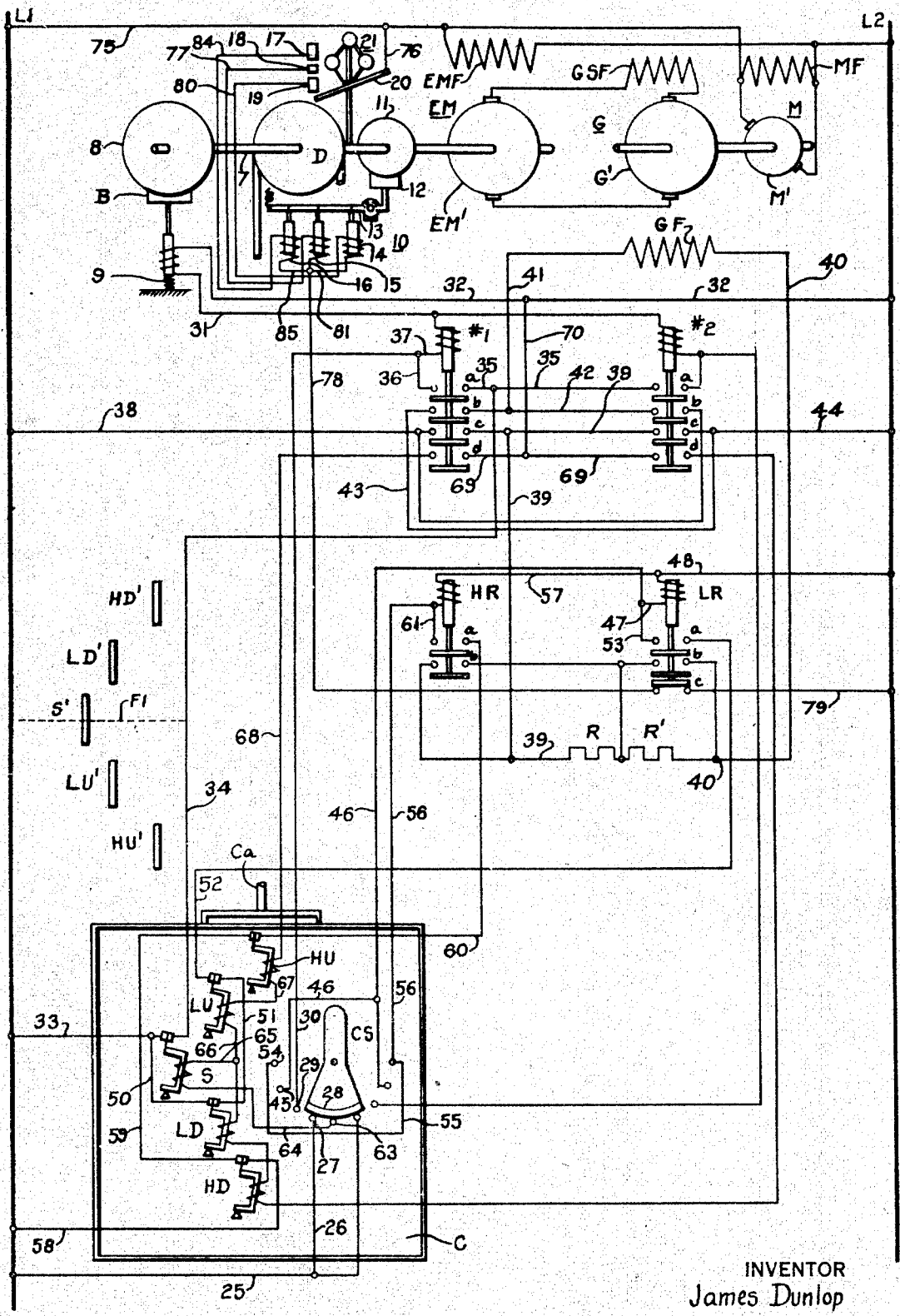
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BRAKE FOR ELEVATORS

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BRAKE FOR ELEVATORS

Application filed February 4, 1929. Serial No. 337,307.

My invention relates to brakes for elevators and more particularly to means for controlling the operation of such brakes.

The object of my invention, in general, is to provide braking apparatus for an elevator that shall be simple and efficient in operation and capable of being economically manufactured, installed and maintained.

Another object of my invention is to provide for applying a braking effect to an elevator at a rate that is proportional to the speed of the elevator car at the time the braking effect is applied thereto.

