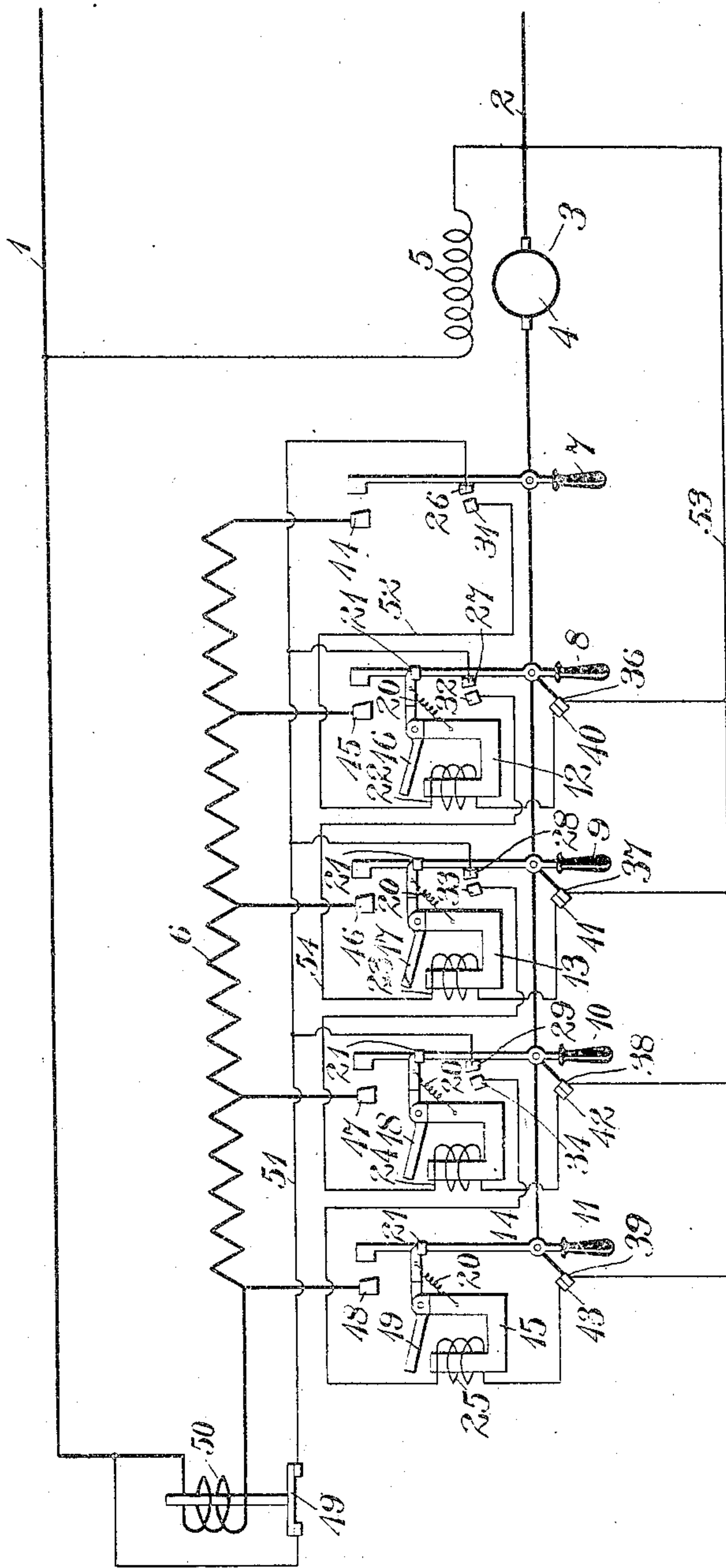


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H. D. JAMES.  
SYSTEM OF ELECTRIC MOTOR CONTROL.  
APPLICATION FILED NOV. 3, 1906.



WITNESSES:

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# UNITED STATES PATENT OFFICE.

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## SYSTEM OF ELECTRIC-MOTOR CONTROL.

No. 892,499.

Specification of Letters Patent.

Patented July 7, 1908.

Application filed November 3, 1906. Serial No. 341,890.

*To all whom it may concern:*

Be it known that I, HENRY D. JAMES, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Systems of Electric-Motor Control, of which the following is a specification.

My invention relates to controlling means for electric motors, and has special reference to systems or devices which are adapted for starting relatively large motors.

The object of my invention is to provide means that shall be simple and durable in construction and effective in operation for controlling the starting resistances of relatively large electric motors and for eliminating the possibility of injuring the motor windings by increasing the applied voltage too rapidly.

For starting relatively large electric motors, a plurality of switches for gradually reducing the resistance in the motor circuit, as they were successively closed, have sometimes been utilized in lieu of the ordinary forms of starting rheostats usually employed with motors of the smaller sizes. The several switches comprised in a starter of the aforesaid class have sometimes been mechanically or electrically interlocked in order to prevent the closure of the switches in other than a predetermined order, or to automatically interrupt the motor circuit in case the switches were so closed.

