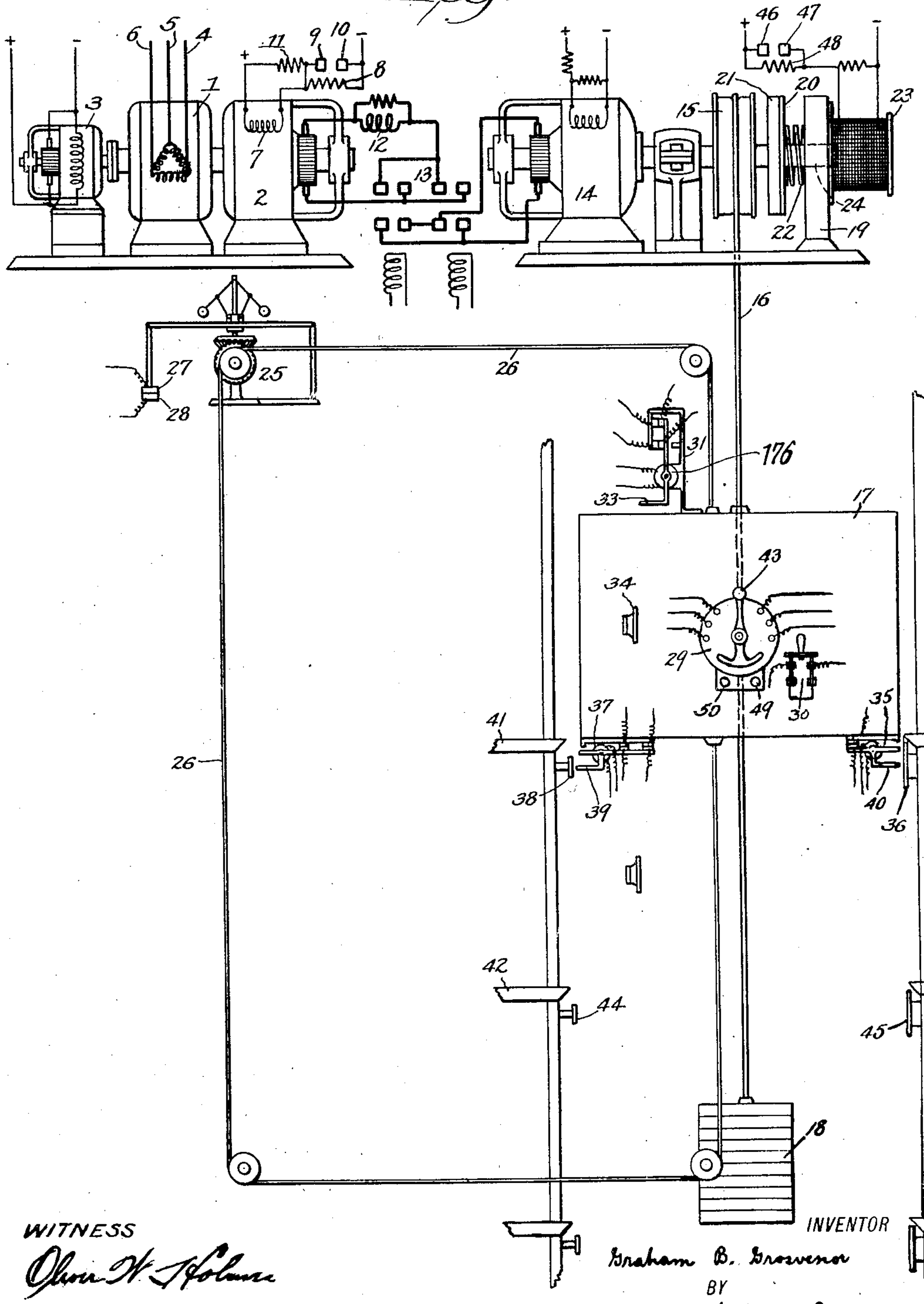
April 7, 1936. G. B. GROSVENOR 2,036,629

ELECTRIC ELEVATOR SYSTEM

Filed March 1, 1923 6 Sheets-Sheet 1

Fig. 1.



WITNESS

Oliver W. Holmes

INVENTOR

Graham B. Grosvenor

BY

Knight Bros

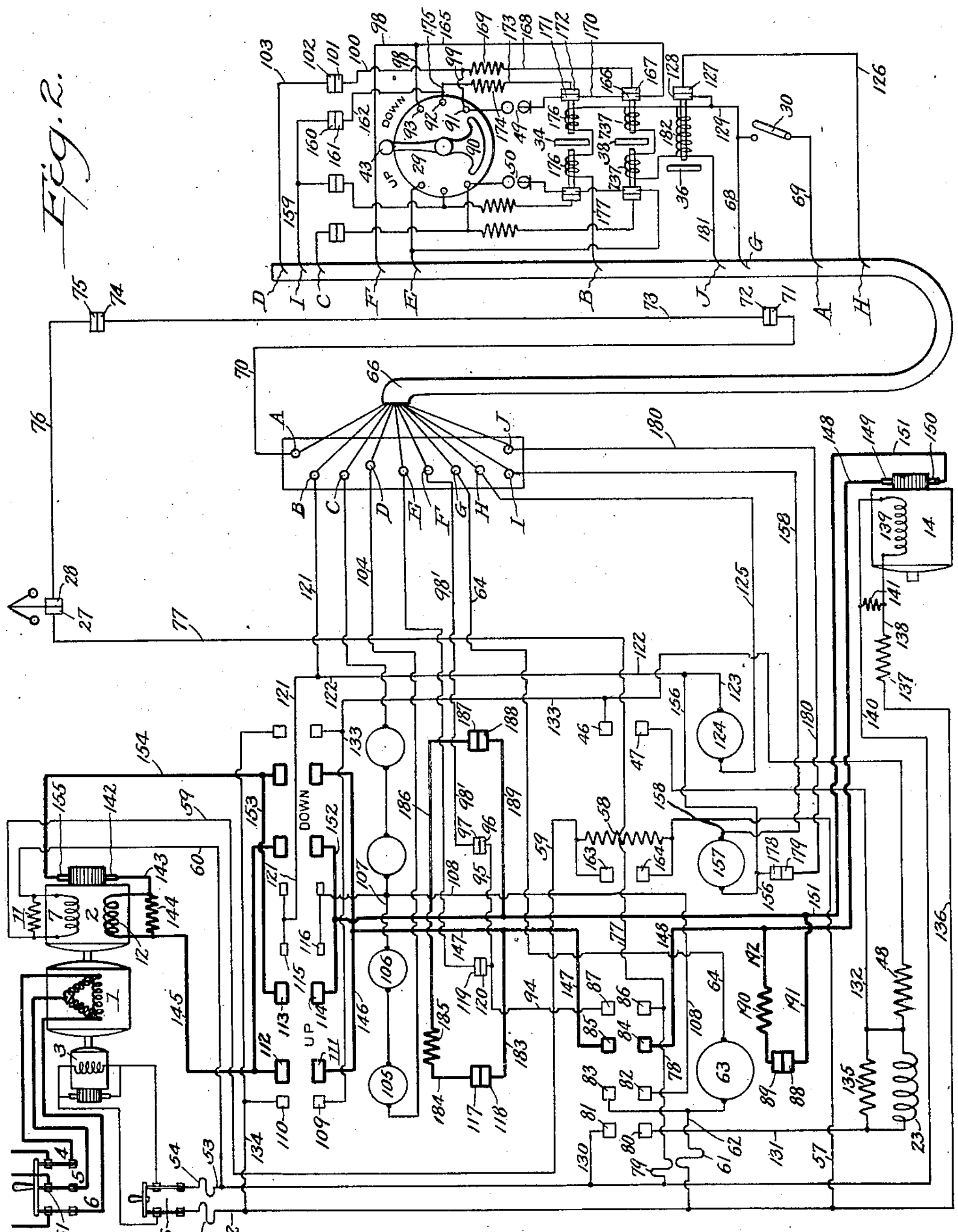
ATTORNEY

April 7, 1936. G. B. GROSVENOR 2,036,629

ELECTRIC ELEVATOR SYSTEM

Filed March 1, 1923 6 Sheets-Sheet 2

Fig. 2.



WITNESS

Oliver W. Holmes

INVENTOR

Graham B. Grosvenor

BY

Knight Bros

ATTORNEYS

April 7, 1936. G. B. GROSVENOR 2,036,629

ELECTRIC ELEVATOR SYSTEM

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Fig. 3.

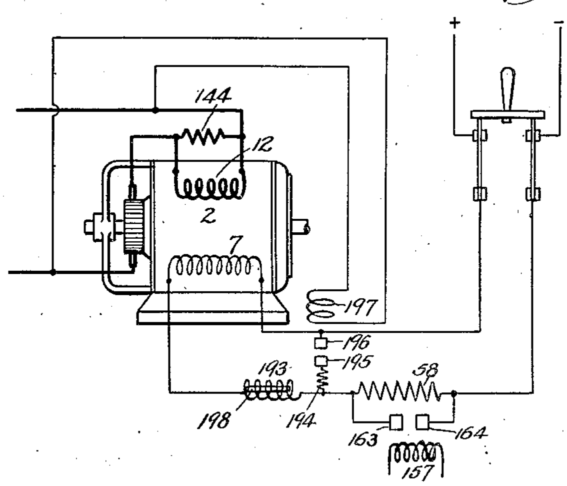
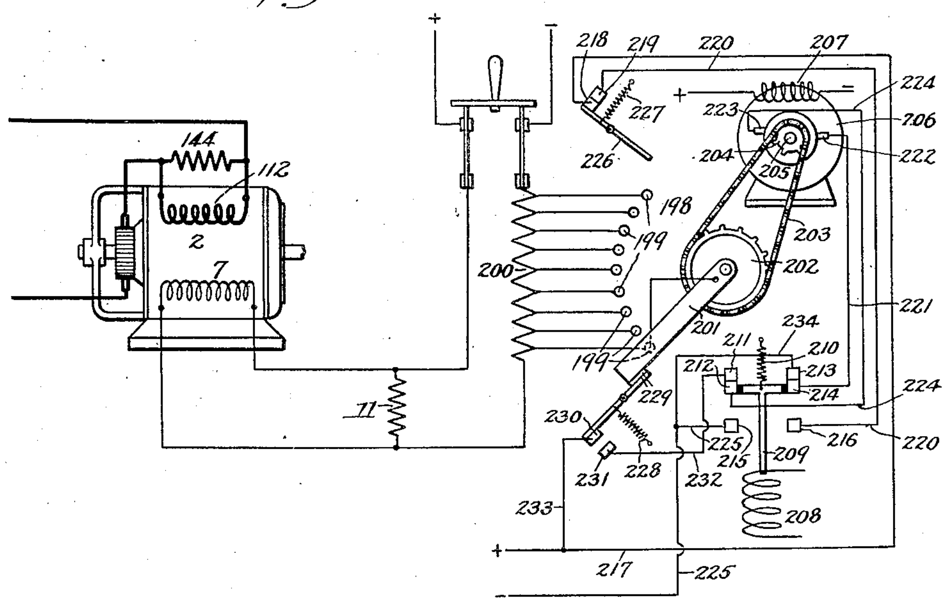


Fig. 4.