A more specific object of my invention is to provide for automatically varying the braking effect applied to an elevator car for bringing it to a stop accurately level with the floor at which the stop is to be made.

It is also an object of my invention to provide for applying a preliminary braking effect to an elevator car to cause the car to run at a predetermined speed as it reaches the point where its power is to be cut off prior to making the stop.

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

For an illustration of one of the many forms my invention may take, reference may be had to the accompanying drawing, the sole figure of which is a diagrammatic view representing an elevator system with braking apparatus that is controlled in accordance with my invention.

The drawing illustrates a car C as suitably suspended by a hoisting cable Ca that passes over a hoisting drum D to a suitable counter-weight (not shown). The hoisting drum D is directly coupled to the armature EM' of an elevator hoisting motor EM.

A variable-voltage system of control may be provided for operating the elevator motor EM, wherein the armature EM' of the elevator motor is connected in loop circuit with the armature G' of a generator G. The generator G is provided with a separately excited field winding GF and a cumulative series field winding GSF. The armature G' of the generator G is suitably driven by means of a driving motor M illustrated as being of the shunt wound type having its armature M' and its field winding MF connected in shunt relation to a source of power designated as the supply conductors L1 and L2. The elevator motor EM has its field winding EMF connected for constant voltage energization to the supply conductors L1 and L2.

The direction and speed of the operation of the elevator motor EM may be suitably controlled by controlling the direction and value of the excitation current that is supplied to the separately excited field-winding GF of the generator G.

The direction of the excitation current for the field winding GF may be suitably controlled by means of an up-direction switch 1 and a down-direction switch 2, while the value of the current supplied to the field winding may be controlled by means of an intermediate speed relay LR and a high speed relay HR.

The operation of the up-direction- and the down-direction-switches 1 and 2 may be controlled by means of a car switch CS that is mounted upon the elevator car C in position to be actuated by an attendant on the car.

While any suitable type of control system may be employed for automatically stopping the car C at the floors past which it operates, I have illustrated the control system as of the automatic inductor landing type, such as is disclosed in the copending application of E. M. Bouton, Serial No. 731,291, filed August 14, 1924, and assigned to the Westinghouse Electric & Manufacturing Company.

The inductor-landing system includes a stopping-inductor relay S, an up-intermediate-speed inductor relay LU and an up-high-speed-inductor relay HU for causing the car to be automatically decelerated from its intermediate and high speeds, respectively, and brought to a stop at a floor landing when the car is traveling upward. Similarly, the stopping-inductor relay S, down-intermediate-speed-inductor relay LD, and down-high-speed-inductor relay HD will cause the car to slow down and stop at the floors when the car is traveling downwardly.

It is assumed that each of the floors past

which the car moves will be provided with a set of inductor plates cooperating with the inductor relays as the car approaches predetermined points in advance of the corresponding floors at which the car is to stop. For example, I have illustrated the inductor plates for one floor as comprising a stopping-inductor plate S′ and up-intermediate-inductor plate LU′ and an up-high-speed-inductor plate HU′ for successively operating the inductor relays HU, LU and S as the car, moving upwardly, approaches the floor (indicated by dotted line F1.) with which the inductor plates are associated. When the car is traveling downwardly, the intermediate speed inductor plate LD′ and the high speed inductor plate HD′, will successively operate the inductor relays HD and SD, respectively, as the car approaches the floor at which a stop is to be made.

Mounted upon the shaft 7 of the hoisting drum D is a brake sheave 8 against which an electromagnetic brake B is normally pressed by means of a spring 9, the electromagnet of which is connected in series relation with the coils of the up-direction and the down-direction switches 1 and 2, so that it will be deenergized when the direction switches are deenergized to cut off power from the hoisting motor EM and thereby effect a braking action for stopping the hoisting drum and preventing further movement thereof while the power is off.

In operating an electric elevator, it has been found that the car will always come to rest accurately level with the floor at which a stop is to be made under the combination of the following conditions:

1. When the power is cut off at a constant distance from the floor.

2. When the braking effect applied to the car remains constant and is applied at the same time in the car's travel, and,

3. When the car is traveling at a predetermined constant speed as it passes the point where the power is cut off the hoisting motor.

With the use of the inductor landing system, no variation in the cut-off point will occur by reason of the fact that the inductor relays will automatically cut off the power for the motor as they pass the inductor plates mounted at a fixed distance from the floor level.

