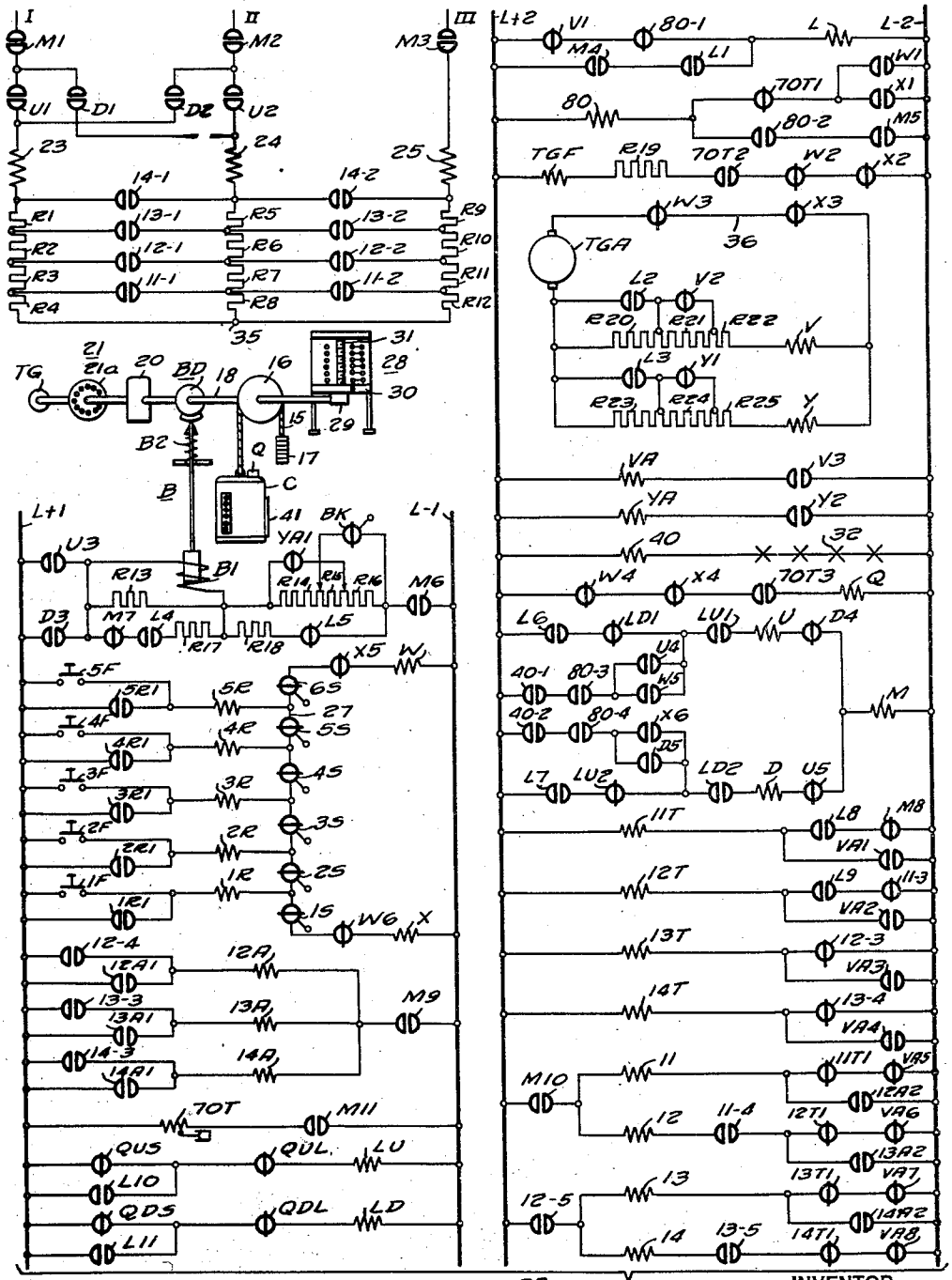
Jan. 21, 1947. D. SANTINI 2,414,562

ELEVATOR LEVELING SYSTEM

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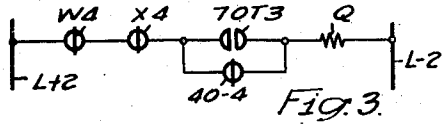


Fig. 3.



Fig. 2.

Fig. 1.

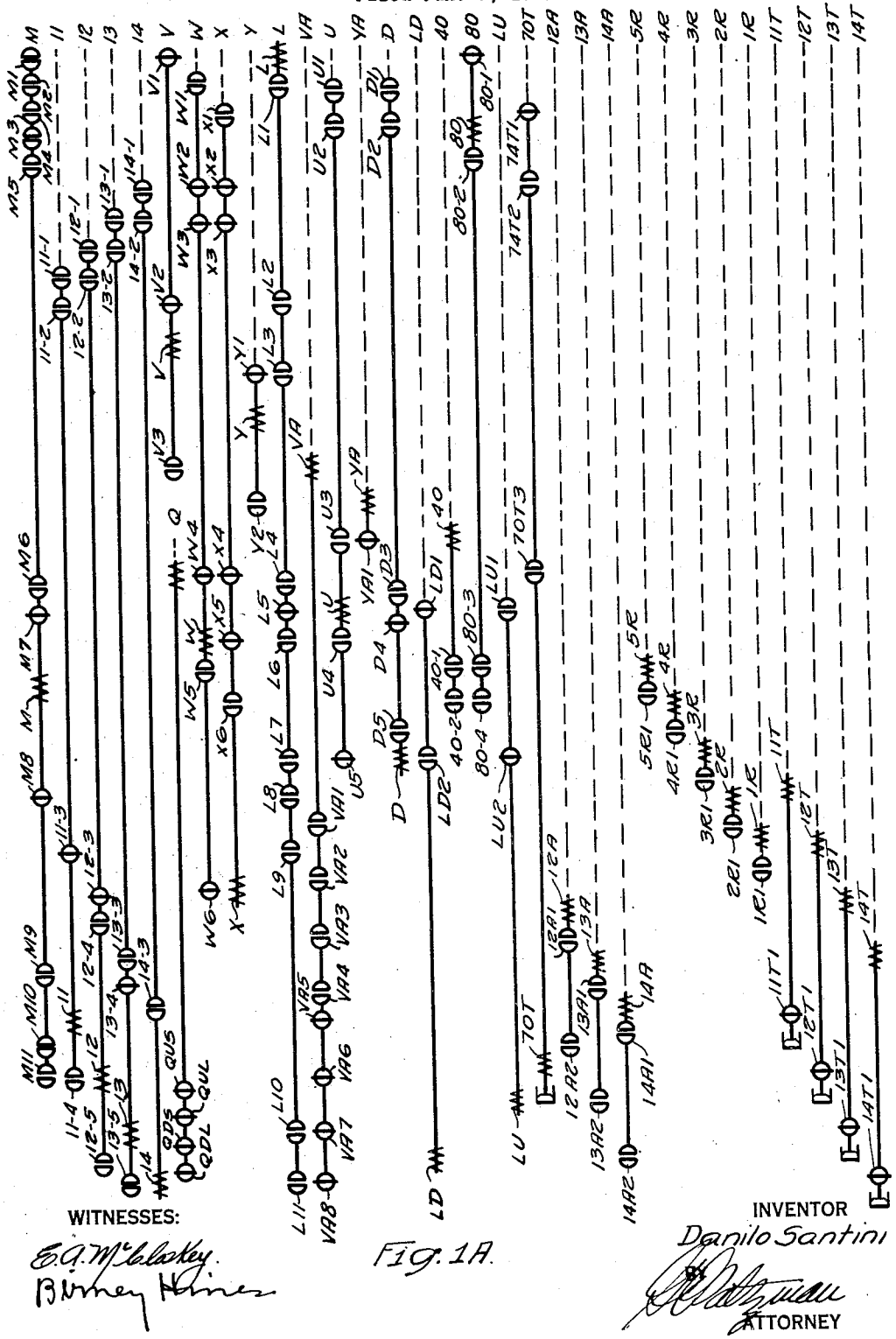
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Jan. 21, 1947. D. SANTINI 2,414,562