WITNESS

Oliver W. Holmes

INVENTOR

Graham B. Grosvenor

BY

Knight Bros

ATTORNEYS

April 7, 1936. G. B. GROSVENOR 2,036,629

ELECTRIC ELEVATOR SYSTEM

Filed March 1, 1923 6 Sheets-Sheet 4

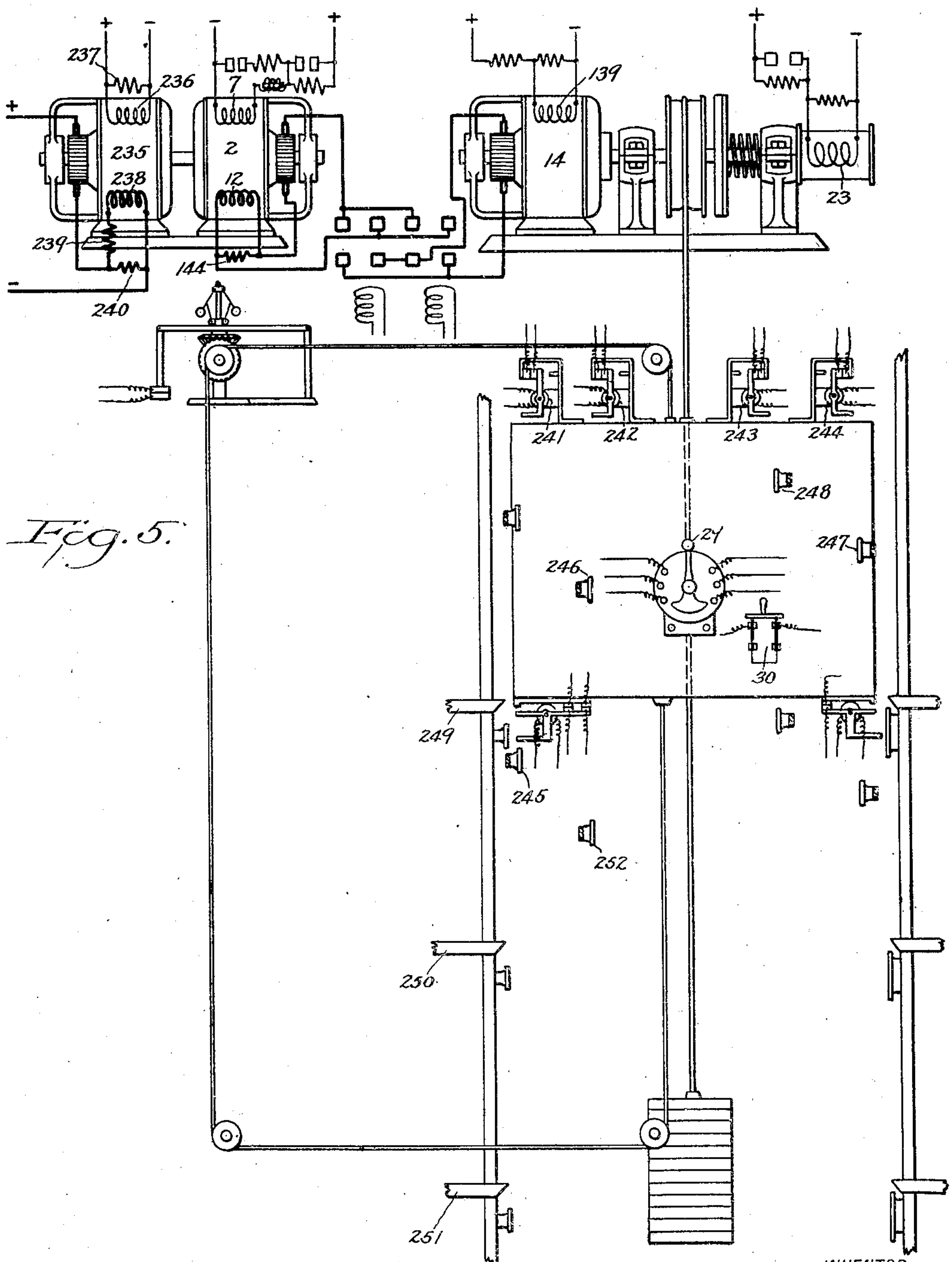


Fig. 5.

WITNESS
Oliver W. Holmes

INVENTOR
Graham B. Grosvenor
BY
Knight Bros
ATTORNEYS

April 7, 1936.

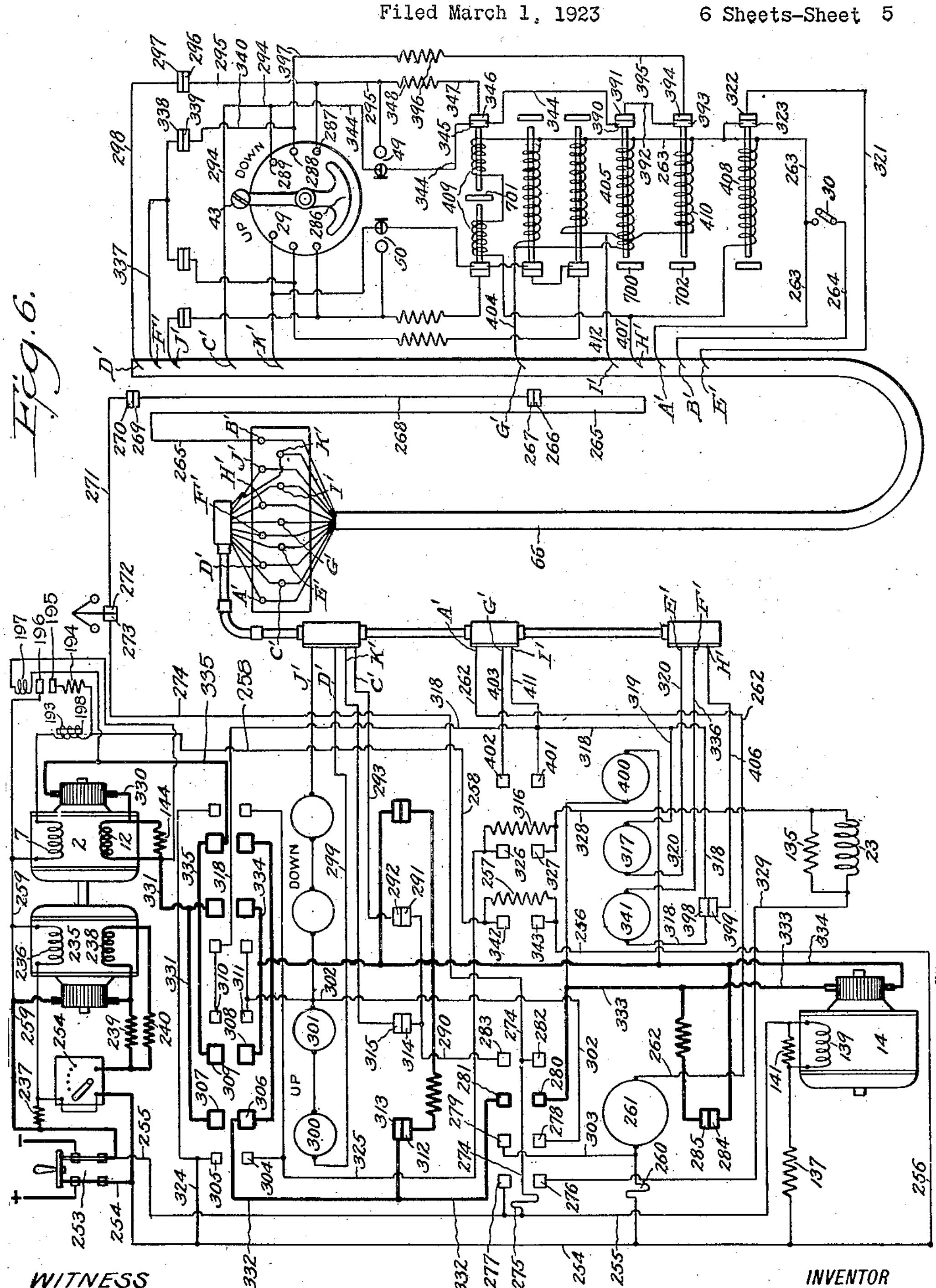
G. B. GROSVENOR

2,036,629

ELECTRIC ELEVATOR SYSTEM

Filed March 1, 1923

6 Sheets-Sheet 5



WITNESS

Oliver W. Holmes

INVENTOR

Graham B. Grosvenor

BY Knight Bros

ATTORNEYS

ELECTRIC ELEVATOR SYSTEM

Filed March 1, 1923 6 Sheets-Sheet 6

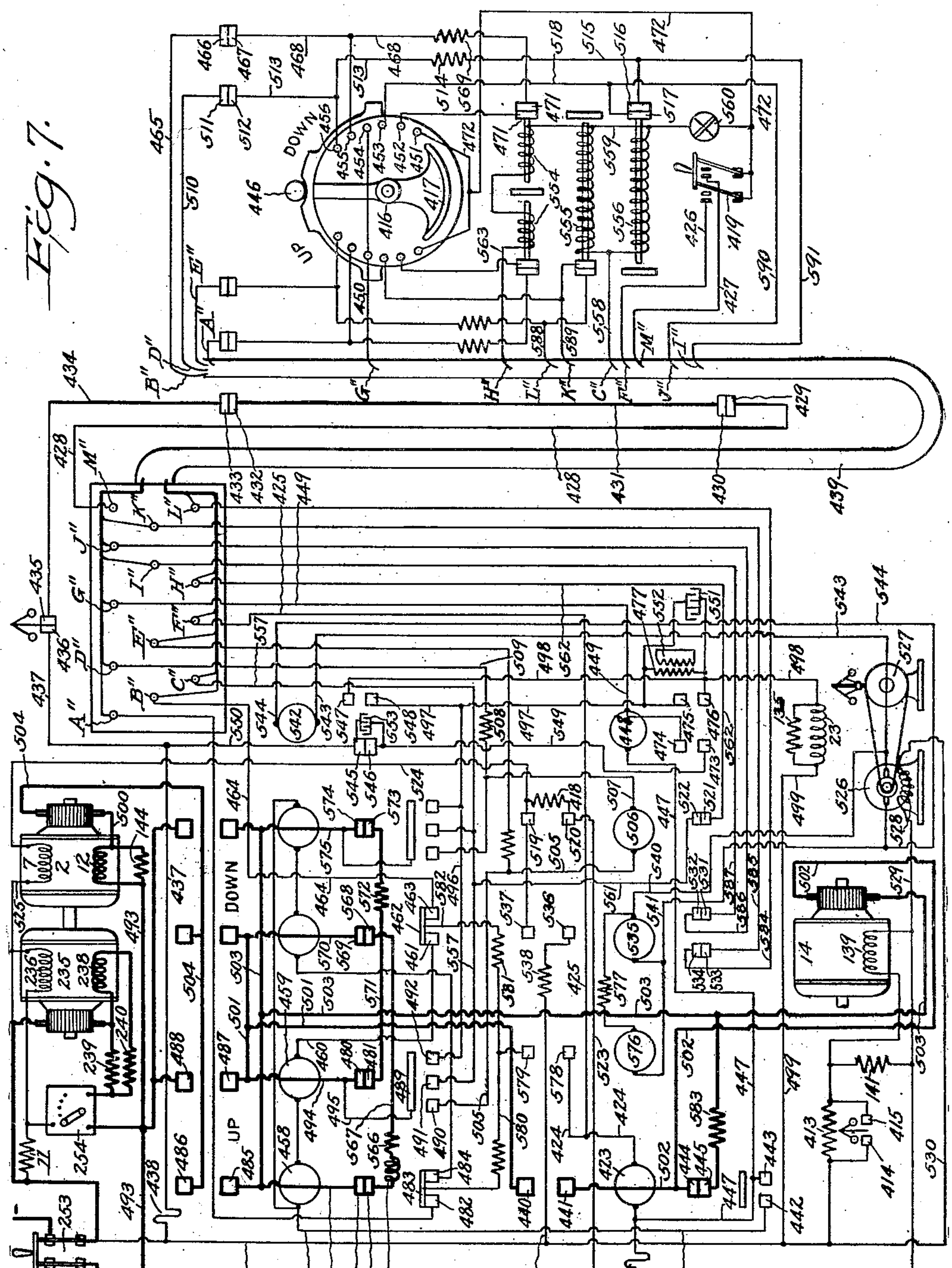


Fig. 7.

WITNESS
Oliver W. Holmes

INVENTOR
Graham B. Grosvenor
By his Attorneys
Knight Bros

Patented Apr. 7, 1936

2,036,629

UNITED STATES PATENT OFFICE

2,036,629

ELECTRIC ELEVATOR SYSTEM

Graham B. Grosvenor, Chicago, Ill., assignor to Otis Elevator Company, Jersey City, N. J., a corporation of New Jersey

Application March 1, 1923, Serial No. 622,149

41 Claims. (Cl. 172—152)

My invention relates to electric elevator systems and more particularly to systems in which the elevator is brought to rest at the landings by automatic means.

An elevator is primarily a device for raising or lowering objects from one level to another and in order to get the maximum service from a given equipment, it is necessary to have the elevators operate at the highest possible average speed consistent with safety and comfort. This is an important consideration in buildings where floor space is valuable and traffic dense. In my Patent No. 1,632,225 I have described an elevator system in which the elevator is automatically slowed down and stopped at landings as desired by the operator, who initiates the slow-down and stop at some time prior to reaching the landing.

The operation of an elevator from one landing to another comprises acceleration and retardation, and in runs of distances great enough for maximum speed to be attained, full speed running. In an ideal system, the time speed curves of acceleration and retardation must be of a definite form to come from rest to full speed and from full speed to rest in a minimum time. The retardation must be completed at or just prior to reaching the landing.

The object of my invention is to provide an elevator system that will fulfill these conditions. In accomplishing this, I so design the system that the acceleration occurs automatically after the manual control has been set. In runs involving an interval of full speed, this full speed automatically continues at the completion of acceleration, until the point is reached at which retardation is to be initiated.

The retarding of the car, for stopping at the floor for which the operator has set the switch, is automatically commenced at a fixed distance from the floor, depending upon the speed, and thereafter the retardation is automatically effected, according to the load, so that the kinetic energy of the load is always brought to a predetermined value depending on the load at or just prior to reaching a point at a fixed distance from the landing. From this fixed point it then remains to bring the car to rest at the landing. In bringing the car to rest two operations are necessary. The power must be disconnected and a braking force must be applied. I automatically disconnect the power at the fixed distance from the landing. The application of the braking force is made just prior to disconnecting the power but preferably only strong enough to restrain the effect of gravity upon disconnecting the power. When the power is disconnected the braking force is increased and the car brought to rest level with the landing without the necessity for correction by supplementary manual or automatic low speed operation.

In the accomplishment of these objects, I utilize many of the features of my Patent No. 1,632,225 and I have found that the elevator system described in my Patent No. 1,566,399 is peculiarly adaptable to bring about the desired results.