Inasmuch as the brakes may be designed to stop the car instantly when they are applied thereto, no trouble is experienced in preventing variation in the braking effect or the time at which it will be applied. This is particularly true when an electromagnetic brake is employed with the system in such manner that its application will be initiated at the time the power for the hoisting motor is cut off. However, a time lag necessarily exists between the time the power is cut off and the time the brake becomes effective by reason of the fact that some time is consumed by the physical movements of the operating parts of the relays, switches, etc., in acting to cause the setting of the brake. This time lag may permit the car to drift several inches before the brake sets and stops it. The distance that the car will travel during the drifting period, that is, between the time the power is cut off and the time the brake takes effect, will vary with the speed of the car but will always be constant for any given car speed. Therefore, it is necessary for the car to travel at a predetermined constant speed as it passes the point where the power is cut off in order to have the car stop accurately level with the floor at which a stop is to be made.

It is possible theoretically to design an elevator system having series and separately excited field windings of such proportions that the car will maintain its speed exactly constant regardless of the load so that it will always arrive at the cut-off point at the same speed when a stop is to be made. However, in actual practice it is found to be difficult to produce, install and maintain an elevator in which the car will maintain a constant speed regardless of its load. Some of the difficulties may be caused by manufacturing inaccuracies or by slight errors in installation. Even if the elevator is manufactured accurately and installed correctly, the speed of the car as it approaches the cut-off point may be affected in many other ways. For instance, the first and second slow-down relays and switches may be rendered slow in action by improper lubrication or by dirt collecting on their moving parts and thus fail to act promptly in reducing the power supplied to the car.

Therefore, I have provided additional mechanical means for controlling and correcting the speed of the car, as it reaches the cut-off point, in such a manner that the car will, at least, always arrive at that point at the same speed, regardless of its load, so as to insure the car landing accurately level with the floor at which the stop is to be made.

In the present instance, I have illustrated this means for controlling the speed of the car as comprising an auxiliary brake 10 for applying a braking effect to the shaft of the hoisting drum at a rate that is proportional to the speed of the car as it approaches the cut-off point in such manner that the car will arrive at the cut-off point at a predetermined speed.

The auxiliary brake 10 comprises a brake drum 11 that is mounted on the shaft 7 of the hoisting drum D, a brake shoe 12, a brake lever 13, and a plurality of electromagnets 14, 15 and 16 for operating the brake lever to apply the brake shoe to the brake drum. The brake lever may be pivotally mounted on a rigid pivot member which serves as a fulcrum.

Inasmuch as it is necessary to provide for correcting the speed of the car when it is running at too low a speed as well as when it is running at too high a speed, it is necessary to apply a braking effect under all speeds and at the same time to vary that braking effect in such manner that it will correct the speed of the car.

In other words, if the car is running at its normal speed, a normal braking effect must be applied, but if the car is running too fast or too slow, a heavy braking effect or a light braking effect, as the case may be, must be applied to correct the speed of the car. Therefore, it will be observed that the electromagnets 14, 15 and 16 for operating the brake lever 13 are disposed at different distances from the point at which the lever is fulcrumed. The variations in the positions of the magnets provide means whereby a variation in the application of the brake shoe to the brake drum may be secured easily by connecting the magnets to corresponding contact members 17, 18 and 19 to be engaged by a switch arm 20 in accordance with the speed of the car.

The switch arm 20 is connected to a centrifugal governor 21 that is operated by the shaft 7 of the hoisting drum D in such manner that the electromagnets 14, 15 and 16 will be energized to apply the auxiliary brake 10 in accordance with the speed at which the car approaches its cut-off point in coming to a stop.

If the car approaches at its normal speed, the switch arm 20 will move to the contact member 18 to energize the electromagnet 15 to apply a normal braking effect to the car. If the car approaches at a speed less than normal, the switch arm 20 will be moved to the contact member 19 to energize the electromagnet 14 to apply a subnormal braking effect to the car. On the other hand, if the car approaches at a speed greater than normal, the switch arm will be moved to the contact member 17 to energize the electromagnet 16 for applying an abnormal braking effect to the car and bring it down to normal speed as it reaches the cut-off point.

It should be observed that the circuit for the electromagnets on the auxiliary brake passes through the contact members C on the intermediate speed relay LR so that the auxiliary brake shall be applied only when the intermediate speed relay has been deenergized in bringing the car to a stop.

