voltage regulator 263. The output of the rectifier 267 is applied across the upper half of a resistor 273, whereas the output of the rectifier 271 is applied across the lower half of the resistor 273. The specific portion of the resistor utilized as a load for each of the rectifiers may be adjusted by means of a tap 273A on the resistor. Desirably, a suitable filter capacitor 267 may be connected across the resistor 273.

To illustrate the operation of the electromagnetic units EU1 and EU2, it will be assumed that each of the transformers 265A and 269A has a secondary voltage of the order of twelve volts. Furthermore, it will be assumed that movement of the magnetic plate P1 through the electromagnetic unit EU1 results in a total output voltage from the secondary windings 285S and 287S which varies continuously between zero and seven volts. Likewise, it will be assumed that movement of the plate P1 through the electromagnetic unit EU2 results in a total output voltage from the secondary windings 289S and 291S which varies continuously between zero and seven volts. The polarities of the windings are such that the voltages across the windings 285S and 287S and the secondary winding of the transformer 265A are in phase with each other and the voltages across the windings 289S and 291S and the secondary winding of the transformer 269A also are in phase with each other.

When the electromagnetic units EU1 and EU2 respectively are located adjacent opposite ends of the plate P1, as is illustrated in FIG. 4A, the voltages induced in the secondary windings of the units are substantially maximum. Thus, the outputs of the rectifiers 267 and 271 as applied to the resister 273 are equal in magnitude (approximately sixteen volts, taking into account winding resistance drop and rectifier forward drop) and opposite in polarity. Consequently, the resultant voltage across the resistor 273 is zero. If the electromagnetic units EU1 and EU2 are displaced upwardly from such positions to a point wherein the unit EU2 is midway between the ends of the plate P1, the output of the rectifier 271 gradually decreases to approximately ten volts, whereas the output of the rectifier 267 is maintained at approximately sixteen volts with the polarities illustrated in FIG. 4A. This means that the upper terminal of the resistor 273 gradually becomes more positive with respect to the lower terminal thereof to a maximum of approximately six volts, as the electromagnetic unit EU2 moves from a position adjacent the lower end of the plate P1 to a position adjacent the middle thereof. As the unit EU2 continues to move upwardly from a position midway between the ends of the plate P1, the upper terminal of the register 273 gradually becomes less positive with respect to the lower terminal thereof until the unit EU2 passes the upper end of the plate P1, at which time there is once again zero net voltage across the terminals of the resistor 273.

Conversely, displacement of the elevator car in the opposite direction from a position of registry with the floor results in the application of voltage to the terminals of

the resistor 273 such that the lower terminal of the resistor is positive with respect to the upper terminal thereof. It will be apparent that the magnitude of this latter voltage varies in a manner similar to that of the voltage when the units EU1 and EU2 are displaced upwardly, as explained heretofore. It follows that when the resistor 273 is connected across the winding PM1 of the pattern motor, the excitation of the generator G (FIG. 4) is always in a proper direction to move the elevator car into registry with the floor at which it is to stop. Inasmuch as the electromagnetic units EU1 and EU2 are mounted directly to the elevator car, whereas the plate P1 is mounted directly in the hoistway of the car, accurate leveling of the elevator car is assured.

It should be noted that the transformers 265A and 269A are provided in order that the rectifiers 267 and 271, respectively, are continuously maintained in conducting condition, regardless of what signals are fed in from the secondary windings of the electromagnetic units EU1 and EU2. This results in greater circuit efficiency, since, if the transformers 265A and 269A were eliminated, approximately one-half of the power output of each electromagnetic unit would be lost in that half of the resistor 273 associated with the rectifier which is non-conducting at the time, and larger electromagnetic units would be required.

Inasmuch as the two halves of the present leveling control circuit comprising the units EU1 and EU2 are symmetrical to each other, it will be apparent that such circuit is self-balancing in response to a variation in ambient temperature. This follows from the fact that such temperature change would alter the exciting currents equally in the respective primary windings of the units EU1 and EU2 and consequently that the secondary winding voltages of both of the units would vary in proportion to the change in primary winding excitation. As a result, the accuracy with which the elevator car is positioned at a floor is unaffected by ambient temperature variations. In the aforesaid Oplinger patent, however, the leveling control circuit employing the single electromagnetic unit EU is assymetrical, and, consequently, is not self-balancing in response to a change in ambient temperature. This deficiency can result in substantial errors in the accuracy of car positioning at a floor.

The majority of the remaining components shown in FIG. 4A are associated with the acceleration device, which controls current delivered to the pattern motor winding PM1 during acceleration of the elevator car. It is desirable for current in this winding to increase linearly with respect to time, thereby bringing the elevator car up to full speed at a substantially constant rate of acceleration. When full speed is reached, it is necessary for the acceleration device to remain fully conductive so that it no longer has control over current in the winding PM1.

In the illustrated embodiment of the invention, the acceleration device includes a pair of discontinuous control type electric valves such as two solid state controlled rectifiers 371 and 373. Each of these controlled rectifiers has a cathode, a gate and an anode electrode, respectively designated by the reference character of the rectifier and the suffixes C, G and A, as the case may be. As is well known in the art, a controlled rectifier is a rectifier which is designed to block current conduction in the forward direction until a relatively small signal is applied to the gate electrode. After the gate electrode signal has initiated conduction, the rectifier will continue to conduct even though this signal is removed. The rectifier will turn off or block current conduction when the voltage across the anode and cathode electrodes becomes zero or when the current through the rectifier is dropped below the holding current thereof. The controlled rectifier will block the conduction of current in the reverse direction as does an ordinary rectifier. This operation is similar to that of a thyratron gas tube.

It will be noted that the controlled rectifiers 371 and 373 are connected in anti-parallel or back-to-back. Thus, the anode electrode 371A is connected to the cathode electrode 373C, while the anode electrode 373A is connected to the cathode electrode 371C, the former electrodes also being connected to an input terminal of the pattern rectifier 359 and the latter electrodes also being connected to a movable tap 361A on the autotransformer 361. The tap 361A is adjusted to set the desired operating level of the pattern rectifier 359. The gate and cathode electrodes 371G and 371C are connected across one secondary winding of a pulse transformer 375, whereas the gate and cathode electrodes 373G and 373C are connected across another secondary winding of the transformer 375.

Control of conduction of current in the forward direction by the controlled rectifiers 371 and 373 is accomplished by means of the remaining components associated with the acceleration device. These components form a pulse generator which determines the firing angle of the rectifiers by supplying a variable phase gate signal to the primary winding of the pulse transformer 375. The components preferably include various solid state or semiconductor devices such as a transistor 377, a unijunction transistor 379 and two zener diodes 383 and 385. The transistor 377 has a base electrode 377B, an emitter electrode 377E and a collector electrode 377C. The unijunction transistor 379 has an emitter electrode 379E, a first base electrode 379B1 and a second base electrode 379B2. This device is a transistor which exhibits a negative resistance characteristic when a predetermined firing voltage is exceeded between its emitter electrode 379E and its base electrode 379B1. The pulse generator employs feedback and thus incorporates means to regulate current buildup in the pattern motor winding PM1 to maintain a constant rate of change of such current.

A rheostat 387 may be adjusted to control the rate of increase of the output current of the contolled rectifiers 371 and 373. The adjustment of the rheostat 387 determines the value of command current I_C, which flows in an error signal resistor 388 in the direction indicated and which is constant for a given setting of the rheostat 387. A resistor 389 conveniently may be connected in series with the rheostat 387 to limit the maximum value to which the current I_C may be adjusted by means of the rheostat. This current is derived from a supply which includes a transformer 390, a full-wave rectifier 391, a limiting resistor 393, a blocking diode 395 and a filter capacitor 397. Conveniently, energy for the primary winding of the transformer 390 may be supplied by the autotransformer 361.

Negative feedback current I_F flows through the resistor 388 in the direction indicated and is proportional to the rate of buildup of voltage across the pattern rectifier 359 and thus across the pattern motor winding PM1 through the differentiating action of a feedback capacitor 399. It will be observed that one terminal of the capacitor 399 is connected directly to the positive output terminal of the rectifier 359, while the other terminal of the capacitor is connected to the negative output terminal of the rectifier 359 through the resistor 388. A suitable filter capacitor 401 is connected across the resistor 388.

Since the command current I_C and the feedback current I_F flow in opposite directions through the resistor 388, the voltage across this resistor is proportional to the difference between these currents, i.e., the net or error signal current $I_C - I_F$. This voltage through a filter network comprising serially-connected capacitor 403 and resistor 405 controls the magnitude of collector electrode current in the transistor 377. Thus, the base electrode 377B of the transistor is connected to one side of the capacitor 403 through a resistor 407, while the emitter electrode 377E is connected to the other side of the ca-

pacitor through a temperature compensating resistor **409**. The transistor **377** in turn controls the magnitude of current which flows to charge a capacitor **411**.

When the voltage across the capacitor **411**, i.e., the voltage between the unijunction transistor emitter and base electrodes **379E** and **379B1**, reaches a predetermined value for a given value of voltage between the base electrodes **379B1** and **379B2**, the unijunction transistor triggers or fires, and the capacitor **411** discharges through the emitter electrode **379E**, the base electrode **379B1** and the primary winding of the pulse transformer **375**. The voltage pulse produced across the primary winding as a result thereof is applied between the gate and cathode electrodes of the controlled rectifiers **371** and **373** by means of the secondary windings of the pulse transformer. Thus, the controlled rectifier which is forward biased (anode electrode positive with respect to cathode electrode) when the pulse is so applied will fire or conduct current in the forward direction from its anode to its cathode electrode.

Assuming that the alternating supply voltage has a frequency of sixty cycles per second, if the voltage across the capacitor **411** does not reach the aforesaid predetermined value within 8.3 milliseconds (one-half cycle) of the alternating supply voltage, the unijunction transistor **379** and consequently the controlled rectifiers **371** and **373** will not fire, and the controlled rectifiers will conduct substantially no current. On the other hand, if the voltage across the capacitor **411** reaches such predetermined value to fire the unijunction transistor within about 1 millisecond, each of the controlled rectifiers will conduct current fully, for all practical purposes, during that half cycle of the alternating supply voltage when its anode electrode is positive with respect to its cathode electrode.

From the foregoing description, it will be appreciated that the pulse generator controls the conduction of the controlled rectifiers and thus the output of the pattern rectifier **359** to increase smoothly and linearly with respect to time. When each of the controlled rectifiers conducts fully over alternate half cycles of the supply voltage, current supplied by the pattern rectifier to the pattern motor winding PM1 arrives at its maximum value, and the elevator car reaches full speed. At this time the feedback current I_F becomes zero, since the output of the rectifier **359** no longer is charging, and the command current I_C flowing in the resistor **388** maintains full conduction of each of the controlled rectifiers over alternate half cycles of the supply voltage. During slowdown of the elevator car, the feedback current I_F reverses direction due to discharge of the capacitor **399**, thus adding to the command current I_C, which also will maintain the controlled rectifiers fully conductive.

It is necessary that the firing pulses applied between the gate and cathode electrodes of the controlled rectifiers by means of the pulse transformer **375** be synchronized with the alternating voltage across the anode and cathode electrodes thereof. Since the autotransformer **361** supplies both the latter voltage and power to the primary winding of the transformer **390**, the transformer windings may be connected so that the alternating voltage across the input terminals of the full-wave rectifier **391** is in phase with the voltage across the anode and cathode electrodes of the controlled rectifiers. The zener diode **385** in conjunction with the resistor **393** functions in a well-known manner to clip and regulate the full-wave direct output voltage of the rectifier **391**. (It will be noted that the blocking diode **395** permits the use of the rectifier **391** both for this purpose and as a component for the source of the command current I_C, in conjunction with the filter capacitor **397**, as previously described.) The clipped and regulated voltage, which has a waveshape **413**, as indicated in FIG. 4A, is applied between the bases **379B1** and **379B2** of the unijunction transistor **379** through a low resistance temperature compensating resistor **414**. When this voltage drops to zero at the end of each half cycle, the unijunction transistor fires and discharges any charge remaining across the capacitor **411**. Thus, at the start of each half cycle, there is zero voltage across the capacitor **411**.

An additional feature may be included in this device to decrease the acceleration of the elevator car at a desired point by substantially increasing the feedback current I_F at such point. To this end, a capacitor **415** is connected in series with the zener diode **383** and a portion of a resistor **417** across the output terminals of the pattern rectifier **359**. Conveniently, the capacitor **415** may have the same capacitance as the capacitor **399**.

The diode **383** has a zener voltage which is substantially lower than the maximum voltage which appears across the resistor **417**. When the output voltage of the pattern rectifier **359** reaches this zener voltage as the elevator car accelerates, the impedance of the zener diode **383** drops to a relatively low value, the diode conducts current, and the capacitor **415** consequently charges at a rate dependent upon the rate of change of the pattern rectifier voltage. Thus, the feedback current I_F approximately doubles in magnitude, since the capacitor **415** now is essentially in parallel with the capacitor **399**. Inasmuch as the error signal current $(I_C - I_F)$ decreases by a comparable amount, the acceleration of the elevator car is halved. The point at which this decrease in acceleration occurs may be adjusted by means of a tap **417A** on the resistor **417**.

This feature of decrease in acceleration of the elevator car at a predetermined point is useful particularly in those instances where the elevator motor has insufficient commutating capacity. Preferably, the zener diode **383** is selected and the tap **417A** is adjusted to prevent the reduction in acceleration until the elevator car reaches a relatively high speed so that the car may accelerate at the higher rate during relatively short runs, such as one-floor runs.

In the event that power is applied when the circuit of the pattern motor winding PM1 accidentally is open, certain components may be damaged by excessive voltage. A zener diode **419** may be provided to prevent such damage. It will be observed that this diode is connected across the feedback capacitor **399** through a current-limiting resistor **421**, which has relatively low resistance. The diode **419** is selected to have a zener voltage which is sufficiently high to prevent conduction of current therethrough under normal operating conditions. However, if the voltage across the capacitor **399** reaches the zener voltage of the diode **419**, the capacitor discharges through the diode and the resistor **421**, and the diode conducts current from the positive output terminal of the pattern rectifier **359**, through the resistors **421** and **388** and back to the negative output terminal of the rectifier **359**. Thus, the feedback current I_F increases sufficiently to limit the output of the controlled rectifiers **371** and **373** to a safe value for the components which otherwise might be damaged.

In general, regulating circuits require damping means for stability. For this purpose, a capacitor **423** may be connected from the positive output terminal of the pattern rectifier **359** to the base electrode **377B** of the transistor **377**. Thus, the capacitor **423** provides a means for conducting negative feedback current to the base electrode of the transistor which is proportional to the rate of change of the pattern rectifier output voltage. This capacitor is selected to have a relatively low capacitance so that at oscillation rates such negative feedback current is effective for damping, whereas at the normal buildup rate of pattern rectifier output voltage the basic operation of the acceleration device is unaffected.

It will be observed that make contacts **A2** are connected in parallel with the zener diode **419**. Consequently, when these contacts are closed, the feedback capacitor **399** discharges through the resistor **421**, and subsequent charging

of the capacitor is prevented until the contacts reopen. In addition, as resistor **425**, which has relatively low resistance, is connected across the resistor **388** through make contacts A3. As a result, when the contacts A3 are closed, the resistor **388** effectively is shorted by the resistor **425**. Thus, as long as the contacts A2 and A3 remain closed, the pulse generator is ineffective for controlling the controlled rectifiers **371** and **373** to accelerate the elevator car.

A resistor **427** is connected from the junction of the controlled rectifier electrodes **371A** and **373C** to the terminal **361L** of the autotransformer **361**. This resistor functions to make the normally inductive load of the controlled rectifiers appear as a more resistive load and to improve stability during acceleration of the elevator car.

A capacitor **429** is connected across the input terminals of the pattern rectifier **359**. This capacitor has relatively low capacitance and thus presents a relatively high impedance to voltage of the supply frequency across the input terminals of the pattern rectifier. On the other hand, the capacitor **429** serves to filter or shunt any undesired high-frequency voltage appearing across the input terminals of the pattern rectifier.