To give a clear understanding of the novel points of my invention, it will be described in connection with the accompanying drawings, in which

Figure 1 is a schematic view of an embodiment of my invention in which the elevator is always moved from one landing to another and reaches maximum speed in runs from one floor to an adjacent floor, the starting of the elevator being under control of the operator whereas the stopping is performed automatically after being initiated by the operator.

Figure 2 is a wiring diagram illustrating the circuits of the apparatus of Figure 1.

Figure 3 illustrates an arrangement for getting the desired acceleration and retardation of the elevator by controlling the time constant of the field of the generator supplying current to the elevator motor.

Figure 4 illustrates another arrangement for getting the desired acceleration and retardation by the use of a motor operated field rheostat for the generator supplying current to the elevator motor.

Figure 5 is a schematic view showing the general arragement of an embodiment in which the elevator is always moved from one landing to another, but in which the height between floors is such that maximum speed is not reached in runs from one floor to an adjacent floor. The starting of the elevator is under control of the operator while the stopping is automatically done after being initiated by the operator.

Figure 6 is a wiring diagram of the circuits used in connection with Figure 5.

Figure 7 is a wiring diagram of a modification of the arrangement of Figure 5 in which the elevator may be stopped by the operator independently of the automatic stopping means.

Referring more particularly to the drawings, an alternating current motor 1 is shown as driving a direct current generator 2 and an exciter 3. Power is supplied to motor 1 by mains 4, 5 and 6. It will be understood that the usual switches and starting devices may be used with motor 1. Generator 2 has a separately excited field 7 which is supplied with current from exciter 3, which is a shunt wound generator. In circuit with field 7 is a resistance 8 which may be short-circuited by contacts 9 and 10. A resistance 11 is connected across the terminals of field 7. A series field 12 for generator 2 is used between its armature and reversing switch 13. Elevator hoisting motor 14 is supplied with power by generator 2 through reversing switch 13 and is a separately excited motor. Sheave 15 is driven by motor 14 and a suitable number of cables 16 pass over it, one end of the cables being attached to the elevator 17 and the other to counterweight 18. A brake 19, having a slidably mounted core 24 and a plate 20 held against disc 21 by spring 22, serves to hold the elevator at rest. Disc 21 is secured to the shaft of sheave 15 and rotates with it. To release the brake, coil 23 is energized by current from exciter 3 so that core 24 is attracted and spring 22 thereby compressed.

A governor 25, suitably located, is driven by cable 26 from the elevator and is equipped with contacts 27 and 28, the object of which is to stop the elevator in case of overspeed, as will be more fully described later. A car switch 29 is mounted in the elevator 17 and by it the operator controls the movements of the elevator. An emergency switch 30 is also mounted in the elevator 17.

Elevator 17 is equipped with a solenoid operated switch 31 which, when rendered operative by the operator, acts through the control circuits to slow down the elevator. Switch 31 has a coil 176 and a magnetic core with an extension 33. Assuming coil 176 energized and the elevator going down, extension 33 will be attracted by the armature 34, which is mounted stationary in the hatchway, as soon as it comes opposite it. Contacts on switch 31 will open and the elevator will slow down.

When elevator 17 approaches the landing, the extension 40 of the core of the solenoid operated switch 35, which is similar to switch 31, is attracted by the armature 36, thereby causing contacts on switch 35 to open, which provides a partial application of the brake preparatory to stopping.

The solenoid operated switch 37, when elevator 17 arrives at a floor landing, has its extension 39 opposite the stationary armature 38. The magnetic attraction causes extension 39 to move, which motion opens contacts on switch 37, thereby disconnecting elevator motor 14 from its power supply and fully applying the brake so that elevator 17 stops level with the floor landing.

To obtain the most efficient transportation for floor to floor travel, the elevator should have the maximum acceleration and retardation allowable and should attain the maximum speed midway between two adjacent floor landings. This arrangement is advantageous in elevator transportation for buildings having high floor heights and especially so where it is desirable that elevators stop at all landings.

Consider elevator 17 to be caused to travel from landing 41 to landing 42. The operator, by moving handle 43 of car switch 29 in the proper direction, engages a series of contacts in the car switch 29 which complete circuits to directional and fast speed switches on the control panel, as will be described in detail in connection with Figure 2. The elevator immediately accelerates; the operator may now permit the car switch handle 43 to return to center. The fast speed and directional switches become self-holding upon being energized but are subject to being released automatically by the solenoid operated switches 31 and 37 when these switches attain a definite relation to the armatures 34 and 44.

When elevator 17 is midway between landings 41 and 42, the elevator will be at full speed and switch 31 will be in the proximity of armature 34 which causes its contacts to open. This will release the fast speed switch, thus causing the elevator to slow down at a definite rate. The length of armature 34 in the direction of elevator travel need be only sufficient to insure the operation of switch 31 and I have found four inches to be a suitable length. When elevator 17 is at the proper distance from landing 42 for the preliminary application of the brake, which takes place approximately at the time the elevator reaches its low speed, the solenoid operated switch 35 is caused to open its contacts, by co-action with armature 45. This causes a relay to open contacts 46 and 47, thereby inserting a suitable resistance 48 in series with the brake magnet coil 23. The brake is then applied partially by the spring 22, the pressure of which will then be greater than the holding power of the brake magnet coil 23 by a predetermined amount. The length of armature 45 is chosen so that when elevator 17 is level with landing 42, extension 40 will be opposite its center.

The elevator will continue to approach the landing at low speed with the brake partially applied until the extension 39 of solenoid operated switch 37 is magnetically attracted by armature 44 when switch 37 will open its contacts, thereby releasing the directional switches and interrupting the power to the elevator motor and at the same time fully applying the brake to bring the car to a stop level with the landing. Armature 44 is of the proper length to permit of the elevator being stopped by dynamic braking and by the electro-mechanical brake from low speed after disconnecting the elevator motor from its power supply. I have found that an armature extending one inch above and below the position of the arm 39, when the elevator is level with the landing, gives good results.

In order that accurate stops may be made with variations of load in the elevator, it is important that the effect of gravity due to such variations be compensated for by corresponding variations in the kinetic energy of the moving parts. This may be done by fixing the speed of the elevator, at the low speed from which stopping is done, in some direct proportion to the unbalanced load being lifted by the elevator motor. Means for accomplishing this are described in my Patent No. 1,632,225.

It is to be noted that armature 34 serves to determine the point at which slow down will commence when the elevator approaches landing 42 from above. Armature 34 also determines the points of slow-down as the elevator approaches landing 41 from below.

Push-buttons 49 and 50 are provided on the car switch 29 for the purpose of operating the elevator in emergencies and emergency switch 30 is supplied to bring the car to rest immediately if desired.

With electrical equipment where circuits may be energized intermittently, the resistance of these circuits will be subject to definite variation determined by the temperature change of the conductors through which the current flows. It is, therefore, desirable that certain elements, particularly the field windings of the motor generator set, exciter and elevator motor, should be wound with conductors which will have a negligible temperature coefficient in order that the resistances of these circuits will remain constant. In this way, speed characteristics of the equipment will be kept within definite bounds, which is an important consideration in the automatic slowing down and stopping of elevators.

Figure 2 is the wiring diagram for the system of Figure 1, the operation of which is referred to in detail.

An A. C. motor 1 of a motor generator set driving an exciter 3, all of which are mechanically coupled, is connected to an A. C. source of supply through main line switch 51 and feeders 4, 5 and 6. Motor 1 should have as nearly constant speed as possible under different loads.

The exciter 3 is shunt wound and self-excited, and supplies a substantially constant voltage through main switch 56, fuses 54 and 55 to feeders 52 and 53.

The generator 2 is of constant polarity and the strength of the shunt field 7, when the elevator is at rest, is governed by the resistance of its circuit which is from feeder 52 through line 57, resistance 58, line 59 to shunt winding 7 of generator 2, line 60 to feeder 53.

Upon closing of the emergency switch 30 on the elevator, a circuit is obtained from feeder 52 through fuse 61, line 62, potential switch coil 63, line 64, terminals G—G of traveling cable 66, line 68, emergency switch 30, line 69, terminals A—A of traveling cable 66, line 70 to lower hatchway, limit switch contacts 71 and 72, line 73 through hatchway, limit switch contacts 74 and 75, line 76, governor switch contacts 28 and 27, lines 77 and 78, fuse 79 to feeder 53.

The potential switch, which is of the normally magnetically operated gravity returning type, is then energized and closes contacts 80 and 81, 82 and 83, 84 and 85, 86 and 87, at the same time opening contacts 88 and 89.

Assume the elevator to be run in the up direction. In this case, car switch handle 43 is moved to the left until car switch contactor 90 touches car switch contact points 91, 92 and 93. The operation of this elevator being full automatic, the wiring is so arranged that no action is obtained until car switch handle 43 is moved to the extreme running position at which time current may be distributed from the last contact finger engaged, which finger is termed the car switch feed.

A circuit is then obtained from feeder 53 through fuse 79, line 78, contacts 86 and 87, lines 94 and 95, bottom contacts 96 and 97 of the down direction switch, line 98′, terminals F—F of traveling cable 66, line 98, car switch finger 93, car switch contactor 90, car switch finger 91, lines 99 and 100, terminal automatic switch contacts 101 and 102, line 103, terminals D—D of traveling cable 66, line 104, the up direction switch magnet coils 105 and 106, lines 107 and 108, contacts 82 and 83, line 62, fuse 61 to feeder 52. The up direction switches then close their respective contacts. These switches are of similar design to the potential switch. For the direction switches, two switches are utilized for each direction of travel, the magnet coils of each pair being connected in series, which results in both coils being energized at the same time.

The contacts controlled by the up direction switches are then closed or opened as follows:—Contacts 109 and 110, 111 and 112, 113 and 114, 115 and 116 are closed in the respective pairs as shown. Contacts 117 and 118 and 119 and 120 are opened in respective pairs.

With the up direction switches closed, the circuits that function to start the elevator in motion are as follows:—Feeder 52, through fuse 61, line 62, contacts 83 and 82, line 108, contacts 116 and 115, lines 121, 122, 123, magnet coil 124 of the auxiliary brake switch, line 125, terminals H—H of traveling cable 66, line 126, contacts 127 and 128, line 129, emergency switch 30, line 69, terminals A—A of traveling cable 66, line 70, contacts 71 and 72, line 73, contacts 74 and 75, line 76, contacts 28 and 27, lines 77 and 78, fuse 79 to feeder 53.

Magnet coil 124 when energized, causes the auxiliary brake switch to close contacts 46 and 47, which contacts short-circuit resistance 48, which is in series with brake magnet coil 23. The brake magnet coil 23 is then sufficiently energized to release the brake to permit the elevator motor to start. The circuit for the brake magnet is as follows:—From feeder 53, through line 130, contacts 81 and 80, line 131, brake magnet coil 23, line 132, contacts 47 and 46, line 133, contacts 109 and 110, line 134 to feeder 52.

The generator 2, having a definite field at all times the elevator is in service, is enabled to deliver current to the elevator armature at a predetermined low voltage immediately upon the closing of the directional switches.

The field of the elevator motor 14 has a constant value and is connected to the feeder as follows:—Feeder 52, through line 136, adjusting resistance 137, line 138, shunt field coil 139, line 140 to feeder 53.

The elevator motor 14, having a constant field, will be enabled to start upon the armature of elevator motor 14 receiving current from the armature of generator 2.

The armature of elevator motor 14 receives power from generator armature as follows:—From armature terminal 142 of generator 2 through line 143, series field 12, which is subject to variable strength as determined by adjustment of resistance 144 connected in parallel with series field 12, line 145, contacts 112 and 111, line 146, line 147, contacts 85 and 84, line 148, elevator motor armature terminal 149, through armature winding out through armature terminal 150, lines 151 and 152, contacts 114 and 113, lines 153 and 154, armature terminal 155 and through armature winding of generator 2.

The elevator motor has now started but as the car switch 29 must be moved to the extreme position in order to start the elevator motor in motion, the necessary circuits to obtain fast speed have also been made, resulting in the elevator accelerating to high speed as soon as the elevator has been started by means of the car switch.

The circuit for the fast speed switch is as follows:—From feeder 52, through fuse 61, line 62, contacts 83 and 82, line 108, contacts 116 and 115, lines 121, 122 and 156, through fast speed switch magnet coil 157, line 158, terminals I—I of traveling cable 66, line 159, terminal slow down contacts 160 and 161, line 162, contact 92 in the car switch, contactor 90, contact 93, line 98, terminals F—F of traveling cable 66, line 98′, contacts 97 and 96, lines 95 and 94, contacts 87 and 86, line 78, fuse 79 to feeder 53.

The fast speed switch magnet coil 157 causes contacts 163 and 164 to close, short-circuiting resistance 58, which is in series with the shunt field winding of generator 2. This increases the voltage across the shunt field winding of the generator 2, resulting in the building up of the magnetic field at a definite time rate determined by the character of the field circuit.

The building up of the magnetic field produces an increasing voltage in the armature winding of generator 2, which voltage is now imposed upon the armature of the elevator motor 14, causing the elevator to accelerate until the voltage has reached a maximum at which time the elevator will be at full speed.

