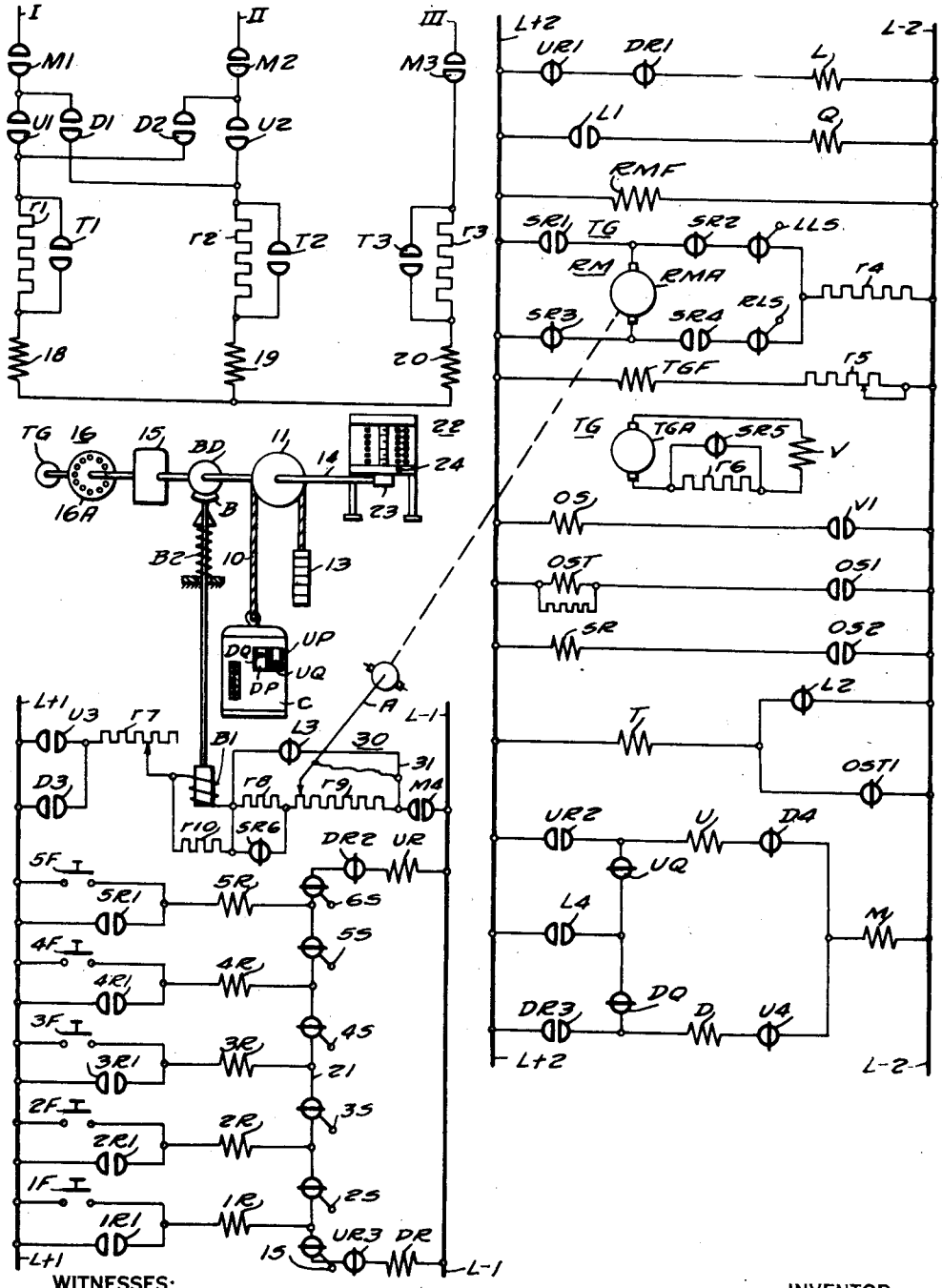
Nov. 21, 1944. W. F. EAMES 2,363,302

ELEVATOR CONTROL SYSTEM

Filed Sept. 15, 1942 2 Sheets-Sheet 1



WITNESSES:

E. A. McCloskey.

Birney Hines

Fig. 1.

INVENTOR

William F. Eames.