My invention will be understood best from an assumed operation of the apparatus:

Assuming that the car is standing at a lower floor and that it is desired to start the car upwardly, then the attendant moves the car switch CS in a clockwise direction to energize the up-direction switch 1 and to release the electromagnetic brake B by way of a circuit that extends from supply conductor L1 through conductors 25 and 26 to contact members 27, 28 and 29 of the car switch CS, conductors 30 and 37, the coil of up-direction switch 1, conductor 31, the coil of the electromagnetic brake B and conductor 32 to supply conductor L2.

The closing of the contact members *a* on the up-direction switch 1 completes a self-holding circuit for the up-direction switch 1. that extends from supply conductor L1 through conductor 33, the contact members of inductor relay S, conductors 34 and 35, the contact members *a* of up-direction switch 1, conductors 36 and 37, the coil of up-direction switch 1, conductor 31, the coil of the electromagnetic brake B and conductor 32 to supply conductor L2..

The closing of the contact members *b* and *c* on the up-direction switch 1 energizes the field winding GF of the generator with current in one direction by way of a circuit that extends from supply conductor L1 through conductor 38, the contact members *c* of up-direction switch 1, conductor 39, resistance R and R′, conductor 40 the field winding GF of generator G, conductor 41 and 42 the contact members *b* of up-direction switch 1 and conductors 43 and 44 to supply conductor L2. The energization of the field-winding GF causes the generator G to supply current in one direction to the hoisting motor EM and the car starts upwardly.

As the attendant continues the movement of the car switch CS in a clockwise direction, a circuit is completed for operating the car at an intermediate speed, which circuit extends from supply conductor L1, through conductors 25 and 26, the contact members 27, 28 and 45 of the car switch CS, conductors 46 and 47, the coil of intermediate speed relay LR and conductor 48 to supply conductor L2.

The closing of the contact members *a* on the intermediate speed relay LR completes a self-holding circuit for that relay which extends from the supply conductor L1, through conductors 33 and 50, the contact members of down-intermediate-inductor relay LD, conductor 51, the contact members of up-intermediate-inductor relay LU, conductor 52, the contact members *a* of intermediate speed relay LR, conductors 53 and 47, the coil of relay LR and conductor 48 to supply conductor L2.

The intermediate speed relay LR when energized closes its contact members *b* to shunt the resistors section R′ from the circuit previously traced for the field winding GF to thereby cause the car to travel at a higher speed.

Should it be desired to cause the car to travel at a still greater speed, the car switch CS may be moved in a clockwise direction to a further position for completing a circuit for energizing the high speed relay HR that

extends from supply conductor L1 through conductors 25 and 26, contact members 27, 28 and 54 of the car switch CS, conductors 55 and 56, the coil of high speed relay HR and conductors 57 and 48 to supply conductor L2.

The energization of the high speed relay HR and the closing of its contact members *a* completes a self-holding circuit that extends from supply conductor L1 to conductor 58, the contact members of down-high-speed inductor relay HD, conductor 59, the contact members of up-high-speed inductor relay HU, conductor 60, the contact members *a* of high speed relay HR, conductor 61, the coil of high speed relay HR and conductors 57 and 48 to supply conductor L2.

The closing of the contact members *b* on the high speed relay serves to shunt the resistor section R from the circuit previously traced for field winding GF, thereby allowing full line voltage to be supplied to winding GF to cause the car to travel at high speed.

Assuming now that the attendant on the car desires to stop the car at a landing and moves the car switch CS in a counter-clockwise direction to its central position, then the car continues to travel at high speed since switches 1, LR and HR are self holding, but a circuit for energizing the coils of the inductor relays HU, LU and S is completed to render these relays effective to cooperate with the inductor HU′, LU′, and S′ for stopping the car. This circuit extends from supply conductor L1 through conductors 25 and 26, the contact members 27, 28 and 63 of car switch CS, conductor 64, the coil of stopping-inductor relay S, conductors 65 and 66, the coil of inductor relay LU, conductor 67, the coil of inductor relay HU, conductor 68, the contact members *d* of up-direction switch 1, conductors 69, 70 and 32 to supply conductor L2.

As the car passes the inductor plate HU′, the energized conductor relay HU will be actuated to open its contact members and thereby deenergize the holding circuit for high speed relay HR to automatically slow down the car to intermediate speed.