After the control circuits as above described have been completed, it is not necessary to hold the car switch handle 43 at the running position, but it may be returned to its neutral position immediately. In such event, the elevator will continue to run until the automatic slowing down and stopping at the landing being approached come into action.

When the car switch is returned to neutral position, the up direction and fast speed switches remain energized with sufficient current through the coils to keep these switches closed, but insufficient current to enable the switches to pull in were they open.

To accomplish this, contact finger points 91, 92 and 93 in car switch 29 are tied together through suitable resistances, which resistances prevent the magnet switches on the control panel from pulling in if they are open. When the car switch has been moved to starting position, these resistances are short-circuited an the current in the magnet coils of the up direction and fast speed switches is increased to a value that is sufficient to close the switches controlled.

Car switch finger point 93 is tied to contact finger point 91 through lines 98 and 165, contacts 166 and 167, line 168, resistance 169 and line 99.

Car switch finger point 93 is tied to contact finger point 92 through lines 98, 165 and 170, contacts 171 and 172, line 173, resistance 174 and line 175.

The coil 176 of the magnetically operated slow-down switch on the car is energized from feeder 53, fuse 79, lines 78 and 77, contacts 27 and 28 on the overspeed governor, line 76, contacts 75 and 74 on the up overtravel limit, line 73, contacts 72 and 71 on the down overtravel limit, line 70, terminals A—A of traveling cable 66, line 69, emergency switch 30, line 129, automatic slow-down coil 176, line 177, terminals B—B of traveling cable 66 line 121, contacts 115 and 116, line 108, contacts 82 and 83, line 62, fuse 61 to feeder 52.

When the elevator is approximately midway between two adjacent floors, a projection of the core of magnet coil 176 will be opposite the stationary armature 34 (see Figure 1 for arrangement). The motion of the core will open contacts 171 and 172 which are included in the self-holding circuit for the magnet 157 of the fast speed switch on the control panel. Contacts 163 and 164 on the fast speed switch will open inserting resistance 58 in series with the field winding 7 of the generator. The field of generator 2 will discharge through resistance 11 which is across winding 7. The time rate of field discharge will be determined by the resistance 11 connected across the terminals of field 7 and may be increased or decreased, as desired, by changing the value of resistance 11. As the generator field discharges its energy, the voltage of the generator will decrease until the minimum voltage determined by the value of the series resistance 58 has been reached and the elevator will then run at low speed.

The series field 12 asssists in decreasing the total magnetic field, due to the regenerative action of the elevator motor when slowing down. The current in the series field is reversed during slow-down period and the magnetic flux due to it will be in opposition to that of the separately excited field. This action therefor supplements the discharge resistance across the field winding 7.

At slow speed the series field acts to compensate for load and by properly proportioning the strength of the series field, a lower speed may be obtained when lowering loads than that obtained when lifting loads.

The fast speed switch, when its coil is deenergized, also closes contacts 178 and 179, which provides the following circuit:—From feeder 52 through fuse 61, line 62, contacts 83 and 82, line 108, contacts 116 and 115, lines 121, 122 and 156, contacts 178 and 179, line 180, terminals J—J of traveling cable 66, line 181, automatic brake and stopping switch coils 182 and 737 in parallel, line 129, emergency switch 30, line 69, terminals A—A of traveling cable 66, line 70, contacts 71 and 72, line 73, contacts 74 and 75, line 76, contacts 28 and 27, lines 77 and 78, fuse 79, line 53.

Upon approaching the floor the core of magnet 182 is caused to move when it comes opposite armature 36. This opens contacts 128 and 127 and deenergizes magnet 124, causing contacts 46 and 47 to open thereby inserting resistance 48 in series with brake magnet 23. This weakens brake magnet 23 which can no longer counteract the action of the brake springs entirely, resulting in partial application of the brake shoes.

The elevator continues to approach the floor landing until the magnet core of magnet 737 comes opposite stationary armature 38 at which time contacts 166 and 167 will open and the up direction switch magnets 105 and 106 will be deenergized. The up direction switch in dropping out opens contacts 109 and 110, 111 and 112, 113 and 114 and 115 and 116. The opening of these contacts permits full application of the brake, interrupts power supply to the elevator armature as well as current to the automatic switches on the car, and to the fast speed switch on the control panel.

The elevator will now come to rest from low speed approximately level with the landing, through the action of the electro-mechanical brake and the dynamic braking action of resistance 185, the circuit of which is as follows:—From elevator armature terminal 149 through line 148, contacts 84 and 85, lines 147 and 183, contacts 118 and 117, line 184, dynamic resistance 185, line 186, contacts 187 and 188, lines 189 and 151, armature terminal 150 and elevator motor armature winding.

The potential switch which is controlled by the magnet 63 may be opened by various safety means such as the emergency switch 30 in the car, overtravel limit switch contacts 71 and 72 or 74 and 75 in the hatch, overspeed governor contacts 27 and 28 and other usual safety devices. Upon deenergizing the potential switch magnet coil 63, contacts 80 and 81, 82 and 83, 84 and 85 and 86 and 87 are opened while contacts 88 and 89 are closed. The contacts that open interrupt power supply to the elevator motor armature and all operating circuits and the electro-mechanical brake is applied. The contacts 88 and 89 connect dynamic stopping resistance 190 across the elevator motor armature leads 149 and 151 through leads 191 and 192. Thus, in the event of an emergency stop, dynamic braking assists in bringing the car to rest.

From the above description of Figures 1 and 2, it is seen that in this embodiment of my invention, under normal operation, the starting of the elevator is under control of the operator whereas its acceleration and stopping are automatically controlled; the operator merely selecting, at some time previous to the elevator reaching it, the floor at which he desires to stop and then manipulating the car switch to throw the automatic stopping means into operative condition. Since the elevator reaches full speed in making one floor runs, the stopping is accomplished by the same means whether the elevator is caused to travel one floor or two or more floors before stopping.

The rate of acceleration of an elevator, when controlled by the system outlined in Figure 2, is dependent upon the inductance and resistance of the field circuit of the generator 2, since these determine the time constant of the field circuit, which governs the rate at which the voltage will increase across the generator terminals. The rate of voltage rise, in turn, determines the rate at which the elevator motor will accelerate. In Figures 1 and 2 the generator is so designed that its inherent time constant gives the proper acceleration. The retardation is dependent upon the rate at which the voltage of the generator decreases and this may be governed by the value of the discharge resistance across the elevator field, after the high speed switch is opened. The higher the resistance the greater the retardation. In Figures 1 and 2 the resistance 11 is properly chosen to give the same rate of retardation as acceleration.

Under certain conditions, it is desirable to use special apparatus and circuits to afford adjustment of the rate of acceleration and retardation by other means than the inductance and resistance of the generator field winding.

It is well known that the ratio of inductance to resistance of a circuit is a measure of the time required to increase or decrease current in an electrical circuit between minimum and maximum values. Therefore, by increasing the inductance of the circuit in which is included winding 7, the time required for current in the circuit to change in value may be increased.

In Figure 3 such an inductance 193 is shown inserted in series with field winding 7 of generator 2. This inductance may be varied by removing the core 198 or by securing core 198 at any particular position between the limits of complete removal or entirely within the inductance coil 193.

The inductance coil 193 affords a means for obtaining any desired rate of acceleration less than that determined by the time constant of the generator field, as the growth of current in the field winding 7 can be delayed. This, in turn, delays the building up of the magnetic field developed and therefore the voltage of generator 2. A magnetic circuit contains energy which is a function of the magnetic field developed and when discharging or attempting to reduce the current through the magnet coil producing this field, the collapsing field induces a voltage in the magnet coil which sets up a voltage opposing any change in current. By utilizing a resistance across the magnet coil the time of discharge can be governed by permitting the induced voltage in the coil to circulate current through the field coil and resistance.

The resistance across the coil is useful in retardation during the dissipation of the greater proportion of the contained energy of the magnetic field. However, when the greatest portion of the energy has been dissipated, the time rate of discharge of the field energy is materially decreased as is well known from curves showing decaying current in a circuit including inductance.

In order to obtain an approximately uniform rate of discharge, resistance 194, Figure 3, is connected in series with contacts 195 and 196 across field winding 7 and inductance coil 193. Solenoid winding 197 controls contacts 195 and 196 and is connected so that it is subjected to the voltage of generator 2.

Coil 197 is so wound that it will cause contacts 195 and 196 to be opened by gravity when the voltage has decreased to some low value, whereby resistance 194 will become inoperative, which will be equivalent to increasing the resistance of the discharge path of field 7 and inductance coil 193 at the time that the rate of discharge is desired to be increased.

Figure 4 illustrates another means for governing the rate of change of current in the field winding 7 of generator 2. 198 is a special form of field rheostat where contact points 199 are so connected to resistance 200 that the increase and decrease of current in the field coil 7 may be determined by the amount of resistance inserted or removed by each step of the rheostat. Resistance 11 is paralleled across the field coil for protective purposes and is of a sufficiently high value not to materially affect the rate of change of current in the field winding 7.

The rheostat consists of a contact arm 201 mounted upon a sprocket 202 driven, for example, by chain 203 which engages a sprocket wheel 204 mounted upon armature shaft 205 of a shunt motor 206, the field 207 of which is connected across the line.

The contact arm 201 moves at a definite rate of speed determined by the speed of motor 206. Contact arm 201 engages a series of contacts 199 short-circuiting resistance in the circuit of field winding 7.

When accelerating the fast speed coil 208 is energized which exerts a pull on core 209 against the spring 210. This opens contacts 211 and 212 and contacts 213 and 214, then closes contacts 212 and 215 and contacts 214 and 216. A circuit is then obtained from and through line 217, contacts 218 and 219, line 220, contacts 216 and 214, line 221, armature terminal 222, armature winding, armature terminal 223, line 224, contacts 212 and 215, line 225 to negative.

Motor 206, having a constant field, turns in a direction that will carry contact arm 201 up until all of contact points 199 have been in contact with the arm in turn. When all of resistance 200 is short-circuited, the arm 201 will be at its limit of travel and will strike arm 226, moving it against spring tension 227 about its pivot and opening contacts 218 and 219 thereby disconnecting armature of motor 206 from the power supply and stopping the motor.

As contact arm 201 leaves its lower limit of travel, spring 228 pulls back on arm 229 closing contacts 230 and 231.

When retarding, magnet coil 208 is deenergized and spring 210 pulls on core 209, opening contacts 216 and 214 and contacts 215 and 212, then closing contacts 211 and 212 and contacts 213 and 214. This reverses current in the armature winding of motor 206, causing it to return contact arm to lower limit of travel where contact arm will strike arm 229, opening contacts 230 and 231.

The circuit for armature of motor 206, when the elevator is being retarded, is as follows:—Through line 233, contacts 230 and 231, line 232, contacts 211 and 212, line 224, armature terminal 223, armature winding, armature terminal 222, line 221, contacts 214 and 213, lines 234 and 225 to negative.

It will be understood that in the embodiments of Figures 3 and 4 are shown only the elements governing the rates of acceleration and retardation of the elevator motor, and also that solenoid coils 157, Figure 3, and 208, Figure 4, may be used in connection with the systems described in Figure 2 similarly to coil 157 of the fast speed switch. When using generators having laminated magnetic circuits, the time constant of the field may be less than one second and, as the time required to accelerate a high speed elevator to six hundred feet per minute should be about two seconds, means must be provided to regulate the time required to build up the generator voltage. The means shown in Figure 4 is particularly advantageous in accomplishing this end since, not only may the time required to build up the generator field be accurately determined, but the rate of acceleration during different parts of the period of acceleration may be as desired. This latter is done by the selection of suitable values of the steps of the resistance 200. For example, a constant rate of acceleration or an acceleration giving equal increments of energy in the moving parts may be obtained. The rate of retardation may also be governed accurately and may be made different from the rate of acceleration by causing the speed of motor 206 to be different in its two directions of rotation in any well known way, as for instance by inserting resistance in its armature circuit in one direction.

In Figure 5 a direct current source of supply is shown and a direct current motor for driving the motor generator set, also an arrangement of switches on the elevator to control the slow-down and stop under the conditions of variable speed in approaching landings.

The direct current motor 235 may be connected through any well known form of rheostat or starting switch to the direct current source of supply.

Shunt field winding 236 together with its protective parallel resistance 237 is connected across the line. With direct current source of supply, the exciter is not necessary as in Figures 1 and 2 since direct current is already available.

The compounding of motor 235 is arranged so that the series field 238 is connected to oppose the shunt winding 236 in order to provide for higher speeds of the motor generator set with increased loads on the equipment. The higher speed of the motor generator set with load on the elevator motor causes increased voltage with load and consequently assists the series field of generator 2 in obtaining a higher speed of the elevator motor under load. The differential compounding of motor 235 is particularly valuable at full speed whereas the series field of generator 2 is most effective at low speed.

Resistances 239 and 240 are connected in series and in parallel respectively with the series field 238 of motor 235 in order to obtain a time constant of the field 238 which will closely follow changes of current values in the feeders due to load on the equipment and resistance 240 is chosen to give the right degree of compounding.

