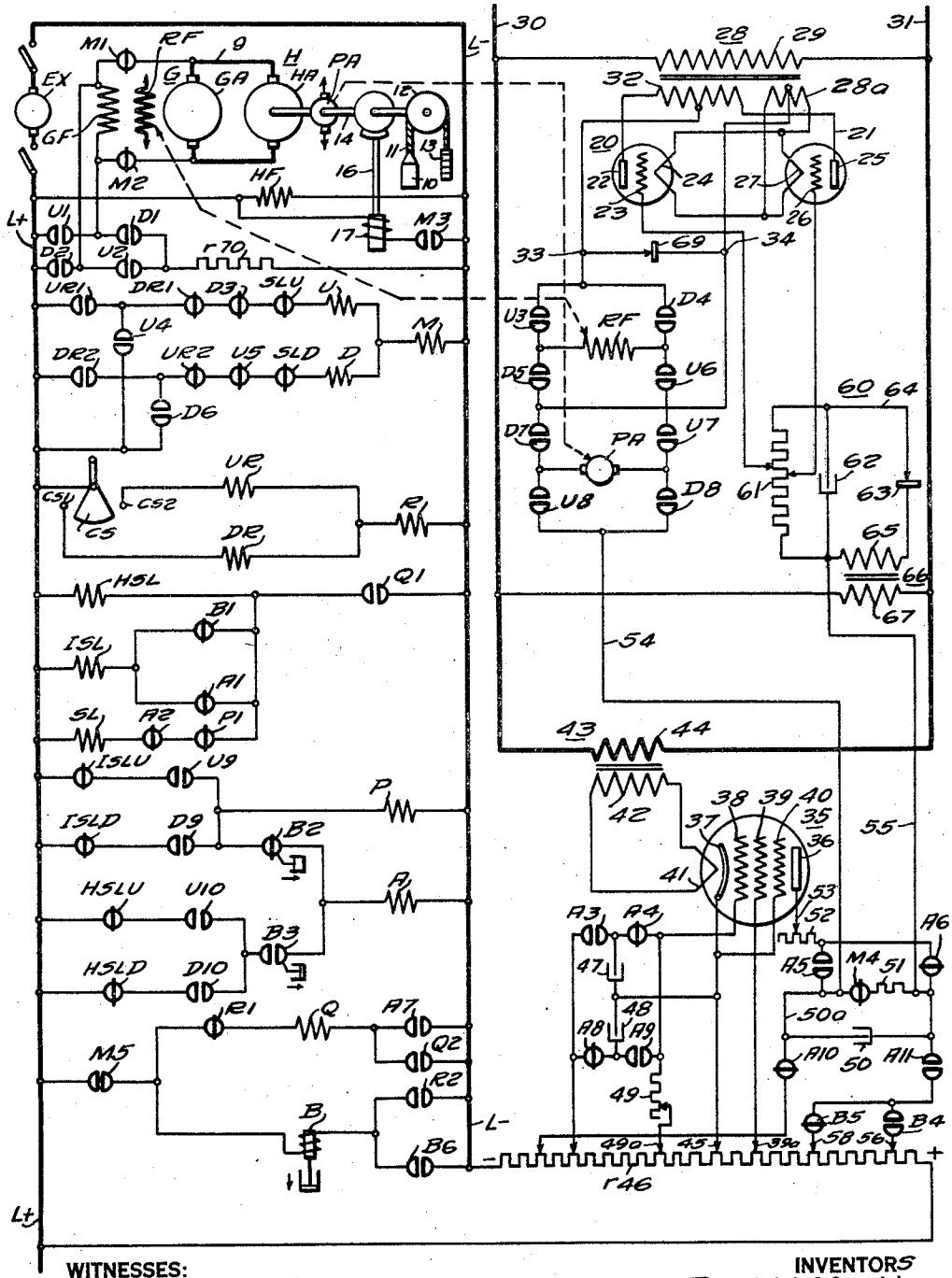
March 16, 1943. P. M. MARTIN ET AL 2,313,955

ELEVATOR CONTROL SYSTEM

Filed Dec. 2, 1941 2 Sheets-Sheet 1



WITNESSES:

E. G. McCloskey.

Birney Hines

Fig. 1.

INVENTORS

Paul M. Martin

and Alvin O. Lund.