As the car continues towards the floor level, the energized inductor relay LU passes the inductor plate LU′ and is actuated thereby to open its contact members to deenergize the low speed relay LR to automatically bring the car to a still lower speed as it approaches the point at which the power will be cut off.

At this point in the deceleration of the car, the deenergization of the intermediate speed relay LR will close its contact members *c* to complete a circuit for bringing into operation the auxiliary brake 10 for controlling and correcting the speed of the car as it approaches the inductor plate S′ that is located at the point where the power for operating the car should be cut off.

Assuming now that the control system is functioning correctly and that the car after passing the inductor plate LU′ continues at its normal predetermined speed, then the centrifugal governor 21 connected to the shaft 7 of the hoisting drum D will have assumed a position corresponding to the normal speed of the car. Consequently the switch arm 20 carried by the centrifugal governor will be disposed on the contact member 18 for energizing the electromagnet 15 to apply a normal braking effect to the car by way of a circuit that extends from the supply conductor L1 through conductors 75 and 76, switch arm 20, contact member 18, conductor 77, the coil of the electromagnet 15, conductor 78, the contact members *c* of the low speed relay LR and conductor 79 to supply conductor L2.

By reason of the application of a normal braking effect by the auxiliary brake 10 as the car *c* was running at its normal speed, as just described, the car will continue to travel at its normal predetermined speed as the inductor relay S thereon passes the inductor plate S′ and is actuated to open its contact members for opening the circuit to deenergize the up-direction switch 1 and the magnet of the electromagnet brake B for stopping the car.

Inasmuch as the car was traveling at its normal predetermined speed when its power was cut off, and the time consumed by the operation of the electromagnetic brake B is constant, and the distance between the cut off point and the floor level is constant, the car stops accurately level with the floor.

Assuming now that a large number of passengers are taken on at the stop just made and that the attendant moves the car switch CS in a clockwise direction, the car will start and accelerate to a high speed as described in the prior operation. Assuming, further, that the attendant again centers the car switch to make a stop, but that in addition to the car being heavily loaded, some part of the control apparatus operates faster than usual, then the car will slow down at a more rapid rate of deceleration than that previously described after it passes the first inductor plate HU′. Therefore, the car will be traveling at a rate of speed that is less than normal as it arrives at the inductor plate LU′. Inasmuch as it is traveling at less than normal speed, as it reaches the inductor plate LU′, the operation of the speed governor 11 will cause the switch arm 20 to engage the contact member 19 of the auxiliary braking system for energizing the brake magnet 14 to apply the brake shoe 12 to the brake drum 11 with less than normal force, by the completion of a circuit that extends from supply conductor L1 through conductors 75 and 76, the switch arm 20, contact member 19, conductor 80, the brake magnet 14, conductors 81 and 78, the contact members *c* of the low

speed relay LR and conductor 79 to supply conductor L2.

Inasmuch as the braking effect applied to the car is less than normal, the deceleration of the car as it proceeds from the inductor plate LU′ to inductor plate S′ will not be as rapid as usual and the car will arrive at the inductor plate S′, where its power will be cut off, at an approximately normal speed. Therefore, as the car arrives at the cut-off point at normal speed and the other two factors of first, the distance from the landing floor and, second, the efficiency of the stopping brake B remain constant, the drift of the car before the stopping brake sets will remain constant and car will stop accurately level with the floor.

Assuming further that only a few passengers are taken on at the stop just made and that the attendant moves the car switch in a clockwise direction, the car will start and again accelerate to a high speed as described before. Inasmuch as elevators are usually counterweighted to balance approximately 40% of the full load for which they are designed, the car being lightly loaded will have a tendence toward high speed while ascending, if the various parts of its control system are not functioning properly.

Assuming now that the attendant again centers the car switch to make a stop but that some relay or switch connected with the slow-down portion of the control apparatus functions sluggishly, then the car will slow down at a less rapid rate of deceleration than in the cases previously mentioned after it passes the slow-down inductor plate HU′. Therefore, the car will be traveling at a rate of speed greater than normal as it arrives at the inductor plate LU′.