For buildings where the height of the floors and the speed of the elevators will not permit of full speed being reached in one floor runs, means must be provided so that the slow-down may be initiated at fixed distances from the floor landings determined by the speed at which the elevator is traveling. For this purpose, in Figure 5, four automatic slow-down switches are employed upon the car, each switch having a separate row of stationary armatures in the hatchway. Two of these switches are used for each direction of travel, one switch of each pair for one floor runs, and one switch of each pair for two or more floor runs.

The operation of the automatic magnetically operated switches 241, 242, 243 and 244 is essentially the same as the similar switch in Figure 1.

Consider the elevator descending from landing 249 to 250. Immediately upon starting up, the coils of switches 242 and 243 are energized. The coils of switches 241 and 244 are controlled by means which will react in direct proportion to the speed of the elevator as, for example, by a relay connected across the elevator motor terminals. As the voltage at the armature terminals is a function of the motor and elevator speed, the coils of switches 241 and 244 may be energized only when approximately full speed of the elevator has been reached, by adjusting the controlling relay to suit. Such being the case, the coils of switches 241 and 244 will not be energized when running between adjacent floors and elevator can accelerate in the down direction until the core of switch 242 is opposite stationary armature 246. At this time, a contact will be opened by the core of switch 242 and the fast speed switch will open and the elevator will slow down. Armature 246 is so located that the proper distances for acceleration and retardation will be provided for one floor runs. The partial application of the brake and stopping of the elevator will be accomplished in the same manner as with Figure 1.

When running from landing 249 to 251, the car switch handle 29 is kept at the running position until elevator platform is near landing 250; at this time the elevator will be fully accelerated which is feasible with ordinary floor heights as found in building construction. The coil of switch 241 will therefore be energized, and upon returning car switch handle to neutral, the elevator will continue to run at high speed until the core of switch 241 is opposite stationary armature 245 at which time the core of switch 241 will open its contact and retard the elevator through a greater distance than that for a one floor run (equal to the vertical distance between stationary armatures 245 and 252) which additional distance will be required for slow-down from the greater speed.

For the up direction of travel, switch 243 is utilized. For one floor runs, for example, operating between landing 251 and 250, switch 243 and stationary armature 248 coact to cause slow-down. For two or more floor runs in the up direction with the destination being landing 249, switch 244 is used in connection with stationary armature 247.

Figure 6 is a wiring diagram for an installation as out-lined in Figure 5. The source of power supply for the elevator motor armature is provided for by a motor generator set, the motor

235 of which may be started by any method suitable, such as the rheostat 254. Power for operating motor 235 is supplied through main line switch 253. The shunt field winding 236 and its protective resistance 237 are connected across the power feeders when main line switch 253 is closed.

The series field 238 of motor 235 is connected so as to provide differential compounding to compensate for load and drop in voltage through various windings, contacts and leads. Resistance 240 is connected in series with the series field winding 238 to increase the ratio of inductance to resistance to obtain a lower time constant of this circuit. Resistance 239 is connected so as to shunt current around the series field winding 238 to obtain the proper degree of compounding. Permanent field is provided for the generator 2 to obtain constant polarity voltage from the armature of the generator. This circuit is obtained through main line switch 253, feeder 254, line 256, resistance 257, line 258, inductance coil 193, field winding 7, line 259 to feeder 255. This provides a weak field for generator 2, the armature of which will provide a low potential of constant polarity with the elevator at rest. The series field winding 12 is connected to provide for over-compounding with the resistance 144 shunted across the series winding 12 to obtain the required amount of accumulative effect. By having the winding 7 saturate the field structure when full potential is applied to the winding, the over-compounding of generator 2 may be made effective only at low voltage of the generator 2 while the differential compounding and shunt field of the driving motor 235 may be so adjusted to be effective at high speed of the elevator, which will be obtained when generator 2 provides full voltage for the armature of elevator motor 14. With the motor generator started, the elevator may be put into service by the closing of the emergency switch 30 on the elevator. The closing of the switch 30 completes a circuit from feeder 254 through fuse 260, potential switch magnet coil 261, line 262, terminals A'—A' of traveling cable 66, line 263, emergency switch 30, line 264, terminals B'—B' of traveling cable 66, line 265, contacts 266, 267 of the bottom overtravel limit switch, line 268, contacts 269 and 270 of the top overtravel limit switch, line 271, contacts 272 and 273 of the overspeed governor switch, line 274, fuse 275 and to feeder 255. The potential switch magnet 261 when energized, causes the switch controlled to close contacts 276 and 277, 278 and 279, 280 and 281, and 282 and 283, and opens contacts 284 and 285.

The elevator is now prepared to be operated by car switch 29 mounted on the elevator. The method of connecting the various circuits entailed is such as to permit the elevator to continue to run to a definite point after the elevator has been started, by movement of the car switch handle 43 of the car switch 29, even though the switch handle 43 be returned to center or neutral position. The operation of the elevator does not differ materially for either direction of travel, with the exception that selective means must be provided for the direction of elevator motor armature current and the automatic slow down and stopping of the elevator at a landing. The function of each successive circuit closed or opened is identical for either direction.

Consider elevator to be operated in the up direction. In this case the car switch handle 43 will be moved to the left to the extreme position at which time contactor 286 in the car switch will engage the series of contact fingers 287, 288 and 289. The elevator cannot be started until contact finger 289 is engaged, since contact finger 289 provides direct connection to the power supply and is termed the up car switch feed. Consider that car switch handle 43 is placed in the extreme up position. The initial circuit which functions is obtained from feeder 255 through fuse 275, line 274, contacts 282 and 283, line 290, contacts 291 and 292, line 293, terminals C'—C' of traveling cable 66, line 294, contact finger 289, contactor 286 and contact finger 287 of the car switch 29, line 295, terminal automatic contacts 296 and 297, line 298, terminals D'—D' of traveling cable 66, line 299, up direction switch magnet coils 300 and 301, line 302, contacts 278 and 279, line 303, fuse 260 to feeder 254. The up direction switches are closed by the energizing of coils 300 and 301 and contacts 304 and 305, 306 and 307, 308 and 309, and 310 and 311 are closed in their respective pairs. Contacts 312 and 313 and 314 and 315 are opened. The auxiliary brake magnet switch which short-circuits resistance 316 in series with the brake magnet 23 and its discharge resistance 135 is closed by the energizing of magnet coil 317, circuit for which is completed as follows:—From feeder 254 through fuse 260, contacts 278 and 279, line 302, contacts 311 and 310, lines 318 and 319, auxiliary brake magnet coil 317, line 320, terminals E'—E' of traveling cable 66, line 321, contacts 322 and 323 of automatic brake switch on the elevator, line 263, emergency switch 30, line 264, terminals B'—B' of traveling cable 66, line 265, contacts 266 and 267, line 268, contacts 269 and 270, line 271, contacts 272 and 273, line 274, fuse 275 to feeder 255.

The brake magnet coil circuit is completed from feeder 254 through line 324, contacts 305 and 304, line 325, contacts 326 and 327, line 328, brake magnet coil 23 and its discharge resistance 135, line 329, contacts 276 and 277 to feeder 255. The brake magnet coil is then fully energized and releases the brake shoes from the brake wheel. The brake being released, the elevator motor 14 will start, its field winding 139 and protective resistance 141 are of constant strength and connected permanently across the line when main line switch 253 is closed. The closing of the up direction switch completes the armature circuit as follows:—From the armature of generator 2 through line 330, series field 12 and parallel resistance 144, line 331, contacts 307 and 306, line 332, contacts 281 and 280, line 333, armature winding of the elevator motor, line 334, contacts 308 and 309, line 335, and back through armature winding of generator 2. The elevator motor will now run at low speed but will automatically accelerate to high speed because of the car switch handle having been brought over to the extreme position to start the elevator. The circuit for the fast speed magnet coil 341 is obtained from feeder 254 through fuse 260, line 303, contacts 279 and 278, line 302, contacts 311 and 310, line 318, fast speed switch magnet coil 341, line 336, terminals F'—F' of traveling cable 66, line 337, contacts 338 and 339 of the terminal automatic switch, line 340, car switch contact finger 288, contactor 286 and contact finger 289, line 294, terminals C'—C' of traveling cable 66, line 293, contacts 292 and 291, line 290, contacts 283 and 282, line 274, fuse 275 to feeder 255. The fast speed switch magnet coil 341 when energized closes contacts 342 and 343 which short-circuit resistance 257 in series with the field winding 7 of the generator 2 connecting the field winding 7 across the line from feeder 254 through line 256, contacts 343 and 342, line 258, inductance coil 193, field winding 7, line 259 to feeder 255.

The field winding 7 of generator 2, connected across the line, builds the field up to full strength which increases the voltage of the generator 2 at a definite rate, depending upon the value of inductance 193 and the character of the field circuit. The elevator motor 14 accelerates to full speed, following approximately the voltage induced in the armature winding of generator 2. As described in connection with Figure 3, coil 197 causes the engagement of contacts 195 and 196 to connect resistance 194 across the field winding 7 and inductance coil 193 when the generator voltage reaches a certain value.

The car switch handle 43 may be returned to neutral which will remove the bridging of contact fingers 287, 288 and 289 by the contactor 286. However, the contact fingers 289 and 287 are bridged by resistance which permits sufficient current to flow to hold in the up direction switches but not sufficient current to close these switches through an appreciable air gap, as when they are open. This circuit is obtained from contact finger 289 through line 344, contacts 345 and 346 of the automatic stopping switch, line 347, resistance 348, line 295 to car switch finger 287. This makes the up direction switches self-holding subject to the opening of the contacts 345 and 346 of the automatic stopping switch.

Car switch fingers 289 and 288 are bridged from finger 289 through line 344, contacts 390 and 391, line 392, contacts 393 and 394, line 395, resistance 396, line 397 to contact finger 288. The resistance 396 is so selected as to permit the fast speed switch to be self-holding subject to the opening of contacts 390 and 391 or 393 and 394 of the automatic slow-down switches for the up direction.

The automatic slow-down, brake and stopping switches are so constructed and when the coils are energized, the cores may be attracted by iron plates or armatures mounted stationary in the hatch. The movement of the cores results in the opening of the contacts provided on the switches, resulting in slowing down, partial brake application and stopping of the elevator motor. When the elevator is running at high speed, contacts 398 and 399 are opened when fast speed switch magnet coil 341 is energized. The opening of contacts 398 and 399 deenergizes the automatic brake and stopping magnets on the car, so that slow-down must first be initiated preparatory to stopping, before the brake can be partly applied or the direction switches opened.

The slow-down contacts in each direction are controlled by two individual slow-down magnets, the purpose of which will appear from the following:—

The distance between adjacent floors is frequently of such a value that it is impossible to obtain full speed in one floor runs with equipment that is furnished to obtain the maximum passenger transportation for regular service. In such cases, to obtain the minimum running time between adjacent floors, the run must consist of acceleration and retardation only; that is, slow-down must be initiated before full speed is attained, but not so early that an extremely long period of slow-down is obtained. When a two or more floor run is made, full speed is attained, and, therefore, a greater distance for retardation is necessary. To take care of these two conditions, the automatic slow-down switches are provided in two groups, one for single floor runs, the other for two or more floor runs.

The group for one floor runs consists of one switch for each direction of travel, and these are energized immediately upon starting. The cores of these switches are attracted by stationary armatures at the minimum distance from the landing required to slow down the elevator for one floor runs.

The automatic switches for slowing down in two or more floor runs are arranged to be inoperative until the elevator is approximately at full speed, which will be attained when the elevator motor armature has maximum potential at its terminals. When this voltage is reached a properly wound magnet coil is sufficiently energized to cause it to close contacts which complete the circuit to the magnet coil of the slow-down switches for two or more floor runs. When the elevator arrives at the distance from a landing required to retard the elevator from its full speed preparatory to stopping, contacts which release the fast speed switch are opened by the motion of the core of the automatic slow-down switch when it is attracted by a stationary armature in the hatch.

Consider the elevator at full speed, the potential across the armature of elevator motor 14, Figure 6, is a maximum and the magnet coil 400 being connected across elevator armature lines 333 and 334 is energized sufficiently to cause the switch to close contacts 401 and 402. A circuit is then completed from line 254 through fuse 260, line 303, contacts 279 and 278, line 302, contacts 311 and 310, line 318, contacts 401 and 402, line 403, terminals G′—G′ of traveling cable 66, line 404, magnet coil 405 for the automatic up slow-down switch, line 263, emergency switch 30, line 264, terminals B′—B′ of traveling cable 66, line 265, contacts 266 and 267, line 268, contacts 269 and 270, line 271, contacts 272 and 273, line 274, fuse 275 to feeder 255.

The car switch handle 43 may be now returned to center at or near a landing previous to the one it is desired to stop at. Magnet coil 405 being energized, the core is attracted by a stationary armature 700 in the hatch set at a distance required to retard the elevator preparatory to stopping. Contacts 390 and 391 are opened, which open the circuit of the fast speed switch magnet coil 341. The opening of this circuit causes the fast speed switch to release, thus opening contacts 342 and 343, inserting resistance 257 in the circuit of field winding 7 of generator 2. The energy in field 7 is discharged through resistance 194, the voltage of generator 2 decreases, and the speed of elevator 14 decreases with it. The time of retardation is governed by resistance 194 and inductance 193 as previously explained.