ELEVATOR LEVELING SYSTEM

Filed June 9, 1945 2 Sheets-Sheet 2



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Fig. 1A.

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UNITED STATES PATENT OFFICE

2,414,562

ELEVATOR LEVELING SYSTEM

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Application June 9, 1945, Serial No. 598,477

10 Claims. (Cl. 187—29)

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My invention relates to elevator control systems and more particularly to systems of this character which provide for leveling a car to a floor when it overruns or underruns that floor.

One object of the invention is to provide for accurately leveling a car, when it overruns or underruns a floor, at a predetermined satisfactory speed and stopping it level with the floor so that a second leveling operation will not be necessary.

Another object is to provide the hoisting motor of an elevator car with sufficient torque to set the car in motion in a leveling operation, but, once the motion is produced, to reduce the torque to a value sufficient to continue the movement of the car at the desired speed for leveling.

A further object is to prevent excessive speeds in leveling operations of the car and thereby prevent the necessity of additional leveling.

A further object is to provide for promptly restarting a car in case it should stall during a leveling operation.

A still further object is to provide for so controlling the brake during leveling operations as to cause it to softly and smoothly stop the car without any roughness in operation.

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

Figure 1 is a diagrammatic representation, in what is known as the straight line style, of an elevator system embodying my invention;

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

Fig. 2 is an enlarged view of the inductor relay mounted on the top of the car for stopping it at the floor level; and

Fig. 3 presents a modified form of the circuit for the inductor relay Q.

The following relays are included in the drawings:

U=up direction switch
D=down direction switch
W=up direction relay
X=down direction relay
M=car running relay
80=call indicating relay
B=brake coil
LU=up stopping relay
LD=down stopping relay
TG=tachometer or speed measuring relay
V=low speed responsive relay

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VA=auxiliary low speed responsive relay
Y=predetermined high speed responsive relay
YA=auxiliary high speed responsive relay
L=leveling relay
40=door relay
10T=noninterference time relay
5R=call registering relay
4R=call registering relay
3R=call registering relay
2R=call registering relay
1R=call registering relay
11=accelerating contactor
12=accelerating contactor
13=accelerating contactor
14=accelerating contactor
11T=time relay for accelerating contactor
12T=time relay for accelerating contactor
13T=time relay for accelerating contactor
14T=time relay for accelerating contactor
12A=holding relay for the accelerating contactor
13A=holding relay for the accelerating contactor
14A=holding relay for the accelerating contactor

Referring more particularly to the drawings, I have illustrated an elevator car C as supported by a cable 15 which passes over a hoisting drum 16 to a suitable counterweight 17. The car is illustrated for use in connection with five floors, but it may be used for any desired number of floors.

The hoisting drum is mounted on a shaft 18 driven by an electric motor 21. A suitable gear reducing mechanism 20 connects the shaft 18 with the motor 21 to secure an appropriate speed for the car when the motor is in operation. The hoisting motor 21 is illustrated as a three-phase single speed alternating current motor comprising a rotor 21a and stator windings 23, 24, and 25 disposed to be connected to a suitable alternating current supply of energy represented by the conductors I, II and III for operating the car at a normal high speed of approximately one hundred feet per minute, although it may be designed for other speeds where desired.

An electromechanical brake B is provided for engaging a brake drum BD on the shaft 18 for stopping and holding the car at the floor landings. The brake may be the usual electromagnetic relay type of brake such as is provided with an electromagnetic coil B1 and a brake applying spring B2.

A high discharge resistor R13, a low discharge resistor R17, a series resistor R18 and a plurality of checking resistors R14, R15 and R16 are disposed in the circuit for the brake coil.

The high discharge resistor R13 is permanently

connected in shunt relation to the brake coil to permit a rapid flux decay when the brake coil is disconnected from its source of energy.

The low discharge resistor R17 is controlled by contacts of the car running relay M and the leveling relay L to be inserted in shunt with the brake coil when it is being deenergized during leveling operations to keep the brake from being too rough.

The series resistor R18 is controlled by back contacts on the leveling relay L to insure full energization of the brake coil while the car is running at high speed and also to cut down the current so it will not over-heat.

The checking resistors R15 and R16 are controlled by a brake operated switch BK to insure the brake picking up enough and quickly so a leveling operation can start without delay when the car in answering a stop call stops short of or beyond the floor. The switch BK is disposed to be opened by the brake when it is partially picked up to insert the resistors R15 and R16 so that the brake will be just on the verge of setting again.

The resistor R14, and also the resistor R15 at times, is connected for control by a pair of contacts YA1 to insert additional resistance in the brake circuit to partially apply the brake to prevent excessive leveling speeds during leveling operations, as will be hereinafter described.

A simple push-button system is provided for operating the motor to move the car and it includes a plurality of push buttons, one for each floor landing, disposed in the car for operation by a car attendant or passenger. When one of the push buttons is pressed, the car will, after its door is closed, move to and stop at the floor of the operated button. The push buttons are given the reference numerals 1F, 2F, 3F, 4F and 5F for the respective floors.

Associated with each push button is a call-registering relay which is electrically connected to a circuit 27 for causing the car to move in the up direction or in the down direction in accordance with the direction the car must move in response to the operation of a floor button.

