Dec. 17, 1935. W. R. HARDING ET AL 2,024,732

ELEVATOR SYSTEM

Filed April 26, 1935 4 Sheets-Sheet 1.

Fig. 1.

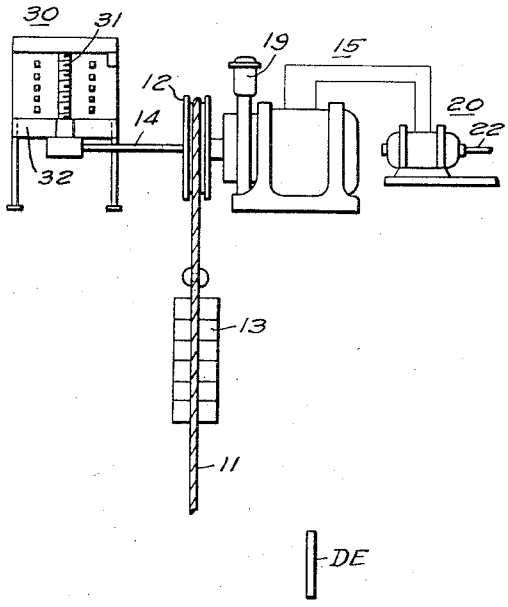
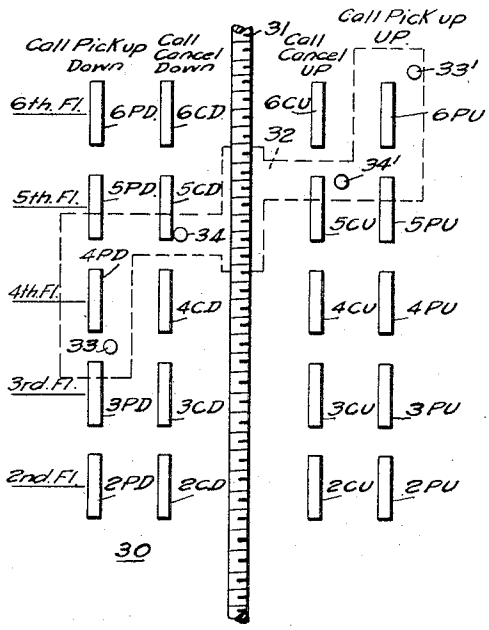


Fig. 2.



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ELEVATOR SYSTEM

Filed April 26, 1935 4 Sheets-Sheet 2

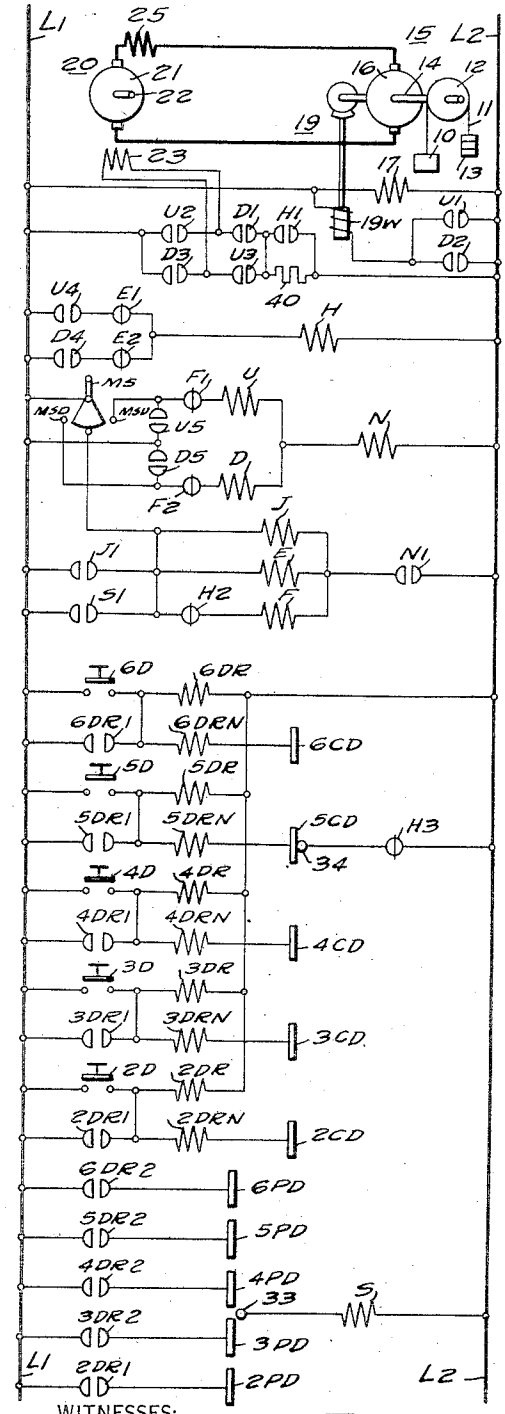


Fig. 3.

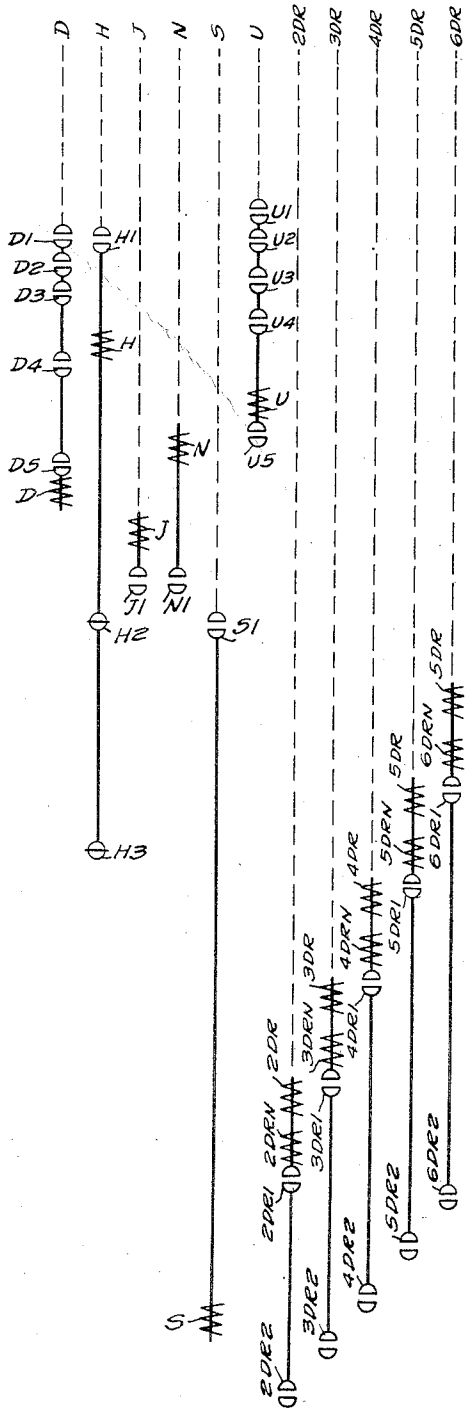


Fig. 4.

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ELEVATOR SYSTEM

Filed April 26, 1935 4 Sheets-Sheet 3

Fig. 5.

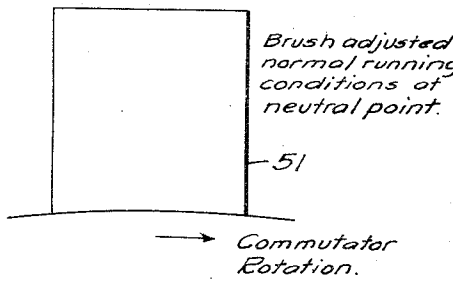


Fig. 6.