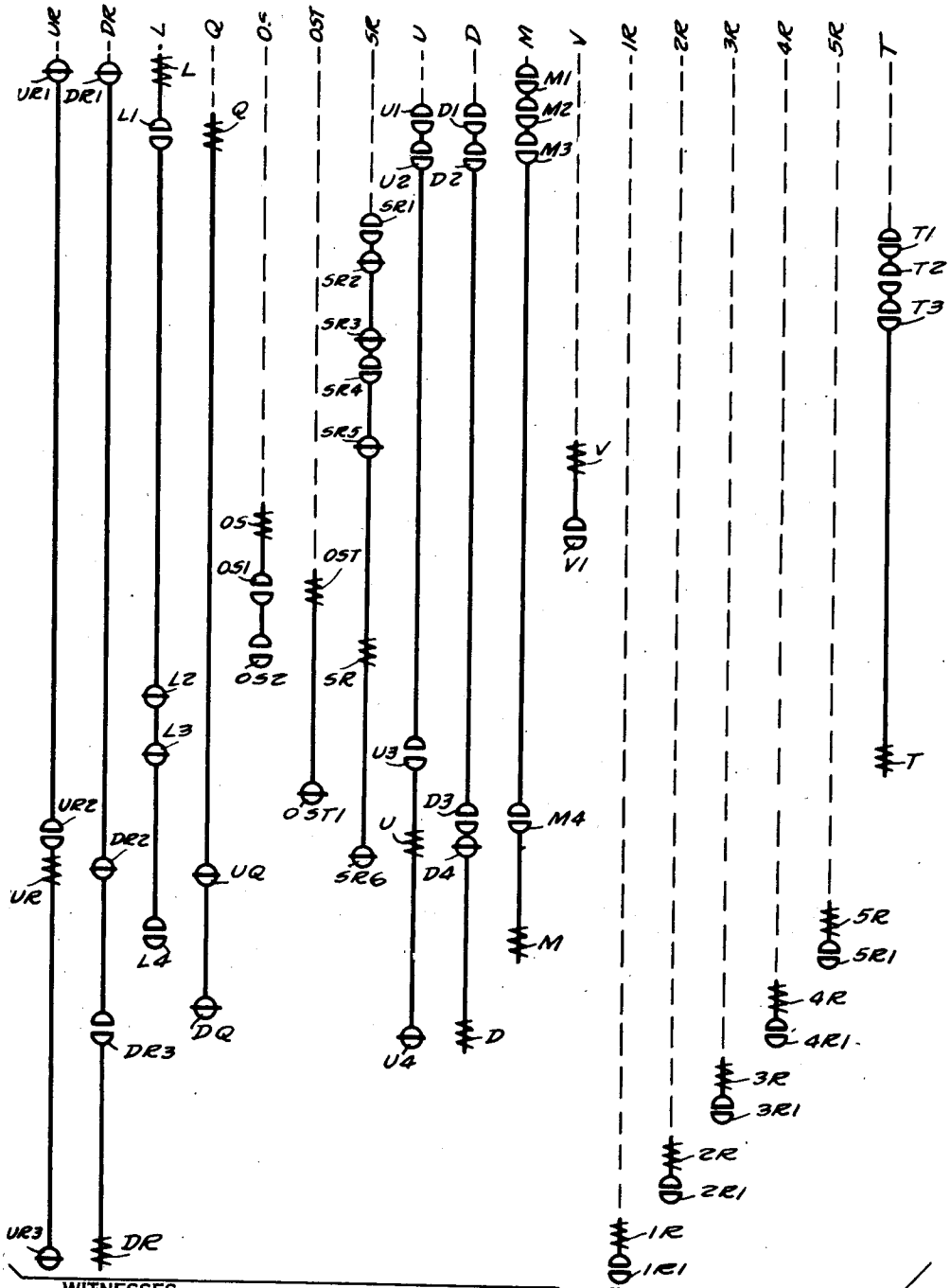
BY

ATTORNEY

Nov. 21, 1944. W. F. EAMES 2,363,302

ELEVATOR CONTROL SYSTEM

Filed Sept. 15, 1942 2 Sheets-Sheet 2



WITNESSES:
E. A. McCloskey.
Blimey Hines

Fig. 1A.

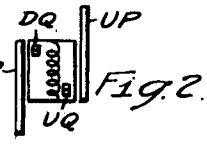


Fig. 2.

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ATTORNEY

Patented Nov. 21, 1944

2,363,302

UNITED STATES PATENT OFFICE

2,363,302

ELEVATOR CONTROL SYSTEM

William F. Eames, Westfield, N. J., assignor to Westinghouse Electric Elevator Company, Jersey City, N. J., a corporation of Illinois

Application September 15, 1942, Serial No. 458,381

9 Claims. (Cl. 187—29)

My invention relates to elevator control systems, and more particularly, to such systems as are provided with levelling means for causing the cars to stop approximately level with the floors and to maintain such position while they are loading and unloading.

One object of my invention is to provide for applying such a braking effect to a single speed elevator motor as will hold the car at a desirable landing speed while it is being levelled with the floor at which it is being stopped, regardless of the load carried by the car and its direction of operation.

A further object is to provide for applying a dragging brake effect to an elevator car having a single speed motor for reducing the speed of the car to a desirable landing and levelling speed and to so control the operation of the dragging brake that it will apply an approximately steady braking effect without tending to hunt or overshoot the desired landing speed.

A further object is to provide a levelling system which will automatically adjust itself to overcome any stalling of the motor when the brake is applied to control the speed of the car while it is being leveled into a floor.

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 coil and contact members disposed in horizontal alignment with their positions in the straight line circuit so that their locations therein may be readily determined; and

Fig. 2 is a diagrammatic representation of the inductor relay mounted on the elevator car in Fig. 1.