In order to render the circuit 27 effective for the correct direction, a plurality of normally closed cam switches 1S, 2S, 3S, 4S and 5S are electrically connected between the floor points in the circuit and mounted on a floor selector 28 in position to be operated by a selector arm 30. The arm is operated in accordance with the movements of the car past the floors by a screw-threaded shaft 31 which is connected by a speed reducing gear 29 to the hoisting motor shaft 18. The cam switches 1S, etc., and the selector arm should be so designed that the switch for a floor will be opened when the car approaches within such a distance to the floor that it can be decelerated and stopped at the floor. However, the invention may be applied to any push-button control system where the push button starts the car, the selector determines when it should be stopped and a car carried inductor relay stops it.

The energy for operating the call registering relays, the direction switches, the car running relay and the other control apparatus is secured from a plurality of supply conductors L+1, and L−1 and L+2 and L−2 which may be connected to any suitable energy source.

An up direction relay W and a down direction relay X are connected to the respective ends of the circuit 27 for controlling an up direction switch U, a down direction switch D and the car running relay M which are used for connecting

the motor to the supply conductors I, II and III in accordance with the direction in which the car should move when a car button is pressed.

An inductor relay Q is provided for stopping the car when it arrives at a floor for which a push button, such as 3F, has been operated. The inductor relay Q includes an electroresponsive or energization coil and core with down stopping contacts QDS and up stopping contacts QUS and is mounted on the car in position to be operated, when energized through contacts of the direction relays W and X for a stop, by the influence of inductor plates of magnetic material mounted on the walls of the hatchway. The plates include an up-direction plate UP and a down-direction plate DP mounted on the hatchway wall at each floor for opening the inductor relay stopping contacts when the car brings the inductor relay opposite the plates at a floor in making a stop thereat. The plates may be of such length that the stopping contacts will be opened when the car is about nine inches from the floor level so that it may decelerate and drift in under the control of the brake to a stop at the floor. The brake should be so designed as to permit the car to drift a reasonable distance when it is applied while the car is running at its normal high speed.

The inductor relay is also provided with normally closed down leveling contacts QDL and normally closed up leveling contacts QUL, the operation and use of which will be described later herein.

Inductor relays of this character are old and well known in the art, but further information regarding them may, if desired, be secured from the White and Hearn Patent No. 1,889,446, issued October 25, 1932.

The inductor relay Q is used for controlling an up-stopping relay LU and a down-stopping relay LD, which are normally energized to maintain closed contacts in the circuits of the up-direction switch U and the down-direction switch D, so that when the inductor relay is energized and is moved opposite the inductor plates for a floor, its contacts are opened and thereby deenergize the stopping relay for the direction of the car, and it, in turn, opens its contacts in the circuit of the corresponding direction switch and thereby effects the stopping of the car.

In order to secure a desirable acceleration of the hoisting motor when the car starts, the stator windings 23, 24 and 25 are provided with a plurality of resistors R1 through R12. In starting the car on a floor-to-floor run, these resistors are short-circuited in timed steps to secure a desirable acceleration of the car.

A plurality of accelerating contactors 11, 12, 13 and 14 are provided for controlling the short-circuiting of these resistors and a plurality of relays 11T, 12T, 13T and 14T which have a time delay on dropping out are provided for causing operation of the accelerating contactors in timed sequence. The time delay of the relays is made very short, say, a few tenths of a second, so that the accelerating action will be comparatively rapid.

A plurality of holding relays 12A, 13A and 14A are provided for maintaining the contactors in an energized condition once they have been energized. The holding relays are set up by the contactors but are maintained by the running relay M and, when energized to hold a contactor, will remain energized until the power is cut off the motor.

The non-interference time delay relay 10T is

provided for insuring time for a complete stopping operation for the car before it starts on another floor run. It is connected to be energized when the car starts and to be deenergized when it begins to slow down for a stop. It has a drop-out delay after being deenergized of sufficient time to permit the car to level and also to permit opening of the car door before the car can restart on another trip.

A door safety relay **40** is provided for preventing operation of the car while either the car door **41** or a hatchway door (not shown) remains open. The door relay is controlled by a circuit which includes safety contacts **32** on each door which are closed only when that door is firmly closed.

In practicing my invention for leveling a car into a floor when it overruns or underruns that floor in making a stop thereat, I provide for controlling the hoisting motor by increasing its torque in timed steps until it overcomes the static friction of the car and its operating apparatus sufficiently to start the car and by then reducing the torque to a value just sufficient to keep the car moving at a slow leveling speed. It also includes means for partially applying the brake if the speed of the car during that leveling operation increases beyond a predetermined value.

The means I have provided for so controlling the motor and the brake during leveling operations comprises a leveling relay L, a pair of up leveling contacts QUL and a pair of down leveling contacts QDL on the stopping inductor relay, a speed measuring generator or tachometer TG, a low speed responsive relay V, an auxiliary low speed relay VA, a predetermined high speed responsive relay Y, and an auxiliary high speed relay YA.

The leveling relay L is provided for conditioning the control circuits to effect the leveling of the car with a landing floor when the car is to stop thereat but underruns or overruns the floor level. The leveling relay L is so controlled by the call indicating relay **80**, the car running relay M and the low speed relay V as to be energized for leveling purposes only after the car comes to rest on its first slow down movement into a floor. While the car is making a floor to floor run, the relay L remains unenergized. The back contacts of the relay V included in the circuit of the relay L keep it from being energized until the car comes to rest in making a stop from a floor to floor run.

The tachometer TG is supplied for controlling the low-speed relay V and the high-speed relay Y and is provided with an armature TGA and a field winding TGF. The field winding is connected across the supply conductors L+**2** and L—**2** by front contacts of the time-delay relay **70T** and by back contacts of the direction relays W and X.

The armature TGA is fixed on one end of the hoisting drum shaft **18** so it will be rotated by the hoisting drum whenever the car moves. The circuits of the low-speed relay V and the predetermined high-speed relay Y are electrically connected to the brushes of the armature TGA so that movement of the car may cause the tachometer TG to supply energy to the relay V and also to the relay Y in accordance with the speed of the car. However, both of the direction relays W and X have back contacts disposed in the circuits of the field winding TGF and the relays V and Y to prevent the tachometer from supplying current to the relays V and Y except during slow-down and leveling operations. This prevents

overheating and change of calibration due to heat.

The relay V should be so selected and adjusted that it will be energized sufficiently for operation by the tachometer TG to close its contact members V3 and open its contacts V**1** and V**2** whenever the car starts to move in a leveling operation; conversely, the relay V will open its contact members V3 and reclose its contact members V**1** and V**2** when the car stops movement in a leveling operation and thereby reduces the speed of the tachometer to zero. Obviously, the relay and generator may be designed and connected for any other speeds than starting speed where desired.

