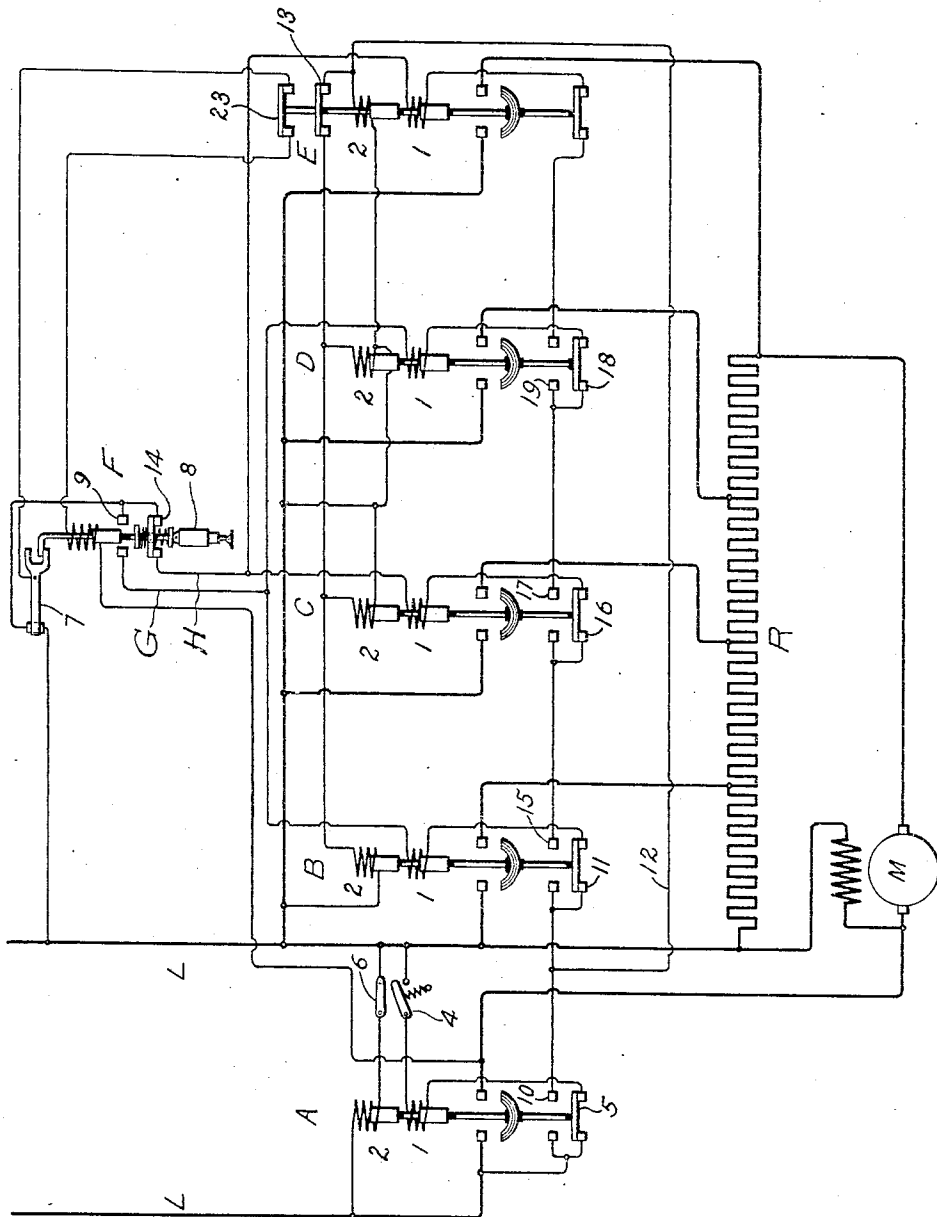


W. O. LUM.
MOTOR CONTROL APPARATUS.

APPLICATION FILED JULY 28, 1906. RENEWED APR. 14, 1908.

937,451.

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UNITED STATES PATENT OFFICE.

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MOTOR-CONTROL APPARATUS.

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To all whom it may concern:

Be it known that I, WALTER O. LUM, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Motor-Control Apparatus, of which the following is a specification.

My invention relates to motor control apparatus, and particularly to those systems in which a plurality of electrically controlled switches are employed to cut out step-by-step the resistance initially inserted in the motor circuit. Such arrangements are often employed in the starting of electric motors and have been so arranged that by closing a single switch the electrically controlled switches are caused to operate automatically to connect the motor to the source and to cut out section-by-section resistance interposed in the motor circuit on starting. In systems of motor control, or in the so-called "automatic starters", of the type above described, it is highly desirable that a certain interval of time should elapse between the successive closing of the resistance controlling switches.

It is an object of my invention to provide an improved arrangement whereby a series of switches may be caused to operate in succession with a definite time interval assured between the operation of successive switches.