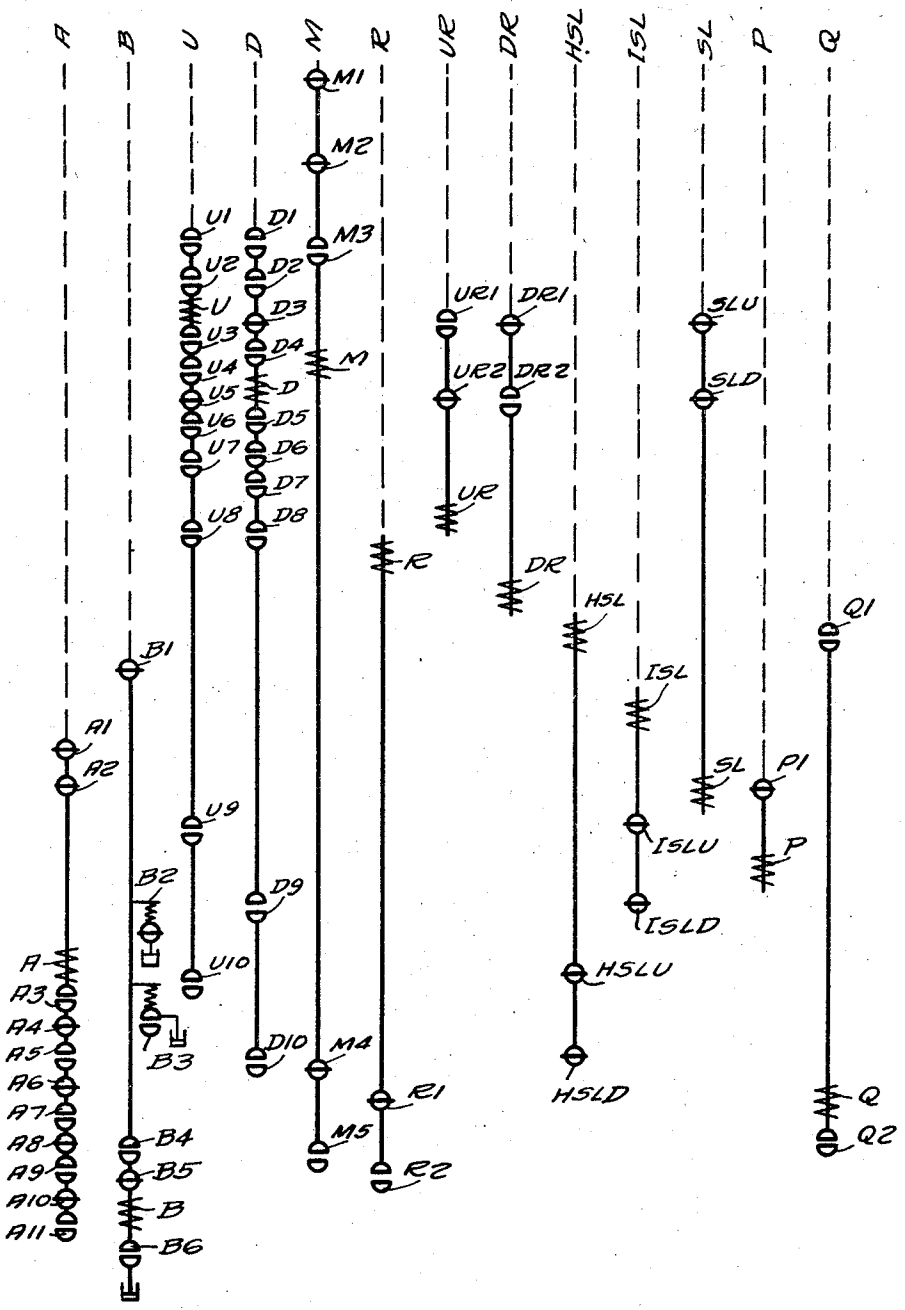
BY

ATTORNEY

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WITNESSES:

E. A. McCloskey.

Birney Hines

Fig. 2.

INVENTORS

Paul M. Martin

and Alvin O. Lund.

BY

ATTORNEY

Patented Mar. 16, 1943 2,313,955

UNITED STATES PATENT OFFICE

2,313,955

ELEVATOR CONTROL SYSTEM

Paul M. Martin, Chicago, Ill., and Alvin O. Lund, East Orange, N. J., assignors to Westinghouse Electric Elevator Company, Jersey City, N. J., a corporation of Illinois

Application December 2, 1941, Serial No. 421,306

10 Claims. (Cl. 172—152)

Our invention relates to electrical control systems of the variable voltage type and, more particularly, to such systems of this character as include a regulating means and are suitable for the operation and control of elevator hoisting motors.

One object of our invention is to provide an electrical control system which shall be inexpensive to construct, install, operate, and maintain in operation.

Another object is to provide an electrical control system which will require less engineering time than heretofore necessary on each individual installation and which will make it possible to use standard stock control units which may be easily and quickly adjusted or changed when installed to suit our particular installation.

A further object is to provide a control system which will so control the elevator cars as to increase their riding ease and eliminate any discomfort to the passengers.

It is also an object to provide an elevator control system in which the time for floor-to-floor runs will be held at a minimum.

For a better understanding of our invention, reference may be had to the accompanying drawings, in which:

Figure 1 is a straight-line diagram of an elevator control system embodying our invention; and

Fig. 2 is a key representation of the relays embodied in Fig. 1 illustrating their coils and contact members disposed in horizontal alignment with their positions in the straight line circuit so that their locations and connections therein may be readily determined.

Our invention is described in connection with a simple elevator system, but it is to be understood that it may be used with much more complicated elevator systems or with similar motors used for other purposes.

The following relays, switches, etc., are used in the circuit of Fig. 1:

A=starting relay for pattern circuit.
B=relay for conditioning the system for a one-floor run or for a more than one-floor run.
U=up direction switch.
D=down direction switch.
UR=up direction relay.
DR=down direction relay.
M=car running relay.
R=car control relay.
HSL=high speed inductor relay.
ISL=intermediate speed inductor relay.
SL=stopping inductor relay.
P=stopping inductor control relay.
Q=inductor conditioning relay.
H=hoisting motor.
G=generator.
Ex=exciter.

