Feb. 6, 1940. G. C. BROWN 2,189,193

ELEVATOR CONTROLLER

Filed June 5, 1936

Fig. 1

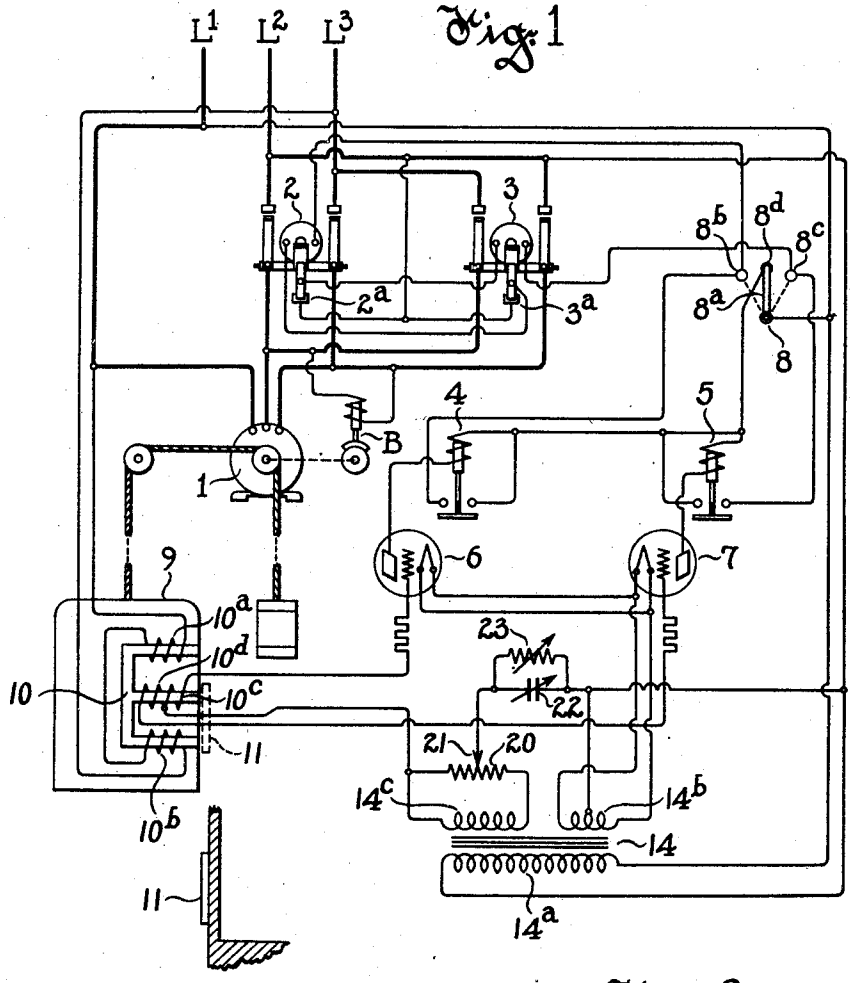


Fig. 2

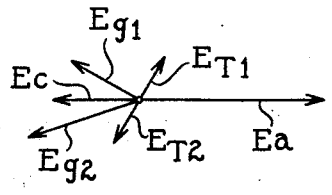
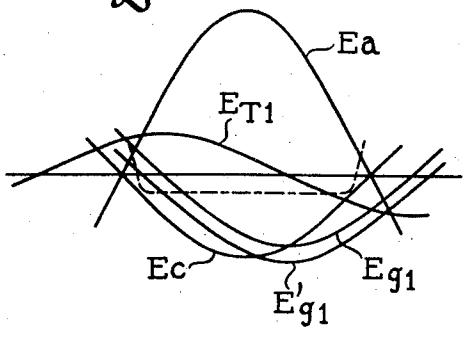


Fig. 3



Inventor
Glendon C. Brown
By Frank H. Hubbard
Attorney

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2,189,193

ELEVATOR CONTROLLER

Glendon C. Brown, Wauwatosa, Wis., assignor to Cutler-Hammer, Inc., Milwaukee, Wis., a corporation of Delaware

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2 Claims. (Cl. 172—239)

This invention relates to control systems for reciprocable mechanisms such as electric elevators and the like and particularly to means for stopping and maintaining the mechanism in registry with any of several selected stopping points.