A resistor R**21** is disposed in the circuit of the relay V and controlled by its back contacts V**2** so that it will be inserted in series with the relay V when the relay picks up to cause it to remain just on the verge of dropping out again. Thus, a small decrease in speed of the car will lower the voltage of the tachometer TG and thereby cause the relay V to drop out.

A resistor R**20** is also disposed in the circuit of the relay V and is controlled by the contacts L**2** of the leveling relay L to prevent excessive currents to the coils V and Y when the car stops from a slow-down action.

The back contacts V**1** of the relay V are used to prevent operation of the leveling relay L until after the car actually stops in answering a stop call at a floor. That is, the leveling can not start until after the car actually slows down and comes to rest in answering a call at a floor.

The front contacts V3 are used for energizing the auxiliary slow-speed relay VA which, in turn, is used for increasing the amount of resistance in the hoisting motor circuit after it has been decreased sufficiently to cause the hoisting motor to overcome the static friction of the car and start it in motion, for the purpose of preventing an excessive increase in the speed of the car as the speed builds up to the desired leveling speed after the car starts during the leveling operation.

The relay VA effects this result by the use of its contacts VA**1** through VA**8** in the circuits of the accelerating contactors and the timing relay contactors.

If the car should stall during a leveling operation, the stopping of the tachometer TF will cause relay V to drop out and it, in turn, will drop out the relay VA so that the time-sequence relays and contactors will again start to short-circuit the resistors in the hoisting motor field winding until the car is again started, whereupon the relay V will again operate to effect the re-insertion of the last resistor short-circuited to get the car started, and thereby maintain the leveling speed of the car at the desired value after it starts.

The predetermined high-speed relay Y should be so selected and adjusted that it will become energized sufficiently by the tachometer TG to close its contacts Y**2** and open its contacts Y**1** whenever the car exceeds the predetermined speed selected as desirable for leveling operations. The contacts Y**1** are used for inserting the resistor R**24** in circuit with the relay Y, when the relay picks up, to cause it to remain just on the verge of dropping out again, so that a small decrease in the speed of the car in lowering the voltage of the tachometer TG will cause relay Y to drop out.

The front contacts Y**2** are used for energizing the auxiliary high-speed relay YA which is provided with back contacts YA**1** for inserting the resistors R**14** and R**15** in the circuit of the brake

coil B1 to reduce the strength of that coil and thus cause partial application of the brake if the car should exceed the selected desirable leveling speed. Thus, if the leveling speed becomes excessive because of an overhauling load, the relay Y picks up and decreases the energization of the brake coil to partially apply the brake and thus decrease the leveling speed.

The up leveling contacts QUL provided in the inductor relay Q are so disposed on the relay that they will, when the relay is energized, open when they are at the plate DP but close whenever the car drops approximately one-half inch below the floor level and thus moves them below the lower end of the down plate DP. Thus the contacts QUL provide part of the means for leveling the car upwardly when it is slightly below the floor.

The down leveling contacts QDL are so disposed on the inductor relay Q that they will, when the relay is energized, open when they are at the plate UP, close whenever the car moves approximately one-half inch above the level of the floor and moves them above the upper end of the plate UP. Thus the contacts QDL provide part of the means for leveling the car downwardly.

When either pair of contacts QUL or QDL is closed, it will energize the stopping relay for the corresponding direction to close contacts in the circuit of the direction switch for the corresponding direction and thus start the car. As soon as the car moves to its correct position with reference to the floor, the contacts QUL and QDL are opened to deenergize the relays LU and LD and thereby open the circuits for the up and the down direction switches to stop the car and prevent its further movement.

The leveling relay L is provided with contacts L10 and L11 which are disposed in parallel with the stopping contacts QUS and QDS to prevent them from having any effect on the operation of the car during leveling operations.

It is believed that the invention may be more readily understood from the following assumed operation of the apparatus.

It will be assumed that the car is standing at the lower floor, and that a passenger enters it, closes its doors and presses the third floor button to cause the car to move up to the third floor.

Inasmuch as the car has been standing at the lower floor and the timing relay 70T has timed out, the inductor relay Q is in a deenergized condition and, therefore, the contacts QUS, QUL, QDS and QDL are closed so that the up stopping relay LU is energized by L+1, QUS, QUL, LU, L—1, and the down stopping relay LD is energized by L+1, QDS, QDL, LD, L—1. The energized relays LU and LD have closed their contacts LU1 and LD2 and LD1 and LU2 in the circuits of the up switch U and the down switch D so that these switches are in condition to be energized for starting the car in either direction whenever the car button is operated and the doors are closed. Also, the leveling relay L and the timing relays 11T, 12T, 13T and 14T are in energized condition.

The closing of the doors energizes the door safety relay 40 by the circuit L+2, 40, 32, L—2. The energized relay 40 closes its contacts 40—1 and 40—2 thereby preparing the holding circuits of the up direction switch U and the down direction switch D for operation.

The operation of the third floor button 3F energizes the call registering relay 3R and the up direction relay W by the circuit L+1, 3F, 3R, 4S, 5S, 6S, X5, W, L—1. (Inasmuch as the car is standing at the lower floor, the selector cam contacts 1S are open, thereby preventing energization of the down direction relay X.) The energized relay 3R closes its contacts 3R1 thereby providing a self-holding circuit for itself which will remain undisturbed until the movement of the car causes the floor selector arm to open the floor selector contact 4S.

The energized up direction relay W closes its contacts W1 and W5 and opens its contacts W2, W3, W4 and W6. The opening of the contacts W2 will prevent energization of the field winding TGF, and the opening of the contacts W3 will prevent operation of the relays V and Y until the car starts to slow down for the next stop.

The opening of the contacts W4 will prevent energization of the inductor relay Q until the car arrives within stopping distance of the third floor. The closing of the contacts W5 further prepares the circuit of the up direction switch U for operation. The opening of the contacts W6 interlocks the down direction relay X to prevent its operation while the up direction relay W is energized.

The closing of the contacts W1 energizes the call indicating relay 80 by the circuit L+2, 80, 70T1, W1, L—2. The energized relay 80 closes its contacts 80—2, 80—3 and 80—4 and opens its contacts 80—1. The opening of the contacts 80—1 deenergizes the leveling relay L which thereupon opens its contacts L8 and L9 thus deenergizing the timing relays 11T and 12T which will time out when their time delay expires. The closing of the contacts 80—2 prepares a self-holding circuit for the relay 80. The closing of the contacts 80—4 has no effect, but the closing of the contacts 80—3 completes a circuit for energizing the up direction switch U and the car running relay M by the circuit L+2, 40—1, 80—3, W5, LU1, U, D4, M, L—2 to cause the car to move upwardly to the third floor. The energized relay M operates its contacts to condition the various circuits for car operation. In doing this, it closes its contacts M11 and thereby energizes the time-delay relay 70T by the circuit. L+1, 70T, M11, L—1. This relay will remain energized during the run of the car until the relay M is deenergized in a stopping operation.