Referring more particularly to Figure 1, we have illustrated an elevator car 10 as suspended by a cable 11 which passes over a hoisting drum 12 to a counter weight 13. The hoisting drum 12 is fixed upon a shaft 14 operated by a hoisting motor H. The motor H is provided with a field winding HF connected across a pair of supply conductors L+ and L— which may be supplied with direct current from a suitable source such as an exciter Ex. A spring-operated brake 16 controlled by an electromagnetic coil 17 is provided for preventing operation of the hoisting drum 12 when the hoisting motor is deenergized.

A variable voltage system of control is provided for operating the hoisting motor H wherein its armature HA is connected in a closed circuit 9 with the armature GA of a generator G, having a separately excited constant differential field winding GF and a controlled main field winding RF. The main field winding provides the energization for the generator. The differential field winding GF is connected to oppose the main field winding RF for purposes of control as will be defined later. The armature GA of the generator may be driven at a constant speed by means of any suitable drive motor (not shown).

The direction and speed of the hoisting motor H may be controlled by controlling the direction and value of the excitation current for the generator main field winding RF. The direction is controlled by an up direction switch U and a down direction switch D. The value of the excitation current will be controlled as hereinafter described.

The operation of the up and the down direction switches is controlled by an up direction relay UR and a down direction relay DR which, in turn, are controlled by a manually operated switch CS mounted in the car in position to be controlled by the car attendant when he desires to effect the starting or stopping of the car.

A car-running relay M is provided for conditioning the control system for operation when the car is to be moved and also for effecting the release of the brake 16 when the car is in operation.

Any suitable system may be utilized for automatically decelerating the car and stopping it level with a floor in response to a stopping operation of the car switch CS. In the present case we have illustrated a high speed decelerating inductor relay HSL, an intermediate speed decelerating inductor relay ISL, and a stopping inductor relay SL. These relays may be mounted on the car in position to be operated by suitable inductor plates mounted on the hatchway walls (not shown) at suitable distances from each floor so that they will operate the relays, when they are energized, to decelerate the car from its high speed or from its intermediate speed, then

stop it level with the floor where a stop is being made.

Inasmuch as inductor relay systems for decelerating and stopping elevator cars are old and well known in the art, no specific illustration of the plates and their location is given. However, if further information is desired, it may be obtained in Patent No. 1,884,446, issued October 25, 1932, to K. M. White and G. K. Hearn, and assigned to the Westinghouse Electric Elevator Company.

An inductor control relay Q is provided for rendering the inductor relay system effective when the car is to make a stop at a floor.

A floor adjusting relay B is provided for conditioning the control system so that the car will make a one-floor run in the most effective manner when the car switch CS is thrown to full running position and immediately returned to its stopping position, and for causing the car to make a more than one-floor run in the most effective manner when the car switch is moved to and retained in its car running position.

A relay P, controlled by the intermediate inductor relay ISL and the up and down direction relays is provided for preparing the stopping inductor relay SL for operation after the relay ISL has operated.

A conditioning relay R, controlled by the car switch CS, is provided for preventing operation of the relays Q and B, while the car is operated at high speed until a stop is to be made at a floor.

A starting relay A is provided for preparing the control circuits of the car for operation when the car is to be started and also for controlling the use of a pattern circuit or speed controlling system to be described later.

In the operation of the variable voltage system and, particularly, where it is used in connection with an elevator, there are many unlooked-for variations in the conditions under which the generator and the motor operate which cause variations in the desired speed of the hoisting motor.

For instance, there may be unlooked-for changes in the friction of the driven parts, the resistance value of the windings, changes in load, changes in brush contact which vary the series excitation, etc., which may cause the speed of the motor to vary from the speed it should have in response to any selected setting of its controller. In order to overcome these difficulties, we have provided a novel regulating means for exciting and correcting the energization of the field of the generator, so that the speed of the motor will be automatically held accurately at the desired value at all times, and also in order that certain desirable accelerating and decelerating characteristics may be obtained when starting and stopping the car.

The regulating means includes the controlled main field winding RF for the generator G which is designed to cooperate with the constant differential field winding GF to give the generator and the hoisting motor the output characteristics desired.

We have further provided for controlling the main field RF by the use of a pair of gaseous electronic discharge tubes **20** and **21**. The tube **20** is provided with an anode **22**, a grid **23**, and a cathode **24**. The tube **21** is provided with an anode **25**, a grid **26**, and a cathode **27**. The cathodes may be of the heated type and supplied with current from the secondary winding **28***a* of a transformer **28** having a primary winding **29** connected to a suitable supply of alternating current represented by supply conductors **30** and **31**, and an additional secondary winding **32**. The anodes of the tubes are connected to the secondary winding **32**. The terminals **33** and **34** of the field winding RF are connected to the central portions of the secondary windings **32** and **28***a*.

It will be obvious that the current supplied by the tubes **20** and **21** to the main field winding RF will control the energization of that field winding and thereby control the energization of the generator GA. The output of the tubes may be controlled by providing a means for controlling the energization of their grids **23** and **26**.

