

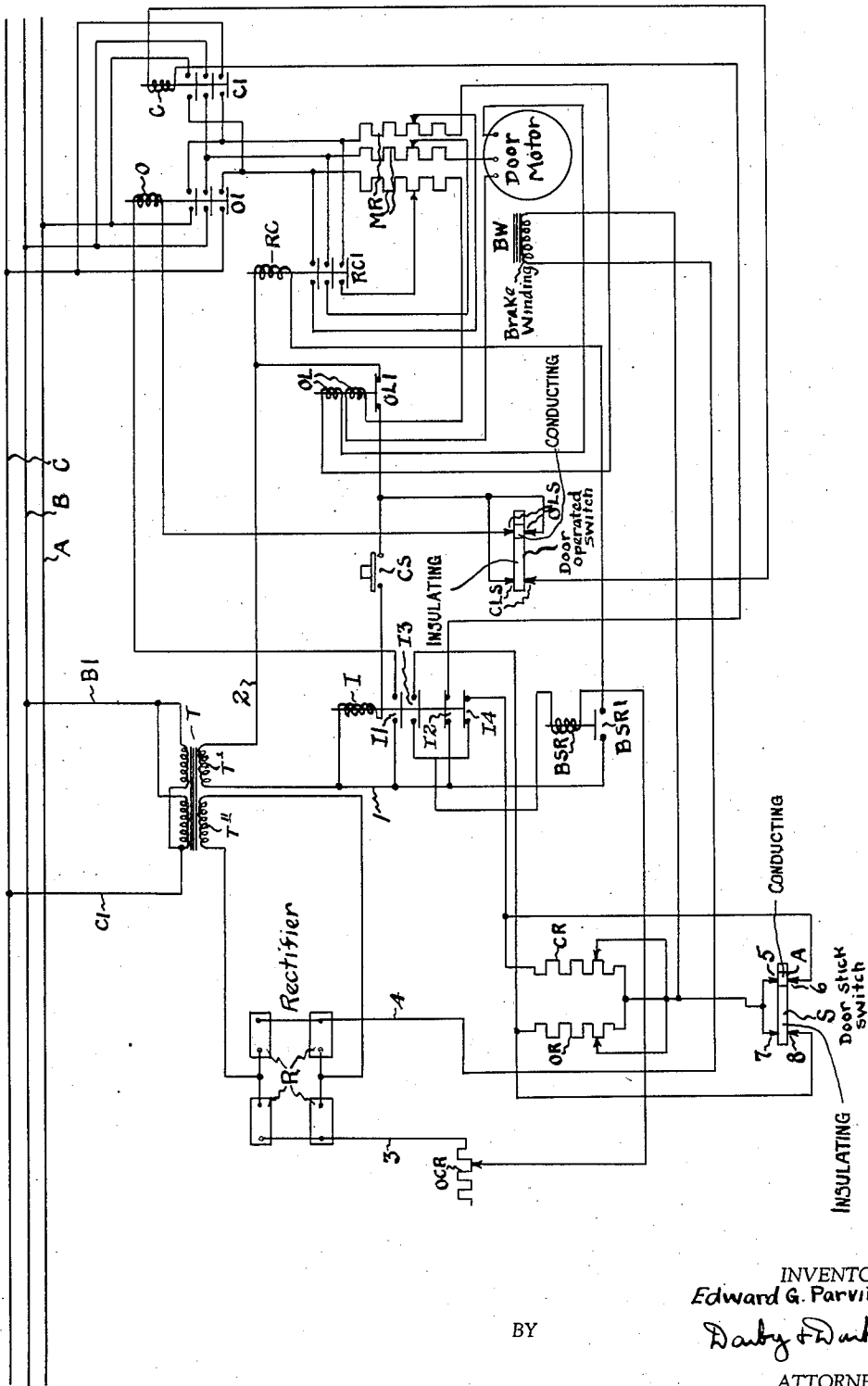
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ELECTRIC DOOR OPERATOR

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ELECTRIC DOOR OPERATOR

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This invention relates broadly to improvements in electric door operating apparatus particularly of the type in which the door travel is relatively small and the door is cushioned in its movement at the end of its stroke in either direction.

A broad object of this invention is to provide an improved form of electric door operator which insures the smooth rapid opening and closing of a door with a cushioning action at the end of its opening and closing strokes.