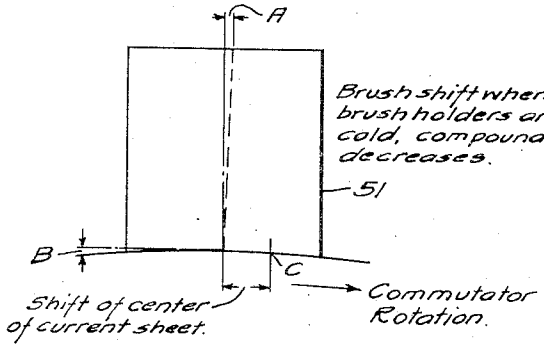


Fig. 7.

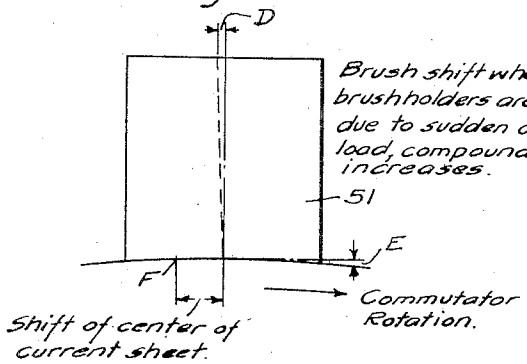


Fig. 8.

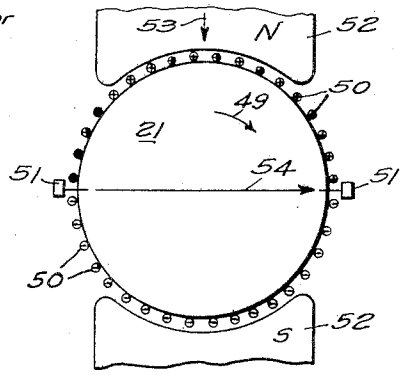


Fig. 9.

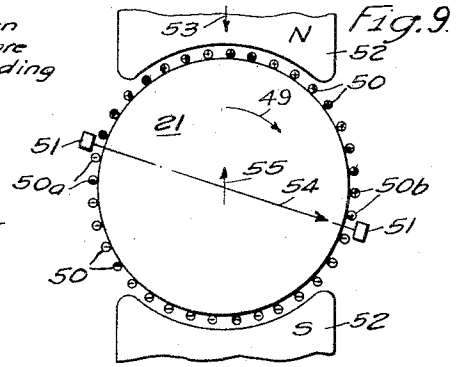
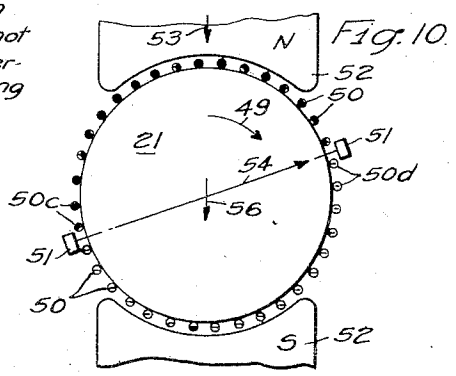


Fig. 10.



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ELEVATOR SYSTEM

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Fig. 11.

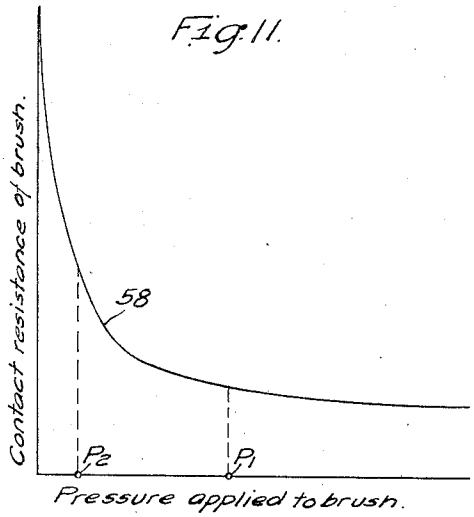


Fig. 12.

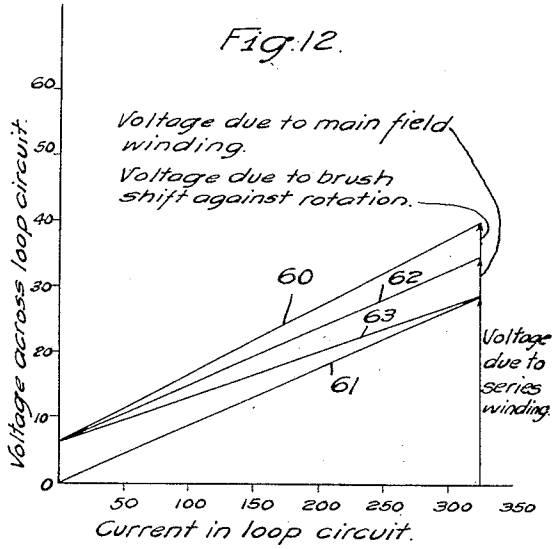
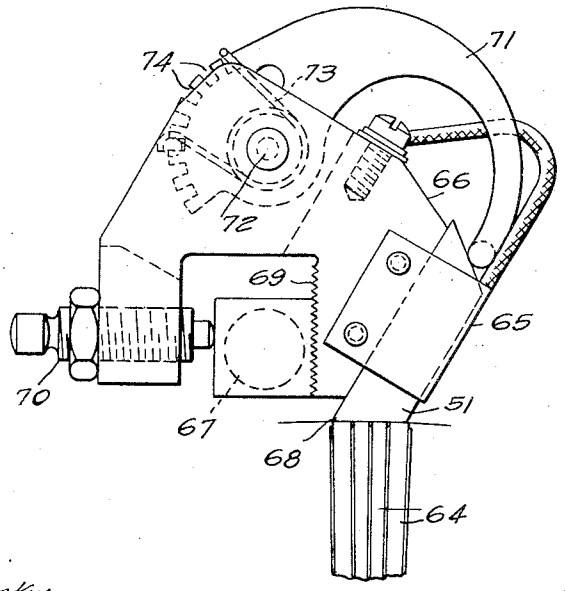


Fig. 13.



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Patented Dec. 17, 1935 2,024,732

UNITED STATES PATENT OFFICE

2,024,732

ELEVATOR SYSTEM

William R. Harding, Wilkinsburg, and John L. Brown, Verona, Pa., assignors to Westinghouse Electric Elevator Company, Chicago, Ill., a corporation of Illinois

Application April 26, 1935, Serial No. 18,293

18 Claims. (Cl. 172—152)

Our invention relates, generally, to electric elevator systems, and it has particular relation to elevator systems in which the elevator car is to be operated at high speed.

In the operation of elevator cars at speeds above 1000 feet per minute, many variable factors influencing the desired operating characteristics of the system become of increasing importance, as compared to their importance in connection with the operation of the elevator car in systems in which low speeds, such for example as 400 to 600 feet per minute, are employed. This is particularly true when the operating periods between starting and running conditions and between full speed and landing speed, which ordinarily is less than 50 feet per minute, are considered. When it is understood that the same dynamo-electric devices must be employed for starting and running the elevator car, and also for reducing the speed thereof to landing speed, preparatory to stopping it at a floor, it will be appreciated that the equipment must operate under widely varying conditions.

In order to control the operation of the elevator car in the hatchway, a variable voltage or generator filed control system is provided, which includes a hoisting dynamo-electric device or motor having driving connection with the elevator car and a driven dynamo-electric device or generator, the armature of which is connected in loop circuit relation to the armature of the hoisting dynamo-electric device. The generator may by coupled to any suitable driving mechanism, which will permit the return of power thereto in order to take advantage of the dynamic or regenerative braking characteristics of the variable voltage control system. Both the generator and the motor are provided with separately excited main field windings. The control of the speed and direction of movement of the elevator car is effected principally by varying and reversing the excitation which is applied to the separately excited field winding of the generator. However, certain speed changes are also effected by altering to a certain degree the excitation which is applied to the separately excited main field winding of the motor.