The means for controlling the grids comprises a voltage tachometer or pilot generator PA designed to give an actual speed voltage corresponding to the speed of the motor and an electronic tube **35** of the pentode type in conjunction with a capacitor or condenser **50** designed to give a pattern voltage for the desirable speed-time characteristic of the elevator for all load conditions.

The tachometer PA is mounted on and operated by the shaft **14** of the hoisting motor and it can be as small as is practical to build, since the current drain will be very minute. It should preferably have either permanent magnet fields or regulated electromagnetic fields in order to make the output voltage directly proportional to the speed of the hoisting motor and independent of all other variables, such as temperature or exciter voltage.

The pentode tube **35** comprises a plate or anode **36**, a cathode **37**, a control grid **38**, a screen grid **39**, and a suppressor grid **40**. The cathode **37** is provided with a filament heater **41** which is connected to the secondary winding **42** of a transformer **43**, the primary **44** of which is connected to the alternating current supply conductors **30** and **31**. The cathode **37** is connected by a tap **45** to a resistor *r***46**, the outer terminals of which are connected to the direct current supply conductors L+ and L—. The screen grid **39** is connected to the resistor *r***46** by a tap **39***a* at a point preferably about 20 to 50 volts positive with relation to the tap **45**. The suppressor grid **40** is connected to the cathode **37**.

A pair of condensers **47** and **48** and an adjustable resistor **49** comprising a variable time delay grid network are connected in the circuit of the grid **38** with a bias tap **49***a* on the resistor *r***46** which is negative with respect to tap **45**.

The action of the time delay network in the grid circuit of tube **35** is as follows: (assuming the condition before the car starts) condenser **48** has been charged to a negative potential which is beyond the value which would reduce the plate current of tube **35** to zero. When the car starts, or relay A picks up, condenser **48** is connected to the grid and at the same time begins to discharge through the resistor **49**. Thus, the grid potential slowly changes from a value more negative than that which would cut off the plate current to the final grid potential determined by the setting of the grid bias control on resistor *r***46**. Thus, the plate current builds up relatively slowly. The time taken for this depends on the time constant of the circuit **48**, **49**, which is proportional to the product of the resistance and the capacity. Typical values are 1 mfd. for condenser **48** and 1,000,000 or more for resistor **49**.

The timing condenser 50, across which the pattern voltage is obtained, is connected in the circuit 50a of the anode plate 36. A pair of contacts M4 are disposed in the circuit 50a to assure that there is no voltage on the condenser 50 before the car starts. (This is important.) A resistor 51 of low value (100 ohms maximum) is also associated with the timing condenser 50 to prevent freezing of the contacts M4 should they be closed when the condenser 50 is charged.

An adjustable resistor 52 is connected in the circuit leading from the plate 36 to the timing condenser 50 in order to produce a smooth transition from the constant rate of increase of voltage to constant voltage on the condenser 50. The action is as follows: the pentode tube 35 has the property of maintaining a constant plate current for a wide range of plate voltages except for voltages between 0 and about 25 volts, where the value of the current is decreased. This results in an increase in the time required to charge the condenser, being lengthened near the fully charged point. (The voltage on the tube is the difference between the cathode tap 45 to the contact B4, tap 56 voltage and the voltage existing on the condenser at any particular time.) Recognizing then that the condenser current does not reach zero abruptly, it is possible to make the transition from the constant current value (corresponding to the constant rate of build-up of voltage on condenser 50) to zero current, longer in time by increasing the plate voltage at which the deviation from constant current takes place. This is done by inserting an additional voltage drop in the plate circuit, that across resistor 52 which can be varied at will by adjusting the position of the tap on conductor 53.

The value of the constant acceleration or deceleration of the car may be varied by a simple adjustment of the grid bias control to the tube 35. The amount of the smooth transition into constant acceleration or deceleration may be varied by changing the value of the grid time delay network by varying the amount of the resistor 49 included in the circuit. The amount of the smooth transition from the constant acceleration or deceleration may be varied by changing the value of the resistor 52.

The system also allows an adjustment of the running speed of the car which is very simple. The voltage at which the tap 56 for the contacts B4 is set determines the high speed of the car. Should any of the cars in a bank of elevators require lower speeds at certain periods of the day, this adjustment may be made with a simple, inexpensive potentiometer. The voltage at which the tap 58 is set determines the predetermined speed of the car for a one-floor run.

The pattern voltage conductor 53 leading from the plate 36 and the actual speed voltage conductor 54 leading from the tachometer PA are differentially connected to the conductor 55 leading to the grids 23 and 26.

A grid bias comprising a manually-set bias resistor 61, a high value condenser 62 and a half-wave rectifier plate 63 are connected in series with the conductor 55 leading to the grids 23 and 26. Any suitable rectifier may be used. The loop circuit 64 extending through the resistor 61 and the rectifier plate 63 is connected to the outer ends of the secondary winding 65 of a transformer 66, the primary 67 of which is connected across the alternating current supply conductors 30 and 31. The high value condenser 62 is connected in parallel with the resistor 61 as a filter condenser to produce a substantially constant or pure direct current output voltage.