In Patent No. 1,961,133, I have described such an improved automatic leveling system for elevators and the like employing electronic tubes and providing for automatic leveling of the elevator car when it is within a given distance from the landing at which it is to be stopped. The system described in the aforementioned patent includes an elevator controller which may be of any of the conventional types and in addition, mounted on the elevator car, an electromagnetic balance whose magnetic circuit is closed by an armature mounted in the hatchway in such a manner that the reluctance of the magnetic circuit is a minimum when the car is exactly level with a landing and that the reluctances of two parallel branches of the magnetic circuit differ from each other when the car is near a landing but not exactly at its level. A voltage induced in a coil subjected to the flux of said balance is a measure of the departure of the car from the desired level and affects the reversing controller to cause leveling of the car.

To influence the reversing controller, the voltage induced in the coil aforementioned is caused to affect the impedance of two electronic tubes which are connected to the forward and reverse switches of the elevator controller, respectively, by influencing their grid potential.

It has been found that with the aforementioned system under certain conditions the voltage variation obtainable to affect the grid voltage of the tubes is not sufficiently great to obtain the desired accuracy of leveling while the unavoidable inductance in the grid circuit also reduces the sensitivity of response and the present invention has for its object to overcome the aforementioned influence and to make the grid control more sensitive to the position of the elevator car. To accomplish this result it is proposed to provide an energy storage discharge circuit connected into the grid circuit in such a manner that the energy storage circuit accumulates a charge which impresses on the grid a potential which is negative with respect to the cathodes of the tubes during their conducting half cycle, which negative bias combines with the other voltages impressed upon the grid circuits.

The accompanying drawing illustrates the invention in connection with a single speed elevator driven by a three-phase squirrel cage motor.

In the drawing,

Figure 1 is a diagram of such an elevator system,

Figure 2 is a vector diagram of certain voltages of the controller illustrated in Figure 1, and

Figure 3 is a diagram of the relations of the instantaneous voltages of one of the electron tubes.

Referring to the drawing, L^1, L^2 and L^3 are the terminals of a three-phase current supply system. 1 is a squirrel cage induction motor which may be reversibly connected to the lines through the electromagnetic switches 2 and 3. An electromagnetic brake B is provided in the usual manner. The switches 2 and 3 are provided with normally open main contacts for reversibly connecting the motor to the line when the respective switch is energized and normally closed auxiliary contacts 2^a and 3^a respectively, which insure in the usual manner, that only one of the switches 2 and 3 may be energized at a time. The controller also includes two electromagnetic relays 4 and 5, each provided with a winding and a normally open contact, such contacts being connected in circuit with the windings of switches 2 and 3 respectively. In series with the windings of the relays 4 and 5, are gaseous electronic discharge tubes 6 and 7, respectively, each having a cathode, an anode and a grid. The cathodes may be of the heated type and supplied with current from the secondary winding 14^b of a transformer 14, the latter having a primary winding 14^a and an additional secondary winding 14^c. The primary winding 14^a is connected across the lines L^1 and L^2. An elevator car switch 8 provided with a contact lever 8^a and stationary contacts 8^b and 8^c provides for the selective energization of the switches 2 and 3 for reversing the motor connections, while stationary contact 8^d is engaged by the lever 8^a when the car switch is in the neutral or "off" position.

The motor drives an elevator cage 9. Mounted on the cage is an E-shaped transformer core 10 having on its outer legs windings 10^a and 10^b respectively, and on its central leg windings 10^c and 10^d. Mounted in the hatchway and coplanar with the face of the transformer 10 are armatures 11, one of such armatures being provided for each floor landing where it is desired to obtain automatic leveling of the car. When