Depending upon the load carried by the elevator car and the friction in the mechanism associated therewith, the dynamo-electric devices may either be drawing power from the power source to operate the car, or may be returning it thereto. In most instances, when the speed of the car is to be reduced to landing speed, preparatory to stopping it at a floor, a considerable amount of power is returned through dynamic or regenerative braking action to the power source. Under these conditions, the hoisting dynamo-electric device functions as a generator, and the driven dynamo-electric device functions as a motor, to operate the driving device, such as an induction motor, as an asynchronous generator.

The controls for stopping the elevator car at a floor are adjusted for a predetermined landing speed, for example, 20 feet per minute. When the car is operating at this speed at a predetermined distance from the floor, the brake may be applied and the car will coast a definite distance. It will then be understood that the system may be adjusted to apply the brake at a distance from the floor which will cause the elevator car to stop at the floor within the desired limits of accuracy. However, if the speed of the elevator car is above the predetermined landing speed and the brake is applied at the predetermined distance from the floor, the elevator car will overshoot the floor, since the brake is adjusted to stop the car within the predetermined distance from the predetermined landing speed. In like manner, if the elevator car is approaching the floor at a speed which is less than the predetermined landing speed, and the brake is applied, the car will undershoot or will stop short of the floor. This action will take place because the brake is adjusted to stop the car within a predetermined distance when it is operating at a higher speed. Therefore, when it is operating at a lower speed and the brake is applied, it will be stopped in a shorter distance. It is, therefore, apparent that, for consistent operation, the elevator car must be brought to the predetermined landing speed and must be operating at this speed with substantially no deviation therefrom in order to accurately stop the car at a floor.

As set forth hereinbefore, the speed of the elevator car is reduced from operating speed by reducing the excitation which is applied to the generator. The excitation may be reduced either by decreasing the current flowing through the separately excited field winding or by the provision of a special field winding which is arranged to be excited only when the elevator car is to operate at the landing speed. With this arrangement, the main field winding may be completely deenergized.

In a system which we have constructed, when the elevator car is operated at full speed, the generator is arranged to apply 360 volts across the loop circuit. The voltage drop in the loop circuit due to the resistance of the various elements com-

prising it is compensated for by a series field winding in the generator. It is, therefore, unnecessary to compensate by means of variations in the excitation applied to the main field winding for voltage drop in the loop circuit due to resistance. When the elevator car is operated at a landing speed of 20 feet per minute in this system, the main field winding is arranged to apply across the loop circuit a voltage of six volts. It will be understood that this voltage is in addition to the voltage which is applied across the loop circuit, because of the excitation of the series field winding to compensate for resistance drop. The foregoing conditions are based on the assumption that the elevator car is being operated under such load conditions that it is necessary for the generator to supply power to the motor to move the car in the hatchway.

When the elevator car is operated at the landing speed, it is necessary to reduce the excitation of the generator so that it operates along the lower portion of its saturation curve. In this region, there is no saturation in the magnetic circuit of the generator. Thus, only a slight change in the magnetomotive force of the excitation applied to the field structure of the generator can materially reduce the required six volts which are necessary to operate the elevator car at the landing speed in addition to the voltage which is required to overcome the resistance drop in the loop circuit. These conditions will be more readily understood when it is recalled that the generator must operate over a very wide range of operating conditions. For example, when it is supplying power to the motor to operate the elevator car at a speed of 1200 feet per minute, it is necessary that it generates 360 volts in addition to the voltage necessary to overcome the resistance drop in the loop circuit. When the elevator car is to be operated at the landing speed of 20 feet per minute, the generator must supply only six volts. There is, therefore, approximately a voltage ratio of 60 to 1 over which the generator must function in order to obtain a speed range of 60 to 1.

In the system which we have constructed, we have employed a four-pole generator which is provided with a commutator that is slightly greater than 10 inches in diameter. Brushes are provided which are individual to each pole and which are located at the neutral points around the periphery of the commutator. In particular, the centers of the current sheet across the faces of the brush are so arranged as to coincide substantially exactly with the neutral points of the commutator. By the term "center of the current sheet" we mean the effective point along the surface of the brush at which it may be considered that the entire current flow is concentrated.

Since the generator is operating at the lower end of its saturation curve during the period when the elevator car is operated at the landing speed, a very slight shift in the center of the current sheet will cause a magnetomotive force to be generated which will either increase or decrease the effect of the excitation provided by the main field winding, depending upon the direction in which the center of the current sheet is shifted. For example, we have found that a shift of the center of the current sheet of .030 inch from the neutral point in the direction of rotation will cause a flux to be generated by the full load current flowing through the armature conductors which will exactly neutralize the flux generated by the separate or main field winding at the landing speed. In like manner, if the center of the current sheet is shifted, a like distance from the neutral point against the direction of rotation of the commutator, a flux will be generated by the full load current flowing through the armature conductors which will exactly double the flux that is generated by the separately excited main field winding at the landing speed.

When the center of the current sheet is shifted in the direction of rotation of the commutator to such an extent that the flux generated by the main field winding is completely neutralized, a sufficient voltage will not be applied to the loop circuit to cause the motor to operate the elevator car at full load in the up direction. Full load current will still be circulated because of the flux generated by the series field winding. However, this flux is just sufficient to compensate for the voltage drop in the loop circuit due to its resistance, and, therefore, since sufficient voltage is not provided to permit the motor to generate a counter-electromotive force, it will stall and the elevator car will not be brought to the floor. With a shift of the center of the current sheet of less than .030 inch from the neutral point the speed of the elevator car will be correspondingly reduced and the car will creep into the floor level at a reduced speed.

In like manner, when the center of the current sheet is shifted .030 inch against the rotation of the commutator, the voltage, generated in the loop circuit by the armature of the generator due to the flux generated by the main field winding aided by the compounding effect of the brush shift, at full load, will be double that necessary to operate the elevator car at the landing speed. It will then approach the floor at a speed which is greater than that for which the system has been adjusted and, as a result, it will overshoot the floor.

The center of the current sheet will be shifted in the direction of rotation of the commutator when brushholders, constructed in accordance with the prior art, are cold, as compared to the operating temperature thereof under normal operating conditions. That is, assuming that the brushes are properly adjusted so that the centers of the current sheet coincide with the neutral points of the commutator under operating conditions when the brushholders are heated to operating temperature, then, when the system is shut down, the brushholders of the prior art will be distorted due to the change in temperature to such an extent that the centers of the current sheet will be shifted in the direction of rotation of the commutator. Thus, if the system is adjusted to operate properly when the generator has been heated to normal operating temperature, then when the system is initiated in operation, the brushes will be so positioned that a compounding effect will be present due to current flowing through the conductors in the generator armature that will cause a decrease in the voltage applied to the loop circuit by the main field winding. As a result, the elevator car will either creep into the floor at a very slow speed or will be stopped short of the floor.

When the generator is subjected to sudden overload conditions, so that the heat flowing from the brushes and commutator is considerably above the normal heat flow therefrom, the brushholders constructed and mounted in accordance with the teachings of the prior art will cause the brushes to be shifted slightly due to distortion so that the centers of the current sheet will be

shifted against the direction of rotation of the commutator and the compounding effect of the armature conductors will be such as to increase the voltage which would otherwise be applied to the loop circuit due to the flux generated by the main field winding. As a result, the elevator car will operate at a landing speed which is higher than the desired landing speed and it will overshoot the floors.