A more specific object of the invention is to provide, in combination with an electric motor door operator of a retarding device connected thereto whereby the motor is brought to a maximum speed of operation quickly so that such a condition is attained before the door is fully opened or fully closed and indeed before the door reaches the cushioning zone in either direction of movement.

A further object of this invention is to provide a control system for an apparatus of this type in which the retarding means, which is electromagnetic, is maintained energized in full open and full door closed position to hold the door thereat.

Other and more specific objects of this invention which are successfully secured by means of the mechanism herein disclosed will become apparent hereinafter.

This invention resides substantially in the combination, construction, arrangement and relative location of parts, all as will be detailed below.

In the accompanying drawing, the single figure diagrammatically illustrates a combination employing the invention herein.

The operation of doors, such as those found on vehicles, as for example the doors of buses, street cars, subway trains, elevator cars and the like, by means of a motive device, is not a simple thing to accomplish satisfactorily under modern requirements often encountered. For example, an elevator door of necessity has mechanism connected thereto which involves spring resistance to the opening movement of the door requiring a somewhat stronger motor than would be necessary to operate the door itself. On the other hand, during the closing movement this very spring mechanism instead of resisting movement of the door is aiding it which, in conjunction with a motor which is now stronger than necessary to close the door, causes an unduly rapid movement thereof. In part, because of these conditions it is desirable to cushion or retard the door in its movement near the end of its stroke in either direction so that it is more

or less gradually brought to rest at the extreme open and closed positions.

Furthermore, in the motor operation of doors, such for example as elevator doors, and particularly when electric motors are employed, the shortness of the door stroke is such that the door in either direction of movement reaches the cushioning zone before the electric motor operator has attained maximum speed. The result is that upon reaching the cushioning zone the door must begin to slow down at the time the motor is still accelerating. Of course this involves a very sudden change in conditions which are undesirable for many obvious reasons.

An important object of this invention is to provide a braking or retarding means connected to the electric motor which, in effect, considerably lowers the maximum operating speed of the motor so that the motor, in combination therewith, very much more quickly reaches this lower speed and before the door reaches the cushioning zone. It follows, therefore, that the motor now decelerates not from an accelerating condition, but from an attained stable condition.

Referring to the drawing, there is shown a three-phase power supply circuit including the wires A, B, and C. Connected across one phase of this circuit, as for example the wires B and C, are the branch circuit wires B1 and C1 which are connected, in parallel, to the primaries of a pair of transformers T. The secondary T' is connected to the current supply wires 1 and 2. The voltage of the circuit comprising the wires 1 and 2 may, for example, be of the order of 110 volts and the voltage of the polyphase circuit may be of the order of 220 volts representing conditions normally encountered in this art. The secondary T'' is connected to the input of a suitable rectifier R. The particular type of rectifier employed is of no importance per se although it may be noted that the copper oxide type is practical. The output of the rectifier is connected to the direct current voltage circuit wires 3 and 4.

At I, O, C and RC are diagrammatically illustrated the operating windings of relay switches which are connected as shown across the circuit wires 1 and 2. The relay winding I operates the contacts I1, I2, I3 and I4 of which the contacts I1 and I3 are normally open switches while the contacts I2 and I4 are normally closed switches, when the winding I is deenergized. The relay winding O controls the contacts O1 which are normally open switches when the winding is deenergized. The relay winding C controls the con-

tacts CI and are normally open switches when the winding is deenergized. The relay winding RC controls the contacts RC1 which are normally open switches when the winding is deenergized.

5 The contacts CS are the door control contacts which are commonly incorporated in the elevator car controller and controlled manually by the car operator, or automatically in automatic systems. The switch comprising these contacts is
10 open when the door is closed and is closed to open the door. It will be seen that the contacts CS are in series with the winding I. The contacts I1 are in series with the winding O and a switch OLS while the winding C is in series with the contacts
15 I2 and a switch CLS. The three circuits of the windings I, O and C are in series with contacts OLI.

The contacts OLS and CLS represent well known types of door limit switches which are arranged to be operated by the door. The contacts
20 OLS are normally closed, as indicated, when the door is closed and the contacts CLS are normally open when the door is closed. When the door is completely open switch OLS opens and switch
25 CLS closes as soon as the door starts to open, the former condition being restored when the door starts to close and is closed.