The accompanying drawing shows diagrammatically a motor and a starting device arranged in accordance with my invention. I wish to state, however, that I have shown my invention as incorporated in an automatic starting system simply for the sake of simplicity, and that I realize that it may be used in connection with many forms of electrical apparatus. The particular embodiment of my invention, which is hereinafter described, is, therefore, merely illustrative and is not to be considered as limiting my invention as hereinafter defined in the appended claims.

Referring to the drawing, M indicates a motor, illustrated as a shunt wound direct current motor, although any type of motor may be used.

R is a resistance which is adapted to be

connected in circuit with the motor in starting, and to be removed therefrom gradually and automatically as the motor speeds up.

A indicates a line switch adapted to connect the motor to a source of current indicated by lines L and L¹.

B, C, D, and E are resistance-controlling switches, they being adapted to short-circuit the resistance R.

F is a relay for controlling the automatic progression of the switches B, C, D, and E.

The switch A and each of the resistance controlling switches, B, C, D and E are provided with a lifting coil 1 and a holding coil 2. The lifting coil of switch A has its circuit completed through a normally open push-button switch 4 and a normally closed auxiliary switch 5 connected to the main switch. The holding coil of switch A is controlled by a normally closed push button switch 6.

When it is desired to start the motor, the button 4 is momentarily pressed and, the circuit of the actuating coil of switch A being thus closed, this switch closes and the motor circuit is completed with all the resistance in series with the armature. In closing, the main switch opens auxiliary switch 5, thus breaking the circuit of the actuating coil; the switch being maintained closed, however, by means of the holding coil. As soon as switch A is closed, current flows also from line L through actuating coil of the relay F, through auxiliary switch 23 associated with switch E, through auxiliary switch 7 associated with the relay, to line L¹, and the core of the relay is drawn upward subject to the influence of the dash pot 8. When the core reaches the upper position it closes auxiliary switch 9, so that current may flow from line L through auxiliary switch 10 associated with switch A, through auxiliary switch 11 associated with switch B, through the actuating coil of this latter switch, through actuating wire G and switch 9, to line L¹. Switch B therefore closes, short-circuiting a section of resistance R,— and, in closing, breaks its actuating circuit at switch 11. It is maintained closed, however, by current passing from line L through switch 10, conductor 12, auxiliary switch 13 associated with switch E, through holding coil of

switch B, to line L¹. The relay, upon reaching its upper limit, also breaks its own circuit through the operation of switch 7; and therefore the core of the relay again drops, subject to the retarding influence of dash pot 8, until the lowermost position is reached and switch 14 is closed. Current then flows from line L through switches 10 and 15, switch 16, through the actuating coil of switch C, through another actuating wire H and relay switch 14 to line L¹; switch C is therefore closed cutting out a second section of the resistance. In closing, switch C interrupts its actuating circuit at switch 16, and establishes an actuating circuit for the succeeding main switches at switch 17; the switch C as in the case of switches A and B, being held closed by means of the holding coil. It will be seen that the circuit of the relay is also completed at the same time that the relay closes the circuit for the switch C by the closing of switch 7 which occurs when the relay is in its lowermost position. Therefore, when it has closed the actuating circuit for the switch C, the relay starts again on its upward movement, breaking circuit at switch 14 and completing the actuating circuit G for switch D at switch 9. Switch D closes, cuts out a third section of resistance and shifts the actuating circuit from auxiliary switch 18 to auxiliary switch 19, so that when the relay again drops, the actuating circuit H for switch E is completed through relay switch 14. The switch E places a shunt about the entire resistance, so that the motor is connected directly to line and switches B, C, and D need no longer remain closed. Therefore the holding circuit for the switches B, C and D is interrupted by auxiliary switch 13, when the switch E closes, and these switches resume their normal open position. The closing of switch E also causes the circuit of the relay to be interrupted at switch 23, whereby further operation of the relay is prevented. When it is desired to stop the motor, the switch or push button 6 is opened, deenergizing the coil of the switch A and causing this switch, and therefore switch E, to open, interrupting the motor circuit. The progression of the switches is therefore effected automatically after the momentary closing of a single push button switch, and the stopping of the motor takes place upon the operation of another push button. It is clear that since the actuating wires G and H lead to alternate resistance controlling switches, and since these wires are temporarily energized alternately by the action of the relay F, that a certain time interval is assured between the operation of successive resistance controlling switches which interval may be varied at will by adjusting the dash pot on the relay in any well known manner.

It will be seen that although a large num-

ber of resistance steps may be obtained in starting the motor, only a small amount of energy is consumed in the starting apparatus, since the lifting coils are only momentarily in use and only the maintaining or holding coils of switches A and E remain in circuit when all the resistance is cut out.

What I claim as new and desire to secure by Letters Patent of the United States, is,

1. In combination, a plurality of switches adapted to be actuated in automatic succession, a two-position relay having contacts located in the actuating circuits of a series of said switches and adapted to be closed in one position of the relay, and a second set of contacts adapted to be closed in the other position of said relay and arranged in the actuating circuits of switches alternating in progression with the switches of said series.