Referring to the block diagram of FIG. 6, it is believed that a brief of discussion thereof will clarify further the relationship of the components of FIGS. 1, 4 and 4A. As explained above, the initiation of acceleration of the elevator car **11** is controlled by make contacts A2 and A3 of the acceleration relay A, whose operation in turn is controlled by the cam-operated brake plunger switch **335**, as will be described more fully below. The force or torque exerted by the pattern transducer or motor PM on the lever **215** is controlled by each of the following: the acceleration device, which includes the controlled rectifiers **371** and **373** and their associated pulse generator components; the selector transducers, comprising the up and down solenoid control units UM and DM; the hoistway transducer, which includes the electromagnetic units EU1 and EU2 and the magnetic plates or vanes P1; and the terminal slowdown transducer **311**. The velocity transducer, which exerts torque or force on the pattern transducer lever **215** dependent upon the rate and the direction of rotation of the armature of the elevator motor **1**, comprises the electroconductive disk **231** and the permanent magnet **237**. Movement of the lever **215** controls the adjustment of the output elements or rheostats **239** and **241**, which in turn control energization of the field winding GF of the generator G. The resultant variable output of the generator is coupled to the elevator motor **1** to vary the motor armature's rate and direction of rotation.

For increasing the static gain of the speed regulator, positive feedback to the pattern motor winding PM2 is provided in accordance with energization of the generator field GF by means of the rheostat **341** and the decoupling resistor **347**. To minimize hunting of the elevator motor, acceleration negative feedback to the winding PM2 is provided from the output of the generator through the resistor **343** and the capacitor **345**. Finally, in order to minimize the circulating current in the generator and motor armature loop circuit, the residual output of the generator is fed back negatively through break contacts FK1 and FK2 to the pattern motor winding PM1 when the elevator car is stopped in a position of registration with a landing.

OPERATION

(*A*) *Car moves from first floor to sixth floor*

It is believed that an understanding of the invention will be facilitated by a discussion of certain typical operating sequences of the elevator system. For the first sequence, it will be assumed that the elevator car is parked at the lower terminal or first floor in a poistion of registry therewith, that the car gate **21** (FIG. 1) and the hoistway door **19** are open and that a passenger desiring to proceed to the sixth floor enters the elevator car.

While the elevator car is parked at the lower terminal floor with its gate and hoistway door open, the transfer relay TR (FIG. 5) is energized. Also, the coil **193** is energized. As is explained in the aforesaid Oplinger and Savage Patents, this coil, when energized, effects resetting of the synchronous carriages **43S** and **45S** relative to the advance carriages **43A** and **45A** (FIG. 1). In addition, the down pawl relay DPL (FIG. 5) and the acceleration relay A are also energized. Furthermore, the terminal slowdown relay TSD is energized and picked up through the cam-operated switch **337**, the selector switch **12SD** and the holding contacts **TSD6**. All other electromagnetic relays and switches in FIG. 5 are deenergized at this time.

When the passenger enters the elevator car, the elevator attendant operates the car call push button **6***c* to register a car call for the sixth floor. As is explained in the aforesaid Oplinger patent, this push button remains in its operated condition until the car has completed and up trip.

Next, the elevator car attendant operates the up push button UPB to energize the door closing relay DC through closed make contacts TSD3. This relay, when energized, initiates closure of the hoistway door for the lower terminal floor and the car gate in a conventional manner. As a result of such closures, the door relay **40** is energized. This relay closes its make contacts **40–2**, **40–3**, **40–4** and **40–5** to prepare certain circuits for subsequent energization and opens its break contacts **40–7** and **40–8** without immediately effecting operation. In addition, break contacts **40–6** open to deenergize the coil **193**. As a result of such deenergization, free movement of the synchronous carriages **43S** and **45S** (FIG. 1) is prevented.

When the door closing relay DC (FIG. 5) was energized, it opened its break contacts DC1 and DC2. Opening of the contacts DC1 has no immediate effect on operation, while opening of the contacts DC2 results in deenergization of the down pawl relay DPL.

The operation of the up push button UPB also completes the following circuit following closure of make contacts **40–1**:

B1, UPB, **40–1**, D8, U, 1SD, 32, B2–*a*.

The switch 1SD is adapted to have its contacts closed from a position wherein the elevator car is approximately one foot above a stop to a position wherein the selector carriages have their full advance for travel in a downward direction.

Upon energization, the up switch U closes its make contacts U1 and U2 (FIG. 4A) to connect the winding PM1 of the pattern motor PM through the terminals **351** and **353** to the output terminals of the pattern rectifier **359**, when break contacts TR2 and TR3 close, for energization in the proper direction for up travel of the elevator car. Closure of make contacts U11 has no immediate effect on operation. Make contacts U3 (FIG. 5) close to prepare a holding circuit for the up switch and the car running relay **32** for subsequent completion. Make contacts U4 close to prepare the up pawl relay UPL for energization as it aproaches a position corresponding to a floor for which an up floor call is registered. Make contacts U6 and U7 close to complete an energizing circuit for the armature of the advance motor AM. The direction of energization of the advance motor, as determined by the contacts U6 and U7, is correct for up travel of the elevator car. Break contacts U8 open to prevent energization of the down switch D, while make contacts U9 close to energize the field control relay FK. Pickup of the relay FK results in the opening of break contacts FK1 and FK2 (FIG. 4) without immediate effect on system operation. Returning to FIG. 5, make contacts U10 of the up switch close to shunt the closed selector switch **125D** and make contacts **TSD6**.

At this stage, a substantial part of the resistor R2 is shunted, and the armature of the advance motor AM is energized through the circuit:

B1–*a*, 40–5, *u*SU, 7SD, DPL4, UPL4, U6, AM, U7, B2.

As is explained in the aforesaid Oplinger patent, the advance motor AM rapidly moves the advance carriage 43A (FIG. 1) in an upward direction through the distance permitted by the lost-motion coupling between the advance and synchronous carriages. The relative motion of the advance and synchronous carriages results in movement of the armature UMA out of the coil UMC of the up solenoid control unit UM to provide minimum impedance of the solenoid coil.

As the advance carriages are moved by the advance motor relative to the synchronous carriages, the switch 1SU (FIG. 5) opens to prevent energization of the down switch D. Additionally, the switch 4SU opens to prevent energization of the coil 193.

As the advance carriages continue to move, the switch 3SU closes to permit energization of the up pawl relay UPL by a registered car call. However, for reasons which will be set forth below, such energization cannot take place until the advance carriage nears a position corresponding to a floor for which a car call is registered.

During movement of the advance carriages, the switch 11SU also opens to deenergize the transfer relay TR. This occurs when the movement of the advance carriages is equivalent to ten inches of car travel. (In the aforesaid Oplinger patent, the switches 11SU and 11SD are closed when the elevator car is within approximately twenty inches of a floor from which it is leaving or at which it is to stop for either direction of travel. For present purposes, however, it will be assumed that the switches 11SU and 11SD are adjusted so that this distance is of the order of ten inches.) In addition, the switch 7SU opens as the advance carriages near their fully advanced positions to introduce a substantial portion of the resistor R2 in series with the armature of the advance motor AM. This reduces heating of the advance motor, but sufficient torque is produced by the advance motor under these conditions to force the advance carriages to follow the synchronous carriage movements.

Upon dropout, the transfer relay TR closed its break contacts TR1 to complete a holding circuit for the up switch U and the car running relay 32 which may be traced as follows:

B1, TR1, 40–2, U3, D8, U, 1SD, 32, B2–*a*.

Consequently, the car attendant now may release his up push button UPB. Such release deenergizes the door closing relay DC, which closes its break contacts DC1 and DC2. The closure of these contacts has no immediate effect on system operation.

The transfer relay also closed its break contacts TR2 (FIG. 4A) and TR3 and opened its make contacts TR4 and TR5 to place the pattern motor winding PM1 through the contacts U1 and U2 under control of the acceleration device.

It will be assumed that the advance carriages now are fully advanced. From this point on, the advance carriages can advance only with the associated synchronous carriages.

If desired, the elevator system may be so designed that the elevator car starts to move before the advance carriages reach their fully advanced positions. However, in a preferred embodiment of the invention, the advance carriages are moved rapidly and reach their fully advanced positions before the elevator car starts to move.

It will be recalled that the car running relay 32 (FIG. 5) was energized at the same time the up switch U was energized. As a result of its energization, the relay 32 closed its make contacts 32–2 and 32–3 to prepare holding circuits for the pawl relays UPL and DPL for subsequent energization. The car running relay also closed its make

contacts 32–1 (FIG. 4) to energize the brake solenoid 7*c* and thus to release the elevator car brake. Such release permits upward travel of the elevator car.

As the brake plunger 7*p* moves to release the brake shoe 7*s* from the drum 7*d*, the cam 349 disengages the cam follower of the switch 335 to open the switch. Referring to FIG. 5, opening of the switch 335 results in deenergization and dropout of the acceleration relay A. As a result, break contacts A4 close without affecting operation of the field control relay FK, since this relay already is picked up through make contacts D9, as noted above. In addition, break contact A1 (FIG. 4A) close to complete, through make contacts TSD1 and U11, the following circuit across the input terminal of the pattern rectifier 359: the coil UMC, the resistor 360, that portion of the autotransformer 361 between its terminal 361L and its tap 361A, and the cathode and anode electrodes of the controlled rectifiers 371 and 373.

The acceleration relay also opens its make contacts A2 to permit charging of the feedback capacitor 399 and opens its make contacts A3 to disconnect the low resistance resistor 421 across the error signal resistor 388. As a result, the acceleration device pulse generator, comprising the transistor 377, the unijunction transistor 379, the zener diode 385 and their associated components, applies a variable phase gate signal between the gate and cathode electrodes of the controlled rectifiers 371 and 373 through the pulse transformer 375. Thus, the controlled rectifiers supply through make contacts U1 and U2 and break contacts TR2 and TR3 smoothly and linearly increasing current to the pattern motor winding PM1 by means of the pattern rectifier 359 in a manner which will be clear from the preceding discussion of FIG. 4A. Since the impedance of the coil UMC is minimum at this time and the resistance of the resistor 360 is relatively low, these components have negligible effect upon the voltage applied to the input terminals of the pattern rectifier 359. The resistor 360, however, limits the inrush current through the capacitors 355 and 429 and serves to improve system stability during acceleration of the elevator car.

Turning now to FIG. 4, as a result of energization of the winding PM1 of the pattern motor in the foregoing manner, force is applied to the lever 215 to rotate the lever in a counterclockwise direction about its pivot 217. Consequently, the effective resistance of the resistor 241R gradually decreases. Such decrease results in the flow of gradually increasing current in the generator field winding GF, as will be understood from the preceding description of FIG. 4. Thus, the output voltage of the generator G increases substantially smoothly and linearly to energize the pattern motor winding PM2 through the resistor 343 and the capacitor 345. This develops force on the lever 215 acting in opposition to the force produced by energization of the winding PM1. However, such energization of the winding PM2 exists only while the energization of the field winding GF is changing and is for the purpose of decreasing hunting of the motor 1, as previously explained.

The motor 1 now accelerates at a substantially constant rate to move the elevator car in the up direction. It will be recalled that the start of acceleration of the car was responsive to the position of the brake plunger 7*p* as the brake was released. Consequently, any variation in the time of release of the brake shoe 7*s* from the drum 7*d* automatically is compensated for, and the car always starts smoothly from a floor.

Acceleration of the motor 1 is accompanied by acceleration of the disk 231, which is coupled electromagnetically to the lever 215 through the magnet 237. As the speed of the motor increases, torque applied to the lever 215 by the disk 231 increases until a condition of equilibrium is reached at which the speed of the motor corresponds to the desired running speed of the elevator car. Any deviation of the car from the desired speed results in a change in the torque applied to the lever 215 by the

disk 231. This change is in the proper direction to restore the motor 1 to the desired speed.

As the elevator car moves away from the first floor, the cam follower 307 (FIG. 1) of the switch 303 engages the cam 309 for the first floor to close the switch. When the car is a distance of 22¼ inches from the first floor, the cam follower 307 disengages the cam 309 to reopen the switch 303. Such closure and opening of the switch 303 results in energization and then deenergization of the down leveling relay LD (FIG. 5) without affecting system operation.

When the output voltage of the pattern rectifier 359 (FIG. 4A) reaches a predetermined magnitude, as determined by the setting of the tap 417A on the resistor 417, the capacitor 415 charges through the zener diode 383 and a portion of the resistor 417. As previously explained, this results in the approximate doubling of the feedback current I_F. Thus, the elevator car continues to accelerate, but at a rate which is approximately half that before the capacitor 415 started to charge. Finally, the pulse generator effects conduction of the respective controlled rectifiers 371 and 373 fully over alternate half cycles of voltage from the autotransformer 361, the output of the ractifier 359 thus becomes maximum, resulting in maximum energization of the pattern motor winding PM1, and the elevator car consequently reaches full speed.

Returning to FIG. 4, enerigization of the generator field winding GF is accompanied by the appearance of a voltage drop across the effective resistance of the positive feedback rheostat 341 in series therewith. Thus, the pattern motor winding PM2 is energized through the decoupling resistor 347 in a direction to produce force on the lever 215 acting to aid the force produced by energization of the winding PM1. As explained heretofore, such energization of the winding PM2 is for the purpose of increasing the sensitivity of the system by minimizing the effort of the spring force of the rheostats 239 and 241 in order to increase the static gain and to improve substantially the high speed regulation of the system (and, subsequently, the accuracy with which the elevator car is stopped at each floor).

As the elevator car moves, car motion is transmitted through the transmitter or generator SG (FIG. 1) to the motor SM. This motor thereupon drives the synchronous carriages 43S and 45S in accordance with car movement. Since the advance carriages 43A and 45A now are biased by the advance motor AM in the direction of travel of the synchronous carriages, it follows that all of the carriages move in unison.

As is stated in the aforesaid Oplinger patent, one of the switches in the set of pile-up switches 49A (FIG. 5) is employed for picking up car calls in either direction of travel of the elevator car. Thus, the switch 49A(1) is in the floor stop unit for the first floor, the switch 49A(2) is in the floor stop unit for the second floor, etc. However, closure of one of these switches is effective for a control operation only if the associated car call push button is in operated condition.

As the advance carriage 43A nears its position corresponding to the sixth floor, it closes the switch 49A(6) for the sixth floor. This closure may take place when the advance carriage is short of the position which it occupies when the elevator car is at the sixth floor by a distance of the order of four feet measured in terms of car travel. Assuming, as in the Oplinger patent, that the advance carriages lead the elevator car by a distance equivalent to twenty feet of car travel, it follows that the switch 49A(6) is closed when the elevator car is approximately twenty-four feet from the sixth floor.

Upon closure of the switch 49A(6), the following circuit is completed:

B1–*a*, 6*c*, 49A(6), 40–4, 3SU, UPL, B2.

Upon energization, the up pawl relay UPL closes its make contacts UPL1 to complete a self-holding circuit through parallel make contacts 32–2 and break contacts DC1. Opening of break contacts UPL3 introduces substantial resistance in series with the advance motor AM shortly before the advance carriages are brought to a stop, while opening of break contacts UPL4 has no effect on operation inasmuch as the switch 7SU in series therewith previously had opened as noted above.

Energization of the up pawl relay UPL also projects a cam into position for operating the set of switches 49 for the sixth floor (see the discussion of the cam 105 in the aforesaid Oplinger patent). The expression "49(6)" designates the set for the sixth floor. One of these switches, 49(6)–1, is closed by the cam to energize the canceling coil 6URN for the sixth floor in the event that an up floor call is registered for the sixth floor. However, under the assumed conditions, no such call has been registered. The cam also closes a switch 49(6)–2 for the purpose of energizing the up lantern 6LAU for the sixth floor. In addition, the energization of the up pawl relay UPL projects a stop pawl into position to engage a lug associated with a clamp of the floor stop unit associated with the sixth floor (see the discussion of the stop pawl 95, the lug 97 and the clamp 113 in the aforesaid Oplinger and Savage patents). Consequently, as the advance carriage 43A (FIG. 1) continues its upward travel, the pawl engages the lug for the floor stop unit of the sixth floor to bring the advance carriages to a stop.