The shifting of the centers of the current sheet is not due to linear elongation of the brushholders resulting in a bodily movement of the brushes around the commutator, but rather it is due to the distortion of the brushholders of the prior art which tends to cock the brushes. This cocking action relieves the pressure at the leading or trailing edge of the brush depending upon the direction of the distortion and, as a result, there is an effective shifting of the center of the current sheet from a predetermined given position. For example, we have found that if the leading or trailing edge of a brush is lifted out of contact engagement with the commutator for a distance of .0001 inch, there will be a shift of the center of the current sheet from the center of the brush to a point midway between the center of the brush and the edge which remains in contact engagement with the commutator.

The distortion of the brushholders of the prior art is due to the fact that the brushholder acts somewhat in the manner of the bimetallic strip when it is subjected to the heat generated by current flow in the brushes and commutator. The distortion is further magnified by the methods which have been employed in the prior art for mounting the brushholders around the commutator. According to prior practice, the centers of support of the brushholders have been located at some distance from the commutator and the trailing edges of the brushes. As a result, a considerable turning movement is available to cock the brush when the brushholder is distorted under varying conditions of heat. Furthermore, the brushholders of the prior art have been constructed without regard to heat flow therethrough and conduction of heat therefrom. There has been an unequal distribution of heat in the brushholders with resulting distortion causing a cocking of the brushes and a shifting of the centers of the current sheet.

In the past, it has been the practice to adjust the system so that proper landings at the various floors may be obtained when the generator is heated to normal operating temperature. Thus, during the warming up period which may extend over possibly 30 minutes and during periods of overload, the centers of the current sheet are shifted from their positions coinciding with the neutral points of the commutator during normal operating conditions and the operation of the elevator car is erratic.

It is, therefore, an object of our invention to provide an elevator system which shall be simple and efficient in operation and which may be readily and economically manufactured and installed.

An important object of our invention is to provide for maintaining the brushes of the generator of a variable voltage elevator system in a fixed relation with respect to the commutator under all operating conditions, so that there will be substantially no compounding action in the generator caused by a shifting of the centers of the current sheet across the faces of the brushes when the elevator car is operated at low speed preparatory to stopping it at a floor.

A further object of our invention is to provide brushholders of unitary, massive construction for supporting the brushes of the generator of a variable voltage elevator system in engagement with the commutator, the brushholders being rigidly mounted at a distance from the axis of rotation of the commutator slightly greater than the radius thereof to maintain the centers of the current sheet across the faces of the brushes in coincidence with the neutral points of the commutator regardless of the heat flow to the brushholders from the brushes and commutator.

Other objects of our invention will, in part, be obvious, and in part, appear hereinafter.

Accordingly, our invention is disclosed in the embodiment hereof shown in the accompanying drawings, and comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth and the scope of the application of which will be indicated in the appended claims.

For a more complete understanding of the nature and scope of our invention, reference may be had to the following detailed description, taken in connection with the accompanying drawings, in which:

Figure 1 illustrates diagrammatically the arrangement of an elevator car arranged to be operated by a driving mechanism in a hatchway;

Fig. 2 illustrates the layout of a floor selector which may be employed for controlling the operation of the elevator car;

Fig. 3 illustrates, diagrammatically, the circuit connections which may be employed in practicing our invention;

Fig. 4 illustrates the physical relationship of the contact members and operating windings of certain switches and relays illustrated in Fig. 3;

Figs. 5, 6 and 7 show different positions of a typical brush corresponding to different temperature conditions of the brushholder of the prior art supporting it;

Figs. 8, 9 and 10 correspond respectively to Figs. 5, 6 and 7 and show the effect in the generator of the various positions of the typical brush;

Figs. 11 and 12 show curves which demonstrate certain features of our invention; and

Fig. 13 shows a preferred form of brushholder which may be used in practicing our invention.

According to our invention, we prevent the cocking of the brushes and resulting compounding action due to shift in the centers of the current sheet across the faces of the brushes from the neutral points of the commutator by providing brushholders which are so constructed and mounted in the generator that substantially no distortion thereof takes place, although they are subjected to widely varying temperature conditions due to heat flow from the brushes and commutator. In particular, the preferred type of brushholder is of the unitary, massive construction comprising a material such as bronze to readily permit the conduction of heat therethrough. The length of the hammer holding the brush in engagement with the commutator is reduced to a minimum. The brushholder is rigidly supported at a distance from the axis of the commutator which is slightly greater than the radius thereof. There is then a minimum of distance from the support point about which distortion of the brushholder can take place due to change in tempera-

ture with a resulting shift in the center of the current sheet across the brush face.

In order to more clearly set forth the novel features of our invention, a description will first be given of an elevator system in which it has been employed. The novel features of the construction and arrangement of the brushholders will then be set forth in detail with particular reference to the functioning when the elevator car is operated under landing speed conditions.

Referring now particularly to Figs. 1, 2 and 3 of the drawings, an elevator car, shown generally at 10, is provided, which may be of conventional type. The elevator car 10 is supported for movement in the hatchway by means of a cable 11 which is passed over a sheave 12 and which is suitably balanced by means of counterweights 13. The sheave 12 is mounted on a shaft 14 of a hoisting dynamo-electric device or motor 15, which is provided with an armature 16 and a separately excited field winding 17. In order to automatically stop the elevator car 10 when the hoisting dynamo-electric device 15 is not energized, a brake, shown generally at 19, is provided having an operating winding 19w. A driven dynamo-electric device or generator 20, having an armature 21 mounted on a shaft 22, a separately excited field winding 23, and a series field winding 25, is provided. The armature 21 is connected in loop circuit relation with the armature 16, as is customary in variable voltage control systems. The shaft 22 may be connected to any suitable driving mechanism, such as a polyphase induction motor (not shown), which may be connected to a suitable source of alternating current.

In order to stop the elevator car 10 at a floor where a call is registered, a floor selector, shown generally at 30, is provided. As illustrated, the floor selector 30 is provided with a lead screw 31 which is arranged to be rotated through a suitable gear reducing mechanism by means of the shaft 14. As is shown more clearly in Fig. 2 of the drawings, the lead screw 31 is arranged to move a brush carriage 32, which carries brushes 33 and 34 for engagement with floor segments when the car moves in the down direction, and corresponding brushes 33' and 34' for engagement with floor segments when the car moves in the up direction. It will be observed that the brush 33 is arranged to successively engage call pick-up segments 2PD through 6PD, while brush 34 is arranged to engage call cancelling segments 2CD through 6CD. In like manner, when the elevator car 10 is moved in the up direction, the brushes 33' and 34' are arranged to engage corresponding floor segments.

Since our invention may be practiced in connection with an elevator system having any desired number of floors, only the connections for floors 2 through 6 are illustrated herein. It will be understood, however, that the system may be extended to a larger number of floors, as may be desired. Further, in order to simplify the showing of our invention, only the circuits associated with the floor segments for the down direction of travel are illustrated in the diagram shown in Fig. 3.

The elevator car 10 may be stopped at a floor where a call is registered by means of a slowdown inductor E and a landing inductor F, both of which are carried by the elevator car. When the operating windings of the inductors E and F are energized, the respective contact members thereof will be opened on moving into proximity with inductor plates located in the hatchway individual to each floor. Thus, as the elevator car 10 approaches the fifth floor in the down direction, with the operating winding of the inductor E energized, contact members E2 will be opened when they come into proximity with the inductor plate DE. In like manner, when the contact members F2 of the landing inductor F come into proximity with the inductor plate DF, they will be opened. Inductor plates UE and UF are provided for opening members E1 and F1, respectively, when the car 10 is moved toward the fifth floor in the up direction.