Inasmuch as the car is now traveling at greater than normal speed as it reaches the inductor plate LU′, the operation of the speed governor 21 will cause the switch arm 20 to be disposed on the contact member 17 of the auxiliary braking system for energizing the brake magnet 16 for applying the brake shoe 12 to the brake drum 11 with greater than normal force, by the completion of a circuit that extends from supply conductor L1 through conductors 75 and 76, the switch arm 20, contact member 17, conductor 84, the brake magnet 16, conductors 85 and 78, the contact members *c* of the low speed relay LR and conductor 79 to supply conductor L2. As the braking effect applied to the car is greater than normal, the deceleration of the car as it moves from inductor plate LU′ to inductor plate S′ will be more rapid than usual and the car will arrive at the inductor plate S′, where its power will be cut off, at approximately normal speed.

Therefore, inasmuch as the abnormal speed of the car has been corrected to normal speed at the cut off point, and the other two factors of, first, the distance from the landing floor and, second, the efficiency of the stopping brake B remain constant as before, the car will stop accurately level with the floor.

While I have illustrated and described the auxiliary brake 10 as providing for only three variations in the preliminary braking effect to be applied to the car; that is, normal, subnormal, and abnormal, the brake may be designed to provide for any suitable number of variations.

Thus it will be observed that I have devised a braking system for applying a preliminary braking effect to a car to bring it to a predetermined normal speed as it approaches the point at which its power is cut off and a final braking effect to stop it after it drifts a predetermined distance that will cause the car to land accurately level with the floor regardless of its load and the accuracy of operation of its control apparatus.

While I have illustrated and described only one specific embodiment of my invention, I realize that it is susceptible of wide application and I do not desire to be limited to the precise construction illustrated and described.

I claim as my invention:

1. The combination with a car operable past a landing, a motor for operating the car and means for energizing and deenergizing the motor, of a braking system including means for applying a partial braking effect prior to the deenergization of the motor and for applying an increased braking effect when the motor is deenergized.

2. The combination with a car operable past a landing, a motor for operating the car and means for energizing and deenergizing the motor, of a braking system including means for applying a partial braking effect proportional to the speed of the car prior to the deenergization of the motor and for applying an increased braking effect when the motor is deenergized.

3. The combination with a car operable past a landing, a motor for operating the car and means for energizing and deenergizing the motor, of a braking system including means for applying a partial braking effect prior to the deenergization of the motor and for applying an additional constant braking effect after the motor is deenergized.

4. The combination with a car operable past a landing, power operated means for driving the car, a main brake for stopping the car, and means for deenergizing the driving means at a point a predetermined distance from the landing and for applying said main brake, of an auxiliary brake for controlling the speed of the car and means for operating said auxiliary brake to cause the car to arrive at the deenergizing point at a constant speed whereby the car may be stopped accurately level with the landing by the application of the main brake.

5. The combination with a car operable past a landing, power operated means for driving the car, a main brake for stopping the car, and means for deenergizing the driving means at a point a predetermined distance from the landing and for applying said main brake, of an auxiliary brake for controlling the speed of the car and means operably responsive to the speed of the car for operating said auxiliary brake to cause the car to arrive at the deenergizing point at a constant speed whereby the car may be stopped accurately level with the landing by the application of the main brake.

6. The combination with a car operable past a landing, power operated means for driving the car, a main brake for stopping the car, and means for deenergizing the driving means at a point a predetermined distance from the landing and for applying said main brake, of an auxiliary brake for controlling the speed of the car and means operably responsive to the speed of the car for variably operating said auxiliary brake to cause the car to arrive at the deenergizing point at a constant speed whereby the car may be stopped accurately level with the landing by the application of the main brake.

7. The combination with a car operable past a landing, power operated means for driving the car, a main brake, means for decelerating the car at a point a predetermined distance from the landing, and means for deenergizing the driving means and for applying said main brake to stop the car, of an auxiliary brake for controlling the speed of the car and means operably responsive to the speed of the car as it passes the decelerating point for operating said auxiliary brake to cause the car to arrive at the deenergizing point at a constant speed whereby the car may be stopped accurately level with the landing by the application of the main brake.

8. The combination with a motor-driven load, of means for applying a braking force when slow-down is initiated, and means for regulating the degree of braking force applied in accordance with the speed of the load at the instant when slow-down is initiated.

9. The combination with a motor-driven load and a brake for decelerating said load, of means for applying said brake when slow-down is initiated, and means for regulating the degree of braking force applied in accordance with the speed of the load at the instant when slow-down is initiated.

In testimony whereof, I have hereunto subscribed my name this 25th day of January, 1929.

JAMES DUNLOP.