As the elevator car continues upwardly, the synchronous carriage 43S moves with respect to the advance carriage 43A to operate the switch 1SU (FIG. 5) and similar switches mounted on the advance carriage. The switches are operated in accordance with the development illustrated in FIG. 7 of the aforesaid Oplinger patent (with the exception of the switches 11SU and 11SD, as noted heretofore).

The movement of the synchronous carriage 43S relative to the advance carriage 43A also operates to move the armature UMA (FIG. 4A) toward the coil UMC of the up solenoid control unit UM. The movement of the armature is accompanied by a gradual increase in the impedance of the coil UMC and thus a gradual decrease in current suplied by the controlled rectifiers 371 and 373 to the pattern motor winding PM1 through the pattern rectifier 359. This decrease in energization of the winding PM1 results in a reduction of torque applied to the lever 215 (FIG. 4) by the pattern motor. Consequently, the lever moves in a clockwise direction about its pivot 217 to increase the effective resistance of the resistor 241R. The resultant gradual decrease in current supplied to the generator field winding GF effects a corresponding gradual slowdown of the elevator car. Since the ouput of the generator G changes, the pattern motor winding PM2 is energized through the resistor 343 and the capacitor 345 in a proper direction for minimizing hunting of the motor 1.

When the elevator car reaches a distance of the order of 22¼ inches from the sixth floor, the cam follower 305 (FIG. 1) of the switch 301 engages the cam 309 for the sixth floor to close the switch. Such closure is accompanied by pickup of the up leveling relay LU (FIG. 5), which closes its make contacts LU1 without affecting system operation and closes its make contacts LU4 to energize and pick up the landing time relay LT. As a result, make contacts LT1 close to parallel the closed break contacts TR1 and make contacts 40–2 in the holding circuit of the up switch U and the car running relay 32.

It will be recalled that when the elevator arrives at a distance of twenty inches from the sixth floor, the electromagnetic unit EU1 (FIG. 1) is adjacent the lower end of the plate P1 for the sixth floor and that as the car continues its upward movement the voltages induced in the secondary windings 285S and 287S (FIGS. 2 and

4A) of the unit EU1 gradually decrease. Such decrease, however, has no effect on system operation for the reason that the transfer relay TR (FIG. 5) is deenergized at this time, and its make contacts TR4 and TR5 (FIG. 4A) consequently are open as aforesaid.

As the elevator car continues to approach the sixth floor at gradually decreasing speed under control of the up solenoid control unit UM and when it reaches a distance of the order of ten inches from the sixth floor, the selector switches 11SU and 11SD (FIG. 5) close to complete an energizing circuit for the transfer relay TR. This relay opens its break contacts TR1, but such opening does not affect operation for the reason that make contacts LT1 now are closed, as aforesaid. The transfer relay also opens its break contacts TR2 and TR3 (FIG. 4A) to disconnect the pattern motor winding PM1 from the output terminals of the pattern rectifier 359. Make contacts TR4 and TR5 close to connect the winding PM1 for energization under control of the electromagnetic units EU1 and EU2.

At the time the transfer is made, the unit EU1 is adjacent the middle or widest portion of the plate P1, which consequently has maximum shielding effect on the unit EU1, whereas the unit EU2 is spaced downwardly from the plate P1. Thus, maximum voltages are induced in the windings 289S and 291S, while minimum or negligible voltages are induced in the windings 285S and 287S. As a result, greater current is provided by the rectifier 271 than by the rectifier 267, and the winding PM1 of the pattern motor is energized with proper polarity to continue the upward motion of the elevator car at a slow speed.

As the elevator car continues its upward motion, current supplied by the rectifier 267 continuously increases, while current supplied by the rectifier 271 remains at maximum, and thus the difference between the currents supplied by these rectifiers decreases. This gradually reduces energization of the winding PM1 and consequently gradually reduces the speed of the elevator car.

When the car reaches a distance of ¼ inch from a position of registry with the sixth floor, the cam 309 (FIG. 1) for the sixth floor disengages the cam follower 305 of the switch 301 to open the switch and thus to deenergize and drop out the up leveling relay LU (FIG. 5). Opening of make contacts LU1 has no effect on operation, while opening of make contacts LU4 results in deenergization of the landing time relay LT from the buses B1 and B2–*a*. However, it will be recalled that the capacitor 331 and the resistor 333 provide the relay LT with a substantial time delay in dropout. Consequently, make contacts LT1 remain closed to maintain energization of the up switch U and the car running relay 32 until such time delay expires.

As the car reaches a position of registry with the sixth floor, the electromagnetic unit EU1 (FIG. 4A) is adjacent the upper end of the plate P1 for the sixth floor, and the unit EU2 is adjacent the lower end thereof. As a result, both of these units have substantially maximum output, and the voltage applied to the winding PM1, therefore, is reduced to zero to reduce the elevator car speed to zero. Consequently, the car comes to rest accurately at the sixth floor.

Returning to the landing time relay LT (FIG. 5), the capacitor 331 and the resistor 333 across the relay coil are selected to provide the relay with a time delay in dropout sufficient to insure the accurate stopping of the elevator car before the relay drops out to open its make contacts LT1. Such opening interrupts the holding circuit for the up switch U and the car running relay 32.

Deenergization of the up switch U has no immediate effect on system operation. Dropout of the car running relay 32 is accompanied by opening of its make contacts 32–2 and 32–3 without affecting operation and by opening of its make contacts 32–1 (FIG. 4) to deenergize the brake solenoid 7*c*, thus permitting application of the brake shoe 7*s* to the drum 7*d*. It will be noted that the brake is not applied until the elevator car has come to a complete stop. Thus, the application of the brake cannot be detected by car passengers.

As the brake plunger 7*p* nears the end of its travel, the cam 349 effects closure of the switch 335. This results in pickup of the acceleration relay A (FIG. 5), which opens its break contacts A4 to deenergize the field control relay FK, since make contacts U9 opened when the up switch U dropped out, as aforesaid. Referring to FIG. 4, closure of break contacts FK1 and FK2 results in negative feedback of the residual output voltage of the generator G across the pattern motor winding PM1. Energization of the winding PM1 in this manner effects the application of force to the lever 215 such that the lever rotates in a clockwise direction about its pivot 217 to decrease the effective resistance of the resistor 239R. It will be observed that such force is in a direction opposite to that applied to the lever as the elevator car approached the sixth floor in the up direction. Consequently, the generator field winding GF is energized in a direction to produce flux opposing the residual flux of the generator, and the residual flux is substantially reduced. Thus, the generator residual output voltage also is reduced. This results in a substantial decrease of the circulating current in the generator and elevator motor armature loop circuit and thereby in the minimizing of heating of the armatures. As the residual output voltage of the generator decreases, energization of the winding PM1 also decreases, and the lever 215 moves toward its neutral position.

Pickup of the acceleration relay A also is accompanied by opening of its break contacts A1 (FIG. 4A), but such opening has no immediate effect on the operation of the system. Closure of make contacts A2 results in discharge of the feedback capacitor 399 through the resistor 421. In addition, make contacts A3 close to place the resistor 425 across the error signal resistor 388. It will be recalled that the resistor 425 has relatively low resistance, so that it now effectively shorts the resistor 388. Thus, as long as the contacts A2 and A3 remain closed, the acceleration device pulse generator is inoperable for controlling the controlled rectifiers 371 and 373 to accelerate the elevator car.

Should the elevator car be displaced by more than ¼ inch on the sixth floor for any reason, such as cable contraction or stretch, after the car has stopped in a position of registry with the floor and its gate and the hoistway door for the sixth floor are open, the car will be returned into registry with the floor as a result of the following sequence of operations. Such displacement of the car results in closure of one of the cam-operated switches 301 or 303 (FIG. 1), as the case may be, by the cam 309 for the sixth floor. This results in pickup of the associated up or down leveling relay LU or LD (FIG. 5). Since the car gate and hoistway door are open, the door relay 40 is dropped out to close its break contacts 40–7 and 40–8. Consequently, closure of make contacts LU1 or LD2 is accompanied by pickup of the car running relay 32 and the up switch U or the down switch D, the latter of which closes its respective make contacts U9 or D9 to energize the field control relay FK. The relay FK opens its break contacts FK1 and FK2 (FIG. 4) to prevent energization therethrough of the pattern motor winding PM1. In addition, closure of make contacts LU4 or LD4 (FIG. 5) effects pickup of the landing time relay LT, which closes its make contacts LT1 to complete a holding circuit for the car running relay 32 and for whichever of the switches U or D is picked up as aforesaid.

Pickup of the car running relay results in closure of its make contacts 32–1 (FIG. 4) to release the elevator brake 7, and the plunger 7*p* thus moves to open the switch 335 by means of the cam 349. Opening of the switch 335 results in dropout of the acceleration relay A (FIG.

5), which closes its break contacts A4 in parallel with the previously closed make contacts U9 or D9.

Inasmuch as the elevator car is displaced from its position of registry with the sixth floor, the outputs of the electromagnetic units EU1 and EU2 (FIG. 4A) are unbalanced. Consequently, the pattern motor winding PM1 is energized with proper polarity to return the elevator car slowly into accurate registration with the sixth floor as will be understood from the previous discussion.

When the car arrives at a distance of ¼ inch from the sixth floor, the switch 301 or 303 (FIGS. 1 and 5) opens to drop out the up leveling relay LU or the down leveling relay LD, and make contacts LU4 or LD4 open to initiate a timing operation of the landing time relay LT. This relay drops out after the car comes to a stop to open its make contacts LT1, thus deenergizing the car running relay 32 and the up switch U or the down switch D. Dropout of the relay 32 results in opening of its make contacts 32–1 (FIG. 4) to reset the brake 7. As a result, the switch 335 recloses to pick up the acceleration relay A (FIG. 5), which opens its break contacts A4 to drop out the field control relay FK. The relay FK closes its break contacts FK1 and FK2 (FIG. 4) to energize the pattern motor winding PM1 in a direction which effects neutralization of the residual flux of the generator G in a manner which will be clear from the preceding discussion of the stopping of the elevator car at the sixth floor.

(B) Car moves from sixth floor to third floor

Next, it will be assumed that the elevator car is positioned at the sixth floor during a down trip. The down pawl relay DPL (FIG. 5) is assumed to have been energized to bring the car to a stop at the sixth floor, and the down lantern for the sixth floor is illuminated. At this time, a prospective passenger on the third floor operates the push button 3D for the third floor in order to register a down floor call. It will be noted that operation of the push button 3D energizes the down floor call registering relay 3DR. This relay closes its make contacts 3DR1 to establish a self-holding circuit. In addition, the relay closes its make contacts 3DR2 to prepare for subsequent energization therethrough of the down pawl relay DPL.

The car attendant now operates the down push button DPB to energize the door closing relay DC through make contacts TSD4. This initiates closure of the hoistway door for the sixth floor and the car gate. The door closing relay also opens its break contacts DC1 and DC2. In opening, the contacts DC1 have no immediate effect on operation, while the contacts DS2 deenergize the down pawl relay DPL and this relay thereupon opens the contacts 53(6)–2 (not shown, but corresponding to the contacts 53(3)–2 for the third floor) to interrupt the illumination of the down lantern for the sixth floor. The opening of the contacts 53(6)–1 (corresponding to the contacts 53(3)–1 for the third floor) and DPL1 has no immediate effect. Break contacts DPL3 and DPL4 close to shunt substantial parts of the resistor R2 in the energizing circuit of the armature of the advance motor AM.

Closure of the car gate and the hoistway door for the sixth floor energizes the door relay 40. This relay closes its make contacts 40–1, 40–2, 40–4 and 40–5 and opens its break contacts 40–7 and 40–8 without immediately affecting operation of the system. In addition, the door relay opens its break contacts 40–6 to deenergize the coil 193 in order to permit the motor SM (FIG. 1) to drive the synchronous carriages 43S and 45S.

The operation of the down push button DPB (FIG. 5) by the elevator car attendant also completes the following circuit after closure of make contacts 40–3:

B1, DPB, 40–3, U8, D, 1SU, 32, B2–*a*.

The resulting energization of the down switch D closes make contacts D1 and D2 (FIG. 4A) to prepare the coil PM1 of the pattern motor for energization in the proper direction for down travel of the elevator car. Make contacts D11 close without immediate effect on operation.

Returning to FIG. 5, closure of make contacts D3 and D4 has no immediate effect on system operation. Closure of make contacts D6 and D7 completes an energizing circuit for the armature of the advance motor AM, the direction of energization being correct for down travel of the car. Break contacts D8 open to prevent pickup of the up switch U, while make contacts D9 close to energize the field control relay FK. The relay FK opens its break contacts FK1 and FK2 (FIG. 4) without immediate effect on system operation. The down switch also closes its make contacts D10 (FIG. 5) to parallel the closed cam-operated switch 337 in the circuit of the terminal slowdown relay TSD.

Since a substantial portion of the resistor R2 is shunted, the advance motor AM rapidly advances the associated advance carriages. As the advance carriages are moved relative to their associated synchronous carriages, the switch 1SD opens to prevent energization of the up switch U. The switch 3SD closes to permit energization of the down pawl relay DPL when the elevator car is to answer a registered car call. The switch 4SD opens to prevent energization of the coil 193 during down travel of the car. The switch 7SD opens to introduce resistance in series with the armature of the advance motor AM shortly before the advance carriages reach their maximum advance for the down direction. Finally, the switch 11SD opens to deenergize the transfer relay TR, which closes its break contacts TR1 to complete a holding circuit for the down switch D and the car running relay 32 which may be traced as follows:

B1, TR1, 40–2, D3, U8, D, 1SU, 32, B2–*a*.

Consequently, the car attendant now may release the down push button DPB. Such release deenergizes the door closing relay DC, which closes its break contacts DC1 and DC2 without immediate effect on system operation.

The transfer relay also closes its break contacts TR2 (FIG. 4A) and TR3 and opens its make contacts TR4 and TR5 to place the pattern motor winding PM1 through the contacts D1 and D2 under control of the acceleration device.

The car running relay 32, upon being energized as aforesaid, closes its make contacts 32–2 and 32–3 to prepare holding circuits for the pawl relays UPL and DPL for subsequent operation. In addition, make contacts 32–1 (FIG. 4) close to energize the brake solenoid 7*c* and thus to release the elevator brake. Such release permits downward travel of the elevator car.

As the brake releases, the cam-operated switch 335 opens to drop out the acceleration relay A (FIG. 5). Closure of break contacts A4 has no immediate effect on system operation. Break contacts A1 (FIG. 4A) close to complete a series circuit, including the coil DMC of the down solenoid control unit, across the input terminals of the pattern rectifier 359. It will be recalled that the advance carriages reach their maximum advances in the downward direction prior to movement of the elevator car. Such advance is accompanied by movement of the armature DMA away from the coil DMC to reduce the impedance of the coil to its minimum value.

The acceleration relay also opens its make contacts A2 and A3, thus rendering the acceleration device pulse generator operable to effect the supply of smoothly and linearly increasing current to the pattern motor winding PM1 by the controlled rectifiers 371 and 373 through make contacts D1 and D2 and break contacts TR2 and TR3, as will be clear from the preceding discussion. Referring to FIG. 4, such energization of the winding PM1 is in the proper direction to produce downward motion of the elevator car. Thus, the pattern motor PM applies torque to the lever 215 acting in a clockwise direction about the pivot 217. The resulting movement

of the lever 215 operates the springs 239A through 239F to reduce gradually the effective resistance of the resistor 239R. As a result, gradually increasing current flows in the generator field winding GF. Thus, the elevator car accelerates at a substantially constant rate in the down direction. During such acceleration, the pattern motor winding PM2 is energized through the resistor 343 and the capacitor 345 to minimize hunting of the motor 1, as explained above.