The elevator car 10 is also provided with a master switch MS having three positions. When the handle of the master switch MS is moved to the right, a circuit is completed through contact member MSD for operating the elevator car 10 in the down direction. When the handle is moved to the left, a circuit is completed through contact member MSU to operate the elevator car 10 in the up direction. In the center position, the master switch MS is arranged to complete a circuit for stopping the elevator car 10 at the will of the operator.

In response to the operation of the master switch MS to either the left-hand or the right-hand position, reversing switches U and D are respectively operated. The operating windings of the reversing switches U and D are arranged to be energized through the operating winding of an auxiliary relay N. The elevator car 10 is brought up to full speed by the operation of a speed switch H, which at contact members H1, is arranged to short circuit a resistor 40 that is connected in series circuit relation with the separately excited field winding 23 of the driven dynamo-electric device 20.

Each floor is provided with a hall button, individual to the direction in which it is desired to travel. For example, the fifth floor is provided with a hall button 5U for stopping the elevator car 10 when it is moving in the up direction and a hall button 5D for stopping it in the down direction. Only hall buttons 2D through 6D are illustrated in Fig. 3 herein, for the reasons set forth hereinbefore.

In response to the operation of any of the hall buttons 2D through 6D, call storing relays 2DR through 6DR are energized, depending upon the hall button that is operated. As illustrated, the call storing relays are provided with main operating windings and releasing or neutralizing windings 2DRN through 6DRN. When any one of the call storing relays is energized, it is automatically locked in through its own contact members and it remains in this condition until the call cancelling brush 34 engages the corresponding call cancelling segment to complete a circuit for energizing the corresponding neutralizing winding. When the neutralizing winding is energized, the ampere turns of the main operating winding are neutralized and the contact members of the relay are then permitted to be restored to their non-operated position.

When the call pick-up brush 33 comes into contact engagement with a call pick-up segment that is energized as a result of the operation of a call storing relay, a call pick-up relay S is energized. The call pick-up relay S is provided with contact members S1 which are arranged to initiate the slowdown sequence for the elevator car 10.

In order to provide for effecting the energization of the separately excited field windings 17 and 23, as well as for providing for energizing the various operating windings for the switches and

relays described hereinbefore, a suitable source of direct current may be provided and connected across conductors L1 and L2. This source may be provided by means of an exciter generator connected to be driven with the armature 21 of the generator 20 or by any other suitable source.

In describing the functioning of our novel elevator control system, it will be assumed that the conductors L1 and L2 have applied thereto a suitable energizing voltage. It will also be assumed that the generator 20 is connected to be driven by a suitable driving mechanism through which the kinetic energy of the elevator system may be transferred during the slowdown period. It will further be assumed that the elevator car 10 is at the top of the hatchway and that the load conditions are such that current generated by the generator 20 flows in the loop circuit when the elevator car is operated in the down direction at full speed.

With a view to operating the elevator car in the down direction, the operator moves the master switch MS to complete a circuit through contact member MSD for energizing the reversing switch D and the auxiliary relay N. This circuit may be traced as follows:

L1, MS, MSD, F2, D, N, L2

The separately excited field winding 23 of the generator 20 is energized over a circuit which may be traced as follows:

L1, D3, 23, D1, 40, L2

Also, the brake winding 19*w* is energized to release the brake 19,

L1, 19*w*, D2, L2

The elevator car 10 is operated at full speed in the down direction on the energization of the speed switch H, which at contact members H1, short circuits the resistor 40 and permits full excitation to be applied to the separately excited field winding 23. The circuit for energizing the operating winding of the speed switch H may be traced as follows:

L1, D4, E2, H, L2

It will now be assumed that the down call button 5D is operated at the fifth floor for the purpose of stopping the elevator car at this floor in order to pick up a passenger. As a result of the depression of the call button 5D, a circuit is completed for energizing the call storing relay 5DR,

L1, 5D, 5DR, L2

At contact members 5DR1 a holding circuit is completed around the contact members of the call button 5D, for the purpose of maintaining the call storing relay 5DR in the operated condition until the call is cancelled. A further result of the energization of the call storing relay 5DR is to close contact members 5DR2 and connect the down call pick-up segment 5PD to conductor L1.

As soon as the call pick-up brush 33 engages the call pick-up segment 5PD, an obvious circuit is completed for energizing the operating winding of the call pick-up relay S. It, in turn, completes, at contact members S1, a circuit for energizing a holding relay J,

L1, S1, J, N1, L2

At contact members J1, an obvious holding circuit is completed which obviates the necessity for the contact members S1 being maintained in the closed position for a time longer than is necessary to energize the operating winding of the holding relay J.

The operating winding of the slowdown inductor E is energized in parallel circuit relation with the operating winding of the holding relay J. It is then in condition to open contact members E2 as soon as they come into proximity with the slowdown inductor plate DE. It will be understood that the call pick-up brush 33 is given a sufficient lead in its location on the brush carriage 32, so that the foregoing sequence of operations can take place before the contact members E2 are moved into proximity with the inductor plate DE.

As soon as the elevator car 10 carries the contact members E2 into proximity with the inductor plate DE, they are opened and the previously traced circuit for energizing the operating winding of the speed switch H is opened. Accordingly, the contact members H1 are opened and the resistor 40 is reinserted in series circuit relation with the separately excited main field winding 23 of the generator 20.

Since the excitation applied to the generator 20 has been materially reduced, it will function as a motor, returning power to the power source through the shaft 22, while the motor 15 functions as a generator to energize the device 20. It will be understood that the excitation applied to the separately excited field winding 23 may be reduced in a number of steps, rather than by the insertion of a single resistor 40. However, for the purposes of illustration, only the single step of resistance, as represented by the resistor 40, is illustrated herein.

For the purposes of clarity, the remaining steps in the slowdown sequence will be set forth before a detailed description is given, regarding the particular effects caused by shifting of the centers of the current sheet across the faces of the brushes of the generator 20 during the slowdown period. For the time being, it will be assumed that the speed of the elevator car 10 is reduced in the desired manner.

The deenergization of the speed switch H causes contact members H2 to close and thereby completes a circuit for energizing the operating winding of the landing inductor F in parallel circuit relation with the operating winding of the slowdown inductor E. Consequently, as soon as contact members F2 are moved into proximity with the inductor plate DF, they are opened. The previously traced holding circuit for the reversing switch D and the auxiliary relay N is then opened at contact members F2. As a result, the separately excited field winding 23 is deenergized, the operating winding 19*w* of the brake 19 is deenergized, and the brake is applied to stop the elevator car 10 at the fifth floor.

As the elevator car 10 reaches the fifth floor, the call cancelling brush 34 engages the call cancelling segment 5CD and an energizing circuit is completed for the neutralizing winding 5DRN,

L1, 5DR1, 5DRN, 5CD, 34, H3, L2

The call storing relay 5DR is then restored to the non-operated position.

After the passenger has entered the elevator car 10, the operator may then again move the master switch MS to the right, to again initiate the movement of the elevator car in the down direction.

In order to more clearly demonstrate the novel

features of our invention, reference may be had to Figs. 5 through 12 of the drawings. In these figures, a comparison is set forth showing the effects in compounding action which take place when the centers of the current sheet are shifted from the exact neutral points around the commutator. For the purposes of illustration, the armature 21 has been illustrated in Figs. 8, 9 and 10 in connection with a two-pole field structure rather than to illustrate four poles resulting in unnecessary complication. The armature 21 is provided with armature conductors 50 in the periphery thereof and is driven in the clockwise direction of rotation as indicated by the arrow 49.