The following is a list of the relays illustrated in the drawings:

U=up direction switch
D=down direction switch
UR=up direction relay
DR=down direction relay
M=car-running relay
B=brake
1R=call registering relay, first floor
2R=call registering relay, second floor
3R=call registering relay, third floor
4R=call registering relay, fourth floor
5R=call registering relay, fifth floor
V=speed responsive relay
OS=overspeed relay
OST=time delay relay
SR=speed regulating relay
TG=tachometer or speed measuring generator
Z=leveling circuit relay
Q=leveling inductor relay
T=motor torque increasing relay
RM=rheostat motor

Referring more particularly to the drawings, I have illustrated an elevator car C as supported by a cable 10 which passes over a hoisting drum 11 to a suitable counterweight 13. The car is shown as for serving five floors but it may be used for any desired number of floors.

The hoisting drum is mounted on a shaft 14 driven by an electric motor 16. A suitable gear reducing mechanism 15 connects the shaft 14 with the motor 16 to secure an appropriate speed for the car when the motor is in operation. An electromechanical brake B is provided for engaging a brake drum BD on the shaft 14 for stopping and holding the car at the floor landings. The brake may be the usual electromagnetically released type of brake such as is provided with an electromagnetic coil B1 and a brake-applying spring B2.

The hoisting motor 16 is illustrated as a three phase single speed alternating current motor comprising a stator having windings 18, 19 and 20 and a rotor 16A. The stator windings may be connected to a suitable alternating current supply represented by the conductors I, II and III by means of an up direction switch U and a down direction switch D in connection with a car running relay M.

The energy for operating the direction switches, the relay M and such additional control apparatus as is used, may be secured from supply conductors L+1 and L−1 and L+2 and L−2 which may be connected to any suitable source of electrical energy.

An up direction relay UR and a down direction relay DR are provided for controlling the direction switches U and D and the car running relay M in conjunction with other control apparatus to be hereinafter described.

Any suitable arrangement may be provided for controlling the direction relays to start and stop the car. However, for the sake of simplicity, I have illustrated a simple push button system for starting and stopping the car comprising a push-button for each floor landing and a call storing or registering relay for maintaining the calls until they are answered.

The push buttons may be mounted in any suitable position in the elevator car so that the car

attendant may press the button corresponding to the floor to which he wishes to move the car and thus cause it to move to that floor. The call registering relays may be mounted in any suitable place as in the penthouse.

The push buttons are given the reference numerals 1F, 2F, 3F, 4F and 5F for the respective floors and the call registering relays are given the reference numerals 1R, 2R, 3R, 4R and 5R for the respective floors. The call registering relays are electrically connected to a circuit 21 for the up direction relay UR and the down direction relay DR.

The circuit 21 is controlled by a plurality of normally closed can switches 1S, 2S, 3S, 4S, 5S and 6S mounted on a floor selector 22 which is connected by a suitable gear reducing device 23 to the shaft 14. The shaft 14 operates the arm 24 of the selector in accordance with the movements of the car thereby opening and closing the selector switches consecutively as the car moves along its hatchway. The switches 1S, etc. and the cam 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. The invention is applicable to any push button control system where the push buttons start the car, the selector determines when it should be stopped and a car carried inductor relay stops it.

In the present instance I have illustrated an inductor relay Q 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 electro-responsive or energization coil or core with a down contact member DQ and an up contact member UQ mounted on the car in position to be operated, when energized, 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 contacts when the car brings the inductor relay opposite the plates at a floor in making a stop thereat. These relays are old and well known in the art but further information regarding them if desired, may be had from the White and Hearn Patent 1,884,446, issued October 25, 1932.

A levelling relay L is provided for conditioning the control circuits to effect the levelling of the car with a landing floor when a stop is made thereat. The levelling relay L is controlled by the up and the down direction relays. When the up direction or the down direction relay is deenergized for a stop at a floor, that relay energizes the levelling relay L which, in turn, energizes the inductor relay Q to effect the stopping and levelling of the car with the floor. This is effected because the inductor relay Q controls the circuits to the up direction switch U and the down direction switch D and the car running relay M for cutting off the power to the hoisting motor and applying the brake to stop the car.

In practicing my invention, I provide a control system for causing the brake B to be applied intermittently with varying degrees of force when a levelling operation is being made so as to bring the car to and hold it at a desirable landing speed during the time it is levelling into the floor. This is effected by rapidly weakening and strengthening the brake at a varying average until the hoisting motor pulls through it at the desired levelling speed; in other words, by using a dragging brake which keeps the car at the desired levelling speed. In the present instance, it is assumed that the hoisting motor will operate the car at a constant speed of approximately 100 feet per minute, and that the brake control means will cause the car to reduce its speed to approximately 20 feet per minute as it comes into its stop at the floor; and that it will also, if the car stops short of or runs beyond the floor, cause it to level into the floor at a speed of approximately 20 feet per minute. A balanced car of this class will probably drift from seven to nine inches before it actually stops at the floor. Hence the distance the stopping switch is set from the floor must be properly selected for the drift after the power is cut off and the brake applied. The amount of drift varies with the loading condition. The system may be designed for any other running and levelling speeds desired.