Bottom contacts 398 and 399 on the fast speed switch close with the deenergizing of coil 341. A circuit is completed through contacts 398 and 399 as follows:—Feeder 254 through fuse 260, line 303, contacts 279 and 278, line 302, contacts 311 and 310, line 318, contacts 398 and 399, line 406, terminals H′—H′ of traveling cable 66, line 407, automatic brake switch coil 408 and automatic stopping switch coil 409, in parallel, line 263, emergency switch 30, line 264, terminals B′—B′ of traveling cable 66, line 265, contacts 266 and 267, line 268, contacts 269 and 270, line

271, contacts 272 and 273, line 274, fuse 275 to feeder 255.

The automatic brake and stopping switch coils are now energized. Upon approaching the floor, and at a short distance from it, a stationary armature is placed to cause attraction for the core of the automatic brake switch magnet coil 408, at which time contacts 322 and 323 will be opened, which will deenergize auxiliary brake magnet coil 317, and this will open contacts 326 and 327, inserting resistance 316 in series with brake magnet coil 23, thus causing partial brake application.

Upon nearly reaching the floor landing, the elevator will bring the core of magnet coil 409 opposite a stationary armature 701 in the hatchway, the attraction of which will cause contacts 345 and 346 to open, thereby deenergizing the up direction switch magnet coils 300 and 301. This causes the opening of the armature and operating circuits and applies full brake application by deenerging brake magnet 23 completely. As explained in connection with Figure 3, coil 197 is wound to permit the separation of contacts 195 and 196 under the influence of gravity when the generator voltage reaches a predetermined value. The separation of these contacts disconnects resistance 194, thus increasing the resistance of the discharge path of field 7 and inductance coil 193 at the time that the rate of discharge is desired to be increased.

In one floor runs, magnet coil 400 will not be energized sufficiently to close contacts 401 and 402 which complete the circuit for magnet 405, so that the switch controlled by magnet 405 will be inoperative and it will pass by its cooperating stationary armature 700 in the hatchway without functioning. A circuit is completed for magnet coil 410, however, which will cause magnet coil 410 to be energized, and its core to be attracted by a stationary armature 702 in the hatch. Armature 702 is located nearer the landing being approached than armature 700, by an amount determined by the difference in speed between two floor and one floor runs. This circuit extends from feeder 254 through fuse 260, line 303, contacts 279 and 278, line 302, contacts 311 and 310, lines 318 and 411, terminals I′—I′ of traveling cable 66, line 412, magnet coil 410, line 263, emergency switch 30, line 264, terminals B′—B′ of traveling cable 66, line 265, contacts 266 and 267, line 268, contacts 269 and 270, line 271, contacts 272 and 273, line 274, fuse 275 to feeder 255.

The switch controlled by magnet coil 410 opens contacts 393 and 394 which are in series with contacts 390 and 391 of the switch controlled by magnet coil 405. The fast speed switch magnet coil 341 is deenergized, contacts 342 and 343 open and the elevator slows down, as described above in connection with two floor runs. The partial application of the brake and the stop at the landing are also as described above.

The push buttons 49 and 50 are provided for emergency operation at slow speed, these buttons bridging the extreme contact finger points only (as for example, 287 and 289) of the car switch. High speed operation is prevented by eliminating the connection corresponding to the intermediate contact finger points in the car switch 27.

In Figure 7 a motor generator set is utilized as in Figure 6.

The elevator motor 14 has its shunt field winding 139 connected in series with resistance 413 and across the line. Contacts 414 and 415 are governed by the action of a speed governor driven at a speed proportional to that of the elevator so that contacts 414 and 415 will short-circuit resistance 413, increasing the strength of shunt field 139 and checking the speed of elevator motor 14 when it exceeds a predetermined maximum. This arrangement is advantageous when using motors having poor speed regulation as it enables the slow-down to be initiated from more nearly perfect conditions under different degrees of load.

The car switch 416 is constructed so as to have three positions for either direction of travel; one is common to each and is the neutral position; the second position is where contactor 417 will engage the full series of contact finger points on either side; and the third is where contactor 417 will engage the first or lower three contact fingers only. This latter position is the position provided when it is desired to obtain automatic slow-down and stopping. The neutral position will permit stopping at will. The extreme position will render the automatic slow-down and stopping inoperative.

The field winding 7 of generator 2 is connected permanently across the line in series with resistance 418 so that when the motor generator set is running the armature of generator 2 has a low potential of constant polarity.

The closing of the emergency switch 419 in the elevator completes a circuit for the potential switch magnet coil 423 after which the elevator may be operated. This circuit extends from feeder 420 through fuse 422, potential switch coil 423, lines 424 and 425, terminals F″—F″ of traveling cable 439, line 426, through each side of emergency switch 419, line 427, terminals M″—M″ of traveling cable 439, line 428, contacts 429 and 430 of bottom overtravel limit switch, line 431, contacts 432 and 433 of the top overtravel limit switch, line 434, contacts 435 and 436 of the overspeed governor, line 437, fuse 438 to feeder 421.

The potential switch will be closed by the energizing of the coil 423, closing contacts 440 and 441 and contacts 442 and 443. Contacts 444 and 445 will be opened.

Moving car switch handle 446 so that contactor 417 will engage contact finger 451 will not complete a circuit. Continuing until contactor covers contact fingers 451 and 452, a circuit will be completed from feeder 420 through fuse 422, line 447, contacts 443 and 442, line 457, up direction switch coils 458 and 459, line 460, contacts 461, 462 and 463, line 464, terminals B″—B″ of traveling cable 439, line 465, terminal stopping switch contacts 466 and 467, line 468, resistance 469, contacts 470 and 471 to car switch contact finger 452, contactor 417, car switch contact finger 451, line 472, emergency switch 419, line 427, terminals M″—M″ of traveling cable 439, line 428, contacts 429 and 430, line 431, contacts 432 and 433, line 434, contacts 435 and 436, line 437, fuse 438 to feeder 421. The resistance 469 is of such value that the up direction switches cannot be closed by the magnet coils 458 and 459 as insufficient current is permitted to flow.

Moving contactor 417 to cover contact finger 453 does not obtain any further action for while this governs, in a sense, the fast speed magnet circuit, this latter circuit cannot be completed until the direction switch has closed.

When contactor 417 covers contact finger 454, a circuit is obtained from feeder 420 through fuse 422, line 447, auxiliary brake relay magnet 448, line 449, terminals G″—G″ of the traveling cable

439, line 450, car switch finger 454, contactor 417, contact finger 451, back to feeder 421 as before.

The energizing of magnet coil 448 closes contacts 473 and 474 and contacts 475 and 476. Contacts 473 and 474 provide a self-holding circuit for coil 448 when the car switch handle is returned to center or automatic stopping position and will be considered later as it has no given function at this time. Contacts 475 and 476 short-circuit resistance 477 in series with the brake magnet coil 23 preparatory to the direction switch going in to provide full excitation of the brake magnet when lifting.

Moving contactor 417 of the car switch 416 to cover contact finger 455 results in short-circuiting of resistance 569 and contacts 470 and 471 which were pointed out as being in series with the up direction switch magnet coils. This increases the current in this circuit to a value which will enable the up direction switches to close and the elevator to run on low speed.

The up direction switch on closing, opens contacts 478 and 479, contacts 480 and 481 and contacts 482, 483 and 484. Contacts 485 and 486, contacts 487 and 488 and contacts 490, 491 and 492 are closed. The brake magnet 23 is energized upon closing of the up direction switch through a circuit from feeder 420 through line 493, contacts 488 and 487, lines 494 and 495, contacts 489 and 492, lines 496 and 497, contacts 475 and 476, line 498, brake magnet coil 23 and protective resistance 135 in parallel, line 499 to feeder 421. The armature circuit of elevator motor 14 is completed from armature of generator 2 through line 500, series filed 12 and parallel resistance 144, line 493, contacts 488 and 487, line 501, contacts 440 and 441, line 502, through elevator motor 14 armature winding, line 503, contacts 485 and 486, line 504 to armature of generator 2.

A circuit is established for the fast speed switch at this time also, the resistance of this circuit being such that the fast speed switch cannot be closed by its magnet coil 506 but can be held closed once the switch has pulled in and reduced the air gap of the magnetic circuit. This circuit extends from feeder 420, through line 493, contacts 488 and 487, lines 494 and 495, contacts 489 and 490, line 505, fast speed magnet coil 506, line 507, resistance 508, line 509, terminals D''—D'' of the traveling cable 439, line 510, contacts 511 and 512 of the terminal stopping switch, line 513, resistance 514, line 515, contacts 516 and 517 of the automatic slow-down switch, line 518, contact finger 453, contactor 417, contact finger 451 and back to feeder 421 as before.

Moving car switch contactor 417 to cover contact finger 456 short-circuits resistance 514 and contacts 516 and 517 by bridging lines 513 and 518. This increases the current in the fast speed magnet coil 506, enabling it to pull in, closing contacts 519 and 520 and opening contacts 521 and 522.

The closing of contacts 519 and 520 short-circuits resistance 418 in series with field winding 7 of the generator 2 which increases the voltage of the generator at a rate consistent with the building up of the generator. The armatures of the elevator motor 14 and generator being now tied together electrically, the elevator motor increases its speed.

The circuit of field winding 7 of the generator 2 then extends from feeder 420 through line 523, contacts 520 and 519, line 524, field winding 7, line 525 to feeder 421.

A generator 526, the separately excited field 528 of which is connected to feeders 420 and 421 through lines 529 and 530 for permanent excitation is driven at a speed proportioned to the speed of the elevator. As shown, it is belt driven from a pulley mounted on the speed governor, which in turn is driven by an iron rope traveling over the governor sheave and secured to the elevator car. The speed of the generator being a function of the speed of the elevator, it follows that the voltage will correspond to the speed of the elevator also. Three magnet coils are supplied with energy by the generator 526 and so adjusted as to function at definite car speeds.

In order to provide for one floor runs as well as two or more floor runs without having an extremely long period of slow speed running for the one floor runs, the automatic slow-down magnet is made to be inoperative at that point in the hatch at which it should be effective for two or more floor runs.

This is done as follows for each floor landing:—Two stationary armatures are provided for slowing down automatically, the farthest one from the floor being utilized for two or more floor runs, the closest one for one floor runs. Then when running to any particular landing, two slow-down points are passed, the first stationary armature to be met with will attract the core of the automatic slow-down switch as well as the second. For two or more floor runs, the first stationary armature initiates the slow-down. For one floor runs, the automatic slow-down switch will be rendered inoperative when passing the stationary armature by virtue of contacts 531 and 532 and contacts 533 and 534, which will bridge contacts on the automatic slow-down switches. Contacts 531 and 532 will be for the up direction and bridge contacts 516 and 517, through lines 586 and 587, terminals I''—I'' and J''—J'' of the traveling cable 439, and lines 590 and 591. Contacts 533 and 534 are used for the down direction of travel.

When the elevator has reached a point in the hatch that the automatic slow-down switch core has passed the first stationary armature, the speed of the elevator is sufficient to provide a voltage from generator 526 sufficient in value to energize magnet coil 535 through lines 540 and 541 so that contacts 531 and 532 and contacts 533 and 534 will open, permitting the automatic slow-down switch to become effective.

Auxiliary brake relay magnet coil 542, through lines 543 and 544 is energized sufficiently to operate its contacts at a voltage corresponding to the speed attained in one floor runs.

The magnet coil 542 then causes contacts 547 and 548 to close and contacts 545 and 546 to open. The closing of contacts 547 and 548 has the same function as the contacts 475 and 476 controlled by the magnet 448 as both pairs of contacts are connected in parallel and through lines 497 and 498 short-circuit resistance 477 in series with the brake magnet coil 23. Upon the opening of contacts 545 and 546, the self-holding circuit for magnet coil 448 is opened and it is prevented from holding in after car switch handle 446 has been returned to intermediate or neutral position.

The purpose of this particular circuit arrangement is to provide partial application of the brake when approaching a landing. Immediately upon moving car switch handle to running position and starting the elevator, then returning the handle to the action of the switches controlled by magnet coils 448 and 542, is as follows:—The circuit of magnet coil 448 is completed and short-circuits resistance 477 through contacts 475 and 476 to permit quick release of the brake. Contacts 473 and 474 permit magnet coil 448 to be self-holding by a circuit completed as follows after car switch contactor 417 uncovers contact finger point 454:—From feeder 420, through fuse 422, line 447, magnet coil 448, contacts 474 and 473, line 549, contacts 546 and 545, lines 550 and 437, fuse 438 to feeder 421.

When the elevator has reached a predetermined speed, generator 526 will have a voltage sufficient to cause magnet coil 542 to close its switch, contacts 548 and 547 will then short-circuit brake resistance 477 and contacts 545 and 546 will open the circuit of magnet coil 448. Magnet coil 448 will then be deenergized and open contacts 473 and 474 and contacts 475 and 476.