The pattern voltage and the actual speed voltage are differentially connected so that the difference voltage is connected in series with the bias 60 to the leads 23 and 26 of the two grid controlled gas rectifier tubes 20 and 21 which supply power to the main field winding RF of the generator.

The grid bias 60 is set so that the tubes 20 and 21 are just prevented from conducting current when there is no pattern voltage. When the pattern voltage is started, the tubes 20 and 21 will fire, or conduct, as long as there is a small difference between the pattern voltage and the speed voltage. When the running voltage of the pattern circuit is reached, the tubes 20 and 21 will fire only often enough to maintain the elevator motor speed at the point where the actual speed voltage equals the pattern voltage.

The method of controlling the grid rectifier tubes 20 and 21 may be applied to single-phase half-wave or multi-phase half or full-wave rectifier systems in a manner similar to that shown for single-phase full wave.

Referring again to the differential field winding GF, this field is provided with a weak constant energization in a direction to produce an opposite voltage to that of the main field winding RF. The purpose of this is to require the tubes to fire at intervals even at zero excitation. This permits a field forcing toward zero excitation that would not exist otherwise as it is possible to get only a one direction flow of current from tubes. If no constant differential field were provided, the tubes 20 and 21, at low motor speeds (corresponding to low generator output voltages), would not be required to fire often to maintain the generator field flux, thus causing the voltage output to fluctuate badly. With the addition of the differential field winding GF, the tubes are required to fire more often and thus reduce the fluctuation. Also, the differential field winding is of such strength as to overcome the residual voltage of the field structure when a stop is made. The reduction in fluctuation and the overcoming of the residual voltage increase the reliability of the system at landing speeds. In practice, the strength of the differential field will preferably be made about 10% to 25% of the full field flux of the generator. It is then evident that the tubes will fire intermittently to maintain zero speed.

The transformers shown do not necessarily have to be separate, but all the windings can be on one transformer. In normal use, the plate voltage and the filament voltage on the tubes 20 and 21 can be applied simultaneously since the load circuit is not connected until the car starts. However, in practice, provision should be made to prevent the application of the load until the filaments are thoroughly heated. Ordinarily a delay of from ½ to 1 minute should be provided.

The operation of the system may be better understood from an assumed operation of the car. Assuming that the attendant on the car desires to move it from one floor to the next floor above, he throws the car switch CS into engagement with the contact CS2 for the up direction and immediately returns the switch to its center position so that the car will make the one floor run under the most desirable conditions. The engagement of the switch CS with the contact CS2 temporarily energizes the up

direction relay UR and the car control relay R to start the car upwardly by the circuit:

L+, CS, CS2, UR, R, L—

The temporarily energized relay UR closes its contact members UR1 and thus energizes the up direction switch U and the car running relay M by the circuit:

L+, UR1, DR1, D3, SLU, U, M, L—

The energized relay M opens its contact members M1, M2 and M4 and closes its contacts M3 and M5 to condition the car circuits for operation. The closing of the contacts M3 energizes the brake coil 17 to release the brake 16. The opening of the contacts M1 and M2 disconnects the differential generator field winding GF from the circuit of the armature GA.

The opening of the contacts M4 allows the "pattern" or timing condenser circuit to become ready for operation.

The closing of the contacts M5 prepares a circuit for the relay Q.

The energized switch U closes its contacts U1, U2, U3, U4, U6, U7, U8, U9, U10 and opens its contacts U5. The closed contacts U4 provide a self-holding circuit for the switch U and relay M.

The closing of the contacts U1 and U2 energizes the generator differential field winding GF by the circuit:

L+, U1, GF, U2, *r*70, *l*—

The closing of the contacts U3 and U6 prepares the main field winding RF for operation in moving the car upwardly.

The closing of the contact members U7 and U8 prepares the tachometer PA for operation in connection with moving the car upwardly.

The closing of the contacts U9 energizes the inductor control relay P to open its contacts P1 to prevent operation of the stopping inductor relay SL until the car control system is conditioned to cause the car to make a stop. The circuit for the relay P extends

L+, ISLU, U9, P, L—

The closing of the contact members U9 also energizes the pattern starting relay A by the circuit:

L+, ISLU, U9, B2, A, L—

The energized relay A opens its contact members A1, A2, A4, A6, A8 and A10 and closes its contacts A3, A5, A7, A9 and A11. The opening of the contacts A1 and A2 prepares the circuits of the inductor relays ISL and SL for operation under certain conditions.

The closing of the contacts A3 and A9 and the opening of the contacts A4 and A8 reverse the connection of the condensers 47 and 48 and short circuit the resistor 49 in the time delay grid network for the cathode 37 and the grid 38 to effect the desired control of the pattern voltage circuit. One pair of contacts of the relay A are arranged to allow one condenser to be fully charged (in the negative direction) before the start of the accelerating period (or start of the car) and another pair are arranged to have the second condenser fully charged before the start of the retardation period, when it will discharge through the adjustable resistor 49.

The opening of the contact members A6 and A10 and the closing of the contact members A5 and A11 connect the pattern condenser 50 to the tube 35 and thus allow the condenser to become charged at the rate determined by the setting of the grid bias control and modified by the action of the time delay grid network. The firing of the tubes 20 and 21 and consequently, the motor speed, then follows the pattern developed by the condenser voltage.