In Fig. 8 of the drawings, brushes 51 are illustrated as being located exactly at the neutral points of the commutator which is associated with the armature 21. Field poles 52 are provided having the polarities indicated in which a flux which may be represented by the vector 53 is generated by the main field winding 23 when the elevator car is to be operated at landing speed. It will be recalled that this flux is only sufficient to generate a voltage of the order of six volts in the loop circuit in addition to the voltage which is applied thereto to overcome the resistance drop of the loop circuit.

The current flowing through the conductors 50 is represented by the conventional notations. With the current flowing in the manner indicated, the armature conductors 50 generate an armature reaction flux which may be represented by the vector 54 which coincides with the plane containing the brushes 51. As illustrated in Fig. 5, the brushes 51 have been adjusted so that, under running conditions, their contact surfaces are in complete engagement with the commutator. Under these conditions, the pressure existing between the contact surface of the brushes 51 and the commutator surface will be uniform throughout and the center of the current sheet will correspond to the geometrical centers of the brushes 51 which, in turn, coincide with the neutral points of the commutator.

The effect of the cocking of the brushes 51 when the temperature of the brushholders decreases from that which exists when the brushes are adjusted, as illustrated in Figs. 5 and 8, is shown in Figs. 6 and 9. Assuming that the brush 51 is adjusted to properly make contact engagement with the commutator, as illustrated in Fig. 5, when the generator is operating under normal conditions, than with the brushholders of the prior art when the system is shut down, the cooling thereof will cause a certain amount of distortion which will cause the brush to be cocked through a slight angle which may be designated by A and at the leading edge of the brush 51 it will be moved out of engagement with the commutator as illustrated by the angle B. This cocking of the brush 51 causes a shift of the center of the current sheet across the face of the brush 51, as illustrated, to a point C which lies between the center of the brush 51 and its trailing edge.

This slight shift in the center of the current sheet has the effect, as illustrated in Fig. 9, of shifting the brushes 51 in the direction of rotation of the commutator. The vector 54 representing the armature reaction is then no longer at right angles to the vector 53 and as a result, there is a component which may be represented by the vector 55 which directly opposes the flux represented by vector 53. As set forth hereinbefore, if the effective brush shift in the system which we have constructed is of the order of .030 inch, then the vector 55 will be equal and opposite to the vector 53, and as a result sufficient voltage will not be applied to the loop circuit to energize the motor 15 for moving the elevator car 10.

It will be observed that the vector 55 represents the magnetomotive force which is generated by the current flowing through conductors 50a and 50b. The current flowing through these conductors is opposite in direction to the current flowing therethrough when the brushes 51 are located exactly at the neutral points, as illustrated in Fig. 8. There is, therefore, a magnetomotive force generated by the current flowing through the armature conductors which directly opposes the magnetomotive force of the separately excited field winding 23 which at landing speed is only sufficiently excited to generate the flux represented by the vector 53.

In like manner, when brushholders of the prior art are employed and the generator is subjected to sudden overloads, there will be considerable heat flow from the brushes and commutator to the brushholders. If proper provision is not made for rendering the brushholders substantially distortionless due to this added heat flow, the change caused therein will be such as to cock the brushes 51, as illustrated in Fig. 7. As there shown due to a sudden overload, the brush 51 may be cocked by the distortion of the brushholder so that it is slightly shifted through an angle D resulting in the trailing edge being moved slightly out of engagement with the commutator, as indicated by the angle E. The center of the current sheet across the face of the brush 51 will then be moved against the rotation of the commutator to a point F which lies between the center of the brush 51 and its leading edge.

As illustrated in Fig. 10, the shift of the center of the current sheet in a direction opposite to the rotation of the commutator causes the armature reaction flux as indicated by the vector 54 to produce flux which may be represented by the vector 56, which is in the same direction as the flux represented by the vector 53. There is, therefore, an additive compounding effect due to brush shift in a direction opposite to the rotation of the commutator and consequently the voltage which is applied to the loop circuit is correspondingly increased.

It will be observed that the current flowing through conductors 50c and 50d is opposite to the current that flows therethrough, as illustrated in Fig. 8, when the brushes 51 are located exactly at the neutral points. The current flowing through these conductors is effective to produce a magnetomotive force which adds to the magnetomotive force of the main field winding 23 which generates the flux that is represented by the vector 53.

In Fig. 11, a curve is shown having units of pressure plotted as abscissæ and units of contact resistance of the brush as ordinates. If it is assumed that the brush 51, adjusted for the conditions illustrated in Figs. 5 and 8 of the drawings, is operated at a pressure represented by P1, then a change in the contact pressure at, for example, the leading edge of the brush 51, as illustrated in Fig. 6, to a pressure P2 will cause a marked increase in the contact resistance of the brush 51 in the vicinity of the leading edge. As a result, the current flowing through the brush 51 tends to be more and more effectively concentrated at some point such as C, which is shifted ahead of the center of the brush 51. In the

event that the leading edge of the brush 61 actually moves out of engagement with the commutator, then the contact resistance at this point becomes infinity and the contact resistance across the face of the brush may then be substantially represented by the curve 58, the left hand portion representing the contact resistance at the leading edge and the right hand portion representing the contact resistance at the trailing edge.

The effect of the shifting of the centers of the current sheet against the direction of rotation of the commutator, as illustrated in Figs. 7 and 10 of the drawings, is illustrated by the curve 60 shown in Fig. 12, in which the amperes of the current flowing in the loop circuit are plotted as abscissæ and the volts across the loop circuit are plotted as ordinates. The curve 61 represents the voltage generated in the loop circuit as a result of the flux generated by the series field winding 25 to compensate for the voltage drop in the loop circuit due to the resistance thereof. The curve 62 represents the sum of the voltage due to the series field winding 25 and the voltage which is generated in the loop circuit due to the flux generated by the main field winding 23. When the voltage represented by the curve 62 is generated in the loop circuit, the elevator car 10 will be operated at the desired landing speed and the control adjustments will be consistent in their effect in stopping the car at the floor level.

However, if there is a shifting of the centers of the current sheet across the faces of the brushes 61, as illustrated in Figs. 7 and 10 of the drawings, then there will be a cumulative compounding action which will cause the voltage generated in the loop circuit to be that represented by the curve 60 which is higher than desired and, as a result, the elevator car 10 will operate at a landing speed which is higher than is desired.

In the event that there is an effective shifting of the center of the current sheet in the direction of rotation of the commutator, as illustrated by Figs. 6 and 9 of the drawings, then a differential compounding action will take place, as represented by the curve 63, and the elevator car will operate at a speed which is lower than the desired landing speed. If the differential compounding action is sufficient, the elevator car 10 will be completely stalled, since the flux generated by the main field winding 23 and represented by the vector 53 is, in this case, completely neutralized by the flux generated by the conductors 50*a* and 50*b*, and represented by the vector 55.

In view of the foregoing, it will, therefore, be obvious that the brushes 61 must be mounted in such manner to engage the commutator that there will be substantially no cocking thereof due to changes in temperature of or heat flow through the brushholders supporting them. A brushholder which is particularly adapted to accomplish these results is illustrated in Fig. 13 of the drawings. The brush 61 is shown as being in the form of a truncated prism, the lower slanting surface of which is disposed in engagement with the bars 64 of the commutator. The brush 61 is slidably mounted in brackets 65, only one of which is shown, which are secured to a brushholder 66.