an armature 11 is opposite the magnet core 10 it reduces the reluctance of the transformer and thus increases the electromagnetic coupling between the coils 10^a or 10^b on the one hand and the contral coils 10^c and 10^d on the other hand. The coils 10^a and 10^b are connected in series across the lines L^1 and L^2 and they are wound in such a manner that the fluxes which they induce in the central leg cancel each other so as to normally produce no resultant flux passing therethrough. On the other hand, if an armature 11 bridges only one outer leg and the center leg as indicated in dotted lines in Figure 1 a flux passes through the lower and central legs which induces a voltage of a certain phase relation with respect to the voltage of the coils 10^a and 10^b in the coils 10^c and 10^d whereas, if the armature should bridge the upper and the center legs, a voltage is induced in the coils 10^c and 10^d which is opposed in phase to the first mentioned induced voltage. The two coils 10^c and 10^d are so connected to the grids of the tubes 6 and 7 that they impress upon them voltages with respect to their cathodes which are opposed in phase to each other.

The common terminal of the coils 10^c and 10^d is connected to one terminal of the transformer winding 14^c. This transformer winding is shunted by a resister 20 having an adjustable contact 21 which latter in turn is connected through an adjustable condenser 22 and the parallel adjustable resistance 23 to the center tap of the transformer winding 14^b and thus to the cathodes of the tubes 6 and 7 respectively. Thus an adjustable portion of the voltage of winding 14^c may be super-imposed upon the voltages of the coils 10^c and 10^d, and the resultant voltage induced is impressed between the grids and the cathodes of tubes 6 and 7 respectively.

I shall now explain the operation of the system when the car approaches a landing and the switch 8 is moved to the center position, so as to complete circuit through contact 8^d.

Referring to Figure 2, it will be seen that E^a is the voltage impressed between the cathode and the anode of the tubes 6 and 7. E^c is the voltage impressed in the circuit between the cathodes and the grids of the two tubes by the transformer winding 14^c, while E_{T1} and E_{T2} are the voltages impressed upon the same circuit by the transformer windings 10^c and 10^d respectively. The values of the latter depend upon the position of the armature 11. The resultants of the voltages E^c and E_{T1} or E_{T2}, are the voltages E_{G1} and E_{G2}, respectively.

Referring to figure 3 in which the instantaneous voltages for one of the tubes are illustrated it will be noticed that E_{G1} is more positive than the critical voltage at the moment when E^a becomes positive and thus the respective tube would start conducting at the beginning of the anode positive half cycle and continue to conduct during that entire half cycle, but due to the inductance of its respective coil 4 or 5, in series with the anode circuit, such conduction continues for some time during the succeeding anode negative half cycle. This conduction during the anode negative half cycle provides a low resistance path for a charging current from the cathode to the grid, while the voltage E_{G1} is positive and this current puts a charge on that plate of the condenser conductively connected to the grid, which is more negative than the charge which would result if the tube were not conducting during part of the anode negative half cycle, the potential depending upon the adjustment of the condenser 22 and the resistance 23. This charge combines with the potential E_{G1} to result in an effective grid potential E^1_{G1}. It will be observed that the negative charge supplied to the condenser by the tube constantly tends to discharge through the resistance 23, especially also during the succeeding grid negative half cycle but by proper proportioning of the latter and of the condenser 22 the charge still remaining on the condenser is sufficient to reduce the grid potential to a value which at the beginning of the next anode positive half cycle requires a lesser change in E_{T1} to determine whether or not the tube starts conducting. Thus a smaller variation in the position of the armature 11 with respect to the frame 10 is required to determine whether the tube is conducting or non-conducting, thereby resulting in more accurate leveling. The voltage of the condenser also increases the voltage E_{G2} impressed upon the grid of the other tube to a value which shall be called E^1_{G2}.

It will further be noticed that with the armature positioned as aforementioned, the voltage E_{G2} is lagging behind the voltage E^a by a very large phase angle, so that it is negative during substantially the entire positive half cycle. Hence the other tube is prevented from conducting. For the best results the voltages E^c should be relatively low, as then a small variation in E_{T1} will cause a great variation of E_{G1} and E^1_{G1}, while with a relatively low voltage E^c the phase shift of E_{G2} is increased, which is also desirable for maximum sensitivity.