The brake control means comprises a rheostat 30 for controlling the strength with which the brake is applied, a speed reglating relay SR for controlling the rheostat, a speed responsive relay V for controlling the speed regulating relay SR, and a tachometer or speed measuring generator TG for operating the speed responsive relay V.

The rheostat 30 includes a resistor $r8$ and a resistor $r9$ connected in series in the circuit of the brake coil B for the purpose of controlling the value of the current in the brake coil in accordance with the speed of the car, when it is levelling. A shunt circuit 31 is disposed around the resistors $r8$ and $r9$ and is so controlled by a pair of normally closed contacts L3 of the levelling circuit relay L that the resistors may be rendered effective only during levelling operations of the car.

The resistor $r8$ is controlled by the contacts SR6 of the speed regulating relay SR and the resistor $r9$ is controlled by an arm A operated by a control means such as the armature RMA of a rheostat motor RM, which is also controlled by the speed regulating relay SR. The motor RM is provided with a field winding RMF which is connected across the supply conductors L+2 and L—2 for constant energization. A pair of limit switches LLS and RLS are disposed in the armature circuit of the motor RM to stop it when it moves the arm A to the limit of its action. The action of the contacts SR6 in controlling the resistor $r8$ is quick while the operation of the arm A is relatively slow. The resistor $r8$ in conjunction with contact SR6 is used to cause the brake to be continually in a state of potential actuation. Thus, when the levelling speed is slightly high, the contacts SR6 will be open and resistor $r8$ will so weaken the brake coil as to cause it to be on the verge of applying the brake shoes harder against an opposing frictional force inherent in the brake levers. Also when the levelling speed is slightly low, the contacts SR6 will be closed. thus shorting out resistor $r8$, so that the brake coil will be additionally energized by an amount to cause it to be on the verge of releasing the shoe pressure again against the inherent opposing frictional force of the brake levers.

The rheostat motor RM adjusts the position of arm A on resistor $r9$ so that a value of brake current is obtained in the coil B1 which on the average causes the brake shoes to produce a drag on the brake drum to limit the speed of the motor to the selected levelling speed. This drag is an adjustable quantity which is different for each different load. Thus the torque of the motor equals brake torque plus load torque when the

desired levelling speed is obtained regardless of the load in the car.

The speed regulating relay SR is so controlled by the relay V acting through the relay OS that it will be energized when the car is running at more than approximately 20 feet per minute and will be deenergized when the speed of the car drops below approximately 20 feet per minute. The only reason for using the overspeed relay OS intermediate the relays V and SR is that the relay V is very sensitive with delicate contacts which cannot handle much current. Therefore, the auxiliary overspeed relay OS is used to provide contacts large enough to handle the current involved in operating the relay SR.

The speed measuring generator TG for controlling the relay V 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 for constant energization and its circuit includes a current adjusting resistor r5 by means of which it may be adjusted as desired. The armature TGA is fixed on one end of the hoisting drum shaft 14 so that rotation of the hoisting drum in operating the car will rotate the armature TGA. The brushes on the armature are electrically connected through the speed responsive relay V. Hence movement of the car causes the generator TG to supply energy to the relay V in accordance with the speed of the car.

The relay V is so selected and adjusted that it will become energized sufficiently by the generator TG to close its contact members when the car moves at a speed of approximately 20 feet per minute; conversely, the relay V will open its contacts when the car drops below 20 feet per minute and thereby so reduces the speed of the generator that current supplied falls below the value necessary to hold it closed. Obviously, the relay and generator may be designed and connected for other speeds where desired. A resistor r6 is disposed in series with the coil of the relay V to render the relay more sensitive. The relay SR, by its contacts SR5, controls a shunt circuit around the resistor r6 so as to cause the closing and opening of the relay to be at practically the same voltage, thus compensating for friction and the varying air gap of relay V between its open position and its closed position and rendering the relay very sensitive and quick acting. In practice the relay V vibrates with a frequency of about 3 or 4 operations per second. This rate of vibration is adjustable over a considerable range by the resistor r6. The relays V, OS and SR in connection with resistor r6 and r8 provide a self-controlled means for causing fluctuations at a predetermined frequency in the brake current to cause the brake to vibrate at such frequency. The self-controlled means is called self-controlled because the relays V, OS, and SR automatically insert and short the resistor 26 in the circuit of the relay V during each cycle of its operation.

In this connection, it should be noted that the rheostat 30 and its controlling relays do not obtain the dragging brake action by merely weakening the current through the brake coil B. It secures the dragging action by rapidly varying the amount of current through the brake coil by rapidly changing the amount of resistance secured from the resistors r8 and r9 so that the brake receives a quivering action; that is the strength of the brake is vibrated rapidly by the rapidly ebbing and flowing of the magnetic force in the brake coil, with the net result that the motor is slowed down or permitted to speed up to hold the car at its selected levelling speed. The system is designed to vibrate at a fixed frequency. The desired frequency is about three or four times per second which makes the brake quiver about that often. The average current strength in the brake coil may vary in a quivering line over a range from approximately one-third to two-thirds of maximum current, and conversely the braking strength will vary from approximately two-thirds maximum braking strength at one-third maximum current to approximately one-third braking strength with two-thirds maximum current. These figures are, of course, approximate, and the system may vary therefrom in practice.