The energized up switch U closes its contact members U1, U2, U3 and U4 and opens its contacts U5. The closing of the contacts U4 provides a self-holding circuit for the switch U. The closing of the contacts U3 energizes the brake coil B1 to release the brake by the circuit L+1, U3, B1, R18, L5, M6, L—1.

The closed contacts U1 and U2 connect the field windings 23, 24 and 25 to the supply conductors I, II and III by the circuits

I, M1, U1, 23, R1, R2, R3, R4 to a point 35;
II, M2, U2, 24, R5, R6, R7, R8 to the point 35; and
III, M3, 25, R9, R10, R11, R12 to the point 35.

The hoisting motor is now energized for starting the car from the landing floor and it is now accelerated because the deenergized timing relays 11T and 12T now time out and close their back contacts 11T1 and 12T1, thereby energizing the contactor 11 by the circuit L+2, M10, 11, 11T1, VA5, L—2, and preparing the contactor 12 for operation. The energized contactor 11 closes its contacts 11—1 and 11—2, thereby short-circuiting the resistors R4, R8 and R12 to accelerate the hoisting motor.

The energized relay 11 also closes its contacts 11—4, thus energizing the contactor 12 to close its contacts 12—1 and 12—2, thereby short-cir-

cuiting the resistors R3, R7 and R11, thus accelerating the hoisting motor still more. The energized contactor 12 also closes its contacts 12—4 and thereby energizes the holding relay 12A by L+1, 12—4, 12A, M9, L—1, which closes its self-holding contacts 12A1 and closes its contacts 12A2 to provide a holding circuit for the contactor 11.

The energized contactor 12 also closes its contacts 12—5 to prepare the contactors 13 and 14 for operation and at the same time opens its contacts 12—3 to deenergize the time delay relay 13T.

The relay 13T now times out and closes its back contacts 13T1 and thereby energizes the contactor 13 by the circuit L+2, 12—5, 13, 13T1, VA7, L—2, to close its contacts 13—1, 13—2, 13—3 and 13—5 and opens its contacts 13—4. The closing of the contacts 13—1 and 13—2 short-circuits the resistors R2, A6 and R10, thereby accelerating the hoisting motor still further.

The closing of the contacts 13—5 prepares the contactor 14 for operation. The opening of the contacts 13—4 deenergizes the timing relay 14T. The closing of the contacts 13—3 energizes the holding relay 13A by the circuit L+1, 13—3, 13A, M9, L—1.

The energized relay 13A closes its self-holding contacts 13A1 and also closes its contacts 13A2 to keep the contactor 12 in an energized condition.

The timing relay 14T now times out and closes its back contacts 14T1, thereby energizing the contactor 14 by the circuit L+2, 12—5, 14, 13—5, 14T1, VA8, L—2. The energized relay 14 closes its contacts 14—1 and 14—2 and thereby short-circuits the resistors R1, R5 and R9 in the field of the hoisting motor, thus further accelerating the hoisting motor. The closing of the contacts 14—3 energizes the holding relay 14A by the circuit L+1, 14—3, 14—A, M9, L—1. The energized relay 14A closes its self-holding contacts 14A1 and also closes its contacts 14A2 for maintaining the contactor 14 in its energized condition.

The car now accelerates to its full running speed and continues upwardly to the third floor. As it approaches the third floor at its normal running speed of approximately one hundred feet per minute, it causes the floor selector arm to move along the selector switches and engage and open the switch 4S for stopping the car at the third floor.

The opening of the switch 4S restores the call registering relay 3R to its normal condition and deenergizes the up-direction relay W, which thereupon opens its contacts W1 and W5 and closes its contacts W2, W3, W4 and W6. The closing of the contacts W4 energizes the inductor relay Q to effect the deenergization of the hoisting motor and the application of the brake when the car arrives at the up inductor plate for the third floor. The circuit through the relay Q extends L+2, W4, X4, 10T3, Q, L—2. The closing of the back contacts W2 energizes the tachometer field winding TGF by the circuit L+2, TGF, R19, 10T2, W2, X2, L—2. The closing of the contacts W3 closes the ring circuit 36 connected with the armature TGA of the tachometer for energizing the low speed relay V and the high speed relay Y. Inasmuch as the car is moving, the rotation of the hoisting shaft 18 rotates the armature TGA and sufficient current flows through the relays V and Y to energize them.

The energization of the high speed relay Y closes its contact members Y2, thus energizing the auxiliary high speed relay YA by the circuit L+2, YA, Y2, L—2. The energized relay YA opens its contacts YA1, thereby inserting the resistors R14 and R15 in the brake circuit but this has no effect at this time because of the circuit through L5.

The energization of the low speed relay V closes its contacts V3 and opens its contacts V1 and V2. The opening of the contacts V1 will prevent energization of the leveling relay L until the car actually stops for the third floor. The opening of the contacts V2 inserts the resistor R21 in circuit with the relay V to render it more sensitive to a decrease in the speed of the tachometer. The closing of the contacts V3 energizes the auxiliary low speed relay VA by the circuit L+2, VA, V3, L—2. The energized relay VA closes its contacts VA1, VA2, VA3 and VA4, and opens its contacts VA5, VA6, VA7 and VA8. The closing of the contacts VA1, VA2, VA3 and VA4 energizes the timing relays 11T through 14T to restore them to their normal energized condition ready for the next operation. The opening of the contacts VA5, VA6, VA7 and VA8 opens the starting circuits for the contactors 11, 12, 13 and 14, but they still remain energized because of the contacts of the holding relays 12A, 13A and 14A. Thus when the car running relay M is deenergized for the stop, the relays 12A, 13A and 14A will be deenergized so that the time relays, the contactors and the holding relays will be reset and ready for use in leveling.

As the car continues toward the third floor, it brings the inductor relay Q opposite the up plate UP and thereby opens the leveling contacts QDL which thereupon deenergize the down direction stopping relay LD, but, inasmuch as the relay LD is not effective in any circuit, nothing happens. As the car continues still nearer to the third floor, the up stopping contacts QUS come opposite the lower end of the up inductor plate UP and are thereby opened to deenergize the up stopping relay LU, which, in turn, opens its contacts LU1 and thereby deenergizes the up direction switch U and the car running relay M.

The deenergized up direction switch U opens its contacts U1 and U2 and thereby deenergizes the hoisting motor. It also opens its contacts U3 and thereby deenergizes the brake coil B1, thus applying the brake to stop and hold the car at the third floor. Inasmuch as the contacts U3, D3, M6 and L4 are open, the setting of the brake will be controlled by the discharge resistor R13. It may be noted that the brake is so designed and the inductor plates are so located that the car will normally drift a distance of approximately nine inches in slowing down and stopping at a floor.