The contacts O1 and C1 are in the three-phase circuits to the motor M and are employed in the manner illustrated and well known to provide reversing means whereby when the switches O1 are
30 closed the motor is energized in a direction to open the door and when the switches C1 are closed the motor is energized in the reverse direction to
35 close the door. The circuits to the motor are completed through the resistors MR when the switches RC1 are opened, but are partly short-circuited when these switches are closed. In accordance with common practice, the circuit to
40 the motor is completed through the overload relay winding OL, which, when energized, opens the normally closed contacts OLI.

Returning now to the direct current circuit, there is shown a winding BW which is the energizing winding of the retarding or braking mechanism. This winding is connected in series from
45 the wire 4 to the wire 3 through a resistance OCR, a relay operating winding BSR and in series through either the resistor OR or the resistor CR.
50 The contacts or switches I3 and I4 are in series, respectively, with these resistors. A door operated switch S is provided with two pairs of fixed contacts 5, 6 and 7, 8 and a movable contact A. This switch is shown in the drawing in door closed position where the contact A interconnects the
55 contacts 5 and 6. As shown, the contacts 5 and 7 are connected by the common lead from the winding BW to the resistors OR and CR which lead is also connected by adjustable contacts with the resistors.
60 The contacts 6 and 8 are, respectively, connected to the ends of the resistors CR and OR. The relay winding BSR controls the contacts BSR1 which form a switch in series with the winding RC. This relay is of a type which requires full energization of its winding to open its contacts, partial energization not being sufficient to hold them open.

Before describing the operation of this circuit it should be noted that the door motor M may be of
70 any one of a number of well known types of poly-phase motors suitable for this purpose. The retarding or braking means in this case is really an induction motor having a stator and a rotor whose shaft is common with the rotor shaft of
75 the motor M. The winding BW represents the

field or stator winding of the brake. Such a combination is known in the art and one form is shown in detail in my copending application Serial No. 115,176 filed December 10, 1936.

The operation of this apparatus will now be
5 given in detail. It is first to be noted that the mechanism diagrammatically illustrated is shown in door closed position at which time the switch CS is open. At this time the switch I2 is closed but the winding C is not energized because the
10 limit switch CLS is open. However, the brake winding BW is energized from wire 3 through resistor OCR, relay winding BSR, switch I4, contact 6, contact A, contact 5 and through the winding BW to the wire 4. It will be seen that the resistor CR is short-circuited so that the full current is on the brake winding so that the brake
15 is fully applied to hold the door closed. The energization of the winding BSR keeps the switch BSR1 open so that the winding RC is deenergized and the contacts RC1 are open. The result is that all of the resistances MR are in circuit with the motor M. However, the motor is not energized because relay winding O is deenergized and switches O1 are open and, of course,
20 the same is true of winding C and switches C1.

To open the doors switch CS is closed energizing the winding I from wire 1 through switch CS and overload relay switch OLI to wire 2. Energization of the winding I causes the closing of
30 switches I1 and I3 and the opening of switches I2 and I4. The closing of switch I1 causes the energization of winding O which closes the switches O1 supplying current to the motor M. The switch I4, upon energization of the winding I opens so that the current to winding BSR is supplied through resistor OR but is of such small value that the switch BSR1 closes. Thereupon
35 winding RC is energized closing switches RC1 so as to short out portions of the resistors MR so that the motor is operating at full power. Of course those skilled in the art will readily see that this all occurs simultaneously so that the full power is put on the motor about as soon as the switch CS is closed.
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At this time the brake winding BW is energized from the wire 3 through resistor OCR, winding BSR, switch I3, all of resistance OR adjusted in circuit for use to the winding BW and wire 4. It will be recalled that the brake is connected
50 to the motor and a partial energization of the winding BW causes the brake to resist the motor so that it is quickly brought up to the maximum speed which it may attain against the resistance of the brake and with the energization possible as determined by the adjustments of the resistances MR and OCR. This desirable condition is quickly reached and before the door reaches the cushioning zone. The door switch S is adjusted
55 so that just as the door reaches the cushioning zone as it opens, the contact A interconnects contacts 7 and 8. The result of this is that all of resistance OR is short-circuited and the current flows directly from the winding BSR through the contacts 8, A and 7, to the brake winding
60 BW increasing the energization thereof and acting to retard the door motor.