The closing of the contacts A7 completes a circuit for energizing the inductor conditioning relay Q by the circuit:

L+, M5, R1, Q, A7, L—

The energized relay Q closes its self-holding contacts Q2 and closes its contacts Q1 to energize the high speed inductor relay HSL and the intermediate speed inductor relay ISL for effecting the stopping of the car at the next floor.

With this arrangement the pattern voltage from the condenser 50 operates in conjunction with the voltage from the tachometer PA to so control the grids 23 and 26 as to energize the main field winding RF in such manner in comparison with the load on the car that the car will accelerate to its most desirable one-floor-run speed. (This is set by the position of the tap 58 for contacts B5 on the voltage divider resistance *r*46.)

The closing of the contacts U10 does not affect the pattern-circuit starting relay A, because the contacts B3 of the time delay relay B do not close on account of the car switch CS being centered immediately for only a one-floor run.

Returning now to the temporary energization of the relay R, that relay temporarily opened its contacts R1 and closed its contacts R2. However, its contacts R2 did not remain closed long enough to energize relay B to overcome its time delay. Therefore, relay B did not close its self-holding contacts B6 and inasmuch as the contacts R2 reopened instantly, the relay B remains in its unenergized condition. In this condition, for a one-floor run, the contacts B4 remain open and the contacts B5 remain closed, thus conditioning the circuit for the plate 36 and condenser 50 for a one-floor run instead of for a run of more than one floor.

Assume now that the car is continuing its movement toward the next floor. In doing so, it passes the intermediate speed inductor plate in the hatchway for that floor (not shown) and thus operates the energized inductor relay ISL to decelerate the car from its intermediate speed to its stopping speed. The operation of the inductor relay ISL opens its contacts ISLU, thus deenergizing the relay P and the relay A.

The deenergized relay P closes its contact members P1, thus preparing the circuit of the stopping inductor relay SL for operation when the car comes opposite the stopping plate for the floor.

The deenergized relay A opens its contacts A3 and A9 and closes its contacts A4 and A8 to connect the time delay grid circuit for the cathode 37 and the grid 38 so as to prepare the pattern voltage circuit for a decelerating pattern. The opening of the contacts A5 and A11 and the closing of the back contact members A6 and A10 in the timing condenser circuit condition that circuit to control the pattern voltage to effect deceleration of the car from intermediate speed to stopping speed.

When the contacts A6 and A10 close, the condenser 50 is connected so as to discharge through the tube 35 (at the same rate as it had previously built up during the acceleration period). The differential connection of the condenser voltage and the tachometer or pilot generator voltage is

now such as to make the tubes 20 and 21 conduct or fire only often enough to cause the elevator motor to adhere to the pattern voltage and the motor slows down.

In an extreme case, the tubes 20 and 21 could cease firing altogether and so cause the rate of deceleration to be determined by the decay of the generator field flux through the parallel "rectox" discharge unit 69. This is not the most desirable pattern, however, and it is mentioned as an example of the flexibility of the system.

Assuming now that the car has decelerated to its stopping speed and has almost arrived at the next floor and that the inductor relay SL passes its inductor plate (not shown), then the relay SL is operated to open its up contacts SLU, thus deenergizing the up direction switch U and the car running relay M.

The deenergized relay M opens its contact members M3, thus applying the brake 16 to stop and hold the car and also closes its contacts M1 and M2 to reconnect the differential generator field winding GF to the armature GA for the purpose of eliminating any residual magnetism in the field as the stop is made.

At the same time, the deenergized up direction switch U opens its contacts U1 and U2, U3 and U6, and U7 and U8, thus deenergizing the generator field windings GF and RF and the tachometer PA. The deenergization of the generator field windings and the application of the brake 16 stop the car level with the next floor.

The deenergization of the relay M also opens its contact members M5 to render the relays Q and B ineffective and closes its contact members M4 to short circuit the timing condenser 50 through the resistor 51, thus insuring that the condenser 50 will have no charge when the car is started again.

An assumed operation of the car for a run of more than one floor is now given. It will be assumed that the car attendant desires to make an up run of three floors and, therefore, moves the car switch CS into engagement with the contact CS2 and maintains it in that position until the car approaches to within the stopping zone of that floor. The closing of the contacts CS2 energizes the up direction relay UR and the car control relay R as previously described in the one floor operation. The energized relay R closes its contacts R2 and opens its contacts R1. The opening of the contacts R1 prevents energization of the inductor conditioning relay Q until the car reaches the zone at which deceleration of the car for the next floor stop should start. The closing of the contacts R2 prepares a circuit for energizing the relay B.

The closing of the contacts UR1 of the up direction relay UR energizes the up direction switch U and the car running relay M as previously described.

The energized up direction switch U operates to connect the generator field windings GF and RF for energization and also prepares the tachometer PA for operation for the up direction, as previously described in the one-floor run.

The energized relay M closes its contacts M3, thus energizing the brake coil 17 to release the brake 16, thus permitting the car to start upward. The relay M also closes its contact members M5, thus energizing the relay B through the circuit:

L+, M5, B, R2, L—

At the end of its time delay, the relay B will operate to open its contact members B5 and close its contact members B4 to connect the circuit of the timing condenser 50 to that portion of the resistor r46 suitable for a more than one-floor run.