The deenergized relay M opens its contacts M5 and thereby deenergizes the call indicating relay 80, which closes its back contacts 80—1 to prepare the leveling relay L for operation.

The opening of the contacts M11 deenergizes the timing relay 10T, which will open after the expiration of approximately three seconds.

The opening of the contacts M9 deenergizes the holding relays 12A, 13A and 14A, which in turn open their contacts 12A2, 13A2 and 14A2 and thereby deenergize the contactors 11, 12 and 13, and the deenergization of the contactor 12 opens its contacts 12—5 and thus deenergizes the contactor 14 so as to restore the accelerating resistors R1 through R12 to the circuits of the hoisting motor field windings.

As the car drifts into the stop, its speed decreases to the predetermined high speed point set

for the relay Y, that relay drops out and de-energizes the relay YA which in turn closes its back contacts YA1 and thereby short-circuits the resistors R14 and R15 in the circuit of the brake coil B1 to prepare the brake circuit for the next operation.

The car now stops its drift and stands still.

The car should stop level with the third floor landing, but it will be assumed that because of various operating conditions it overruns the third floor level so that the car floor is now above the third floor level.

The stopping of the car stops the armature TGA of the tachometer TG and it ceases to supply current to the low speed relay V, thereby de-energizing that relay.

The deenergized relay V closes its contacts V1 and V2 and opens its contacts V3. The closing of the contacts V2 shorts the resistor R21 in the circuit of relay V to make it easier for that relay to pick up when the tachometer starts.

The opening of the contacts V3 deenergizes the relay VA to open its contacts VA1, VA2, VA3 and VA4 in the circuits of the energized timing relays 11T, 12T, 13T and 14T to place their sequence of deenergization in the leveling operation under the control of the contacts M and the sequential operation of the contactors. At the same time, the relay VA closes its contacts VA5, VA6, VA7 and VA8 to prepare the contactors 11, 12, 13 and 14 for operation.

The closing of the contacts V1 energizes the leveling relay L by the circuit L+2, V1, 80—1, L, L—2. Thereupon the relay L closes its contacts L1, L2, L3, L6 through L11 and opens its contacts L5. The closed contacts L1 prepare a self-holding circuit for the relay L until the car is ready to make its next trip. The closed contacts L2 and L3 short circuit the resistors R20 and R23 in the circuits of the relay V and Y which were used to protect the coils V and Y from high voltage from the device TG when running at full speed.

The closing of the contacts L4 completes a circuit for the low discharge resistor R17 in the brake circuit to keep the brake from being too rough in leveling operations.

The closing of the contacts L8 and L9 reenergizes the timing relays 11T and 12T before they drop out under the opening action of contacts VA1 and VA2. The opening of the contacts L5 places the control of the brake under the circuit in which the resistors R14, R15 and R16 and contacts YA1 and BK are disposed, during the leveling period. Hence, all the timing relays remain in operated condition and ready for operation if leveling is necessary. At the same time it will be recalled that the contactors 11, 12, 13 and 14 are in deenergized condition and that hence the resistors R1 through R12 are all effectively connected in the field winding circuit of the hoisting motor.

The closing of the contacts L10 and L11 provides a shunt circuit around the stopping inductor contacts QUS and QDS, and thereby render effective only the leveling inductor contacts QUL and QDL during the leveling period.

The closing of the contacts L6 and L7 close the leveling connections for the up-direction switch U and the down-direction switch D so that they may be operated without regard to the operation of the direction relays W or X, the door relay 40 or the call indicating relay 80. Now that the leveling circuits to the direction switches are completed by the leveling relay L, the closed

condition of the leveling contacts QDL because they are above the up plate UP will energize the down-direction stopping relay LD which, in turn, closes its contacts LD2 and thereby energizes the down-direction switch D and the car conditioning relay M by the circuit L+2, L7, LU2, LD2, D, U5, M, L—2.

The energized switch D closes its contacts D1 and D2, thereby energizing the field windings of the hoisting motor and closes its contacts D3 to release the brake to move the car downwardly. We may assume that there is yet insufficient motor torque to start the motor.

At the same time, the energized relay M opens its contacts M8, thereby deenergizing the timing relay 11T, which after a delay of a few tenths of a second closes its back contacts 11T1 and thereby energizes the contactor 11 because the energized relay M has also closed its contacts M10.

The energized relay 11 closes its contacts 11—1 and 11—2, thereby short-circuiting the resistors R4, R8 and R12 to increase the torque of the hoisting motor. The energized relay 11 also opens its contacts 11—3 and thereby deenergizes the timing relay 12T which after a few tenths of a second times out and closes its back contacts 12T1, thereby energizing the contactor 12 which in turn closes its contacts 12—1 and 12—2 and thereby short-circuits the resistors R3, R7 and R11 to further increase the torque of the hoisting motor. We may assume that the motor still does not start. The energized contactor 12 also closes its contacts 12—4 thereby energizing the holding relay 12A to close its self-holding contacts 12A1 and also to close its contacts 12A2 for maintaining the contactor 11 in its energized condition.

The energized contactor 12 also opens its contacts 12—3 thus deenergizing the timing relay 13T which after a short time delay times out and closes its contacts 13T1 thereby energizing the contactor 13. The energized contactor 13 closes its contacts 13—1 and 13—2, thereby short-circuiting the resistors R2, R6 and R10 to still further increase the torque of the hoisting motor. The energized relay 13 also closes its contacts 13—3 and thereby energizes the holding relay 13A which in turn closes its self-holding contacts 13A1 and closes its contacts 13A2 for holding the contactor 12 in energized condition.

The energized contactor 13 also opens its contacts 13—4 and thereby deenergizes the timing relay 14T for operating the contactor 14, etc.

The torque now developed in the hoisting motor proves sufficient to overcome the static friction of the car and its apparatus and thereby causes the car to start downwardly. The starting of the car rotates the armature TGA of the tachometer TG and thereby energizes the now very sensitive low speed relay V to open its contacts V1 and V2 and close its contacts V3. The opening of the contacts V1 does not affect the leveling relay L because it has provided a self-holding circuit by means of its contacts L1. The opening of the contacts V2 inserts resistor R21 in the circuit of the relay V as hereinbefore described. The closing of the contacts V3 energizes the auxiliary low speed relay VA which now closes its contacts VA1, VA2, VA3 and VA4 for reenergizing the timing relays 11T, 12T, 13T and 14T, and at the same time opens its contacts VA5, VA6, VA7 and VA8 to place the contactor relays 11, 12, 13 and 14 solely under the control of the holding relays 12A, 13A and 14A.