As the motor 1 accelerates, it rotates the disk 231 to apply through the magnet 237 torque to the lever 215 which acts in opposition to the torque applied by energization of the winding PM1. An equilibrium finally is reached when the elevator car operates at the desired speed, the zener diode 383 (FIG. 4A), the capacitor 415 and the resistor 417 acting to halve the acceleration of the car at a predetermined point, as will be understood from the preceding discussion.

It will be observed that the pattern motor winding PM2 once again is energized through the decoupling resistor 347 in accordance with the voltage drop across the rheostat 341. It will be recalled that such energization increases the sensitivity of the system by minimizing the effect of the spring force of the rheostat 239 in order to increase the static gain and improve the high speed regulation of the system.

As the elevator car moves in the down direction, the position generator or transmitter SG (FIG. 1) energizes the motor SM to drive the synchronous carriages 43S and 45S in synchronism with movement of the elevator car. Since the advance carriages are maintained in their advanced positions, they move in unison with the synchronous carriages during full speed travel of the car in the down direction.

Registered down floor calls are picked up by one of the switches in each of the sets 55A (FIG. 5). As the advance carriage 45A approaches each of the associated floor-stop units in succession, it operates successively the sets of switches 55A. When the advance carriage reaches a predetermined point, such as a position which may be four feet (measured in terms of car travel) before the third floor, it closes the switch 55A3–1. This is one of the switches of the set 55A associated with the floor stop unit for the third floor. Since the advance carriage may lead the elevator car by a distance such as twenty feet (measured in terms of car travel), it follows that the switch 55A3–1 is closed when the elevator car is about twenty-four feet from the third floor.

Upon closure of the switch 55A3–1, the down pawl relay DPL is energized through the following circuit:

B1–*a*, 55A3–1, 3DR2, D4, DPL, B2.

The down pawl relay closes its make contacts DPL1 to establish through the now closed make contacts 32–3 a self-holding circuit. In addition, break contacts DPL3 open to insert additional resistance in series with the armature of the advance motor AM shortly before the advance carriages are brought to a stop.

The down pawl relay DPL also operates the set of switches 53 for the third floor. This set includes a switch 53(3)–1, which is closed to energize the canceling coil 3DRN. Such energization cancels the down floor call registered for the third floor. As a result, make contacts 3DR2 open, but the down pawl relay remains energized through its self-holding circuit. In addition, a second switch of the set, 53(3)–2, closes to energize the down floor lantern 3LAD for the third floor.

Energization of the down pawl relay DPL also operates to bring the advance carriages to a stop when the elevator car is approximately twenty feet from the third floor. Continued movement of the car results in movement of the synchronous carriages relative to the advance carriages. It will be recalled that such relative motion operates a plurality of switches mounted on the advance carriage 45A (FIG. 1).

The relative motion of the carriages also moves the armature DMA toward the coil DMC to increase the impedance of the coil gradually. Such increase in impedance results in a gradual decrease in current supplied to the winding PM1 (FIG. 4A) of the pattern motor in a manner which will be clear from the preceding discussion of the approach of the elevator car to the sixth floor. The resultant movement of the lever 215 (FIG. 4) increases the effective resistance of the resistor 239R and thus reduces the excitation of the generator G. Consequently, the elevator car gradually is slowed as it approaches the third floor.

When the car reaches a distance of the order of 22¼ inches from the third floor, the cam follower 307 (FIG. 1) of the switch 303 engages the cam 309 for the third floor to close the switch. This results in pickup of the down leveling relay LD (FIG. 5), which closes its make contacts LD2 without affecting system operation and closes its make contacts LD4 to energize the landing time relay LT. As a result, make contacts LT1 close to parallel break contacts TR1 and make contacts 40–2 in the energizing circuit of the down switch D and the car running relay 32.

As the elevator car reaches a distance of the order of ten inches from the third floor, the switches 11SD and 11SU close to energize the transfer relay TR. This relay opens its break contacts TR1, but such opening has no effect on operation for the reason that the down switch D and the car running relay 32 remain energized through the now closed make contacts LT1. In addition, break contacts TR2 and TR3 (FIG. 4A) open to interrupt energization of the pattern motor winding PM1 from the pattern rectifier 359. Closure of make contacts TR4 and TR5 connects the winding PM1 for energization under control of the electromagnetic units EU1 and EU2.

When the transfer occurs, the electromagnetic unit EU2 is adjacent the middle or widest portion of the plate P1 for the third floor, while the electromagnetic unit EU1 is spaced upwardly from the plate. In this position of the elevator car, negligible voltages are induced in the secondary windings 289S and 291S of the unit EU2 because of the shielding effect of the plate P1, whereas maximum voltages are induced in the secondary windings 285S and 287S of the unit EU1. Consequently, the rectifier 267 supplies substantially more current to the resistor 273 than does the rectifier 271. The resultant voltage across the resistor energizes the winding PM1 of the pattern motor with proper polarity for continued down travel of the elevator car.

As the car continues its approach to the third floor, the width of the plate P1 between the cores of the unit EU2 continuously decreases to decrease the shielding action between the primary and secondary windings of this unit, and the voltage applied to the winding PM1 consequently decreases gradually. This means that the speed of the elevator car also is gradually decreased until the car reaches registry with the third floor.

When the car reaches a distance of ¼ inch from a position of registry with the third floor, the cam 309 (FIG. 1) for the third floor disengages the cam follower 307 of the switch 303 to open the switch and thus to deenergize and drop out the down leveling relay LD (FIG. 5). Opening of make contacts LD2 has no effect on operation of the system, while opening of make contacts LD4 disconnects the landing time relay LT from the bus B1. Since this relay has a substantial time delay in dropout, however, its make contacts LT1 remain closed to maintain energization of the down switch D and the car running relay 32 until such time delay expires.

As the elevator car arrives at a position of registration with the third floor, the electromagnetic unit EU2 (FIG. 4A) is adjacent the lower end of the plate P1, and the unit EU1 is adjacent the upper end thereof. Consequently, the voltage across the resistor 273 is reduced to

zero, and the speed of the elevator car also is reduced to zero.

After the car stops accurately at the third floor and the time delay in dropout of the landing time relay LT (FIG. 5) expires, this relay drops out to open its make contacts LT1, thus deenergizing the down switch D and the car running relay 32. Dropout of the down switch has no immediate effect on system operation. Deenergization of the relay 32 is accompanied by opening of its make contacts 32–2 without affecting operation and by opening of its make contacts 32–3 to interrupt the holding circuit of the down pawl relay DPL, which drops out without further affecting operation. In addition, make contacts 32–1 (FIG. 4) open to deenergize the brake solenoid 7*c*, thereby permitting application of brake shoe 7*s* to the drum 7*d*. It will be observed again that the brake is not applied until the elevator car has come to a complete stop.

As the brake plunger 7*p* nears the end of its travel, the cam 349 closes the switch 335 to pick up the acceleration relay A (FIG. 5). Break contacts A4 open to drop out the field control relay FK, which closes its break contacts FK1 and FK2 (FIG. 4) to reduce substantially the residual flux of the generator G in a manner which will be clear from the preceding discussion. In addition, break contacts A1 (FIG. 4A) open, but such opening has no effect on operation, and make contacts A2 and A3 close to discharge the feedback capacitor 399 through the resistor 421 and to shunt the error signal resistor 388 with the resistor 425, respectively.

During the final movement of the elevator car, the floor selector switch 4SD (FIG. 5) is closed. Such closure may occur when the car is of the order of two feet from the third floor and prepares the coil 193 for subsequent energization. In addition, the switch 1SD closed when the car was within one foot of the second floor to prepare the up switch U for subesquent energization.

The elevator car attendant now opens the car gate and the hoistway door for the third floor to receive the waiting passenger. Such openings result in deenergization of the door relay 40. Opening of make contacts 40–1, 40–2, 40–3, 40–4 and 40–5 has no immediate effect on the operation of the system. Closure of break contacts 40–6 completes an energizing circuit for the coil 193. This coil, upon being energized, permits registration of the advance and synchronous carriages. Closure of break contacts 40–7 and 40–8 also is without immediate effect. Should the elevator car be displaced from the third floor for any reason, such as cable contraction or stretch, however, these contacts permit energization of the car running relay 32 to release the elevator brake. In addition, the electromagnetic units EU1 and EU2 would effect a return of the car into registry with the third floor, as will be understood from the discussion of the releveling of the car at the sixth floor.

When the waiting passenger at the third floor has entered the elevator car, the car attendant operates the down push button DPB to effect down travel of the car by a sequence of operations which will be clear from the preceding discussion.

It will be noted that when the elevator car makes a short run, such as a run from the third to the second floor, the advance carriages may be brought to a stop before they reach their full advance. For example, let it be assumed that the elevator car attendant operates the car call push button 2*c* for the second floor. Following operation of the down push button DPB, the advance carriages start to advance in the manner previously described. However, if the third and second floors are separated by less than twenty feet, the advance carriages do not reach their full advance before the switch 49A(2) associated with the floor-stop unit for the second floor is closed. Closure of the switch 49A(2) completes an energizing circuit for the down pawl relay DPL and this relay operates in the manner previously described to bring the advance carriages to a stop.

If the third and second floors are spaced by say fifteen feet, the armature DMA (FIG. 4A) is not completely withdrawn from the coil DMC, and the coil will not have its minimum impedance. However, due to operation of the feedback capacitor 399, the elevator car will accelerate as rapidly for the short run as for the long run, the impedance of the coil DMC in this case preventing the car from reaching its maximum speed before the control circuits operate to effect car slowdown and stopping at the second floor. In addition, the zener voltage of the diode 383 is sufficiently high and the tap 417A on the resistor 417 is adjusted to prevent operation of the capacitor 415 to reduce acceleration of the car, as explained heretofore, for such short runs. In all other respects, it will be appreciated that the system operates for a short run in a manner analogous to the operation of the system for a longer run.

Inasmuch as the electromagnetic units EU1 and EU2 operate for a very limited travel of the elevator car, it is clear that they are always employed for controlling the car whether the car is operated on a run from one floor to the next floor or on a longer run. Consequently, they are always available for establishing an accurate slowdown pattern for the elevator car at it nears a floor at which it is to stop.

Let it be assumed in the preceding example that the elevator car attendant operates the car call push button 1*c* (FIG. 5) for the first floor rather than the button 2*c* for the second floor. Under normal circumstances, the advance carriage 45A (FIG. 1) closes the switch 49A(1) (FIG. 5) to complete an energizing circuit for the down pawl relay DPL as the car approaches the first floor, and this relay operates to effect the stopping of the car accurately at the first floor, as will be clear from the previous discussion of the stopping of the car at the third floor.

In addition, when the elevator car reaches a distance of twenty feet from the first floor, relative movement between the advance carriage 45A and the synchronous carriage 45S results in closure of the floor selector switch 12SD to complete a holding circuit through make contacts TSD6 of the terminal slowdown relay TSD, which is picked up through the cam-operated switches 337 and 339.

As the car continues its downward travel and it reaches a distance of nineteen feet from the first floor, the switch 339 opens, but the relay TSD is maintained energized through the switches 337 and 12SD and the contacts TSD6. It will be recalled that the switches 337 and 339 are secured to the elevator car and are operated by cams located in the hoistway adjacent the upper or ninth and lower or first terminal floors, respectively. Furthermore, at such nineteen-foot distance, the cam 325 (FIG.1) engages the roller 313 of the terminal slowdown transducer 311. Consequently, as the car continues its approach toward the first floor, the arm 315 is rotated gradually in a counterclockwise direction, as viewed in FIG. 1, through an angle of approximately 90°. Thus, the movable contact 317 (FIG. 4A) of the autotransformer 319 is actuated by the arm 315 to reduce the output voltage of the autotransformer gradually from maximum to zero as the elevator car substantially arrives at the first floor. But since the terminal slowdown relay TSD is picked up, as aforesaid, its break contacts TSD2 are open to disconnect the output of the autotransformer 319 from the input terminals of the pattern rectifier 359, and its make contacts TSD1 are closed to render the down solenoid control unit DM effective for controlling slowdown of the elevator car, as explained heretofore. In other words, the transducer 311 does not interfere with normal slowdown and stopping of the car at a terminal floor.

Assume, however, that as the elevator car approaches the first floor, the floor selector malfunctions so that the

down pawl relay DPL (FIG. 5) does not operate to effect normal slowdown and stopping of the car. In the absence of the terminal slowdown transducer, it is possible, if the advance carriage **45A** (FIG. 1) remains fully advanced, for the elevator car undesirably to arrive at the first floor while traveling at full speed and to run into the buffer which conventionally is provided to stop the car under such conditions.

Assuming that the floor selector does malfunction so that the advance carriage **45A** remains fully advanced, the switch **12SD** (FIG. 5) will fail to close to complete the holding circuit of the terminal slowdown relay TSD. Consequently, when the car is nineteen feet from the first floor, the cam-operated switch **339** opens to drop out the relay TSD. Opening of make contacts TSD1 (FIG. 4A) disconnects the pattern rectifier **359** from the coil DMC of the down solenoid control unit, while closure of break contacts TSD2 transfers control of the input of the rectifier **359** to the autotransformer **319**. Thus, as the output voltage of the autotransformer gradually decreases to zero during continued travel of the elevator car toward the first floor, the output of the rectifier **359** correspondingly decreases to decrease energization of the pattern motor winding PM1 through make contacts D1 and D2 and break contacts TR2 and TR3, the latter of which remain closed as a result of the assumed floor selector malfunction. It will be understood from the preceding discussion that this effects the gradual slowdown of the elevator car and the stopping of the car substantially at the first floor.

Returning to FIG. 5, it will be observed that make contacts TSD6 in the holding circuit of the terminal slowdown relay prevent pickup therethrough of the relay once it has dropped out, so that the elevator car remains under control of the terminal slowdown transducer until it stops at the first floor. Make contacts **U10** of the up switch U are provided to pick up the relay TSD in the event that the malfunction of the floor selector was such that the synchronous carriage **45S** (FIG. 1) was not moving in synchronism with the elevator car, a fault which may be corrected when the car stops at the first floor to permit subsequent operation of the car in a normal manner. It will be recalled that the up switch U normally picks up to reverse the direction of travel for which the car is conditioned at the first floor from down to up. It also will be noted that pickup of the door closing relay DC (FIG. 5) by operation of the down push button DPB or the up push button UPB is prevented as long as the terminal slowdown relay TSD remains dropped out and its make contacts TSD3 and TSD4, respectively, are open. Thus, until the fault is corrected to reenergize the relay TSD, these push buttons cannot effect closure of the elevator car gate and the hoistway door for the first floor.

By inspection of FIGS. 1, 4 and 5 and from the preceding discussion, it will be understood that the terminal slowdown transducer **311** and the terminal slowdown relay TSD operate in an identical manner if the floor selector should malfunction similarly as the elevator car approaches the ninth or upper terminal floor and the selector switch **12SU** fails to close before opening of the cam-operated switch **337**.

If desired, additional sets of contacts including selector and cam-operated switches may be provided in the energizing circuit of the terminal slowdown relay TSD so that floor selector malfunction after a check point is passed and when the elevator car is closer to a terminal floor also will be detected to transfer control of slowdown of the car to the terminal slowdown transducer **311**. The total number of check points employed may be determined on the basis that floor selector malfunction just after the elevator car has passed one check point will render the contacts associated with the following check point effective to slow down and stop the car adjacent the terminal floor it is approaching and within a zone in which the car gate and associated hoistway door may be opened safely.

FIGURES 7, 8 and 9

FIGS. 7, 8 and 9 illustrate another form of leveling apparatus which is suitable for stopping the elevator car **11** automatically and accurately in registration with each floor and which has an inherently fail-safe feature. This apparatus comprises a hoistway transducer which includes a pair of electromagnetic units EU1A and EU2A respectively mounted on the brackets **22A** and **22B**, which are secured to the elevator car **11**. A separate inductor plate or vane P1A constructed of magnetic material such as steel is located in the hoistway adjacent each of the floors served by the elevator car.