A motor torque-increasing relay T is provided for inserting a predetermined amount of resistance (r1, r2 and r3) in the motor circuit when a levelling operation is taking place at a floor landing, in order to limit the torque of the motor to a value which will not require an excessive brake torque to hold the speed of the car to the selected value. A resistance of 2.5 ohms in each leg of a 440-volt 5 H. P. motor circuit will probably be satisfactory.

As the resistance inserted by relay T heats up and as the motor temperature rises, heavy loads may cause the car to stall and fail to level up with the floor. Therefore, a time relay OST is provided for operating relay T to short out each of the resistors r1 r2 and r3 when the car stays below its selected levelling speed for more than two seconds, thus giving the motor full torque to prevent its stalling and subsequent overheating. The relay OST is controlled by the relay OS and it has a time delay of about 1.3 seconds in opening after being deenergized.

The following operation of the apparatus described will be assumed with the car standing at the lower part of its hatchway (not shown) and with the system ready for operation. In this condition, the inductor relay Q, the levelling circuit relay L and the motor torque increasing relay T are energized. It will be assumed now that an attendant enters the car and presses the third floor button 3F to cause the car to move to and stop at the third floor. The operation of the button 3F energizes the call registering relay 3R and the up direction relay UR by the circuit L+1, 3F, 3R, 4S, 5S, 6S, DR2, UR, L−1. The energized relay 3R closes its self holding contacts 3R1. The energized up direction relay UR opens its back contacts UR1 and UR3 and closes its front contacts UR2. The opening of the contacts UR1 deenergizes the levelling circuit relay L to deenergize the inductor relay Q, and the opening of the contacts UR3 prevents energization of the down direction relay DR while the car is moving upwardly.

The closing of the contacts UR2 energizes the up direction switch U and the car running relay M by the circuit L+2, UR2, U, D4, M, L−2. The energized relay U opens its back contacts U4 and closes its front contact U1, U2 and U3. The energized relay M closes its front contacts M1, M2, M3 and M4. The closing of the contacts U3 and M4 energizes the brake coil B1 to release the brake B by the circuit L+1, U3, r7, B1, L3, M4, L−1. The closing of the contacts M1, M2 and M3 and the contacts U1 and U2 energizes the rotor field windings 18, 19 and 20 of the hoisting motor 16 which thereupon operates the hoisting drum 11 to move the car upwardly from the lower

landing to the third floor. The car now leaves the first floor.

The operation of the hoisting drum and the rotation of the shaft 14 thereby rotates the armature TGA of the speed measuring generator TG and, inasmuch as the field winding TGF of that generator is constantly energized, this generator delivers energy to the speed responsive relay V in accordance with the speed of the car. As the car increases its speed to above 20 feet per minute, the generator TG supplies the predetermined amount of current to the relay V necessary to cause that relay to close its contacts V1 thereby energizing the overspeed relay OS by the circuit L+2, OS, V1, L—2. The energized relay OS closes its contacts OS1 and OS2. The closed contact OS1 energizes the time delay relay OST by the circuit L+2, OST, OS1, L—2. The closed contacts OS2 energizes the speed regulating relay SR by the circuit L+2, SR, OS2, L—2. The energized relay SR opens its back contacts SR2, SR3, SR5 and SR6 and closes its front contacts SR1 and SR4. The closing of the front contacts SR1 and SR4 reverses the rheostat motor RM and causes it to rotate the rheostat arm A from the left to the right until the arm is at the right hand position and the limit switch RLS opens and stops the motor, leaving all of resistor r9 in the circuit. However, this does not affect the rheostat because the contacts L3 have closed the shunt circuit around resistors r8 and r9. The operation of the relays V, OS, OST, SR and the motor RM have no particular effect at this time because the levelling relay L is in a deenergized condition and no levelling operation is taking place, but they are now in condition to control the brake when the car makes the next stop.

As the car continues toward the third floor it increases its speed and quickly reaches its normal running speed of approximately 100 feet per minute. As the car approaches closely to the third floor it moves its floor selector arm 24 along the selector switches until it engages and opens the switch 4S for stopping the car at the third floor. The switch 4S should be so placed that it will be operated to stop the car by causing the setting of the brake at such a distance from the floor that the car will, under normal circumstances, be stopped level with the floor. However, if the car undershoots the floor, it will level on in to the floor and if it overshoots, it will be levelled back to the floor. In the present instance, it is assumed that the car undershoots the floor slightly.

The opening of the switch 4S restores the call registering relay 3R to its normal condition and deenergizes the up direction relay UR. The deenergization of the relay UR closes its back contacts UR1 thereby energizing the levelling relay L by the circuit L+2, UR1, DR1, L, L—2 to effect the levelling of the car at the third floor.