Inasmuch as the contactor 14 had not yet been energized at the time the car started, the

holding relay 14A had not yet been energized to maintain the contactor 13 in an energized condition until the car conditioning relay M was deenergized at the stopping of the car. Consequently, when the tachometer starts and energizes the low speed relay V which in turn energizes the auxiliary low speed relay VA and that relay opens its contacts VA1, contactor 13 is deenergized and thereby opens its contacts 13—1 and 13—2 thus returning the resistors R2, R6 and R10 to the field winding circuits of the hoisting motor and thereby reducing the torque used for starting the car to a desired value for operating at a desired leveling speed.

The foregoing operation illustrated how, in a leveling operation, sufficient torque is applied to the motor to overcome the static friction of the car and its apparatus, but as soon as that static friction is overcome, the torque provided for the motor is reduced to a predetermined amount which will give the car a very desirable leveling speed and not such a high leveling speed as would be the case if the contactor 13 had not been withdrawn after having been placed in action to get the car started.

Occasionally because of load conditions the leveling speed may increase to an undesired value after the contactor 13 is retired in a leveling operation. In such a case the increased speed will cause the tachometer to increase the voltage applied to the high speed relay Y and thereby energizes that relay to open its contacts Y1 to render itself more sensitive and to close its contact Y2 for energizing the auxiliary high speed relay YA. The energized relay YA thereupon opens its contacts YA1 and inserts the resistors R14 and R15 in the circuit to the brake coil B1. The insertion of the resistors R14 and R15 in the brake coil circuit weakens the brake magnet and thereby permits the brake to be applied harder and increase the braking torque. This process continues with the result that the brake remains in the position where the necessary torque is developed to maintain the desired leveling speed. As soon as excessive landing speed is reduced to the desired value, the tachometer TG causes the relay Y to resume its unoperated condition and thereby deenergize the auxiliary relay YA to close its contacts YA1 and thus short-circuit the resistors R14 and R15 in the brake coil circuit to hold the landing speed at the desired point.

As the car moves downwardly, it moves the down leveling contacts QDL down past the top of the up plate UP whereupon they open and thus deenergize the down stopping relay LD, which in turn opens its contacts LD2 and thereby deenergizes the down-direction switch D and the running relay M. The deenergized relay D opens its contacts D1 and D2 to disconnect the hoisting motor from its source of energy and opens its contacts D3 to deenergize the brake coil B1 to apply the brake. The open contacts M10 deenergize the contacts 11 and 12 and the open contacts M9 deenergize the holding relays 12A and 13A. As the brake is applied, the car stops and that stops the tachometer which fails to supply energy to the relay V, which therefore opens its contacts V3 and thus deenergizes the auxiliary relay VA which returns to its normal condition. Inasmuch as the contactors 11, 12, 13 and 14 are all deenergized and the leveling relay L is energized, the timing relays 11T, 12T, 13T and 14T are all energized and in condition for the next starting of the car.

If the car stalls for any reason during a leveling operation, the tachometer TG will cease operation at once and thereby deenergize the slow speed relay V, thus opening its contacts V3 and thereby deenergizing the relay VA to close its contacts VA1 to again operate the relay 13 to decrease the resistance in the hoisting motor field until the car again starts.

It will be assumed at this time, that the car stops level with the third floor and that the passenger opens the car door and the associated hatch door to leave the car. The opening of the car door opens its door safety contact 32 and thereby deenergizes the door relay 40 to prevent any further operation of the car on another trip until the door is closed.

At this point the timing relay 70T times out and recloses its contacts 70T1 to prepare the call indicating relay 80 for operation and opens its contacts 70T2 to prevent operation of the tachometer and opens its contacts 70T3 to prevent operation of the inductor relay Q while the car is standing in its unoperated condition at the third floor.

The system illustrated and described is well adapted for operation by the passengers who use the car, because the car will level only when it overruns or underruns a floor in making a stop and until the relay 70T times out. However, when an attendant is employed for operating the car, it is usually preferable to use a back contact of the door relay 40 (such as 40—4 in Fig. 3) for maintaining a closed circuit for the inductor relay while the car is standing at a floor so that the car can level at any time it moves away from the floor under the influence of cable stretch during its stop at a floor. At the end of the stop, when the door is closed to start the car on its next run, the door relay contacts 40—4 open to prevent operation of the leveling means until the next stop.

From the foregoing operation it will be apparent that I have provided a simple and efficient automatic leveling means for leveling a car into a floor when it overruns or underruns that floor, and that the leveling means provides for maintaining the leveling speed of the car at the predetermined desirable value and that this end is obtained by eliminating sufficient resistance from the field windings to get the car started and by then restoring some of the resistance to the field windings to keep the speed of the car down while it levels into the floor.

It will also be apparent that I have provided an additional means for partly applying the brake in cases where the leveling speed increases regardless of the additional resistance placed in the motor circuit after the motor receives sufficient torque to start the car

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

I claim as my invention:

1. In an elevator control system for operating a car to serve a plurality of landings; a motor for the car; control means for causing the motor to start the car and stop it at the landings; leveling means operable in case the car underruns or overruns a landing in making a stop thereat for causing energization of the motor to move the car to the landing level; means responsive to operation of the leveling means for increasing the torque of the motor until it effects the starting of the car, means responsive to said starting of the car for

reducing the torque of the motor, and means responsive to a predetermined high leveling speed of the car for reducing the leveling speed to a predetermined value.

2. In an elevator control system for operating a car to serve a plurality of landings; a motor for the car; a brake, control means for causing the motor to start the car and stop it at the landings; leveling means operable in case the car underruns or overruns a landing in making a stop thereat for causing energization of the motor to move the car to the landing level; means operable in case the motor does not start upon energization thereof for leveling for causing increase in the torque of the motor until it moves the car, means responsive to movement of the car for causing a reduction in the torque of the motor for operating the car at a predetermined speed during said leveling, and means responsive to the car exceeding a predetermined speed during leveling for partially applying the brake to reduce the leveling speed.

3. In an elevator system for operating a car to serve a plurality of floors, a motor for the car, control means for causing the motor to start the car and stop it at the floors, a leveling means responsive to the car overrunning or underrunning a floor in making a stop thereat, for causing energization of the motor to level the car with that floor, a plurality of switches associated with the motor, means responsive to operation of the leveling means for closing the switches in timed sequence to increase the torque of the motor in timed steps, a low speed device responsive to a predetermined speed of the car in leveling operation for preventing further operation of the timing devices, for opening the last closed switch to reduce the torque of the motor, and responsive to stalling of the car for reclosing said opened switch to again increase the torque of the motor until the car starts.