The equipment as a whole operates in the following manner. If the operator wishes to direct the car in a downward direction he throws the lever 8^a to the left, thereby energizing the magnet switch 2 and connecting the motor primary to the line. As the car approaches the desired level the operator releases the lever 8^a permitting it to move to the central position thereby interrupting the circuit through the winding of the switch 2 and disconnecting the motor from the line, while at the same time current supplied to the brake B is interrupted and the car stops. However, if at that moment the car is in such a position that the armature 11 is located relative to the magnet core 10 as indicated by dotted lines in Figure 1, a voltage E_{T1} is induced in the winding 10^c of such polarity and magnitude that at the beginning of the positive half cycle the resultant grid voltage E^1_{G1} is sufficiently positive to permit tube 6 to become conducting. Thus current is supplied to the relay 4 which closes its contact and energizes the magnet switch 2. The motor is therefore energized and the elevator is moved downward until the magnet core 10 is substantially symmetrical with respect to the armature 11. In this position substantially no voltage is induced in the winding 10^c and therefore the grid potential E^1_{G1} lags substantially 180 degrees behind the plate potential and is negative during the entire positive half cycle because the only alternating potential in the grid circuit is that from the transformer winding 14^c. In addition the instantaneous grid potential is made still more negative by the negative bias derived from the energy storage circuit aforesaid. Under these conditions no current flow is established during substantially the entire positive half cycle of the tube 6 and the relay 4 is de-energized thereby de-energizing the switch 2 and disconnecting the motor. The grid and plate voltage magni-

tudes and relations of tube 7 are under these conditions obviously the same, so that tube 7 is also nonconducting.

If the elevator in its downward travel aforedescribed should over run the landing, the armature 11 will bridge between the center and the upper leg of the transformer 10 and under these conditions the voltage E^c of the winding 14c combines with a voltage E_{T2} of the coil 10d 180 degrees displaced from the position shown in Figure 2 to produce correspondingly displaced grid voltages E_{G2} and E^1_{G2}, respectively, which affect the grid of tube 7 in a manner similar to the effect described in connection with tube 6 and the elevator motor is re-energized until the car is level with the landing.

What I claim as new and desire to secure by Letters Patent is:

1. The combination with a reciprocable mechanism, a motor for driving said mechanism, an alternating current source, electro-magnetic reversing means, and switch means for controlling the operation of the mechanism between selected points of its path, of registering means connected in circuit with said reversing means when said switch means are in the "off" position and the mechanism is near a selected point, including a gaseous electronic discharge tube having a cathode and a grid, a transformer having relatively movable parts one part mounted on the mechanism and another part located at a selected point and adjacent to the path of the first part, said transformer having a primary winding connected to said source and a secondary winding arranged to have induced therein a voltage which varies in accordance with the position of the mechanism relative to the selected point, a supply of constant voltage, an electric energy storage circuit connected between said cathode and said grid to be charged to a given voltage by a current flowing therebetween and varying in response to an operating condition of said tube, and means to impress a voltage which is the resultant of said given voltage, said constant voltage and said varying voltage upon said grid of said tube to control said motor to effect registry of said mechanism.

2. The combination with a reciprocable mechanism, a motor for driving said mechanism, an alternating current source, electromagnetic reversing means and switch means for controlling the operation of said mechanism between selected points of its path, of registering means connected in circuit with said reversing means when said switch means are in the "off" position and the mechanism is near a selected point, including two gaseous electron discharge tubes, one for each direction of operation of said mechanism, each of said tubes having a cathode and a grid, a transformer having relatively movable parts, one part mounted on the mechanism and the other part located at a selected point and adjacent to the path of the first part, said transformer having a primary winding connected to said source and a secondary winding arranged to have induced therein a voltage whose magnitude and phase varies in accordance with the position of the mechanism relative to the selected point, a supply of constant voltage, an electric storage circuit connected between said cathodes and said grids to be charged to a given voltage by a current between said cathodes and said grids and varying in response to an operating condition of said tubes, and means to impress a voltage which is the resultant of said given voltage, said constant voltage and said varying voltage upon said grids of said tubes to thereby control said motor to effect registry of said mechanism.

GLENDON C. BROWN.