The energized levelling relay L closes its contacts L1 and L4 and opens its back contacts L2 and L3. The closed contacts L1 energize the inductor relay Q by the circuit L+2, L1, Q, L—2, to prepare it to stop the car.

The closing of the contacts L4 prepares the levelling circuits for bringing the car in level with the floor by placing the up direction switch U under the control of the inductor relay Q. The down switch D at this stage, is prevented from being operated by relay Q because of the open contacts U4. The circuit for switch U is now L+2, L4, UQ, D4, M, L—2.

The opening of the contacts L—2 deenergizes the torque relay T which thereupon inserts the resistors r1, r2 and r3 in the circuit of the hoisting motor 16 to cause it to operate under stopping and levelling conditions.

The opening of the contacts L3 in the shunt circuit around the resistors r8 and r9 inserts the resistor r9 in the circuit of the brake coil B1, thereby decreasing the current through the brake coil considerably and thus allowing the brake to be applied to decelerate the hoisting motor 16. The car now decreases its speed because the brake B is dragging against the hoisting motor. The decreased speed of the car decreases the speed of the measuring generator armature TGA and thus the flow of energy through the relay V. As the speed of the car decreases to the selected stopping speed of 20 feet per minute and then below it, the energy through relay V drops until that relay opens its contact members thereby deenergizing the overspeed relay OS which in turn opens its contact members OS1 and OS2 thereby deenergizing the time relay OST and the regulating relay SR.

The deenergized relay SR opens its contacts SR1 and SR4 and closes its back contacts SR2, SR3 and SR6. The car is now running at slightly less than its landing speed of 20 feet per minute.

The closing of the contacts SR1 and SR4 and the opening of the contacts SR2 and SR3 reversed the direction of operation of the rheostat motor RM and it now starts to move the rheostat arm A from the right to the left thus decreasing the amount of resistor r9 in the circuit of the brake coil B1. The reclosing of the back contacts SR6 short circuits the resistor r8 also in the circuit of the brake coil B1 thereby increasing the magnetic force in the brake coil and thus decreasing the effect of the brake to a point where the car is held at a speed of approximately 20 feet per minute. If the car should speed up again it would energize the speed responsive relay V to close its contacts thus energizing the regulating relay SR to insert more resistance in the brake coil circuit and thus increase the dragging effect of the brake so as to slow down the car to its landing speed of 20 feet per minute. In practice this change in the relay V and consequently the change in the amount of resistance in the brake circuit occurs about four times per second and results in a vibrating operation of the brake with the net result that the brake effect is such as to hold the car at the selected landing or levelling speed.

It will be assumed now that, as the car approaches still closer to the third floor stop, the inductor relay Q on the car comes opposite the up inductor plate UP and the influence of that plate on the energized relay opens the up contacts UQ, thereby deenergizing the up direction switch U and the car running relay M to stop the car. The deenergized relay U opens its contacts U1, U2 and U3 and closes its contacts U4. The deenergized relay M opens its contacts M1, M2, M3 and M4. The opening contacts M1, M2, M3, U1 and U2 deenergize the hoisting motor and the opening contacts U3 and M4 deenergize the brake coil thus stopping the car and applying the brake B to hold it at the third floor. When the car comes to rest, the relay SR will be in its deenergized condition and in that condition it will cause the motor RM to move the rheostat arm A to the left until the limit switch LLS opens and stops the motor. The rheostat is now ready for a levelling operation, if necessary.

The foregoing operation illustrates how the car may be started and stopped by the apparatus illustrated in the drawing and it also illustrates

how the braking system operates to bring the car into its stop at the floor at a landing speed of approximately 20 feet per minute.

A levelling operation of the car will be assumed now. Assuming that the car during a stop at the third floor goes below that floor for some reason such as stretching of the cables or overshooting the floor landing, then the inductor relay will be moved below the inductor plate such a distance that the inductor contacts UQ coming out from under the influence of the inductor plate UP, reclose and thereby energize the up direction switch U and the car running relay M by the circuits previously described, thereby energizing the motor 16 and decreasing the strength of the brake so that the motor by pulling through the dragging brake may start the car upwardly.