After the slow-down has been initiated, the voltage of generator 526 will decrease with the decreasing speed of the elevator to a point that will permit the switch controlled by magnet coil 542 to return to normal position by gravity opening contacts 477 and 478 and inserting resistance 477 in series with the brake coil 23, thus providing partial application of the brake. Contacts 475 and 476 are used to short-circuit resistance 477 and then opened.

The arcing across contacts 547 and 548 upon these contacts breaking is eliminated by the use of condenser 551 connected across the contacts 547 and 548 through lines 497 and 498. To further insure the elimination of the arc, resistance 477 is inserted in a short-circuited inductance coil 552 if resistance 477 is inductive, as for example if wound in a helix. Across the contacts 545 and 546 a condenser 553 is used to eliminate the arcing across these contacts when releasing magnet coil 448.

Automatic magnetically operated switches are mounted upon the elevator and controlled by magnet coils 554, 555 and 556 and operate by magnetic attraction of a movable core for a stationary armature mounted in the hatchway. This motion causes contacts mounted upon the switches to open and function as outlined. The magnet coils 555 and 556 are in circuit immediately upon starting while magnet coil 554 is energized only at low speed.

The circuit for magnet coils 555 and 556 is obtained from feeder 420 through line 493, contacts 488 and 487, lines 494 and 495, contacts 489 and 491, line 557, terminals C″—C″ of traveling cable 439, line 558, magnet coils 555 and 556, line 559, snap switch 560, line 472, through emergency switch 419, line 427, terminals M″—M″ of traveling cable 439, line 428, contacts 429 and 430, line 431, contacts 432 and 433, line 434, contacts 435 and 436, line 437, fuse 438 to feeder 421.

Consider the elevator as having been brought up to full speed and car switch handle 406 returned to intermediate or automatic stopping position. At this time contactor 417 will cover car switch finger points 451, 452 and 453. This permits the up direction and fast speed switches to remain closed but the circuit is obtained through resistance 469 for the up direction switch and resistance 514 for the fast speed switch. These circuits are subject to the action of the automatic switches mounted upon the elevator. When the core of magnet 556, which is the automatic slow-down for the up direction, passes the stationary armature in the hatch provided for up slow-down for any given floor, contacts 516 and 517 are opened, which open circuits of the magnet coil 506. Magnet coil 506, when deenergized, releases its switch, which opens contacts 519 and 520 and inserts resistance 418 in series with field winding 7 of generator 2, reducing the voltage of generator 2 and consequently that across the armature of elevator motor 14 and the elevator slows down. Its rate of slowing down is determined by the value of resistance 538 which is the discharge resistance for the energy in the field of generator 2 and is connected across the field terminals through wire 524, contacts 537 and 536, wire 539, main 421 and wire 525. Contacts 537 and 536 are closed by coil 535 as the elevator accelerates by current from generator 526.

As the elevator speed decreases, the speed of generator 526 decreases and the voltage of generator 526 decreases in direct proportion to the decrease in speed of elevator motor 14. When this voltage has decreased to a predetermined value, magnet coil 535 is deenergized sufficiently to permit the switch controlled by it to release and open contacts 536 and 537, which open the circuit through resistance 538. By opening this circuit this discharge path is eliminated from the circuit of field winding 7 of generator 2, increasing the rate at which the voltage of generator 2 will decrease. This increases the rate of retardation and since a field winding of high inductance is inherently slow in deenergizing, particularly toward the end of discharge, it provides a means for reaching slow speed in less time without too rapid retardation at any time during the slow-down period.

With further decrease in speed; a greater decrease in voltage of generator 526 is obtained until a point is reached where magnet coil 542 is deenergized sufficiently to permit contacts 547 and 548 to open, inserting resistance 477 in series with brake coil 23, causing partial brake application.

When the elevator platform is near the landing, the core of magnet coil 554 is attracted by a stationary armature causing it to open contacts 470 and 471.

The circuit for magnet coil 554 is obtained from feeder 420 through line 493, contacts 488 and 487, lines 494 and 495, contacts 489 and 491, lines 557 and 561, bottom contacts 522 and 521 of the fast speed switch, line 562, terminals H″—H″ of the traveling cable 439, line 563, automatic stopping switch coil 554, line 559, snap switch 560, line 472, emergency switch 419, line 427 and back to feeder 421 as before.

Contacts 470 and 471, when opened, interrupt circuit through resistance 469 in the circuit of the up direction switch magnet coils, releasing the up direction switches. The main bottom contacts close when the up direction switches release and apply a dynamic stopping action in two steps. The first step is completed across the armature leads 501 and 503 from 503 through line 564, contacts 478 and 479, inductance 565, resistance 566, line 567, contacts 568 and 569, line 570 to 501. This step provides for gradual dynamic braking action by the use of the inductance which prevents a sudden rush of current immediately upon closing contacts 478 and 479. The contacts are so arranged as to permit this circuit to close first upon stopping.

Contacts 480 and 481 complete a circuit from 501 through line 494, contacts 480 and 481, line 571, resistance 572, contacts 573 and 574, line 574 to line 503 completing a low resistance circuit across the armature feeders of elevator motor 14 and applying a low resistance dynamic stop for the elevator motor 14.

For manual control, that is stopping by centering car switch handle 446, a magnet coil 576 in series with suitable resistance 577, is connected across leads 540 and 541 from generator 526. The strength of magnet coil 576 is proportioned to the speed of the elevator and is so adjusted to close contacts 578 and 579 at a suitable speed after starting and to open them at a speed suitable for stopping. For example, they may close at 20% full speed and release at 10% full speed. The contacts 578 and 579 provide a circuit which will permit the direction switches to remain energized until the speed of the elevator has dropped to say 10% of full speed. Neither the car switch nor automatic stopping switch can function until after this low speed has been reached. This prevents stopping suddenly from high speed and allows the elevator to retard at a comfortable rate to a speed suitable for stopping when the car switch is centered when running at full speed. The circuit obtained, for instance, in the up direction is from feeder 420 through fuse 422, line 447, contacts 443 and 442, line 457, up direction switch magnet coils 458 and 459, line 460, contacts 461 and 462, line 582, resistance 581, line 580, contacts 579 and 578, lines 424 and 425, terminals F''—F'' of the traveling cable 439, line 426, emergency switch 419, line 427, terminals M''—M'' of the traveling cable 439, line 428, contacts 429 and 430, line 431, contacts 432 and 433, line 434, contacts 435 and 436, line 437, fuse 438 to feeder 421. The centering of the car switch handle 446, while not stopping the elevator instantly, opens the fast speed magnet circuit, when the elevator will be immediately retarded and stopped by the action of the magnet 579.

The various emergency devices provided such as emergency switch 419, overtravel limits and overspeed governor operate to open the circuit of magnet 423, controlling the potential switch and if caused to act, result in the opening the contacts 440 and 441, which disconnects the armature of the elevator motor from lines leading to the reversing switch. Contacts 444 and 445 close and connect a dynamic stopping resistance 583 across armature leads 502 and 503 to provide the proper degree of stopping when this means must be resorted to.

Snap switch 560 may be used to open the circuits of the contacts on the automatic slow-down and stop switches to disable them and the car will then be under manual control only.

In order to obtain uniform and accurate stops under different conditions of loading and speed, it is important that all switches be quick-acting and have a definite time for opening and closing. Also that the contacts, especially in the armature circuits, be of a low and constant resistance.

I have found that there is a great advantage in using switches mounted on the car and cooperating with means in the hatch for controlling the slow-down and stop of elevators instead of floor-controllers located in the motor-room and driven from the elevator mechanism. This is due to the difficulty of coordinating the movements of the car and floor-controller and also to the small distances available for the operation of switches on a floor-controller.

I desire to point out that in my present invention, I provide means for controlling the rates of acceleration and retardation of the elevator as desired so that they may be substantially the same under all conditions of loading. Also that I provide means for slowing down the elevator at fixed distances from the landings proportional to certain selected speeds corresponding to the conditions of elevator service. I have described conditions wherein the elevator does not reach its full speed in one floor runs, but does so in two floor runs. It is apparent that my invention may be readily adapted for elevators of very high speed, say eight hundred feet per minute, where three slow-down distances may be required, one distance for one floor runs, one for two floor runs and a third for three or more floor runs, it being assumed that the elevator will reach full speed in three floor runs.

I also wish to point out that I provide means for causing the preliminary application of a braking force before the power supply to the elevator motor is interrupted, this braking force being of a predetermined strength and preventing the momentary acceleration of the car by gravity between cutting off the power and applying the final braking force. Furthermore, as a part of the braking operation has already occurred, the application of the final braking force is able to accomplish its purpose that much more quickly. I believe this principle to be broadly new for the purpose here employed, whether these forces are developed in one brake or a plurality of brakes, and the illustration of the principle as applied to the use of a single brake is intended to illustrate the broad principle as stated.

I claim:—

1. An elevator system comprising, an elevator car, a plurality of switches for causing the slowing down of the elevator car to be initiated at different distances from a desired landing, an electromagnet for each switch for causing the operation thereof, each electromagnet having a portion of its magnetic circuit on the elevator car and the remainder of its magnetic circuit in the elevator hatchway.

2. An elevator system comprising, an elevator car, a plurality of switches carried by the car for causing the slowing down of the car to be initiated at different distances from any one of a plurality of landings including at least one intermediate landing, an electromagnet for each switch also carried by the car, each electromagnet having a plurality of armatures in the elevator hatchway, one for each of said landings, for cooperating therewith to cause the operation of the switch for which it is provided.

3. An elevator system comprising, a plurality of landings including at least one intermediate landing, an elevator car, a plurality of electromagnets carried by the car, each electromagnet having a plurality of armatures arranged in the elevator hatchway, one for each of said landings, a switch carried by the car and actuatable by the coaction of one of said electromagnets and any one of the armatures therefor to initiate the slowing down of the elevator car at a predetermined distance from the landing for which that armature is provided, and another switch also carried by the car and actuatable by the coaction of another of said electromagnets and its armature for such landing to initiate the slowing down of the elevator car at a less distance from such landing in the event of the slowing down of the car at such landing not having been initiated by the first named switch.

4. An elevator system comprising, an elevator car, means for bringing the elevator car from rest to full speed, control mechanism in the hatch-

way, means rendered operative by the operator for cooperation with said mechanism to initiate a reduction of the speed of the elevator car at different distances from a selected landing, and means dependent upon the distance travelled by the car for determining the distance from said landing at which said cooperation becomes effective.

5. An elevator system comprising, an elevator car, means for bringing the elevator car from rest to full speed, control mechanism in the hatchway, means rendered operative by the operator in selecting a landing for cooperation with said mechanism to initiate the slowing down of the elevator car at different fixed distances from the landing selected, and means responsive to the speed of the car for determining the fixed distance at which said cooperation becomes effective.

6. An elevator system comprising, an elevator car, a plurality of landings including at least one intermediate landing, means for starting the car and bringing it up to full speed, a plurality of controls in the hatchway for each landing, mechanism carried by the car for cooperation with one of said controls for any one of said landings as the car arrives at a certain distance from such landing to initiate slowing down of the car from full speed and for cooperation with another of said controls for such landing as the car arrives at a less distance from such landing to interrupt acceleration of the car and cause slow down to take place under conditions where slow down has not been initiated by cooperation of said mechanism with said one control.

7. An elevator system comprising, an elevator car, a plurality of landings including at least one intermediate landing, a plurality of controls in the hatchway for each of said landings, said controls for any one of said landings being adapted to cause the initiation of the slowing down of the elevator car at different distances from said one landing, and means responsive to the speed of the car for determining which of said controls for said one landing is effective.

8. A high speed electric elevator system comprising in combination, means for bringing the elevator with definite acceleration up to a predetermined maximum speed, means for slowing down the elevator with definite retardation, slow-down controls in the hatchway at different distances from a landing, manually controlled means for effecting slow-down actuation by the slow-down control nearer the landing when passing it at less than maximum speed, and manually controlled means for effecting slow-down actuation by the slow-down control farther from the landing only when passing it at the said maximum speed.

9. An electric elevator system comprising, a hoisting motor, a generator to supply current to said motor at a variable voltage, said generator having a field winding, a current supply circuit for said generator field winding, and means external to said generator and said field winding current supply circuit for causing substantially a uniform rate of field discharge upon reduction of the field current supplied by said supply circuit.

10. An electric elevator system comprising, a hoisting motor, a generator to supply current to said motor at a variable voltage, said generator having a field winding, a current supply circuit for said generator field winding, and means external to said generator and said field winding current supply circuit for causing substantially a uniform rate of field discharge upon reduction of the field current supplied by said supply circuit, said means comprising resistance shunted across said winding.

11. An electric elevator system comprising, a hoisting motor, a generator to supply current to said motor at a variable voltage, said generator having a field winding, a current supply circuit for said generator field winding, and means external to said generator and said field winding current supply circuit for causing substantially a uniform rate of field discharge upon reduction of the field current supplied by said supply circuit, said means comprising resistance shunted across said winding, and means controlled by the voltage of the generator for increasing the resistance.