The plate P1A conveniently may be fabricated of two closely spaced separate and similar sections, an upper section P1A1 and a lower section P1A2. Preferably, the length of the plate P1A is substantially less than the distance between successive floors. Since such distance generally will be a minimum of approximately eight feet, the plate P1A preferably is substantially less than eight feet in length. In the present instance, it will be assumed that the plate has an overall length of approximately fifty inches. When the car is stopped accurately at a floor, the units EU1A and EU2A are associated with the plate P1A for such floor in the manner illustrated in FIG. 8. It will be appreciated that the length of the plate and the distance between the units EU1A and EU2A are exaggerated in FIG. 8 for the purpose of clarity.

To facilitate leveling of the elevator car, each of the units EU1A and EU2A has an electrical output, the magnitude of which is dependent upon the displacement of the elevator car from registry with a landing or floor at which the car is to be stopped.

The unit EU1A includes a pair of soft magnetic cores **501P** and **501S**, which are C-shaped and which have pole faces adjacent each other to define a rectangular magnetic path. Similarly, the unit EU2A includes a pair of soft magnetic cores **503P** and **503S**, which also are C-shaped and which have pole faces adjacent each other to define a rectangular magnetic path. It will be noted that the pole faces of the cores of each of the units are spaced to provide air gaps through which the plate P1A may pass.

The core **501P** is provided with primary windings **505P** and **507P**, which are connected to direct magnetic flux in the same direction around the associated magnetic path. The magnetic core **501S** has secondary windings **505S** and **507S**, which have voltages induced therein by fluxes passing through the associated magnetic path. Likewise, the core **503P** is provided with primary windings **509P** and **511P**, which are connected to direct magnetic flux in the same direction around the associated magnetic path, while the magnetic core **503S** has secondary windings **509S** and **511S**, which have voltages induced therein by fluxes passing through the associated magnetic path.

It will be observed that the plate P1A is generally hourglass-shaped, each of the sections P1A1 and P1A2 having a tapered portion and a rectangular portion extending from the wide end of the tapered portion. Preferably, each rectangular portion is slightly wider than the wide end of the associated tapered portion so that there is a notch or step at each side of each plate section at the junction of its tapered and rectangular portions. Since the overall length of the plate P1A is assumed to be approximately fifty inches, each of its sections P1A1 and P1A2 has an overall length of approximately twenty-five inches. It further will be assumed that each of the tapered portions of the plate is approximately ten inches long. Consequently, the vertical distance between corresponding notches of the plate sections P1A1 and P1A2 is approximately twenty inches, and thus the distance between the horizontal center lines of the electromagnetic units EU1A and EU2A also is approximately twenty inches.

It also will be noted that the plate P1A is so mounted

that the pole faces of the magnetic cores of the units EU1A and EU2A pass closely adjacent the plate as the elevator car approaches the associated floor. The magnitude of voltage induced in each of the secondary windings 505S, 507S, 509S and 511S depends upon the position of the plate P1A with respect to the associated magnetic cores. When the units EU1 and EU2 are displaced vertically from the plate P1A, maximum voltage is induced in each of the secondary windings, as a result of the relatively low reluctance path for flux in each of the cores and its associated air gaps. When the plate P1A is located between the magnetic cores, it tends to shield the secondary windings from the magnetic flux produced by the primary windings. The extent of such shielding depends upon the position of the plate with respect to the magnetic cores. Maximum shielding is obtained when the magnetic cores of a unit are adjacent either of the rectangular portions of the plate P1A; the shielding decreases as the magnetic cores approach the narrowest or mid portion of the plate going away from either of the rectangular portions.

Assume that the elevator car is approaching a floor while traveling in the up direction and that the primary windings of the units EU1A and EU2A are energized. When the units EU1A and EU2A both are displaced downwardly from the plate P1A, maximum voltage is induced in each of the respective secondary windings, as aforesaid. When the unit EU1A is located adjacent the lower end of the plate P1A, i.e., when the elevator car is approximately thirty-five inches from a position of registration with the floor, the rectangular portion of the lower plate section P1A2 effects maximum shielding of the secondary windings 505S and 507S from magnetic flux produced by the primary windings 505P and 507P. Such shielding is maintained for a distance of approximately fifteen inches until the car is twenty inches from the floor. Due to the tapered configuration of the upper portion of the plate section P1A2, the shielding between the pole faces of the cores 501P and 501S then decreases gradually as the car proceeds upwardly, and correspondingly increasing voltage is induced in each of the secondary windings 505S and 507S. When the car is about fifteen inches from the floor, the unit EU2A is located adjacent the lower end of the plate P1A, since the horizontal center lines of the units EU1A and EU2A are spaced by approximately twenty inches. As a result, the rectangular portion of the plate section P1A effects maximum shielding of the secondary windings 509S and 511S from magnetic flux produced by the primary windings 509P and 511P.

The voltage induced in each of the secondary windings 505S and 507S reaches a maximum when the pole faces of the cores of the unit EU1A are adjacent the narrowest or mid portion of the plate P1A, since at that point the shielding therebetween is minimum. At this time, the elevator car is approximately ten inches from the floor. Thus, further upward travel results in gradually increasing shielding between the pole faces of the cores 501P and 501S as a result of the tapered configuration of the lower portion of the upper plate section P1A1, and the voltages induced in the secondary windings 505S and 507S consequently continuously decrease. Simultaneously, maximum shielding is maintained between the pole faces of the cores 503P and 503S to maintain minimum induced voltage in each of the secondary windings 509S and 511S. When the elevator car reaches the position illustrated in FIG. 8 adjacent the floor, substantially minimum voltage is induced in each of the secondary windings 505S, 507S, 509S and 511S, since the units EU1A and EU2A respectively are adjacent the upper and lower notches in the plate P1A.

As the elevator car continues to move upwardly, voltages induced in the secondary windings 505S and 507S are maintained at minimum for approximately fifteen inches of car travel, while voltages induced in the secondary windings 509S and 511S gradually increase for about ten inches of car travel due to the tapered configuration of the upper portion of the lower plate section P1A2. When the car is ten inches above the floor, the unit EU2A is adjacent the narrowest or mid portion of the plate P1A. Consequently, further upward travel results in gradually decreasing induced voltages in the secondary windings 509S and 511S due to the effect of the shielding of the tapered lower portion of the upper plate section P1A1, while voltages induced in the secondary windings 505S and 507S of the unit EU1A are maintained at minimum for another five inches of travel, at which time such voltages become and remain at maximum, since the plate no longer is disposed between the pole faces of the cores 501P and 501S.

When the elevator car is approximately twenty inches above the floor, the rectangular portion of the plate section P1A1 provides maximum shielding of the secondary windings of the unit EU2A from magnetic flux produced by the primary windings thereof. Such shielding is maintained to maintain minimum induced voltages in the secondary windings 509S and 511S until the car is approximately thirty-five inches above the floor, at which time the unit EU2A passes the upper end of the plate P1A, and maximum voltages once again are induced in its secondary windings.

The induced voltage-distance relationship for downward travel of the elevator car will be apparent from the foregoing discussion of upward travel thereof. Thus, it will be appreciated that the voltage induced in each of the secondary windings 505S, 507S, 509S and 511S is dependent upon the vertical positions of the units EU1A and EU2A with respect to the plate P1A.

It is desirable to provide a relatively steep output voltage-versus-floor distance relationship of the secondary windings around floor level. This steep characteristic is obtained by means of the notches in the plate P1A at the junctions of its rectangular and tapered portions and insures precise leveling of the elevator car at each floor regardless of car loading.

Referring to FIG. 9, it will be noted that the control circuit illustrated therein is a modified form of the control circuit embodying the electromagnetic units EU1 and EU2 in the upper right-hand portion of FIG. 4A. The modified circuit which compares the voltage induced in the secondary windings of the units EU1A and EU2A, may be substituted for the circuit of FIG. 4A to control in a similar manner, through make contacts TR4 and TR5, energization of the pattern motor winding PM1 during the last stage of the approach of the elevator car to a floor at which it is to stop in order to terminate movement of the car accurately at the floor and to maintain it level with the floor.

The primary windings 505P and 507P of the electromagnetic unit EU1A are connected in series aiding across the output terminals of the voltage regulator 263. Likewise, the primary windings 509P and 511P of the electromagnetic unit EU2A are connected in series aiding across the output terminals of the voltage regulator.

The secondary windings 505S and 507S of the unit EU1A are connected in series aiding across the input terminals of the full-wave rectifier 267. Similarly, the secondary windings 509S and 511S of the unit EU2A are connected in series aiding across the input terminals of the full-wave rectifier 271. The output of the rectifier 267 is applied across the upper half of the resistor 273, whereas the output of the rectifier 271 is applied across the lower half of the resistor 273. As before, the specific portion of the resistor utilized as a load for each of the rectifiers may be adjusted by means of the tap 273A on the resistor, and, if desired, the filter capacitor 367 may be connected across the resistor.

To illustrate the operation of the electromagnetic units EU1A and EU2A, it will be assumed that movement of the magnetic plate P1A through the electromagnetic

unit EU1A results in a total output voltage from the secondary windings 505S and 507S which varies between zero and seven volts. Likewise, it will be assumed that movement of the plate P1A through the electromagnetic unit EU2A results in a total output voltage from the secondary windings 509S and 511S which varies between zero and seven volts.

When the units EU1A and EU2A respectively are located adjacent the upper and lower notches of the plate P1A, as is illustrated in FIGS. 8 and 9, the voltages induced in the secondary windings of the units are practically zero, although such voltages as are induced are equal in magnitude. Thus, the outputs of the rectifiers 267 and 271 as applied to the resistor 273 are equal in magnitude (practically zero) and opposite in polarity. Consequently, the resultant voltage across the resistor 273 is zero.

If the units EU1A and EU2A are displaced upwardly from such positions to a point wherein the unit EU2A is midway between the ends of the plate P1A, the output of the rectifier 271 gradually increases to approximately six volts (taking into account rectifier forward drop) with the polarity illustrated in FIG. 9, whereas the output of the rectifier 267 is maintained at substantially zero volts. This means that the lower terminal of the resistor 273 gradually becomes more positive with respect to the upper terminal thereof to a maximum of approximately six volts, as the electromagnetic unit EU2A moves from a position adjacent the lower notches of the plate P1A to a position adjacent the middle or narrowest portion thereof.

Conversely, displacement of the elevator car in the opposite direction from a position of registry with the floor results in the application of voltage to the terminals of the resistor 273 such that the upper terminal of the resistor is positive with respect to the lower terminal thereof. It will be apparent that the magnitude of this latter voltage varies in a manner similar to that of the voltage when the units EU1A and EU2A are displaced upwardly, as explained above. It follows that when the resistor 273 is connected across the pattern motor winding PM1 (FIG. 4A) through make contacts TR4 and TR5 as indicated in FIG. 9, the excitation of the generator G (FIG. 4) is always in a proper direction to move the elevator car into registry with the floor at which it is to stop. Inasmuch as the electromagnetic units EU1A and EU2A are mounted directly on the elevator car, whereas the plate P1A is mounted directly in the hoistway of the car, accurate leveling of the elevator car is assured.

Let it be assumed that the elevator car is approaching a floor at which it is to stop during an up trip and that the transfer relay TR (FIG. 5) is picked up in the manner heretofore described to open its break contacts TR2 and TR3 and to close its make contacts TR4 and TR5 (FIG. 4A). At this time, the car is a distance of the order of ten inches from a position of registry with the floor, and the unit EU1A (FIGS. 8 and 9) is adjacent the middle or narrowest portion of the plate P1A, whereas the unit EU2A is approximately five inches above the lower end of the plate, which consequently has maximum shielding effect on the unit EU2A. Thus, substantially maximum voltages are induced in the secondary windings 505S and 507S, while minimum or negligible voltages are induced in the secondary windings 509S and 511S. As a result, greater current is provided by the rectifier 267 than by the rectifier 271, and the winding PM1 (FIG. 4A) of the pattern motor is energized with proper polarity to continue the upward motion of the elevator car at a slow speed.

As the elevator car continues its upward motion, current supplied by the rectifier 267 continuously decreases, while current supplied by the rectifier 271 remains at minimum, and thus the difference between the currents supplied by these rectifiers decreases. This gradually reduces energization of the winding PM1 and consequently gradually reduces the speed of the elevator car.

As the car reaches a position of registry with the floor, the electromagnetic unit EU1A is adjacent the upper notches of the plate P1A, and the unit EU2A is adjacent the lower notches thereof. As a result, both of these units have practically zero output, and the voltage applied to the pattern motor winding PM1, therefore, is reduced to zero to reduce the elevator car speed to zero. Thus, the car comes to rest accurately at the floor. Should the elevator car, when its gate and the hoistway door for the particular floor are open, be displaced by more than ¼ inch from a position of registry with the floor for any reason, such as cable contraction or stretch, the outputs of the units EU1A and EU2A will be unbalanced, and the pattern motor winding PM1 will be energized with proper polarity to return the car slowly into accurate registration with the floor, as will be apparent from the preceding discussion.

Assume, however, that when the elevator car is displaced from a position of registry with the floor, half of the symmetrical control circuit of FIG. 9 malfunctions. Suppose, for example, that the car is displaced downwardly from the floor and that the upper electromagnetic unit EU1A has failed because one of its primary or secondary windings has opened. As a result, zero voltage is applied across the input terminals of the full-wave rectifier 267. At this time, the unit EU2A is fully shielded by the rectangular portion of the lower plate section P1A2, and thus voltage of a very low magnitude is applied from its secondary windings across the input terminals of the rectifier 271. Consequently, the control circuit senses a slight unbalance in the outputs of the units EU1A and EU2A, such unbalance being in a direction to produce further downward movement of the car at a very low speed.

It will be noted that failure of the lower electromagnetic unit EU2A rather than of the upper unit EU1A as above will result in upward movement of the car slowly into accurate registration with the floor. Conversely, if the car initially is displaced upwardly from the floor, it will be apparent that failure of one of the units will produce movement of the car in a direction opposite to that indicated in the preceding example for failure of the same unit when the car is displaced downwardly.

The rectangular portions of the magnetic plate P1A are made sufficiently long to insure that the cores of the units EU1A and EU2A remain fully shielded, if the malfunction is such as to produce creepage of the car away from the floor, at least until the car is brought to a stop by operation of other means (not shown) in the control system which are well known in the art. In a typical system, the car would be stopped within a distance of the order of ten or twelve inches from the floor.

Although the invention has been described with reference to certain specific embodiments thereof, numerous modifications falling within the spirit and scope of the invention are possible.

We claim as our invention:

1. A load-transporting system comprising a structure, a load-transporting device movable relative to the structure, a control unit for controlling movement of the load-transporting device, said unit having a generally hourglass-shaped configuration and comprising a pair of adjacent similar tapered control portions, a radiant energy-field-producing transducer means mounted for movement relative to said control unit in the direction of the axis of said hourglass-shaped configuration in accordance with movement of said load-transporting device relative to the structure, said control unit being positioned to pass through the field of said transducer means during relative movement therebetween, said transducer means including means for producing an electric quantity dependent on the relative positions of said transducer means and the control unit, and means responsive to said electric quan-

tity for controlling movement of the load-transporting device.

2. An elevator system comprising a structure, an elevator car movable vertically relative to the structure, a control unit of magnetic plate material for controlling movement of the elevator car, said unit having a generally hourglass-shaped configuration and comprising a pair of adjacent similar tapered control portions symmetrically arranged about a first horizontal centerline of said unit, and a similar control portion extending from the wide end of each of said tapered portions, each of said portions having a width continuously greater than the width of the associated tapered portion at said wide end, each of said tapered portions being symmetrical about a second centerline of said unit perpendicular to said first centerline, a pair of alternating-magnetic-field-producing transducers spaced apart vertically by a distance substantially equal to the distance between said control portions and mounted for movement vertically relative to the control unit, said control unit being positioned to pass through the fields of said transducers during relative vertical movement therebetween, said transducers including means for producing for each of said transducers an alternating quantity having a value dependent on the position of the associated transducer relative to the control unit, rectifying means associated with each of said transducers for producing a direct output dependent on the value of said alternating quantity, means combining the two direct outputs of the transducers for producing a resultant direct output having a value dependent on displacement over a substantial range of the control unit from a predetermined position relative to the transducers and having a polarity dependent on the direction of such displacement, and control means responsive to said direct output for moving the elevator car from a location displaced within a substantial range from said predetermined position to said predetermined position.