2. In combination, a plurality of switches adapted to be actuated in automatic succession, a two-position relay having contacts located in the actuating circuits of a series of said switches and adapted to be closed in one position of the relay, and a second set of contacts on said relay arranged in the actuating circuits of switches alternating in progression with the switches of said series, and auxiliary contacts on each switch for controlling the actuating circuit of the next succeeding switch.

3. In combination, a plurality of switches each having an actuating coil and a maintaining coil, means for causing the actuating circuits for said switches to be completed momentarily and in automatic succession, means for completing the maintaining circuits for said switches, and means controlled by the last switch whose actuating circuit is completed to interrupt the maintaining circuits of the preceding switches.

4. In combination, a motor, a line-switch for connecting the motor to a source of current, a speed-controller including a series of switches having actuating and maintaining coils, means operative upon the closing of the line switch to cause the actuating circuits for said series of switches to be completed momentarily and in automatic succession, means for completing maintaining circuits for the switches, and means controlled by the last switch of said series to interrupt the maintaining circuits of the remaining switches of the series.

5. In combination, a plurality of electrically controlled switches, actuating coils therefor, a plurality of actuating circuits successively connected to the actuating coils of successive switches, and means for causing temporary energization of said actuating circuits successively.

6. In combination, a plurality of electrically controlled switches, actuating circuits arranged to control alternate switches, and

means for automatically causing temporary energization of said actuating circuits alternately.

7. In combination, a plurality of electrically controlled switches, two actuating circuits arranged to control alternate switches, and electro-magnetically operated means for automatically causing temporary energization of said actuating circuits alternately.

8. In combination, a plurality of electrically controlled switches, two actuating circuits arranged to control alternate switches, means for automatically causing temporary energization of said actuating circuits alternately, and auxiliary switches in said actuating circuits controlled by said electrically controlled switches for insuring the closing of said last named switches in regular order.

9. In combination, a plurality of electrically controlled switches, two actuating circuits connected to alternate switches, means for automatically causing temporary energization of said circuits alternately, and means controlled by each switch for completing the actuating circuit for the succeeding switch.

10. In combination, a plurality of electrically controlled switches, two actuating circuits connected to alternate switches, and a two-position relay mechanism for automatically causing temporary energization of said circuits alternately.

11. In combination, a plurality of electrically controlled switches, two actuating circuits connected to alternate switches, and a two-position relay controlling contacts on each actuating circuit for automatically causing temporary energization of said actuating circuits alternately.

12. In combination, a plurality of electrically controlled switches, two actuating circuits connected to alternate switches, and a relay controlling contacts in each actuating circuit, which contacts are closed, respectively, when said relay is in its opposite extreme positions.

13. In combination, an electric circuit, a resistance therein, a plurality of electrically controlled switches for short-circuiting said resistance, actuating wires arranged to control alternate switches, and means for automatically causing temporary energization of said actuating wires alternately.

14. In combination, an electric circuit, a resistance therein, a plurality of electrically controlled switches for short-circuiting sections of said resistance, two actuating wires arranged to control alternate switches, and means for automatically causing temporary energization of said actuating wires alternately.

15. In combination, an electric circuit, a resistance therein, a plurality of electrically controlled switches for short-circuiting sections of said resistance, two actuating wires arranged to control alternate switches, and electromagnetically operated means for automatically causing temporary energization of said actuating wires alternately.

16. In combination, an electric circuit, a resistance therein, a plurality of electrically controlled switches for short-circuiting sections of said resistance, two actuating wires arranged to control alternate switches, means for automatically causing temporary energization of said actuating wires alternately, and auxiliary switches in said actuating wires controlled by said electrically controlled switches for assuring the closing of said last named switches in regular order.

17. In combination, an electric circuit, a resistance therein, a plurality of electrically controlled switches for short-circuiting sections of said resistance, two actuating wires connected to alternate switches, means for automatically causing temporary energization of said wires alternately, and means controlled by each switch except the last in closing for completing the actuating circuit for the succeeding switch.

18. In combination, an electric circuit, a resistance therein, a plurality of electrically controlled switches for controlling said resistance, two actuating wires connected to alternate switches, and a two-position relay mechanism for automatically causing temporary energization of said wires alternately.

19. In combination, an electric circuit, a resistance therein, a plurality of electrically controlled switches for controlling said resistance, two actuating wires connected to alternate switches, and a two-position relay controlling contacts in each actuating circuit for automatically causing temporary energization of said actuating wires alternately.

20. In combination, an electric circuit, a resistance therein, a plurality of electrically controlled switches for controlling the connections of said resistance in the circuit, two actuating wires connected to alternate switches, and a relay controlling contacts in each actuating circuit, which contacts are closed respectively when said relay is in its opposite extreme positions.

In witness whereof I have hereunto set my hand this 27th day of July, 1906.

WALTER O. LUM.

Witnesses:

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GRACE M. HANIGAN.