12. An electric elevator system comprising in combination, a hoisting motor, a generator to supply current to said hoisting motor at a variable voltage, a field winding for said generator, a current supply circuit for said generator field winding, and means external to said generator and said field winding supply circuit for fixing the rate of field discharge upon reduction of field current supplied by said supply circuit, to cause the retardation of said hoisting motor to be as desired, said means comprising an inductive reactance in said field winding circuit and a resistance of proper value connected in shunt to said generator field winding and said inductive reactance.

13. An electric elevator system comprising in combination, a hoisting motor, a generator to supply current to said hoisting motor at a variable voltage, a field winding for said generator, a source of current for said winding, means external to said generator for automatically fixing the rate of field current increase to give the desired rate of acceleration to said hoisting motor, said means comprising an inductive reactance in said field winding circuit, and means comprising a resistance of proper value connected in shunt to said generator field winding and said inductive reactance for fixing the rate of field current decrease.

14. An electric elevator system comprising in combination, a hoisting motor, a generator for supplying power to said hoisting motor at a variable voltage, a field winding for said generator, means for varying the current in said field winding, a circuit having a certain resistance connected across said field winding, and means for increasing the resistance of said circuit at a predetermined generator voltage as said voltage decreases.

15. The combination with an elevator car and a motor therefor, of manually operable means for initiating movements of the car, electromagnetic means carried partly on the car and partly in the hatchway for varying the motor speed at predetermined points in the hatchway, and electroresponsive means effective after said speed variation for insuring accurate stopping of said car at desired landings without overtravel or undertravel.

16. The combination with an elevator car and a motor therefor, of manually operable means for initiating movements of the car, electromagnetic means carried partly on the car and partly in the hatchway for decelerating the motor at predetermined points in the hatchway when said manual means is inoperative, and electroresponsive means effective after deceleration of said motor for insuring accurate stopping of said car

at desired landings without overtravel or undertravel.

17. The combination with an elevator car and a motor therefor, of manually operable means for initiating movements of the car, electromagnetic means carried partly on the car and partly in the hatchway for varying the motor speed at predetermined points in the hatchway, means for controlling the voltage impressed on the motor, and electroresponsive means effective after said speed variation for insuring accurate stopping of said car at desired landings without overtravel or undertravel.

18. The combination with an elevator car and a motor therefor, of a generator for controlling the motor, means for varying the generator voltage, manually operable means for controlling the voltage-varying means and electroresponsive means operable in accordance with the movement of said car for controlling the generator when said manual means is inoperative.

19. The combination with an elevator car and a motor therefor, of a generator for controlling the motor, means comprising a field-magnet winding on the generator for varying the generator excitation automatically in accordance with the motor-load, manually operable means for varying the generator voltage, and electroresponsive means operable in accordance with the movement of said car for controlling the generator when said manual means is inoperative.

20. The combination with an elevator car and a motor therefor, of a generator for controlling the motor, means comprising a cumulative series field-magnet-winding on the generator for varying the generator voltage automatically in accordance with the motor-load, manually operable means for controlling the generator voltage, and electro-responsive means operable in accordance with the movement of said car for controlling the generator when said manual means is inoperative.

21. The combination with an elevator car and a motor therefor, of manually operable means for initiating movements of the car, electromagnetic means carried partly on the car and partly in the hatchway for varying the motor speed at predetermined points in the hatchway, and electroresponsive means effective after said speed variation for insuring accurate stopping of said car at desired landings without overtravel or undertravel and without interruption of the motor circuit prior to stopping.

22. An electric elevator system comprising, an elevator car, a plurality of landings including at least one intermediate landing, a manually operable control switch having a running position and an automatic slow-down position, means responsive to the operation of said switch to its running position for causing the starting of the car, control means in the hatchway for each of said landings, and control means carried by the car for cooperating with the control means in the hatchway for any one of said landings to initiate the slowing down of the car at varying distances from such landing, said control means being rendered effective to initiate slow-down by their cooperation upon movement of said control switch from said running position to said automatic slow-down position.

23. An electric elevator system comprising, an elevator car, a plurality of landings including at least one intermediate landing, a manually operable control switch having a running position and an automatic slow-down position, means responsive to the operation of said switch to its running position for causing the starting of the car, control means in the hatchway for each landing, and control means on the car rendered operable upon movement of said control switch from running position to said automatic slow-down position to cooperate with the control means in the hatchway for any one of said landings for initiating the slowing down of the car at different distances from such landing.

24. An electric elevator system comprising, an elevator car, a plurality of landings including at least one intermediate landing, a manually operable control switch, said switch having an operative position and an off position, means responsive to the operation of said control switch from said off position to said operative position for causing the starting of the car and adapted to thereafter cause the acceleration thereof to full speed, means for maintaining said first named means operative after its operation in response to movement of said control switch to its operative position, a plurality of slow-down controls in the hatchway for each of said landings, and control means carried by the car for cooperating with one or another of the slow-down controls for any one of said landings to initiate the slowing down of the elevator car at varying distances from such landing.

25. An electric elevator system comprising, an elevator car, a plurality of landings including at least one intermediate landing, a manually operable control switch in the car, said switch having a running position and an automatic slow-down position, means responsive to the operation of said switch to its running position for causing the starting of the car and acceleration thereof, means for maintaining said first named means operative upon movement of said control switch from running position to automatic slow-down position, a plurality of slow-down controls in the hatchway for each of said landings, and switching mechanism carried by the car and rendered operable upon movement of said control switch from said running position to said automatic slow-down position for actuation by one or another of said slow-down controls for any one of said landings to initiate the slowing down of the car at different distances from such landing.

26. An electric elevator system comprising, an elevator car, a plurality of landings including at least one intermediate landing, a manually operable control switch in the car, said switch having a running position and an automatic slow-down position, means responsive to the operation of said switch to its running position for causing the starting of the car and adapted to thereafter cause the acceleration thereof to full speed, said control switch acting to maintain said means operative so long as it is held in its running position, means for maintaining said first named means operative upon movement of said control switch from running position to automatic slow-down position, control means in the hatchway for each of said landings, and control means carried by the car for cooperating with the control means in the hatchway for any one of said landings to initiate the slowing down of the car at different distances from such landing, said control means in the car and hatchway being rendered conjointly effective to initiate slow-down upon movement of said control switch from said running position to said automatic slow-down position.

27. An electric elevator system comprising, an

elevator car, a plurality of landings including at least one intermediate landing, a manually operable control switch in the car, said switch having a running position and an automatic slow-down position, means responsive to the operation of said switch to its running position for causing the starting of the car and acceleration thereof, means for maintaining said first named means operative upon movement of said control switch from running position to automatic slow-down position, a plurality of slow-down controls in the hatchway for each of said landings, and switching mechanism carried by the car and rendered operable upon movement of said control switch from said running position to said automatic slow-down position for actuation by one of said slow-down controls for any one of said landings to initiate the slowing down of the car at one distance from such landing, and for actuation by another of said slow-down control for such landing to initiate the slowing down of the car at a less distance from said landing in the event that the slow-down has not been previously initiated.

28. An electric elevator system comprising, an elevator car, a plurality of landings served by the car including at least one intermediate landing, a motor for raising and lowering the car, a manually operable control switch in the car, said switch having a running position and an automatic slow-down position, switching mechanism responsive to the operation of said control switch to running position for establishing circuits to cause said motor to start the car and for establishing additional circuits adapted to cause said motor to accelerate the car to full speed, a plurality of slow-down controls in the hatchway for each of said landings, switching mechanism carried by the car and rendered operable upon movement of said control switch from running position to automatic slow-down position for actuation by one or another of the slow-down controls for any one of said landings for causing the interruption of said accelerating circuits at different distances from such landing to initiate the slowing down of the car, and means including said switching mechanism carried by the car for maintaining said accelerating circuits closed until interrupted by the actuation of said switching mechanism by one or another of said slow-down controls.

29. An electric elevator system comprising, an elevator car, intermediate and terminal landings served by the car, a motor for raising and lowering the car, a manually operable control switch in the car, said switch having a running position and an automatic slow-down position, circuits for starting said motor and for accelerating said motor to full speed, switching mechanism for closing said starting and accelerating circuits upon the operation of said control switch to running position, mechanism for maintaining said starting and accelerating circuits closed after movement of said control switch from said running position to said automatic slow-down position, electromagnetic means having a portion of its magnetic circuit on the car and the remainder of its magnetic circuit in the hatchway, for interrupting said accelerating circuits at a certain distance from any one of said landings to initiate the slowing down of the car, and additional electromagnetic means having a portion of its magnetic circuit on the car and the remainder of its magnetic circuit in the hatchway for interrupting said accelerating circuits at a less distance from such landing to initiate the slowing down of the car at such less distance in the event of said accelerating circuits not having been previously interrupted, said control switch maintaining both of said electromagnetic means ineffective to interrupt said accelerating circuits while in running position and rendering them effective upon movement to automatic slow-down position.

30. An electric elevator system comprising, an elevator car, a plurality of landings served by the car, including at least one intermediate landing, a motor for raising and lowering the car, a manually operable control switch in the car, said switch having a running position and an automatic stop position, circuits for causing said motor to start the car, circuits for causing said motor to accelerate the car, switching mechanism responsive to the operation of said control switch to running position for closing said starting circuits and said accelerating circuits, said control switch acting through said switching mechanism to maintain both said starting circuits and accelerating circuits closed so long as it is held in running position, means for maintaining both said starting circuits and accelerating circuits closed upon movement of said control switch from running position to automatic stop position, slow-down control means in the hatchway for each of said landings, stop control means in the hatchway for each of said landings, slow-down control means carried by the car for cooperating with the slow-down control means in the hatchway for any one of said landings for causing the interruption of said accelerating circuits at different distances from such landing to initiate the slowing down of the car, and stop control means carried by the car for cooperating with the stop control means in the hatchway for such landing for causing the interruption of said starting circuits at a less distance from such landing to cause the car to be brought to a stop at such landing, said control switch maintaining said slow-down control means on the car and in the hatchway and said stop control means on the car and in the hatchway ineffective to interrupt said circuits while said control switch is in said running position but rendering them effective upon movement to said automatic stop position.

31. In combination, an elevator car, a landing, magnetizable means forming a zone on either side of said landing, said zones being off-set relatively to each other, and two electro-magnets each common to one of the magnetizable zones and being movable by the car into and out of attractive relation with said magnetizable means.

32. In combination, an elevator car, a number of landings, two series of magnetizable members in off-set relation and forming zones on either side of each landing, and two electro-magnets each common to one series of said magnetizable members, said electro-magnets and magnetizable members being brought into and out of attractive relation by movement of the car.

33. In combination, an elevator car, a number of landings, two series of magnetizable members, in off-set relation and forming zones on either side of each landing, and two electro-magnets each common to one series of said magnetizable members, said electro-magnets and magnetizable members being brought into and out of attractive relation by movement of the car, and means actuated magnetically by bringing said electro-magnets and magnetizable members in attractive relation.

34. In combination, an elevator car, hoisting motor mechanism to operate the car at variable

rates of speed, and means to effect automatic slow-down comprising a magnetizing member and a magnetizable member, one on the car and the other in the hatchway so that both members are brought into and out of attractive relation by movement of the car.

35. In combination, an elevator car, two windings having cores magnetically independent, and two magnetizable members, said windings and members movable into and out of attractive relation by movement of the car.

36. In combination, an elevator car, two windings on the car having cores magnetically independent, a magnetizable member brought into attractive relation with one of said windings as the car approaches a landing in travelling upwardly and being in non-attractive relation with the car substantially level with the landing, and a magnetizable element brought into attractive relation with the other of said windings as the car approaches said landing in travelling downwardly and being in non-attractive relation with the car substantially level with said landing.

37. Control mechanism for elevator motors, comprising switch mechanism having automatic slow-down and stop control contactors, said contactors having actuating means consisting of magnetizing and magnetizable members brought into and out of attractive relation by movement of the car.

38. In combination, an elevator car, switch mechanism on the car effective to cause automatic slow-down and stop at all landings for movement of the car upwardly, switch mechanism on the car effective to cause automatic slow-down and stop at all landings for movement of the car downwardly, and actuating means for said mechanism comprising magnetizable and magnetizing means movable into and out of attractive relation by movement of the car.

39. A system of control for elevators, comprising in combination, a car, motive means to move said car at different rates of speed, control means consisting of a car start switch, contactors to effect automatic slow-down, additional contactors to effect automatic stop, and actuating means for said contactors comprising electro-responsive means part on the car and part in the hoistway brought into and out of attractive relation by car movement.

40. In an elevator-control system, an elevator motor, a generator for supplying variable voltage to said motor, said generator including a separately excited field winding, means for controlling the excitation current supplied to said winding in steps of increasing value, means for stabilizing the change in flux in the field of said generator including a closed circuit for said winding having normally a predetermined value of resistance therein, and means operable responsive to actuation of said controlling means to supply less than a predetermined value of excitation current to said field winding for increasing the effective resistance in said closed circuit.

41. In an elevator-control system, an elevator motor, a generator for supplying voltage to said motor, means for variably controlling the field flux of said generator to cause said motor to operate at a low speed and a higher speed, and means for controlling the rate of decay of said flux, including means for making the rate lower between said high and said low speeds and for making the rate higher between said low and zero speeds.

GRAHAM B. GROSVENOR.