At the time of this current increase the energization of the winding BSR becomes high enough so that contacts BSR1 open. Winding RC is
70 energized through these contacts, opening the switches RC1 and cutting the rest of the resistance MR into the circuit so that the motor continues to move the door to full open position at reduced power. Thus it will be seen that at the
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time the motor M is operating at reduced power the brake winding BW is fully energized and is operated at maximum power. Just as the door reaches full open position limit switch OLS opens, limit switch CLS having closed as soon as the door started to open. The opening of switch OLS deenergizes the winding O so that the switches OI open and the motor comes to a stop. It will be noted, however, that the winding BW remains fully energized, holding the door in open position. The closing of switch CLS prepares the circuit to relay C for closing when the switch I2 closes. Switch I2 does not close, however, until the switch CS is opened, deenergizing the winding I which is not done until the operator is ready to close the doors.

In order to close the door the operator opens the switch CS, deenergizing winding I with the result that contacts I1 and I3 open and contacts I2 and I4 close. The closing of contacts I2 energizes winding C which closes the switches C1, reversely energizing the motor M. At this time the switches RC1 are closed shorting out most of the resistances MR so that the motor M is operating at full power. These switches are closed because winding RC is energized through the closed contacts BSR1 which are closed because the current reaching the winding BSR through adjusted resistance CR is reduced. Under these conditions the door is operated at full power until it approaches the cushioning zone in the closing direction at which time the switch S is shifted from the position previously assumed back to the position shown in the drawing where contact A interconnects contacts 5 and 6. As soon as this happens, the resistance CR is short-circuited and the current through the winding BSR increases so that the contacts BSR1 open, deenergizing relay RC and opening contacts RC1. At the time the current in the winding BSR increased to full value it of course also increased to full value in the brake winding BW. The opening of contacts RC1 takes the short circuit off the resistance MR so that the door motor slows down but continues to operate at reduced power until the door is fully closed, at which time switch OLS closes. Switch CLS opens as soon as the door starts to close. The opening of switch CLS, of course, deenergizes the winding C so that the contacts C1 open and the motor M stops. The door is now fully closed, the motor deenergized and the brake winding fully energized holding the door in closed position.

In passing it need merely be mentioned that the overload relay windings OL are provided to open the switch OL1 in the event of overload, killing all the circuits connected there-through.

The resistance OCR is adjustable so as to adjust the retarding effect of the brake during the cushioning portion of the movement of the door and hence may be stated to be adjustable to give any desired cushioning effect. The resistances OR and CR are adjustable and control the opening and closing speeds of the door. The resistances MR in the motor circuit are adjustable to vary the power delivered by the motor. In adjusting all of these resistances it may be stated that they are all adjusted so that the door will move slowly and open the limit switches when relay RC is deenergized. These resistances will need to be adjusted from time to time as the parts wear and the temperature changes in order to maintain a desired operating condition. The length of the cushioning zones may

be readily varied by adjusting the switch S so as to be operated by the door or some other part of the equipment operating in timed relation therewith at different points in the door travel. As is obvious to those skilled in the art, the length of the cushioning zone may be varied by the proper adjustments of the switch S or, in other words, the equipment may be adapted to operation of doors having different distances of travel.

It is likewise clear that the limit switches OLS and CLS need not be operated directly by the door but by some part of the mechanism moving in timed relation therewith. Thus, for example, these two switches and indeed the switch S may be operated by the motor itself in accordance with well known principles in the art.

The above description will be apparent to those skilled in the art but the details comprising the combination herein disclosed may be varied without departure from the novel scope of the subject matter hereof. I do not, therefore, desire to be strictly limited to the disclosure as given for purposes of illustration, but rather to the scope of the claims granted me.

What I seek to secure by United States Letters Patent is:

1. A motor control system including an electric motor, a magnetic brake connected to said motor to resist operation thereof, an energizing circuit for said motor, control means for connecting said motor to said circuit, connections from said circuit to maintain the brake continuously applied when the system is in operation, and means controlled by said control means for reducing the force of application of said brake when the motor is energized.

2. A motor control system including a reversible electric motor, a magnetic brake connected to said motor to resist operation thereof in either direction, an energizing circuit for said motor, control means for selectively connecting said motor to said circuit for direct or reverse operation, connections from said circuit for maintaining the brake continuously applied when the system is in use, and means controlled by said control means for reducing the force of application of said brake when the motor is energized for operation in either direction.

3. A motor control system including an electric motor, a magnetic brake connected to said motor to resist operation thereof, an energizing circuit for said motor, control means for connecting said motor to said circuit, connections from said circuit to maintain the brake applied when the motor is energized and deenergized, means controlled by said control means for reducing the force of application of said brake when the motor is energized, and means operated by said motor for reducing the speed thereof at the end of a predetermined period of time.