3. In a control device for a moving body, a magnetic assembly comprising a magnetic plate unit having a pair of symmetrical, adjacent and in-line control portions, a pair of similarly aligned, spaced magnetic structures each establishing a first magnetic path having an air gap adjacent the plate unit, means mounting the magnetic structures for movement in operative position relative to both of said control portions toward, adjacent and away from the magnetic plate unit in accordance with the movement of said body to provide a first magnetic reluctance for the resultant magnetic path comprising the first magnetic path of one of said magnetic structrues and, when said one structure is adjacent the magnetic plate unit, the magnetic plate unit, and a second magnetic reluctance for the resultant magnetic path comprising the first magnetic path of the other of said structures and, when said other structure is adjacent the magnetic plate unit, the magnetic plate unit, said plate unit and said magnetic structures being configured to vary continuously one of said first and second magnetic reluctances while maintaining the other of said first and second magnetic reluctances substantially constant during movement of said magnetic structures in a first direction relative to said magnetic plate unit between first and second predetermined positions and to vary continuously said other magnetic reluctance while maintaining said one magnetic reluctance substantially constant during movement of said magnetic structures in a second direction opposite to said first direction relative to said magnetic plate unit between said first predetermined position, and a third predetermined position, means effective when energized for directing alternating magnetic flux through each of said magnetic paths, first and second winding means respectively coupled to said resultant first and second magnetic paths for having voltage induced in each of said winding means by the associated magnetic flux, first rectifier means for rectifying the voltage induced in said first winding means to provide a first direct output, second rectifier means for rectifying the voltage induced in said second winding means to provide a second direct output, and polarity responsive control means responsive to the difference between said first and second direct outputs.

4. In a control device for a moving body, a magnetic assembly comprising a magnetic plate unit having a generally diamond-shaped configuration and including a pair of adjacent symmetrical tapered control portions, a pair of magnetic structures each establishing a first magnetic path having an air gap adjacent the plate unit, said magnetic structures being spaced by a distance substantially equal to the distance between two opposite ends of said plate unit, means mounting the magnetic structures for movement relative to both of said control portions toward, adjacent and away from the magnetic plate unit in accordance with the movement of said body to provide a first magnetic reluctance for the resultant magnetic path comprising the first magnetic path of one of said magnetic structures and, when said one structure is adjacent the magnetic plate unit, the magnetic plate unit, and a second magnetic reluctance for the resultant magnetic path comprising the first magnetic path of the other of said structures and, when said other structure is adjacent the magnetic plate unit, the magnetic plate unit, said plate unit and said magnetic structures being configured to vary continuously one of said first and second magnetic reluctances while maintaining the other of said first and second magnetic reluctances substantially constant during movement of said magnetic structures in a first direction relative to said magnetic plate unit between first and second predetermined positions and to vary continuously said other magnetic reluctance while maintaining said one magnetic reluctance substantially constant during movement of said magnetic structures in a second direction opposite to said first direction relative to said magnetic plate unit between said first predetermined position and a third predetermined position, means effective when energized for directing alternating magnetic flux through each of said resultant magnetic paths, first and second winding means respectively coupled to said resultant first and second magnetic paths for having voltage induced in each of said winding means by the associated magnetic flux, a first source of alternating voltage, rectifier means connecting the alternating voltage produced by said first source in series aiding with the voltage induced in said first winding means to provide a first resultant output, a second source of alternating voltage substantially equal in magnitude to the voltage produced by said first source, rectifier means connecting the alternating voltage produced by said second source in series aiding with the voltage induced in said second winding means to provide a second resultant direct output, and polarity responsive control means responsive to the difference between said first and second direct outputs.

5. In a control device for a moving body, a magnetic assembly including a magnetic plate unit having a generally hourglass-shaped configuration and comprising a pair of adjacent tapered control portions symmetrically arranged about and disposed on opposite sides of a first centerline of said unit, and a similar rectangular control portion extending from the wide end of each of said tapered portions, each of said rectangular portions having a width greater than the width of the associated tapered portion at said wide end, each of said tapered and rectangular portions being symmetrical about a second centerline of said unit perpendicular to said first centerline, a pair of magnetic structures each establishing a first magnetic path having an air gap adjacent the plate unit, said magnetic structures being spaced by a distance substantially equal to the distance betwen said wide ends of said tapered portions, means mounting the magnetic structures for movement relative to said plate unit toward, adjacent and away from the magnetic plate unit in accordance with the movement of said body to provide a first magnetic reluctance for the resultant magnetic path comprising the first magnetic path of one of said magnetic struc-

tures and, when said one structure is adjacent the magnetic plate unit, the magnetic plate unit, and a second magnetic reluctance for the resultant magnetic path comprising the first magnetic path of the other of said structures and, when said other structure is adjacent the magnetic plate unit, the magnetic plate unit, said plate unit and said magnetic structures being configured to vary continuously one of said first and second magnetic reluctances while maintaining the other of said first and second magnetic reluctances substantially constant during movement of said magnetic structures in a first direction relative to said magnetic plate unit between first and second predetermined positions and to vary continuously said other magnetic reluctance while maintaining said one magnetic reluctance substantially constant during movement of said magnetic structures in a second direction opposite to said first direction relative to said magnetic plate unit between said first predetermined position and a third predetermined position, means effective when energized for directing alternating magnetic flux through each of said resultant magnetic paths, first and second winding means respectively coupled to said resultant first and second magnetic paths for having voltage induced in each of said winding means by the associated magnetic flux, first rectifier means for rectifying the voltage induced in said first winding means to provide a first direct output, second rectifier means for rectifying the voltage induced in said second winding means to provide a second direct output, and polarity responsive control means responsive to the difference between said first and second direct outputs.

6. In an elevator system, an elevator car, means including a motor having a rotatable rotor for moving the elevator car, and speed control means controlling the speed of the elevator car, said speed control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electromagnetically coupling the control element to the motor for applying a first force acting on the control element in one of said directions, said first force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for applying a second predetermined force to said control element acting in opposition to said first force, means for energizing said motor to produce rotation of the rotor, means responsive to movement of the control element relative to the support means for modifying the energization of said motor, and feedback means responsive to energization of the motor for applying a force acting on the control element which is proportional to such energization.

7. In an elevator system, an elevator car, means including a motor having a rotatable rotor for moving the elevator car, and speed control means controlling the speed of the elevator car, said speed control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electro-magnetically coupling the control element to the motor for applying a first force acting on the control element in one of said directions, said first force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for applying a second predetermined force to said control element acting in opposition to said first force, means for energizing said motor to produce rotation of the rotor, means responsive to movement of the control element relative to the support means for modifying the energization of said motor to change the speed of the elevator car, first feedback means responsive to a rate of change in energization of the motor for applying a first feedback force acting on the control element to modify the energization of the motor in a direction opposing said change in speed of the elevator car, and second feedback means responsive to energization of the motor for applying a second feedback force acting on the control element to modify energization of the motor in a direction increasing the speed of the elevator car.

8. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a source of field excitation for the generator, impedance means adjustable for varying the field excitation of the generator from said source, excitation motor means effective when energized for adjusting the impedance means to vary the field excitation of the generator, positive feedback means responsive to excitation of the field of the generator from said source for energizing said excitation motor means to adjust said impedance means for increasing said generator field excitation, and means electromagnetically coupling the excitation motor means to the armature of the direct-current motor for applying to the excitation motor means a force acting in opposition to the excitation motor means, whereby the impedance means is adjusted in dependence on the difference in the outputs of the excitation motor means and the electromagnetic coupling means.

9. In a motor control system, an electric motor having a stator and a rotor, speed control means for said motor comprising a structure, a control element mounted for movement relative to the structure, means for applying a first force representative of the desired speed of the motor and acting between the structure and the control element in the direction of said movement, means electromagnetically coupling the control element to said rotor for applying to said control element in opposition to said first force a second force representative of the rate of rotation of the rotor, means for applying between the control element and the structure in opposition to the first force a third force which is dependent on the rate of change of energization of the motor, and means for applying between the control element and the structure in aid of the first force a fourth force dependent on the energization of the motor.

10. In a motor control system, a first electric motor having a stator and a rotor, speed control means for said motor comprising a structure, a control element mounted for movement relative to the structure, a second electric motor having a first energizing circuit effective when energized for applying a first force representative of the desired speed of the first motor and acting between the structure and the control element in the direction of said movement, means electromagnetically coupling the control element to said rotor for applying to said control element in opposition to said first force a second force representative of the rate of rotation of the rotor, said last-named means comprising an electroconductive member and a magnetic member for developing a continuous magnetic field within which the electroconductive member is positioned, means coupling a first one of said members to said rotor for rotation about an axis relative to the structure in accordance with the rotation of the rotor, means coupling a second one of said members to the control element for applying said second force to the control element, a second energizing circuit for the second motor effective when energized for applying between the control element and the structure a third force, said third force being the resultant of a fourth force and a fifth force, said second circuit being connected for energization in accordance with the rate of change in energization of the first motor to produce said fourth force in opposition to any change in said first force, said second circuit also being connected for energization in accordance with energization of the first motor to produce

said fifth force in aid of said first force, and energizing means responsive to movement of the control element relative to the structure for energizing the motor to a value establishing a predetermined relationship between the first and second forces.

11. In a control unit for a moving body, a supporting structure, a control element, means mounting the control element for movement relative to the supporting structure, a mechanical input device mounted for movement relative to the structure, means magnetically coupling the input device to the control element for applying a first force between the control element and the structure acting to urge the control element in a direction of movement dependent on the direction of movement of said body, the first force having a magnitude dependent on the rate of movement of said body, motor means effective when energized for applying between the supporting structure and the control element a second force acting in opposition to the first force, said second force having a magnitude dependent on the energization of the motor means, first adjustable electric impedance means having a predetermined response to movement of the control element in a first direction from a median position, second adjustable electric impedance means having said predetermined response to movement of the control element in a second direction from said median position, and positive feedback means responsive to adjustment of each of said first and second impedance means for aiding said second force.

12. In a control unit for a moving body, a supporting structure, a control element, means mounting the control element for movement relative to the supporting structure, a mechanical input device mounted for movement relative to the structure, means magnetically coupling the input device to the control element for applying a first force between the control element and the structure acting to urge the control element in one direction of movement, the force having a magnitude dependent on the rate of movement of the input device, motor means effective when energized for applying between the supporting structure and the control element a second force acting in opposition to the first force, said second force having a magnitude dependent on the energization of the motor means, said motor means comprising a magnetic structure mounted on the supporting structure and having an airgap, said magnetic structure including means for establishing a constant magnetic field in said airgap, winding means mounted in said airgap for movement in accordance with movement of the control element, said winding means being effective when energized for applying said second force between said control element and the supporting structure, first and second adjustable rheostats, means responsive to deflection in a first direction of the control element from a median position for effecting a predetermined adjustment of the first rheostat, means responsive to deflection in a second direction of the control element from said median position for effecting an adjustment of the second rheostat similar to said predetermined adjustment, and positive feedback means responsive to adjustment of each of said first and second rheostats for applying force to the control element in aid of said second force.

13. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path of serving the landings, a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a source of direct electrical energy, impedance means connected for energization from said source and adjustable for varying the energization of said generator field excitation means from such source, excitation motor means effective when energized for adjusting the impedance means to vary the field excitation of the generator, and means electromagnetically coupling the excitation motor means to the armature of the direct-current motor for applying to the excitation motor means a force acting in opposition to the excitation motor means, whereby the impedance means is adjusted in dependence on the difference in the outputs of the excitation motor means and the electromagnetic coupling means.

14. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a source of alternating electrical energy, rectifier means for rectifying the energy from said source to provide a direct output, impedance means connected for energization by said direct output and adjustable for varying the energization of said generator field excitation means by such output, excitation motors means effective when energized for adjusting the impedance means to vary the field excitation of the generator, and means electromagnetically coupling the excitation motor means to the armature of the direct-current motor for applying to the excitation motor means a force acting in opposition to the excitation motor means, whereby the impedance means is adjusted in dependence on the difference in the outputs of the excitation motor means and the electromagnetic coupling means.

15. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, excitation motor means responsive to energization of a first polarity for developing a first motor force acting in a first direction, said excitation motor means being responsive to energization of a second polarity for developing a second motor force acting in a second direction, a source of alternating electrical energy, first and second transformer means connected for energization from said source, first rectifier means for rectifying the alternating output of said first transformer means to provide a first direct output, second rectifier means for rectifying the alternating output of said second transformer means to provide a second direct output, adjustable impedance means connected for energization by said direct outputs and responsive to actuation by said first motor force for energizing the field excitation means of the generator to produce filed excitation of a first polarity, said adjustable impedance means being responsive to actuation by the second motor force for energizing the field excitation means of the generator to produce field excitation of a second polarity, and means electromagnetically coupling the excitation motor means to the armature of the direct-current motor to develop a force dependent on the direction and rate of rotation of the armature of the direct-current motor and acting in opposition to the force produced by the excitation motor means.

16. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is

energized in accordance with the output of the generator, excitation motor means responsive to energization of a first polarity for developing a first motor force acting in a first direction, said excitation motor means being responsive to energization of a second polarity for developing a second motor force acting in a second direction, a source of alternating electrical energy, first and second transformer means connected for energization from said source, first rectifier means for rectifying the alternating output of said first transformer means to provide a first direct output, second rectifier means for rectifying the alternating output of said second transformer means to provide a second direct output, adjustable impedance means connected for energization by said direct outputs and responsive to actuation by said first motor force for energizing the field excitation of a first polarity, said adjustable impedance means being responsive to actuation by the second motor force for energizing the field excitation means of the generator to produce field excitation of a second polarity, means electromagnetically coupling the excitation motor means to the armature of the direct-current motor to develop a force dependent on the direction and rate of rotation of the armature of the direct-current motor and acting in opposition to the force produced by the excitation motor means, means for applying to said excitation motor means a force dependent on the rate of change of energy supplied by the direct-current generator to the direct-current motor and acting on the impedance means to oppose any change in energization of the direct-current motor by the direct-current generator, and means for applying to said excitation motor means a force dependent on the energy supplied by the direct-current generator to the direct-current motor and acting on the impedance means to aid energization of the direct-current motor by the direct current generator.

17. In a control unit for a moving body, a supporting structure, a control element, means mounting the control element for movement relative to the supporting structure, a mechanical input device mounted for movement relative to the structure, means magnetically coupling the input device to the control element for applying a first force between the control element and the structure acting to urge the control element in a direction of movement dependent on the direction of movement of said body, the first force having a magnitude dependent on the rate of movement of said body, and motor means effective when energized for applying between the supporting structure and the control element a second force acting in opposition to the first force, said second force having a magnitude dependent on the energization of the motor means, first adjustable electric impedance means having a predetermined response to movement of the control element in a first direction from a median position, second adjustable electric impedance means having said predetermined response to movement of the control element in a second direction from said median position, a source of alternating electrical energy, first and second transformer means connected for energization from said source, first rectifier means for rectifying the alternating output of said first transformer means to provide a first direct output, second rectifier means for rectifying the alternating output of said second transformer means to provide a second direct output, means connecting said first and second rectifier means and said first and second impedance means in series circuit relationship with said direct outputs in series aiding relationship, and polarity responsive control means connected to said series circuit for energization of a first polarity by said first direct output through one of said first and second impedance means and for energization of the opposite polarity by said second direct output through the other of said first and second impedance means.