The energization of the up direction switch U also energizes the inductor control relay P and the pattern circuit starting relay A, as previously described. The relay A operates its contacts to connect the pattern tube 35 and the timing condenser 50 for operation as previously described, and the car starts to accelerate toward its normal high speed operation for a run of more than one floor.

It will be assumed that the car, after arriving at its normal high speed, continues toward the floor at which it is to stop, and that, as it approaches the zone in which it should be decelerated for the stop, the attendant centers the car switch CS. The centering of the car switch opens the contact CS2 and thus deenergizes the up direction relay UR and the relay R. The deenergized relay UR does not affect the circuit of the switch U, because of the self-holding contacts U4. However, the deenergization of the relay R causes that relay to close its back contacts R1, thus energizing the inductor control relay Q by the circuit:

L+, M5, R1, Q, A7, L—

The energized relay Q closes its contact members Q1, thus energizing the high speed inductor relay coil HSL to prepare it to effect deceleration of the car from its normal high speed to its landing speed.

When the car nears the floor at which the stop is to be made, the energized relay HSL passes its high speed inductor plate (not shown) for that floor, and is thereby operated to open its "up" contacts HSLU, thus deenergizing the pattern circuit relay A, to cause the car to decelerate to its landing speed. This is effected because, as previously described the deenergized relay A opens its front contacts A3, A5, A7, A9, and A11 and closes its back contacts A1, A2, A4, A6, A8 and A10.

When contacts A6 and A10 close, the condenser 50 is connected so as to discharge through the tube 35 at the same rate as it had previously built up during the acceleration period. The differential connection of the condenser voltage and the tachometer or pilot generator voltage is now such as to make the tubes 20 and 21 conduct or fire only often enough to cause the elevator motor to adhere to the pattern voltage which causes the motor to slow down.

The closing of the contacts A1 energizes the intermediate speed relay ISL and prepares it for operation.

As the car continues on toward the floor, the inductor relay ISL comes opposite its inductor plate (not shown) for that floor and is thereby operated to open its contacts ISLU, thus deenergizing the relay P. The relay P now closes its back contacts P1, thus energizing the stopping inductor relay SL to stop the car. It may be noted here that in this simplified example of an operative system, the car is decelerated continuously from its high speed to its landing speed at the end of a more than one-floor run by the operation of the high speed relay HSL, and, when making only a one-floor run, it is decelerated from the high speed for that run to its landing speed by the action of the intermediate speed relay ISL.

As the car comes closer to the floor level at which the stop is being made, the stopping inductor relay SL comes opposite its stopping inductor plate (not shown) for that floor and is thereupon actuated to open its contacts SLU, thus deenergizing the up direction switch U and the car running relay M which, in turn, effect the stopping of the car level with the floor and apply the brake to hold it there, as previously described in the operation of the one-floor run.

By the foregoing assumed operation, it will be understood that we have provided a control system which will automatically maintain a motor at a substantially constant predetermined speed regardless of load, and that the system will automatically accelerate and decelerate the motor in a predetermined manner in order to secure the most favorable results in operating the motor while it is loaded.

It will also be apparent that our system is so flexible that it may be easily adjusted to suit various operating conditions because the constant acceleration and constant deceleration, the amount of smooth transition into and from constant acceleration and constant deceleration, and the running speed, may be quickly and conveniently adjusted to secure the desired values.

It will be apparent further that this variable voltage system controlled by the gaseous electronic discharge tubes might be readily used to control the acceleration, deceleration, and regulation of motors in other applications where the characteristics previously described are desirable.

Although we have illustrated and described only one specific embodiment of our invention, it is to be understood that many changes therein and modifications thereof may be made without departing from the spirit and scope of the invention.

We claim as our invention:

1. A variable voltage system comprising a power generator having an armature and a main field winding, a motor connected in a loop circuit with said armature, a regulating gaseous electronic discharge tube connected to a source of energy for energizing the main field winding, said tube having a grid by means of which its output may be controlled, a voltage tachometer connected to the motor for providing a voltage corresponding to the speed of the motor, an electronic tube and a condenser connected to a source of energy for providing a pattern voltage, manually operative means for controlling the pattern voltage tube, and means for differentially connecting the tachometer voltage and the pattern voltage from the condenser to the grid of the regulating tube for controlling the energization of the main field winding to maintain the motor at a selected speed regardless of load.

2. A variable voltage system comprising a power generator having an armature and a main field winding; a motor connected in a loop circuit with said armature, a regulating gaseous electronic discharge tube connected to a source of energy for energizing the main field winding, said tube having a grid by means of which its output may be controlled, a voltage tachometer connected to the motor for providing a voltage corresponding to the speed of the motor, an electronic pattern tube and a timing condenser connected to a source of energy for providing a pattern voltage, manually operative means for controlling the pattern voltage tube, means for differentially connecting the tachometer voltage and the pattern voltage from the condenser to the grid of the regulating tube for controlling the energization of the main field winding to maintain the motor at a selected speed regardless of load, and a variable resistance-capacitance time delay circuit included in the grid circuit of the pattern tube for building up the plate current on the pattern tube to its constant value relatively slowly.