4. A motor control system including an electric motor, a magnetic brake connected to said motor to resist operation thereof, an energizing circuit for said motor, control means for connecting said motor to said circuit, connections from said circuit to maintain the brake applied when the motor is energized and deenergized, means controlled by said control means for reducing the force of application of said brake when the motor is energized, means operated by said motor for reducing the speed thereof at the end of a predetermined period of time and increasing the force of application of said brake.

5. A motor control system including a reversi-

ble electric motor, a magnetic brake connected to said motor to resist operation thereof in either direction, an energizing circuit for said motor, control means for selectively connecting said motor to said circuit for direct or reverse operation, connections from said circuit for maintaining the brake applied when the motor is energized and deenergized, means controlled by said control means for reducing the force of application of said brake when the motor is energized for operation in either direction, and means operated by the motor for partially reducing its speed for either direction of operation at the end of a predetermined period of time.

6. A motor control system including a reversible electric motor, a magnetic brake connected to said motor to resist operation thereof in either direction, an energizing circuit for said motor, control means for selectively connecting said motor to said circuit for direct or reverse operation, connections from said circuit for maintaining the brake applied when the motor is energized and deenergized, means controlled by said control means for reducing the force of application of said brake when the motor is energized for operation in either direction, and means operated by the motor for partially reducing its speed for either direction of operation at the end of a predetermined period of time and increasing the force of application of said brake.

7. A motor control system including a reversible electric motor, a magnetic brake for said motor having an energizing winding, an energizing circuit for said motor, connections including resistance for maintaining the brake energized when the motor is at rest, means for reversibly connecting said motor to said circuit, means for connecting additional resistance into the brake winding circuit when the motor is energized for operation in either direction, and means operated with said motor for cutting said additional resistance out of circuit to increase the energization of the brake winding at the end of a predetermined period of time.

8. A motor control system including a reversible electric motor, a magnetic brake for said motor having an energizing winding, an energizing circuit for said motor, connections including resistance for maintaining the brake energized when the motor is at rest, means for reversibly connecting said motor to said circuit, means for connecting additional resistance into the brake winding circuit when the motor is energized for operation in either direction, means operated with said motor for cutting said additional resistance out of circuit to increase the energization of the brake winding at the end of a predetermined period of time, and means including resistances in the motor circuit and controlled by said last mentioned means for cutting the motor resistances into circuit at the same time.

9. In a motor controlled system the combination including an electric motor, an energizing

circuit for said motor including a switch and resistance, a brake for resisting operation of said motor, connections from said circuit to said brake for maintaining it energized, manually controlled means for operating said switch, means simultaneously operated for reducing the energization of the brake when said switch is closed, and means operated with the motor for increasing the resistance in the motor circuit and the energization of the brake at the end of a predetermined period of time.

10. A motor control system including an electric motor, a magnetic brake connected to said motor to resist operation thereof, an energizing circuit for said motor, control means for connecting said motor to said circuit, connections from said circuit to maintain the brake energized whether the motor is energized or deenergized, means controlled by said control means for reducing the energization of said brake when the motor is energized, means operated with the motor for increasing the energization of the brake at the end of a predetermined period of time and means operated by the motor for deenergizing it at the end of a predetermined period of time.

11. A motor control system including an electric motor, a magnetic brake connected to said motor to resist operation thereof, an energizing circuit for said motor, control means for connecting said motor to said circuit, connections from said circuit to maintain the brake energized when the motor is at rest, means controlled by said control means for partially reducing the energization of said brake when the motor is energized, and means operated with the motor for increasing the brake energization and decreasing the motor energization at the end of a predetermined period of time.

12. A motor control system including an electric motor, a magnetic brake connected to said motor to resist operation thereof, an energizing circuit for said motor, control means for connecting said motor to said circuit, connections from said circuit to maintain the brake energized when the motor is at rest, means controlled by said control means for partially reducing the energization of the brake when the motor is energized, means operated with the motor for increasing the brake energization at the end of a predetermined period of time, and means operated by the motor for deenergizing it at a desired time.

13. A motor control system including a reversible electric motor, a magnetic brake for said motor having an energizing winding, an energizing circuit for said motor, connections for maintaining the brake energized at all times while the system is in use, means for reversibly connecting said motor to said circuit, and means for connecting resistance into the brake winding circuit when the motor is energized for operation in either direction.

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