The operation of the motor operates the speed measuring generator TG and, as the car speed increases to above 20 feet per minute, the generator TG supplies a sufficient amount of current to the speed responsive relay V as to cause that relay to close its contacts. Now will follow a series of rapid operations of relays which will hold the car to its selected speed of 20 feet per minute during its levelling operation. The energized relay V closes its contacts V1 thereby energizing the overspeed relay OS. The energized relay OS closes its contacts OS1 and OS2 thereby energizing the time delay relay OST and the speed regulating relay SR. Inasmuch as the car is now going over 20 feet per minute, the relay SR opens its contacts SR6 thereby inserting the resistor r8 in the circuit of the brake coil B1, to weaken the electromotive force in the brake and thereby permit the brake spring B2 to increase the brake pressure thus slowing down the car. At the same time, in order to smooth out the action of the resistor r8, regulating relay SR closes its contacts SR1 and SR4 in the circuit of the motor RM thus reversing that motor and starting its to move the rheostat arm A to the right. This inserts more of the resistor r9 in series with the resistor r8 thus further decreasing the electromagnetic force in the brake coil B1 and thus increasing the effect of the brake spring B2 to increase the brake pressure. This slows down the car and, as it falls below 20 feet per minute, the measuring generator TG decreases the supply of energy to the relay V which now opens its contacts V1 thereby deenergizing the relay OS which, in turn, deenergizes the relay OST and the relay SR. The relay OST does not time out yet for 1.3 second but the deenergized relay SR immediately closes its contacts SR6 thus reinserting the resistor r8 in the brake coil circuit and at the same time closes its contacts SR2 and SR3 thus reversing the rheostat motor RM to start moving the rheostat arm A to the left thereby decreasing the amount of the resistor r9 in the brake coil circuit. This operation of the resistors r8 and r9 increases the electromagnetic force in the brake coil B1 which pulls against the brake spring B2 and thus weakens the force of the brake and permits the speed of the car to increase until the generator TG again supplies sufficient current to the relay V to cause it to close its contacts V1 and thus start the relays OS and SR to insert more resistance in the brake winding circuit thus decreasing the electromagnetic force in the brake coil which, in turn, increases the effect of the brake spring to bring the car back to its selected speed of 20 feet per minute. This happens before the relay OST times out. Hence that relay is reenergized again before it opens its contact members.

It will be assumed that these actions and reactions repeat themselves rapidly, say about four times per second with the net result that they hold the car to a levelling speed of approximately 20 feet per minute. It is obvious that there will be rapid variations of torque applied to the driving sheave in this operation. In practice, these variations are kept to such a range of variation that objectionable vibration is not transmitted to the elevator car. There is a resiliency in the support cables which, combined with the inertia of the mass of the car, results in practically no vibration at the car end of the lift cables.

It will be assumed now, however, that the load on the car is so heavy that the motor fails to pull it back to the landing at the rate of 20 feet per minute and that it stays below 20 feet per minute for more than 1.3 seconds and is about to stall. Under these circumstances the relay OST times out and in doing so closes its back contact members OST1, thereby energizing the torque relay T by the circuit L+2, T, OST1, L−2. The energized relay T closes its contacts T1, T2 and T3 and thereby short circuits the resistors r1, r2 and r3 in a circuit of the motor 16 to increase its torque and thereby prevent the stalling of the car.

It will be assumed now that the motor pulls the car up level with the third floor and, in so doing, the up contacts UQ of the inductor relay Q come opposite the up plate UP and are thereby opened to deenergize the up direction switch U and the car relay M. These deenergized relays operate to deenergize the hoisting motor 16 and the brake B thus stopping the car level with the third floor and holding it at that floor, to which it has been relevelled.

The stopping of the motor 16 stops the measuring generator TG which permits relay V to open its contacts and thus deenergize the regulating relay SR to close its contacts SR2 and SR3, thereby causing the rheostat motor RM to rotate the rheostat arm A to the left position where practically all of the resistor r9 will be excluded from the brake coil circuit so that the system is ready for another relevelling operation if it is necessary.

As stated before, the actions of the relay V and the other regulating relays associated with it occur very rapidly when the car is running at its selected speed of 20 feet per minute. One of the principles of my invention is to have the relay V and its associated relays operate in a rhythmic order so as to secure a quivering brake effect which will change approximately four times per second. The ebb and flow of electromagnetic force in the brake coil in accordance with the strength or weakness of the current through it gives a surging or quivering effect of the brake which permits the motor to drag through it at such a rate as will hold the car to its selected levelling speed.

By the foregoing operation, it will be seen that I have provided a simple but effective levelling system which will hold the car at the desired landing speed as it comes into a floor or when it is relevelled to the floor if it overshoots or underruns an exact level position with the floor and also one in which the car will be levelled back to the floor if it sags below the floor by reason of stretching cables or other causes.

Although I have illustrated and described only

one specific embodiment of my invention, it is to be understood that many changes therein and modifications thereof may be made without departing from the spirit and scope of the invention.

I claim as my invention:

1. In an elevator system, a car, a single-speed motor for operating the car at a predetermined running speed, an electromechanical brake for the motor, control circuits for connecting the motor and the brake to sources of electrical energy, means for operating the control circuits to initiate a stopping operation of the motor, a levelling means, and means responsive to operation of the control circuits to effect stopping the car for rendering the levelling means effective to level the car to the floor at which it is making a stop, said levelling means comprising a plurality of resistors for the brake circuit, a rheostat motor for controlling one of said resistors, a contact for controlling another of said resistors, a regulating device for operating the rheostat motor and said contact to control the rheostat, a speed responsive device for operating the regulating device, and a speed-measuring generator responsive to the speed of the car for supplying energy to the speed-responsive device to cause its operation when the car exceeds a predetermined speed.