3. A variable voltage system comprising a power generator having an armature and a main field winding; a motor connected in a loop circuit with said armature, a regulating gaseous electronic discharge tube connected to a source of energy for energizing the main field winding, said tube having a grid by means of which its output may be controlled, a voltage tachometer connected to the motor for providing a voltage corresponding to the speed of the motor, an electronic pattern tube and a timing condenser connected to a source of energy for providing a pattern voltage, manually operative means for controlling the pattern voltage tube, a circuit for differentially connecting the tachometer voltage and the pattern voltage from the condenser to the grid of the regulating tube for controlling the energization of the main field winding to maintain the motor at a selected speed regardless of load, and a negative bias circuit disposed in series with said differential circuit.

4. A variable voltage system comprising a power generator having an armature and a main field winding; a motor connected in a loop circuit with said armature, a regulating gaseous electronic discharge tube connected to a source of energy for energizing the main field winding, said tube having a grid by means of which its output may be controlled, a voltage tachometer connected to the motor for providing a voltage corresponding to the speed of the motor, a pentode tube and a condenser connected to a source of energy for providing a pattern voltage, manually operative means for controlling the pattern voltage tube, means for differentially connecting the tachometer voltage and the pattern voltage from the condenser to the grid of the regulating tube for controlling the energization of the main field winding to maintain the motor at a selected speed regardless of load, and an adjustable resistor connected between the pentode tube and the timing condenser to produce a smooth transition from the constant rate of increase of voltage to constant voltage on the condenser.

5. A variable voltage system comprising a power generator having an armature and a main field winding; a motor connected in a loop circuit with said armature for operating an elevator car, a regulating gaseous electronic discharge device connected to a source of energy for energizing the main field winding, said device having a grid by means of which its output may be controlled, a voltage tachometer connected to the motor for providing a voltage corresponding to the speed of the motor, an electronic tube and a timing condenser connected to a source of energy for providing a pattern voltage, means for differentially connecting the tachometer voltage and the pattern voltage from the condenser to the grid of the electronic discharge device for controlling the energization of the main field winding to maintain the motor at a selected speed regardless of load; a control system for connecting the circuits of the tube, the device, the timing condenser and the field winding for accelerating, running and stopping the car; and means

responsive to operation of the control system to stop the car for short-circuiting the timing condenser while the car is stopped.

6. A variable voltage system comprising a power generator having an armature and a main field winding, a motor connected in a loop circuit with said armature, an electronic device for feeding the main field winding, said device having a grid by means of which its output may be controlled, a voltage tachometer connected to the motor for providing a voltage corresponding to the speed of the motor, an electronic tube and a timing condenser connected to a source of energy for providing a pattern voltage, means for differentially connecting the tachometer voltage and the pattern voltage to the grid of the electronic device, for controlling the energization of the main field winding to maintain the motor at a selected speed regardless of load, and a differential field winding connected to a constant source of electric energy in opposition to the main field winding of the generator for bucking the flux generated by the main field winding for maintaining the electronic device conducting.

7. A variable voltage system comprising a power generator having an armature and a main field winding, a motor connected in a loop circuit with said armature, an electronic device for feeding the main field winding, and a differential field winding connected to a constant source of electric energy in opposition to the main field winding for maintaining the electronic device conductive over the operating range of the generator.

8. A variable voltage system for operating an elevator car comprising a generator having an armature and a main field winding, a motor connected in a loop circuit with said armature, a regulating gaseous electronic discharge tube for energizing the main field winding, said tube having a grid by which its output may be controlled, a voltage tachometer connected to the motor for providing a voltage corresponding to the speed of the motor, an electronic tube and a timing condenser connected to a source of energy for providing a pattern voltage, a car switch for controlling the pattern voltage tube and condenser, means for differentially connecting the tachometer voltage and the pattern voltage from the condenser to the grid of the regulating tube for controlling the energization of the main field winding, and means responsive to movement of the car switch to its "on" position for only a predetermined time to connect the condenser to one point of potential on its source of supply to cause the motor to accelerate to a predetermined speed for a one-floor run and responsive to maintaining the car switch in its "on" position for a longer predetermined time for connecting the timing condenser another point of potential on its source of supply to cause the motor to accelerate to a higher speed for a more than one-floor run.

9. In a control system, a generator having an armature and a field winding, means for connecting the field winding to a source of electric energy, a motor connected in a loop circuit with said armature, means for providing a voltage corresponding to the speed of the motor, means for providing a pattern voltage, said means comprising a condenser, a resistor and an electronic tube for charging the condenser through the resistor, means responsive to the difference of the speed responsive voltage and the pattern voltage for controlling the energy supplied to the field winding, and a timed means for altering the rate of charging said condenser at its extremities.

10. In a control system, a generator having an armature and a field winding, means for connecting the field winding to a source of electric energy, a motor connected in a loop circuit with said armature, a tachometer generator for providing a voltage corresponding to the speed of the motor, an electronic means for providing a pattern voltage, and means responsive to the difference of the tachometer generator voltage and the pattern voltage for altering the energy supplied to the field winding to thereby reduce said difference in voltage to a minimum.

PAUL M. MARTIN.
ALVIN O. LUND.