In order to render the brushholder 66 substantially free from distortion due to heat flow thereto from the brush 61 and the commutator bars 64, it is formed as a single integral piece, as illustrated, of massive construction. The material of which it is formed is preferably of bronze which readily permits the flow of heat therethrough. The brushholder 66 is arranged to be rigidly mounted on a rectangular support rod 67 which is preferably constructed of steel rod to provide a very rigid mounting for the brushholder 66. As shown, the center of the support rod 67 is as close to the surface of the commutator bars 64 as physical limitations will permit. That is, the center of the support rod 67 is located at a distance from the axis of the commutator of which the bars 64 are a part, which is slightly greater than the radius of the commutator. In addition, the support rod 67 is mounted as close as physical limitations will permit to the trailing edge 68 of the brush 61. For example, in a construction which we have employed with highly satisfactory results, the axis of the support rod 67 has been located one-half inch radially from the surface of the commutator bars 64 and in a plane three-quarter inch from the center of the contact surface of the brush 61. As a result, the radius about which the brush 61 is permitted to turn in the cocking action which is caused due to a distortion of the brushholder 66 is reduced to a minimum.

As shown, the brushholder 66 is provided with a serrated surface 69 which is arranged to engage one side of the rectangular support rod 67. An adjusting screw 70 is provided to apply the necessary retaining force to secure the brushholder 66 in the desired position.

The brush 61 is held in engagement with the commutator bars 64 by means of a hammer 71 which is pivoted at 72. A spring 73 is provided for applying the required biasing force. Notches 74 are provided in the hammer 71 to permit the spring 73 to be adjusted for applying varying pressure to the brush 61.

It will be observed that the lever arm of the hammer 71 is as short as is consistently possible with physical limitations. It will further be observed that the pivot point 72 of the hammer 71 is located above the center of the supporting rod 67. There is, therefore, a minimum of distortion and resulting cocking action of the brush 61 due to variations in the physical dimensions of the hammer 71 caused by heat flow therethrough.

Since the brushholder 66 is of unitary massive construction, the heat flow therethrough will be substantially uniform and no part thereof will be heated to a higher temperature than any other part. As a result, there is substantially no distortion thereof due to unequal heat flow therethrough. Furthermore, the location of the support rod 67, as illustrated and described herein, is such that any distortion of the brushholder 66 that does exist will produce a minimum of cocking action in the position of the brush 61. When it is recalled that a shifting of the trailing edge 68 of the brush 61 from engagement with the commutator bar 65 to the slight extent of .0001 inch is sufficient to cause a marked shift in the center of the current sheet flowing across the face of the brush 61, it will be appreciated that the cocking action of the brush 61 must be reduced to substantially zero. This result has been satisfactorily accomplished by the use of the brushholder arranged and constructed as illustrated in Fig. 13.

It will be understood that in actual practice two or more brushes 61 are provided individual to each field pole, and, therefore, that each set of

brushes individual to a field pole will be provided with suitable brush riggings. However, for the purposes of illustration, only a single brush-holder and brush have been illustrated in detail.

Since certain further changes may be made in the foregoing construction and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter set forth in the foregoing description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for reducing the excitation applied to said field poles for reducing the speed of the elevator car to a very low speed preparatory to stopping it at a floor; a plurality of brush sets, each brush set being individual to a field pole; and support means for maintaining said brush sets in substantially uniform contact engagement with said commutator and in a predetermined relation relative to said field poles regardless of the temperature of said support means under operating conditions, thereby preventing substantially any compounding action in said second dynamo-electric device due to brush shift when the elevator car is operated at said very low speed.

2. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for reducing the excitation applied to said field poles for reducing the speed of the elevator car to a very low speed preparatory to stopping it at a floor; a plurality of brush sets, each brush set being individual to a field pole; and means for maintaining the effective center of current flow through each of said brush sets in a predetermined relation relative to the field pole individual thereto under substantially all operating conditions, thereby preventing substantially any compounding action in said second dynamo-electric device due to brush shift when the elevator car is operated at said very low speed, said last named means comprising a brush rigging individual to each brush set having its center of support in proximity to said commutator and the trailing edges of the brush set individual thereto.

3. In a system in which an elevator car is operated in hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for reducing the excitation applied to said field poles for reducing the speed of the elevator car to a very low speed preparatory to stopping it at a floor; a plurality of brush sets, each brush set being individual to a field pole; and means for maintaining the effective center of current flow through each of said brush sets in a predetermined relation relative to the field pole individual thereto under substantially all operating conditions, said last named means comprising a brush rigging individual to each brush set having its center of support located at a distance from the axis of rotation of said commutator slightly greater than the radius thereof, thereby preventing substantially any brush shift and resulting compounding action in said second dynamo-electric device due to change in operating temperature of said brush riggings when the elevator car is operated at said very low speed.

4. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for reducing the excitation applied to said field poles for reducing the speed of the elevator car to a very low speed preparatory to stopping it at a floor; a plurality of brushes, each brush being individual to a field pole; and means for maintaining the effective center of current flow through each of said brushes in a predetermined relation relative to the field pole individual thereto under substantially all operating conditions, said last named means comprising a brushholder of unitary, massive construction individual to each brush having its center of support located at a distance from the axis of rotation of said commutator slightly greater than the radius thereof, thereby preventing substantially any brush shift and resulting compounding action in said second dynamo-electric device due to change in operating temperature of said brushholders when the elevator car is operated at said very low speed.

5. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for reducing the excitation applied to said field poles for reducing the speed of the elevator car to a very low speed preparatory to stopping it at a floor; a plurality of brushes, each brush being individual to a field pole; and means for carrying said brushes in contact engagement with said commutator at neutral points therealong, said last named means being substantially free from distortion due to change in operating temperature thereof, thereby preventing substantially any compounding action in said second dynamo-electric device resulting from brush shift from said neutral points when the elevator car is operated at said very low speed.

6. In a system in which an elevator car is operated in a hatchway past a plurality of floors,

in combination, a direct current motor having an armature in driving connection with the elevator car, a direct current generator having an armature connected in loop circuit relation to said motor armature, driving means for said generator armature, means for exciting said generator to operate said car at a speed above one thousand feet per minute, and means for reducing the excitation of said generator to operate the elevator car at a speed less than fifty feet per minute preparatory to stopping it at a floor, said generator being characterized by the provision of brushholders disposed to support the brushes with substantially no brush shift from the neutral points regardless of heat flow to said brushholders from the brushes and commutator, thereby reducing to a minimum the compounding action in said generator caused by brush shift from said neutral points when the elevator car is operated at the lower speed.

7. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a direct current motor having an armature in driving connection with the elevator car, a direct current generator having an armature connected in loop circuit relation to said motor armature, driving means for said generator armature, means for exciting said generator to operate said car at a speed above one thousand feet per minute, and means for reducing the excitation of said generator to operate the elevator car at a speed less than fifty feet per minute preparatory to stopping it at a floor, said generator being characterized by the provision of brushholders rigidly mounted at a distance from the axis of rotation of the commutator slightly greater than the radius thereof for supporting the brushes at the neutral points around the commutator, said brushholders being substantially free from distortion due to heat flow from the brushes and commutator, whereby the compounding action in said generator caused by brush shift from said neutral points is reduced to a minimum when the elevator car is operated at the lower speed.

8. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a direct current motor having an armature in driving connection with the elevator car, a direct current generator having an armature connected in loop circuit relation to said motor armature, driving means for said generator armature, means for exciting said generator to operate said car at a speed above one thousand feet per minute, and means for reducing the excitation of said generator to operate the elevator car at a speed less than fifty feet per minute preparatory to stopping it at a floor, said generator being characterized by the provision of brushholders rigidly mounted at a distance from the axis of rotation of the commutator slightly greater than the radius thereof for supporting the brushes at the neutral points around the commutator, said brushholders being of unitary, massive construction thereby being substantially free from distortion due to heat flow from the brushes and commutator, whereby the compounding action in said generator caused by brush shift from said neutral points is reduced to a minimum when the elevator car is operated at the lower speed.

9. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a direct current motor having an armature in driving connection with the elevator car, a direct current generator having an armature connected in loop circuit relation to said motor armature, a commutator for said generator armature, driving means for said generator armature, means for exciting said generator to operate said car at a speed above one thousand feet per minute, means for reducing the excitation of said generator to operate said car at a speed less than fifty feet per minute preparatory to stopping it at a floor, a plurality of brushes disposed at the neutral points around said commutator, and brushholders for carrying said brushes and disposed to maintain the centers of the current sheet across the faces of said brushes substantially at said neutral points regardless of the heat flow thereto from said brushes and commutator, said brushholders being characterized by being of unitary, massive construction and rigidly mounted at a distance from the axis of rotation of said commutator slightly greater than the radius thereof.

10. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for automatically reducing the excitation applied to said field poles in response to a call at a floor for reducing the speed of the elevator car to a very low speed preparatory to stopping it at the floor where the call is registered; a plurality of brush sets, each brush set being individual to a field pole; and support means for maintaining said brush sets in substantially uniform contact engagement with said commutator and in a predetermined fixed relation relative to said field poles regardless of the temperature of said support means under operating conditions, thereby preventing substantially any compounding action in said second dynamo-electric device due to shifting of the centers of the current sheet across the faces of said brush sets from the neutral points of said commutator when the elevator car is operated at said very low speed.

11. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for automatically reducing the excitation applied to said field poles in response to a call at a floor for reducing the speed of the elevator car to a very low speed preparatory to stopping it at the floor where the call is registered; a plurality of brush sets, each brush set being individual to a field pole, and means for maintaining the centers of the current sheet across the faces of said brush sets at the neutral points of said commutator under substantially all operating conditions, thereby preventing substantially any compounding action in said second dynamo-electric device due to shift of the centers of said current sheet from said neutral points when the elevator car is operated at said very low speed, said last named

means comprising a brush rigging individual to each brush set having its center of support in proximity to said commutator and the trailing edges of the brush set individual thereto.

12. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for automatically reducing the excitation applied to said field poles in response to a call at a floor for reducing the speed of the elevator car to a very low speed preparatory to stopping it at the floor where the call is registered; a plurality of brush sets, each brush set being individual to a field pole; and means for maintaining the centers of the current sheet across the faces of said brush sets at the neutral points of said commutator under substantially all operating conditions, said last named means comprising a brush rigging individual to each brush set having its center of support located at a distance from the axis of rotation of said commutator slightly greater than the radius thereof, thereby preventing substantially any shifting of the centers of said current sheet from said neutral points and resulting compounding action in said second dynamo-electric device due to change in operating temperature of said brush riggings when the elevator car is operated at said very low speed.

13. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for automatically reducing the excitation applied to said field poles in response to a call at a floor for reducing the speed of the elevator car to a very low speed preparatory to stopping it at the floor where the call is registered; a plurality of brushes, each brush being individual to a field pole; and means for maintaining the centers of the current sheet across the faces of said brushes at the neutral points of said commutator under substantially all operating conditions, said last named means comprising a brushholder of unitary, massive construction individual to each brush having its center of support located at a distance from the axis of rotation of said commutator slightly greater than the radius thereof, thereby preventing substantially any shift of the centers of said current sheet from said neutral points and resulting compounding action in said second dynamo-electric device due to heat flow to said brushholders from said brushes and commutator when the elevator car is operated at said very low speed.

14. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a first dynamo-electric device having an armature in driving connection with the elevator car, a second dynamo-electric device provided with an armature having a commutator connected in loop circuit relation to said first named armature and a plurality of field poles, means for exciting said field poles to operate the elevator car at high speed, means for automatically reducing the excitation applied to said field poles in response to a call at a floor for reducing the speed of the elevator car to a very low speed preparatory to stopping it at the floor where the call is registered; a plurality of brushes, each brush being individual to a field pole; and means for carrying said brushes in contact engagement with said commutator, the centers of the current sheet across the faces of said brushes being located substantially at the neutral points along said commutator, said last named means being substantially free from distortion due to heat flow thereto from said brushes and commutator, thereby preventing substantially any compounding action in said second dynamo-electric device resulting from shift of said centers of said current sheet from said neutral points when the elevator car is operated at said very low speed.

15. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a direct current motor having an armature in driving connection with the elevator car, a direct current generator having an armature connected in loop circuit relation to said motor armature, driving means for said generator armature, means for exciting said generator to operate said car at a speed above one thousand feet per minute, and means for automatically reducing the excitation of said generator in response to a call at a floor to operate the elevator car at a speed less than fifty feet per minute preparatory to stopping it at the floor where the call is registered, said generator being characterized by the provision of brushholders disposed to support the brushes with substantially no shifting of the centers of the current sheet across the faces of said brushes from the neutral points regardless of heat flow to said brushholders from the brushes and commutator, thereby reducing to a minimum the compounding action in said generator caused by shift of said centers of said current sheet from said neutral points when the elevator car is operated at the lower speed.

16. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a direct current motor having an armature in driving connection with the elevator car, a direct current generator having an armature connected in loop circuit relation to said motor armature, driving means for said generator armature, means for exciting said generator to operate said car at a speed above one thousand feet per minute, and means for automatically reducing the excitation of said generator in response to a call at a floor to operate the elevator car at a speed less than fifty feet per minute preparatory to stopping it at the floor where the call is registered, said generator being characterized by the provision of brushholders rigidly mounted at a distance from the axis of rotation of the commutator slightly greater than the radius thereof for supporting the brushes around the commutator in such manner that the centers of the current sheet across the faces of said brushes substantially coincide with the neutral points of said commutator, said brushholders being substantially free from distortion due to heat flow from said brushes and commutator, whereby the compounding action in said generator caused by shifting of said centers of said current sheet from said neutral points is reduced

to a minimum when the elevator car is operated at the lower speed.

17. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a direct current motor having an armature in driving connection with the elevator car, a direct current generator having an armature connected in loop circuit relation to said motor armature, driving means for said generator armature, means for exciting said generator to operate the elevator car at a speed above one thousand feet per minute, and means for automatically reducing the excitation of said generator in response to a call at a floor to operate the elevator car at a speed less than fifty feet per minute preparatory to stopping it at the floor where the call is registered, said generator being characterized by the provision of brushholders rigidly mounted at a distance from the axis of rotation of the commutator slightly greater than the radius thereof for supporting the brushes around the commutator in such manner that the centers of the current sheet across the faces of said brushes substantially coincide with the neutral points of said commutator, said brushholders being of unitary, massive construction, thereby being substantially free from distortion due to heat flow from said brushes and commutator, whereby the compounding action in said generator caused by shifting of said centers of said current sheet from said neutral points is reduced to a minimum when the elevator car is operated at the lower speed.

18. In a system in which an elevator car is operated in a hatchway past a plurality of floors, in combination, a direct current motor having an armature in driving connection with the elevator car, a direct current generator having an armature connected in loop circuit relation to said motor armature, a commutator for said generator armature, driving means for said generator armature, means for exciting said generator to operate said car at a speed above one thousand fet per minute, means for automatically reducing the excitation of said generator in response to a call at a floor to operate the elevator car at a speed less than fifty feet per minute preparatory to stopping it at the floor where the call is registered, a plurality of brushes disposed at the neutral points around said commutator, and brushholders for carrying said brushes and disposed to maintain the centers of the current sheet across the faces of said brushes substantially at said neutral points regardless of the heat flow thereto from said brushes and commutator, said brushholders being characterized by being of unitary, massive construction and rigidly mounted at a distance from the axis of rotation of said commutator slightly greater than the radius thereof.

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