18. In a control unit for a moving body, a supporting structure, a control element, means mounting the control element for movement relative to the supporting structure, a mechanical input device mounted for movement relative to the structure, means magnetically coupling the input device to the control element for applying a first force between the control element and the structure acting to urge the control element in one direction of movement, the force having a magnitude dependent on the rate of movement of the input device, motor means effective when energized for applying between the supporting structure and the control element a second force acting in opposition to the first force, said second force having a magnitude dependent on the energization of the motor means, said motor means comprising a magnetic structure mounted on the supporting structure and having an airgap, said magnetic structure including means for establishing a constant magnetic field in said airgap, winding means mounted in said airgap for movement in accordance with movement of the control element, said winding means being effective when energized for applying said second force between said control element and the supporting structure, first and second adjustable rheostats, means responsive to deflection in a first direction of the control element from a median position for effecting a predetermined adjustment of the first rheostat, means responsive to deflection in a second direction of the control element from said median position for effecting an adjustment of the second rheostat similar to said predetermined adjustment, a source of alternating electrical energy, first and second transformer means connected for energization from said source, first rectifier means for rectifying the alternating output of said first transformer means to provide a first direct output, second rectifier means for rectifying the alternating output of said second transformer means to provide a second direct output, polarity responsive control means, means connecting said control means, said first and second rectifier means and said first and second rheostats in a bridge circuit for energization of a first polarity of said control means by said first direct output through one of said first and second rheostats and for energization of the opposite polarity of said control means by said second direct output through the other of said first and second rheostats, and positive feedback means responsive to energization of said control means for applying force to the control element in aid of said second force.

19. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means for moving the elevator car, car control means operable in cooperation with the motive means for moving the elevator car relative to the structure and for stopping the elevator car at each of the lands, said car control means including landing leveling means operable for controlling energization of the motive means to stop the elevator car at a position of registration with each of the landings and for thereafter returning the elevator car to such position of registration in the event of unintended displacement of the car therefrom, a brake for the motive means, and time delay means responsive to arrival of the elevator car at a predetermined position of displacement from a landing at which the car is to stop under control of said leveling means for preventing application of the brake to the motive means until the car is stopped by the leveling means at said position of registration with the last-named landing.

20. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means for moving the elevator car, car control means operable in cooperation with the motive means for moving the elevator car relative to the structure and for stopping the elevator car at each of the landings, said car control means including landing leveling means oper-

able for controlling energization of the motive means to stop the elevator car at a position of registration with each of the landings and for thereafter returning the elevator car to such position of registration in the event of unintended displacement of the car therefrom, a mechanically-applied, electrically-released brake for the motive means, brake release means operable for effecting electrical energization of the brake to release the brake during movement of the elevator car by said car control means between landings, means responsive to arrival of the elevator car at a predetermined position of displacement from a landing at which the car is to stop under control of said leveling means for initiating deenergization of the brake by said brake release means, and timing means responsive to such arrival for delaying such deenergization for a predetermined interval of time following such arrival, said interval being sufficient to prevent application of the brake to the motive means until the elevator car is stopped by the leveling means at said position of registration with the last-named landing.

21. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means for moving the elevator car, car control means operable in cooperation with the motive means for moving the elevator car relative to the structure and for stopping the elevator car at each of the landings, said car control means including landing leveling means operable for controlling energization of the motive means to stop the elevator car at a position of registration with each of the landings and for thereafter returning the elevator car to such position of registration in the event of unintended displacement of the car therefrom, a brake for application to the motive means when the elevator car is stopped at said position of registration with each of the landings, and brake control means for effecting release of the brake from the motive means during movement of the elevator car by said car control means between landings, said brake control means comprising first means operable during the major portion of movement of the elevator car from a first of the landings to a second of the landings at which the elevator car is to stop for effecting said brake release, second means operable as the elevator car approaches said second landing under control of said leveling means for continuing such brake release, means transferring control of such brake release from said first to said second means in response to arrival of the elevator car at a first predetermined position of displacement from said second landing, third means responsive to arrival of the elevator car at a second predetermined position of displacement from said second landing as the car completes its approach to such landing for initiating termination of control of said brake release by said second means, and time delay means operable in cooperation with said second means for effecting application of the brake to the motive means only upon expiration of a predetermined interval of time following arrival of the elevator car at said second predetermined position, said interval being sufficient to prevent such brake application until the elevator car is stopped by the leveling means at said position of registration with said second landing.

22. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means for moving the elevator car, car control means operable in cooperation with the motive means for moving the elevator car relative to the structure and for stopping the elevator car at each of the landings, said car control means including landing leveling means operable for controlling energization of the motive means to stop the elevator car at a position of registration with each of the landings and for thereafter returning the elevator car to such position of registration in the event of unintended displacement of the car therefrom, a brake for application to the motive means when the elevator car is stopped at said position of registration with each of the landings, and brake control means for effecting release of the brake from the motive means during movement of the elevator car by said car control means between landings, said brake control means comprising first means operable during the major portion of movement of the elevator car from a first of the landings to a second of the landings at which the elevator car is to stop for effecting said brake release, second means operable as the elevator car approaches said second landing under control of said leveling means for continuing such brake release, means transferring control of such brake release from said first to said second means in response to arrival of the elevator car at a first predetermined position of displacement from said second landing, third means responsive to arrival of the elevator car at a second predetermined position of displacement from said second landing as the car completes its approach to such landing for initiating termination of control of said brake release by said second means, time delay means operable in cooperation with said second means for effecting application of the brake to the motive means only upon expiration of a predetermined interval of time following arrival of the elevator car at said second predetermined position, said interval being sufficient to prevent such brake application until the elevator car is stopped by the leveling means at said position of registration with said second landing, and means responsive to subsequent unintended displacement of the elevator car from such position of registration with said second landing for effecting release of the brake from the motive means, said second, third and time delay means also being effective to control brake release from and reapplication to said motive means in the aforesaid manner as the elevator car reapproaches said second landing under the control of said leveling means.

23. In an elevator system for a structure having landings, an elevator car, motive means including a motor having a rotatable rotor for moving the elevator car to serve said landings, and speed control means controlling the speed of the elevator car, said speed control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electromagnetically coupling the control element to the motor for applying a first force acting on the control element about in one of said directions, said force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for applying a second predetermined force to said control element acting in opposition to said first force, landing leveling means operable for stopping the elevator car at a position of registration with each of the landings and for thereafter returning the elevator car to such position of registration in the event of unintended displacement of the car therefrom, said landing leveling means including means responsive to arrival of the elevator car at a first predetermined position of displacement from a first landing at which the car is to stop for continuously decreasing the second force during continued movement of the elevator toward such landing for the purpose of decreasing the speed of the elevator car, means for energizing said motor to produce rotation of the rotor, and means responsive to movement of the control element relative to the support means for modifying energization of said motor, a brake for application to the motive means when the elevator car is stopped at said position of registration with said first landing, and time delay means responsive to arrival of the elevator car at a second predetermined position of displacement from said first landing as the car completes its approach to such landing under control of said leveling means for effecting application of the

brake to the motive means only upon expiration of a predetermined interval of time following arrival of the elevator car at said second predetermined position, said interval being sufficient to prevent such brake application until the elevator car is stopped by the leveling means at said position of registration with said first landing.

24. In an elevator system for a structure having landings, an elevator car, motive means including a motor having a rotatable rotor for moving the elevator car to serve said landings, and speed control means controlling the speed of the elevator car, said speed control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electromagnetically coupling the control element to the motor for applying a first force acting on the control element about in one of said directions, said force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for applying a second predetermined force to said control element acting in opposition to said first force, landing leveling means operable for stopping the elevator car at a position of registration with each of the landings and for thereafter returning the elevator car to such position of registration in the event of unintended displacement of the car therefrom, said landing leveling means including means responsive to arrival of the elevator car at a first predetermined position of displacement from a first landing at which the car is to stop for continuously decreasing the second force during continued movement of the elevator toward such landing for the purpose of decreasing the speed of the elevator car, means for energizing said motor to produce rotation of the rotor, and means responsive to movement of the control element relative to the support means for modifying energization of said motor, a brake for application to the motive means when the elevator car is stopped at said position of registration with said first landing, time delay means responsive to arrival of the elevator car at a second predetermined position of displacement from said first landing as the car completes its approach to such landing under control of said leveling means for effecting application of the brake to the motive means only upon expiration of a predetermined interval of time following arrival of the elevator car at said second predetermined position, said interval being sufficient to prevent such brake application until the elevator car is stopped by the leveling means at said position of registration with said first landing, and means responsive to subsequent unintended displacement of the elevator car from such position of registration for effecting release of the brake from the motive means, said time delay means also being effective to control reapplication of the brake to the motive means in the aforesaid manner as the elevator car reapproaches said first landing under control of said leveling means.

25. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means for moving the elevator car, control means operable in cooperation with the motive means for moving the elevator car relative to the structure and for stopping the elevator car at each of the landings, and a brake for the motive means, means mounting the brake for movement between a first position wherein it is fully applied to the motive means and a second position wherein it is fully released from the motive means, said control means including first means operable for effecting movement of the brake from its second to its first position to apply the brake to the motive means when the elevator car stops at each of the landings and for effecting movement of the brake from its first to its second position to release the brake from the motive means when the elevator car is to move between landings, said control means further including second means responsive to movement of the brake in response to operation of said first means for controlling operation of the motive means.

26. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means for moving the elevator car, control means operable in cooperation with the motive means for moving the elevator car relative to the structure and for stopping the elevator car at each of the landings, and a brake for the motive means, said brake including an actuating member mounted for movement between a first position wherein the brake is fully applied to the motive means and a second position wherein the brake is fully released from the motive means, said control means including first means operable for effecting movement of the actuating member from its second to its first position to apply the brake to the motive means when the elevator car stops at each of the landings and for effecting movement of the actuating member from its first to its second position to release the brake from the motive means when the elevator car is to move between landings, said control means further including second means responsive to arrival of the actuating member at a predetermined position in response to operation of said first means for controlling operation of the motive means.

27. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a source of energization for said generator field excitation means, control means for varying the energization of said generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, said control means including first means operable in response to arrival of the elevator car at a landing at which the car is to stop for deenergizing said generator field excitation means to terminate movement of the elevator car, a brake for the motive means, and means mounting the brake for movement between a first position wherein it is fully applied to the motive means and a second position wherein it is fully released from the motive means, said control means further including second means operable for effecting movement of the brake from its second to its first position to apply the brake to the motive means when the elevator car stops at the last-named landing in response to operation of said first means, and means responsive to arrival of the brake at a predetermined position in response to operation of said second means for reducing the residual flux of the generator.

28. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, control means for varying the energization of said generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, said control means including first means operable in response to arrival of the elevator car at a landing at which the car is to stop for deenergizing said generator field excitation means to terminate movement of the elevator car, a brake

for the motive means, and means mounting the brake for movement between a first position wherein it is fully applied to the motive means and a second position wherein it is fully released from the motive means, said control means further including second means operable for effecting movement of the brake from its second to its first position to apply the brake to the motive means when the elevator car stops at the last-named landing in response to operation of said first means, and means responsive to arrival of the brake at a predetermined position in response to operation of said second means for energizing said generator field excitation means from said direct-current source in a direction reverse that of the energization of such field excitation means as the elevator car approached said last-named landing, such reverse energization reducing the residual flux of the generator to minimize circulating current between the generator and motor armatures.

29. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, excitation motor means to vary the energization for adjusting the impedance means to vary the energization of the generator field excitation means, means electromagnetically coupling the excitation motor means to the armature of the direct-current motor for applying to the excitation motor means a force acting in opposition to the excitation motor means, whereby the impedance means is adjusted in dependence on the difference in the outputs of the excitation motor means and the electromagnetic coupling means, first control means operable in response to arrival of the elevator car at a landing at which the car is to stop for deenergizing the excitation motor means to adjust said impedance means for deenergization of the generator field excitation means to terminate movement of the elevator car, a brake for the motive means, means mounting the brake for movement between a first position wherein it is fully applied to the motive means and a second position wherein it is fully released from the motive means, second control means operable for effecting movement of the brake from its second to its first position to apply the brake to the motive means when the elevator car stops at the last-named landing in response to operation of said first control means, and means responsive to arrival of the brake at a predetermined position in response to operation of said second control means for energizing the excitation motor means in accordance with the residual output of the generator and in a direction reverse that of the energization of the excitation motor means as the elevator car approached said last-named landing to adjust said impedance means for energizing the generator field excitation means from said direct-current source in a direction reverse that of the energization of such field excitation means as the elevator car approached said last-named landing, whereby the residual flux of the generator is reduced to reduce circulating current between the generator and motor armatures.

30. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a motor for moving the elevator car, control means operable in cooperation with the motive means for moving the elevator car relative to the structure and for stopping the elevator car at each of the landings, a brake for the motive means, and means mounting the brake for movement between a first position wherein it is fully applied to the motive means and a second position wherein it is fully released from the motive means, said control means including first means operable for effecting movement of the brake from its first to its second position to release the brake from the motive means when the elevator car is to move from a first landing at which it is stopped to a second landing, said control means further including accelerating means operable for effecting acceleration of said motor to initiate movement of the elevator car away from said first landing toward said second landing, and means rendering said accelerating means operable to initiate such movement only when the brake has arrived at a predetermined position in response to a releasing operation of said first means.

31. In an elevator system, an elevator car, a structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means for moving the elevator car, control means operable in cooperation with the motive means for moving the elevator car relative to the structure and for stopping the elevator car at each of the landings, said control means including landing leveling means operable for controlling energization of the motive means to stop the elevator car at a position of registration with each of the landings and for thereafter returning the elevator car to such position of registration in the event of unintended displacement of the car therefrom, and a brake for the motive means, said brake including an actuating member mounted for movement between a first position wherein the brake is fully applied to the motive means and a second position wherein the brake is fully released from the motive means, said control means including first means operable for effecting movement of the actuating member from its second to its first position to apply the brake to the motive means after the elevator car is stopped by said leveling means at said position of registration at each of the landings and for effecting movement of the actuating member from its first to its second position to release the brake from the motive means when the elevator car is to move from a first landing at which it is stopped to a second landing, said control means further including accelerating means operable for effecting acceleration of said motor to initiate movement of the elevator car away from said first landing toward said second landing, and means rendering said accelerating means operable to initiate such movement only when the brake actuating member has arrived at a predetermined position in response to a releasing operation of said first means.

32. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, excitation motor means effective when energized for adjusting the impedance means to vary the energization of the generator field excitation means, means electromagnetically coupling the excitation motor means to the armature of the direct-current motor for applying to the excitation motor means a force acting in opposition to the excitation motor means, whereby the

impedance means is adjusted in dependence on the difference in the outputs of the excitation motor means and the electromagnetic coupling means, first control means operable in response to arrival of the elevator car at a landing at which the car is to stop for deenergizing the excitation motor means to adjust said impedance means for deenergization of the generator field excitation means to terminate movement of the elevator car, a brake for the motive means, means mounting the brake for movement between a first position wherein it is fully applied to the motive means and a second position wherein it is fully released from the motive means, second control means operable for effecting movement of the brake from its second to its first position to apply the brake to the motive means when the elevator car stops at the last-named landing and for effecting movement of the brake from its first to its second position to release the brake from the motive means when the elevator car is to move from a first landing at which it is stopped to a second landing, accelerating means operable for energizing the excitation motor means to adjust said impedance means for energizing the generator field excitation means from said direct-current source to effect acceleration of said motor armature for initiating movement of the elevator car away from said first landing toward said second landing, and means rendering said accelerating means operable for energizing the excitation motor means only when the brake has arrived at a predetermined position in response to a releasing operation of said first control means.

33. In an elevator system for a structure having landings, an elevator car, motive means including a motor having a rotatable rotor for moving the elevator car to serve said landings, and speed-control means controlling the speed of the elevator car, said speed-control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electromagnetically coupling the control element to the motor for applying a first force acting on the control element about in one of said directions, said force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for applying a second predetermined force to said control element acting in opposition to said first force, means for continuously and smoothly increasing the second force from zero to a predetermined magnitude for a substantial distance of travel of the elevator car during movement of the car from a position of rest at a first landing to a second landing at which it is to stop for the purpose of accelerating the car, means for energizing said motor to produce rotation of its rotor, and means responsive to movement of the control element relative to the support means for modifying energization of said motor.

34. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, excitation motor means effective when energized for adjusting the impedance means to vary the energization of the generator field excitation means, means electromagnetically coupling the excitation motor means to the armature of the direct-current motor for applying to the excitation motor means a force acting in opposition to the excitation motor means, whereby the impedance means is adjustable in dependance on the difference in the outputs of the excitation motor means and the electromagnetic coupling means, and means for continuously and smoothly increasing energization of the excitation motor means from zero to a predetermined magnitude for a substantial distance of travel of the elevator car during movement of the car from a position of rest at a first landing to a second landing at which it is to stop to adjust said impedance means for continuously increasing energization of the generator field excitation means from said direct-current source to effect continuous and smooth acceleration of said motor armature.

35. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, a control element, means mounting the control element for movement relative to the building structure, means for electromagnetically coupling the control element to the armature of the direct-current motor to apply a first force between the control element and the building structure dependent upon the direction and rate of rotation of the armature of the direct-current motor, excitation motor means effective when energized for applying between the building structure and the control element a second force acting in opposition to the first force, said second force having a magnitude dependent on the energization of the excitation motor means, said excitation motor means comprising a magnetic structure mounted on the building structure and having an airgap, said magnetic structure including means for establishing a constant magnetic field in said airgap, winding means mounted in said airgap for movement in accordance with movement of the control element, said winding means being effective when energized for applying said second force between said control element and the building structure, means responsive to movement of said control element for adjusting said impedance means to vary the energization of the generator field excitation means from said direct-currnt source, whereby the impedance means is adjusted in dependence on the difference between said first and second forces, and means for continuously and smoothly increasing energization of said winding means from zero to a predetermined magnitude for a substantial distance of travel of the elevator car during movement of the car from a position of rest at a first landing to a second landing at which it is to stop for effecting correspondingly continuous and smooth acceleration of said motor armature.

36. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator

car by said motor, a control elment, means mounting the control element for movement relative to the building structure, means for electromagnetically coupling the control element to the armature of the direct-current motor to apply a first force between the control element and the building structure dependent upon the direction and rate of rotation of the armature of the direct-current motor, excitation motor means effective when energized for applying between the building structure and the control element a second force acting in opposition to the first force, said second force having a magnitude dependent on the energization of the excitation motor means, said excitation motor means comprising a magnetic structure mounted on the building structure and having an airgap, said magnetic structure including means for establishing a constant magnetic field in said airgap, winding means mounted in said airgap for movement in accordance with movement of the control element, said winding means being effective when energized for applying said second force between said control element and the building structure means responsive to movement of said control element for adjusting said impedance means to vary the energization of the generator field excitation means from said direct-current source, whereby the impedance means is adjusted in dependence on the difference between said first and second forces, and means for linearly increasing energization of said winding means from zero to a predetermined magnitude for a substantial distance of travel of the elevator car during movement of the car from a position of rest at a first landing to a second landing at which it is to stop for effecting substantially constant acceleration of said motor armature.

37. In an elevator system for a structure having landings, an elevator car, motive means including a motor having a rotatable rotor for moving the elevator car to serve said landings, and speed-control means controlling the speed of the elevator car, said speed control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electromagnetically coupling the control element to the motor for applying a first force acting on the control element about in one of said directions, said force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for applying a second predetermined force to said control element acting in opposition to said first force, means for continuously and smoothly increasing said second force at a first predetermined rate from zero to a predetermined magnitude for a substantial distance of travel of the elevator car during movement of the car from a position of rest at a first landing to a second landing at which it is to stop for the purpose of accelerating the car at a first rate, means for continuously and smoothly increasing said second force at a second predetermined rate less than said first predetermined rate for a substantial distance of travel of the elevator car as it continues to move toward said second landing for the purpose of further accelerating the car at a second rate less than said first rate, means for energizing said motor to produce rotation of its rotor, and means responsive to movement of the control element relative to the support means for modifying energization of said motor.

38. In an elevator system for a structure having landings, an elevator car, motive means including a motor having a rotatable rotor for moving the elevator car to serve said landings, and speed control means controlling the speed of the elevator car, said speed control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electromagnetically coupling the control element to the motor for applying a first force acting on the control element about in one of said directions, said force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for accelerating the elevator car comprising circuit means having an output dependent upon an input signal applied thereto, means for applying a predetermined continuously variable input signal to said circuit means for a substantial distance of travel of the elevator car during movement of the car from a position of rest at a first landing to a second landing at which it is to stop, the output of said circuit means increasing continuously and smoothly from zero to a predetermined magnitude in response to the application of said input signal thereto, means responsive to energization by said output for applying to said control element in opposition to said first force a second force continuously and smoothly increasing from zero to a predetermined magnitude, means for energizing said motor to produce rotation of the rotor, and means responsive to movement of said control element relative to the support means for modifying energization of said motor, whereby the elevator car is accelerated in dependence on the difference between said first and second forces.

39. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landing, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, a control element, means mounting the control element for movement relative to the building structure, means for electromagnetically coupling the control element to the armature of the direct-current motor to apply a first force between the control element and the building structure dependent upon the direction and rate of rotation of the armature of the direct-current motor, means for accelerating the elevator car comprising a source of alternating electrical energy and a pair of discontinuous control type electric valves connected in antiparallel for regulating the flow of current from said source, each of said valves having a control circuit which when energized controls the initiation of the conduction of current from said source through the respective valve, means for applying to said control circuit firing pulses having a continuously decreasing phase angle with respect to the potential of said energy, and means responsive to the flow of current through said valves for applying between the building structure and the control element in opposition to said first force a second force increasing continuously from zero to a predetermined magnitude, and means responsive to movement of said control element for adjusting said impedance means to vary the energization of the generator field excitation means from said direct-current source, whereby the impedance means is adjusted in dependance on the difference between said first and second forces.

40. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source

of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, a control element, means mounting the control element for movement relative to the building structure, means for electromagnetically coupling the control element to the armature of the direct-current motor to apply a first force between the control element and the building structure dependent upon the direction and rate of rotation of the armature of the direct-current motor, means for accelerating the elevator car comprising a source of alternating electrical energy and a pair of discontinuous control type electric valves connected in anti-parallel for regulating the flow of current from said source, each of said valves having a control circuit which when energized controls the initiation of the conduction of current from said source through the respective valve, means for applying to said control circuit firing pulses having a continuously decreasing phase angle with respect to the potential of said source at a first predetermined rate for a substantial distance of travel of the elevator car during movement of the car from a position of rest at a first landing to a second landing at which it is to stop for the purpose of accelerating the car at a first rate, means for applying to said control circuit firing pulses having a further continuously decreasing phase angle with respect to said potential at a second predetermined rate less than said first predetermined rate for a substantial distance of travel of the elevator car as it continues to move toward said second landing for the purpose of further accelerating the car at a second rate less than said first rate, and means responsive to the flow of current through said valves for applying between the building structure and the control element in opposition to said first force a second force increasing continuously from zero to a predetermined magnitude, and means responsive to movement of said control element for adjusting said impedance means to vary the energization of the generator field excitation means from said direct-current source, whereby the impedance means is adjustable in dependence on the difference between said first and second forces.

41. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, a control element, means mounting the control element for movement relative to the building structure, means for electromagnetically coupling the control element to the armature of the direct-current motor to apply a first force between the control element and the building structure dependent upon the direction and rate of rotation of the armature of the direct-current motor, means for accelerating the elevator car comprising circuit means having an output dependent upon an input signal applied thereto, a source of alternating electrical energy, said circuit means including a pair of controlled rectifiers connected in anti-parallel for regulating the flow of current from said source, each of said controlled rectifiers having a cathode electrode, a gate electrode and an anode electrode, pulse generating means for applying between each of said gate electrodes and its associated cathode electrode firing pulses having a continuously decreasing phase angle with respect to the potential of said energy to decrease continuously the firing angle of the respective rectifier, means for applying said input signal to said pulse generating means, said input signal being dependent on said output for compensating for any departure from linearity of the output of said circuit means, whereby said input signal when applied to said pulse generating means effects an increase in the output of said circuit means at a substantially constant rate, and means responsive to energization by the output of said circuit means for applying between the building structure and the control element in opposition to said first force a second force increasing at a substantially constant rate, and means responsive to movement of said control element for adjusting said impedance means to vary the energization of the generator field excitation means from said direct-current source, whereby the impedance means is adjusted in dependence on the difference between said first and second forces and the elevator car is accelerated at a substantially constant rate.

42. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, a control element, means mounting the control element for movement relative to the building structure, means for electromagnetically coupling the control element to the armature of the direct-current motor to apply a first force between the control element and the building structure dependent upon the direction and rate of rotation of the armature of the direct-current motor, means for accelerating the elevator car comprising a circuit means having an output dependent upon an input signal applied thereto, a source of alternating electrical energy, said circuit means including a pair of controlled rectifiers connected in anti-parallel for regulating the flow of current from said source, each of said controlled rectifiers having a cathode electrode, a gate electrode and an anode electrode, pulse generating means for applying between each of said gate electrodes and its associated cathode electrode firing pulses having a continuously decreasing phase angle with respect to the potential of said energy to decrease continuously the firing angle of the respective rectifier, means for applying said input signal to said pulse generating means, said input signal comprising the difference between a signal adjustable to a predetermined magnitude for controlling the rate of increase of the output of said circuit means and a feedback signal proportional to the rate of increase of the output of said circuit means for compensating for any departure from linearity of said output, whereby said input signal when applied to said pulse generating means effects an increase in the output of said circuit means at a substantially constant rate, and means responsive to energization by the output of said circuit means for applying between the building structure and the control element in opposition to said first force a second force increasing at a substantially constant rate, and means responsive to movement of said control element for adjusting said impedance means to vary the energization of the generator field excitation means from said direct-current source, whereby the impedance means is adjusted in dependence on the difference between said

first and second forces, and the elevator car is accelerated at a substantially constant rate.

43. In an elevator system, an elevator car, a building structure having a plurality of spaced landings to be served by the elevator car, means mounting the elevator car for movement through a predetermined path for serving the landings, motive means including a direct-current motor for moving the elevator car, a direct-current generator, said motor and said generator having field excitation means and having armatures connected in a loop circuit, whereby the motor is energized in accordance with the output of the generator, a direct-current source of energization for said generator field excitation means, impedance means adjustable for varying the energization of the generator field excitation means from said source and thereby the speed of movement of the elevator car by said motor, a control element, means mounting the control element for movement relative to the building structure, means for electromagnetically coupling the control element to the armature of the direct-current motor to apply a first force between the control element and the building structure dependent upon the direction and rate of rotation of the armature of the direct-current motor, means for accelerating the elevator car comprising a circuit means having an output dependent upon an input signal applied thereto, a source of alternating electrical energy, said circuit means including a pair of controlled rectifiers connected in anti-parallel for regulating the flow of current from said source, each of said controlled rectifiers having a cathode electrode, a gate electrode and an anode electrode, pulse generating means for applying between each of said gate electrodes and its associated cathode electrode firing pulses having a continuously decreasing phase angle with respect to the potential of said energy to decrease continuously the firing angle of the respective rectifier, means for applying said input signal to said pulse generating means, said input signal comprising the difference between a signal adjustable to a predetermined magnitude for controlling the rate of increase of the output of said circuit means and a feedback signal proportional to the rate of increase of the output of said circuit means for compensating for any departure from linearity of said output, means for increasing the magnitude of said feedback signal at a predetermined point during the increase of said output for decreasing the rate of increase of said output, whereby said input signal when applied to said pulse generating means effects an increase in the output of said circuit means at substantially constant first rate to said predetermined point and thereafter at a substantially constant second rate less than said first rate, and means for applying between the building structure and the control element in opposition to said first force a second force increasing at a substantially constant first rate and thereafter at a substantially constant second rate less then said first rate in response to said first and second rates of increase of the output of said circuit means, means responsive to movement of said control element for adjusting said impedance means to vary the energization of the generator field excitation means from said direct-current source, whereby the impedance means is adjusted in dependence on the difference between said first and second forces, and the elevator car is accelerated at a substantially constant first rate and thereafter at a substantially constant second rate less than said first rate.

44. In an elevator system for a structure having landings, an elevator car, motive means including a motor having a rotatable rotor for moving the elevator car to serve said landings, and speed control means controlling the speed of the elevator car, said speed control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electromagnetically coupling the control element to the motor for applying a first force acting on the control element about in one of said directions, said force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for accelerating the elevator car comprising circuit means having an output dependent upon an input signal applied thereto, a brake for the motive means, means mounting the brake for movement between a first position wherein it is fully applied to the motive means and a second position wherein it is fully released from the motive means, release means operable for effecting movement of the brake from its first to its second position to release the brake from the motive means when the elevator car is to move from a first landing at which it is stopped to a second landing, means responsive to arrival of the brake at a predetermined position in response to a releasing operation of said release means for applying a predetermined continuously variable input signal to said circuit means for a substantial distance of travel of the elevator car during movement of the car from said first landing to said second landing, the output of said circuit means increasing continuously and smoothly from zero to a predetermined magnitude in response to the application of said input signal thereto, means responsive to energization by said output for applying to said control element in opposition to said first force a second force continuously and smoothly increasing from zero to a predetermined magnitude, means for energizing said motor to produce rotation of the rotor, and means responsive to movement of said control element relative to the support means for modifying energization of said motor, whereby the elevator car is accelerated in dependence on the difference between said first and second forces.

45. In an elevator system for a structure having a plurality of landings including a lower and an upper terminal landing, an elevator car, motive means including a motor having a rotatable rotor for moving the elevator car to serve said landings, and speed control means controlling the speed of the elevator car, said speed control means comprising a control element, support means, means mounting the control element on the support means for movement in a first direction relative to the support means and in a second direction opposite to said first direction, electromagnetic coupling means for electromagnetically coupling the control element to the motor for applying a first force acting on the control element about in one of said directions, said force having a magnitude dependent on the rate of rotation of the rotor of said motor, means for applying a second predetermined force to said control element acting in opposition to said first force, first means responsive to arrival of the elevator car at a first predetermined distance from each of said landings when it is desired to stop the car at such landing for continuously decreasing the second force during substantial continued movement of the car toward such landing for the purpose of decreasing the speed of the car, second means responsive to a predetermined malfunction of said first means and to arrival of the elevator car at a second predetermined distance closer than said first predetermined distance from only each of said terminal landings for continuously decreasing the second force to zero for the purpose of decreasing the speed of the elevator car during continued movement of the car toward the last-named landing and for stopping the car adjacent such landing, means for energizing said motor to produce rotation of its rotor, and means responsive to movement of the control element relative to the support means for modifying the energization of said motor.

46. In an elevator system, an elevator car, a structure having a plurality of spaced landings including a lower and an upper terminal landing to be served by the elevator car, means including a motor for moving the elevator car relative to the structure through a predetermined path, and control means for controlling the speed and the position of the elevator car, said control means comprising a floor selector having a support, a synchronous member

coupled to the elevator car for movement relative to the support in synchronism with movement of the elevator car relative to the structure but at a rate substantially less than the rate of movement of the elevator car, and an advance member mounted for movement with the synchronous member relative to the support, said members having a coupling permitting relative movement therebetween, means effective when the elevator car is set for movement in a first direction toward each of said landings and when it is desired to stop the car at such landing for moving the advance member relative to the synchronous member through a limited distance of travel and thereafter for moving the advance member in unison with the synchronous member as the elevator car approaches such landing, means responsive to substantial continued movement of the elevator car past a first predetermined point toward such landing for continuously moving the synchronous member relative to the advance member, means responsive to further movement of the elevator car toward such landing past a preselected position for resetting the advance member relative to the synchronous member, first means responsive to at least a

predetermined portion of the last-named relative movement of the synchronous and advance members for continuously decreasing the speed of the motor to decrease the speed of the elevator car during a first predetermined distance of travel of the car toward such landing, and second means responsive to failure of the floor selector to effect such decrease in speed and to continued movement of the elevator car in said first direction past a second predetermined point closer than said first predetermined point to only the terminal landing displaced from the elevator car in said first direction for continuously decreasing the speed of the motor to zero to stop the car adjacent the last-named terminal landing.

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