2. In an elevator system, a car, a single-speed motor for operating the car at a predetermined running speed, an electromechanical brake for the motor, control circuits for connecting the motor and the brake to sources of electrical energy, means for operating the control circuits to initiate a stopping operation of the motor, a levelling means, and means responsive to operation of the control circuits to effect stopping the car for rendering the levelling means effective to level the car to the floor at which it is making a stop, said levelling means comprising a plurality of resistors for the brake circuit, a rheostat motor for controlling one of said resistors, a contact for controlling another of said resistors, a regulating device for operating the rheostat motor and said contact to control the rheostat, a speed responsive device for operating the regulating device, a speed-measuring generator responsive to the speed of the car for supplying energy to the speed responsive device to cause its operation when the car exceeds a predetermined speed, and means responsive to operation of the regulating device for controlling the supply of energy to the speed responsive device for the purpose of causing it to vibrate in its action a predetermined number of times per minute.

3. In an elevator system, a car, a single-speed hoisting motor for driving the car at a predetermined running speed, means for starting and stopping the motor, an electromechanical brake for the motor, and means for levelling the car with any floor at which a stop is to be made comprising a motor-operated rheostat for controlling the strength of the brake, and means responsive to the speed of the car for controlling the rheostat to effect the application of the brake to decrease the speed of the car from its running speed to a predetermined levelling speed and to hold it at that speed until the motor is stopped.

4. In an elevator system, a car, a single-speed hoisting motor for moving the car at a predetermined running speed, an electromechanical brake for the motor, a circuit for connecting the brake to a source of electric energy, a plurality of resistors, disposed in series in said circuit, motive means for varying the amount of one of the resistors included in the circuit, a contact member for controlling the inclusion of another one of the resistors in said circuit, and means responsive to the speed of operation of the motor for operating said contact and said motive means to control the resistors to cause the brake to hold the car to a predetermined landing speed less than its running speed.

5. In an elevator system, a car, a single-speed motor for operating the car at a predetermined running speed, an electromechanical brake, a circuit for the brake, and means for levelling the car with a floor landing when it stops thereat, said levelling means comprising a rheostat for introducing resistance into the brake circuit, a speed regulating device for controlling the rheostat, means responsive to the speed of the car during a levelling operation for causing the regulating device to operate the rheostat to strengthen the brake when the car exceeds a predetermined landing speed and to weaken the brake when the car falls below said predetermined landing speed, and means responsive to operation of the regulating device for rendering the speed responsive means more sensitive in its operation.

6. In an elevator system, a car, a single-speed motor for moving the car at a predetermined running speed, an electromechanical brake for the motor and car, a circuit for connecting the brake to a source of energy, and a levelling means comprising a resistor for controlling the supply of energy through the brake circuit, a regulating device, a speed responsive device responsive to operation of the car for operating the regulating device in one manner when the car exceeds a predetermined speed and for operating it in another manner when the car falls below said predetermined speed, and means responsive to operation of the regulating device when the car is above its predetermined levelling speed for quickly inserting one portion and more slowly inserting another portion of the resistor in the brake circuit and responsive to operation of the regulating device when the car is below its predetermined landing speed for quickly rendering one portion of the resistor ineffective and for more slowly rendering another portion of the resistor ineffective in the brake circuit, whereby the car will be maintained at its predetermined approximately constant low landing speed.

7. In an elevator system, a car, a single-speed motor for the car, an electromechanical brake for the car, an electric circuit for the brake, a resistance for the brake circuit, and means responsive to the speed of the car when making a levelling operation for quickly including a portion of the resistance in the brake circuit and more slowly adding additional resistance to the brake circuit when the car runs above a predetermined landing speed, and for quickly rendering ineffective a portion of the resistance in the brake circuit and more slowly decreasing the amount of effective resistance remaining in the brake circuit when the car runs below said landing speed.

8. In an elevator system, a car, a single-speed motor for operating the car at a normal high speed, an electromechanical brake for stopping and for holding the car in a stopped condition, a circuit for connecting the brake to a source of electric current, and control means for regulating the current in the brake circuit during leveling operations of the car, said control means including a rheostat means connected with the brake circuit, a speed-measuring generator re-

sponsive to the speed of the car for providing a supply of energy in accordance with the speed of the car, and self-controlled electromagnetic means responsive to operation of the speed-measuring generator for operating the rheostat means with rapid changes for producing fluctuations in the current in the brake circuit at a frequency of not less than one per second to cause the brake to vibrate at said frequency when controlling the car during leveling operation.

9. In an elevator system, a car, a motor for operating the car at a normal high speed, an electromechanical brake for stopping and for holding the car in a stopped condition, a circuit for connecting the brake to a source of electric current, and control means for regulating the current in the circuit during landing operations of the car, said control means including a speed-measuring generator responsive to the speed of the car for supplying energy in accordance with the speed of the car, a speed responsive device connected for operation by the energy produced by the speed-measuring generator when the car exceeds a predetermined speed, a rheostat means connected to the brake circuit, means responsive to operation of the speed responsive device for controlling the rheostat means, and means responsive to operation of the speed responsive means for reducing the supply of energy to the speed responsive device each time it is operated.

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