4. In an elevator system for operating a car to serve a plurality of floors, a motor for the car, control means for causing the motor to start the car and stop it at the floors, a leveling means responsive to the car overrunning or underrunning a floor in making a stop thereat, for causing energization of the motor to level the car with that floor, a plurality of switches associated with the motor, a plurality of timing devices responsive to operation of the leveling means for closing the switches in timed sequence to increase the torque of the motor in timed steps, and a low speed device responsive to a predetermined speed of the car in leveling operation for preventing further operation of the timing devices, and for opening the last closed switch to reduce the torque of the motor.

5. In an elevator system for operating a car to serve a plurality of floors, a motor for the car, control means for causing the motor to start the car and stop it at the floors, a leveling means responsive to the car overrunning or underrunning a floor in making a stop thereat, for causing energization of the motor to level the car with that floor, a plurality of switches associated with the motor, means responsive to operation of the leveling means for closing the switches in timed sequence to increase the torque of the motor in timed steps, a low speed device responsive to a predetermined speed of the car in leveling operation for preventing further operation of the timing devices and for opening the last closed switch to reduce the torque of the motor, an electromechanical brake for the car, said brake having two parallel circuits, means responsive to operation of the leveling means for opening one of the circuits during leveling periods, and means responsive to a predetermined high leveling speed for including a resistor in the other circuit to cause partial application of the brake to reduce the leveling speed.

6. In an elevator system for operating a car to serve a plurality of floors, a motor for the car, control means for causing the motor to start the car and stop it at the floors, an electromechanical brake for the car, a leveling means responsive to the car overrunning or underrunning a floor in making a stop thereat, for causing energization of the motor to level the car with that floor, a plurality of switches associated with the motor, a plurality of timing devices responsive to operation of the leveling means for closing the switches in timed sequence to increase the torque of the motor in timed steps, a low speed device responsive to a predetermined speed of the car in leveling operation for preventing further operation of the timing devices, and for opening the last closed switch to reduce the torque of the motor, and a high speed device responsive to a predetermined high leveling speed of the car for partially applying the brake to reduce the leveling speed to a predetermined value.

7. In an elevator system for operating a car to serve a plurality of floors, a motor for the car, control means for operating the motor to start the car and stop it at the floors, an electromechanical brake for the car, a leveling means for causing energization of the motor to level the car with a floor when it overruns or underruns that floor in making a stop thereat, a plurality of resistors connected in the circuit of the motor, a plurality of switches for short circuiting the resistors when the motor is to be accelerated, a plurality of timing devices for operating the switches in timed sequence, a low speed device rendered effective by a stopping operation of the control means and responsive to the stopping of the car when it is making a stopping operation for rendering the leveling means effective and for preparing the timing devices for operation, means responsive to operation of the leveling means for energizing the motor to move the car to a level with the floor at which the stop is being made and for starting the timing devices in operation to increase the torque of the motor, and means responsive to operation of the low speed device when the motor reaches a predetermined speed for stopping further operation of the timing devices and for causing the last operated switch to reinsert the resistor associated with it in the motor circuit to decrease the torque of the motor and thereby cause the car to level into the floor with a predetermined leveling speed.

8. In an elevator system for operating a car to serve a plurality of floors, a motor for the car, control means for operating the motor to start the car and stop it at the floors, an electromechanical brake for the car, a leveling means for causing energization of the motor to level the car with a floor when it overruns or underruns that floor in making a stop thereat, a plurality of resistors connected in the circuit of the motor, a plurality of switches for short circuiting the resistors when the motor is to be accelerated, a plurality of timing devices for operating the switches in timed sequence, a tachometer generator operable by movement of the car, means responsive to operation of the control means in

a stopping operation for rendering the tachometer generator effective during stopping and leveling periods, a low speed device responsive to the stopping of the tachometer generator when the car is making a stopping operation for rendering the leveling means effective and for preparing the timing devices for operation, means responsive to operation of the leveling means for energizing the motor to move the car to a level with the floor at which the stop is being made and for starting the timing devices in operation to increase the torque of the motor, and means responsive to operation of the low speed device when the motor reaches a predetermined speed for stopping further operation of the timing devices and for causing the last operated switch to reinsert the resistor associated with it in the motor circuit to decrease the torque of the motor and thereby cause the car to level into the floor with a predetermined leveling speed.

9. In an elevator system for operating a car to serve a plurality of floors, a motor for the car, control means for operating the motor to start the car and stop it at the floors, an electromechanical brake for the car, a leveling means for causing energization of the motor to level the car with a floor when it overruns or underruns that floor in making a stop thereat, a plurality of resistors connected in the circuit of the motor, a plurality of switches for short circuiting the resistors when the motor is to be accelerated, a plurality of timing devices for operating the switches in timed sequence, a plurality of holding devices, each of said holding devices being responsive to operation of a switch for maintaining the operation of the last previously operated switch, a tachometer generator operable by movement of the car, means responsive to operation of the control means in a stopping operation for rendering the tachometer generator effective during stopping and leveling periods, a low speed device responsive to the stopping of the tachometer generator when the car is making a stopping operation for rendering the leveling means effective and for preparing the timing devices for operation, means responsive to operation of the leveling means for energizing the motor to move the car to a level with the floor at which the stop is being made and for starting the timing devices in operation to increase the torque

of the motor, and means responsive to operation of the low speed device when the motor reaches a predetermined speed for stopping further operation of the timing devices and for causing the last operated switch to reinsert the resistor associated with it in the motor circuit to decrease the torque of the motor and thereby cause the car to level into the floor with a predetermined leveling speed.

10. In an elevator system for operating a car to serve a plurality of floors, a motor for the car, control means for operating the motor to start the car and stop it at the floors, an electromechanical brake for the car, a leveling means for causing energization of the motor to level the car with a floor when it overruns or underruns that floor in making a stop thereat, a plurality of resistors connected in the circuit of the motor, a plurality of switches for short circuiting the resistors when the motor is to be accelerated, a plurality of timing devices for operating the switches in timed sequence, a tachometer generator operable by movement of the car, means responsive to operation of the control means in a stopping operation for rendering the tachometer generator effective during stopping and leveling periods, a low speed device responsive to the stopping of the tachometer generator when the car is making a stopping operation for rendering the leveling means effective and for preparing the timing devices for operation, means responsive to operation of the leveling means for energizing the motor to move the car to a level with the flood at which the stop is being made and for starting the timing devices in operation to increase the torque of the motor, means responsive to operation of the low speed device when the motor reaches a predetermined speed for stopping further operation of the timing devices and for causing the last operated switch to reinsert the resistor associated with it in the motor circuit to decrease the torque of the motor and thereby cause the car to level into the floor with a predetermined leveling speed, and a high speed device responsive to a predetermined high speed of the tachometer generator during leveling operations for partially applying the brake to reduce the leveling speed of the car to a predetermined leveling speed.

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