According to my present invention, I not only prevent the closure of the control switches in other than a predetermined order, but also so arrange the system that it becomes a physical impossibility for an attendant to decrease the resistance of the motor circuit too rapidly by successively closing the switches regardless of the current flowing in the motor circuit.

The single figure of the accompanying drawing is a diagrammatic view of a system of electric motor control arranged in accordance with my invention.

Referring to the drawing, electrical energy may be supplied from any convenient source through line conductors 1 and 2 to an electric motor 3 which comprises an armature 4 and a field magnet 5 and which is provided with a starting resistance 6. The propor-

tion of the starting resistance included in the motor circuit is determined by a series of manually-operated switches 7, 8, 9, 10 and 11, switches 8, 9, 10 and 11 being provided with electro-magnetically controlled means for preventing their closure, which comprises stationary core members 12, 13, 14 and 15, and pivotally mounted pawls 16, 17, 18 and 19. When the switches are open, the pawls normally occupy such positions that closure of the switches is prevented, each pawl being so held by a spring 20 or by gravity that its outer end engages a projection 21 on the corresponding switch. The cores 12, 13, 14 and 15 are severally provided with magnet windings 22, 23, 24 and 25 which, when energized, act in opposition to the springs 20 to release the pawls from engagement with the projections 21 and consequently permit the manual closure of the switches.

The switches 7, 8, 9 and 10 are provided with auxiliary contact terminals 26, 27, 28 and 29, which are adapted to engage stationary contact terminals 31, 32, 33 and 34, when the switches are closed. The switches 8, 9, 10 and 11 are further provided with auxiliary contact terminals 36, 37, 38 and 39 which are adapted to engage stationary contact terminals 40, 41, 42 and 43 when the switches are open. The ends and a plurality of intermediate points in the starting resistance 6 are connected to stationary switch contact terminals 44, 45, 46, 47 and 48 which are respectively engaged by the switch blades.

The electrical connections between the several magnet coils are such that the pawls 16, 17, 18 and 19 are successively released as the switches 7, 8, 9 and 10 are closed, provided the current in the motor circuit does not exceed a predetermined amount. In case such predetermined amount is exceeded, the release action is delayed by a limiting device 49.

The operation of the system is as follows:—Electrical energy is supplied, when the switch 7 is closed, through conductor 1, a series magnet coil 50 of the limiting device 49, starting resistance 6, switch terminal 44, and the movable member of switch 7 to the armature 4 of the motor 3, from which point circuit is completed through the line con-



ductor 2. The characteristics of the starting resistance 6 will, of course, be determined by the size of the motor and the conditions of load under which it is started and, if the motor current exceeds a predetermined amount, the limiting device 49 will be actuated by the series coil 50 and will interrupt an auxiliary circuit 51. As soon as this limiting device is closed, circuit is completed from the line conductor 1, through said device, auxiliary conductor 51, contact terminals 26 and 31, conductor 52, magnet winding 22, contact terminals 40 and 36, and conductor 53 to the opposite line conductor 2. The magnet winding 22, when energized, actuates the pawl 16 in opposition to the spring 20, so that the switch 8 may be closed. When the switch 8 is closed the magnet winding 22 will be de-energized but the switch will then be independent of the pawl 16, so that its release at this point will have no effect. Energy will now be supplied, provided the limiting device is closed, through contact terminals 27 and 32, conductor 54, magnet winding 23, contact members 41 and 37, and conductor 53 to the line conductor 2. The winding 23, when energized, actuates the pawl 17 so that the switch 9 may be closed. In a similar manner, the pawls 18 and 19 may be successively actuated so that the switches 10 and 11 may be closed.

It will be observed that the closure of the switches is confined to a predetermined sequence and that the closure of each switch is dependent upon the limiting device, so that the starting resistance cannot be short-circuited too rapidly. As each of the switches 8, 9 and 10 is closed a greater portion of the resistance 6 is excluded from the motor circuit and, when the switch 11 is closed, the entire resistance is finally short-circuited.

The motor starter of my present invention is equally applicable to alternating and direct current circuits and for voltage as well as rheostatic control, and I desire that only such limitations be imposed as are indicated in the appended claims.

I claim as my invention:

1. A motor-starting device comprising a series of manually operated switches, electrically released mechanical means for confining their closure to a predetermined sequence and electrical means for delaying their closure.

2. A motor-starting device comprising a series of manually operated independent accelerating switches, electrically released mechanical means for preventing the closure of the same except in a definite order, and electrical means for delaying the closure of each until the automatic fulfillment of predetermined conditions.

3. The combination with an electric motor, a starting resistance therefor, and a plurality of manually operated accelerating

switches, of electrically released mechanical means for preventing the closure of the switches except in a predetermined order, and electrical means for delaying the closure of each switch until the motor current falls below a predetermined amount.

4. The combination with an electric motor, a starting resistance therefor, and a plurality of manually operated independent switches for bridging sections of the resistance, of electrically released mechanical means for preventing the closure of the switches in other than a definite order, and electrical means for preventing the closure of any resistance-reducing switch until the current in the motor circuit falls below a predetermined amount.

5. The combination with an electric motor, a starting resistance therefor, a plurality of manually operated independent switches for controlling the resistance of the motor circuit, a limiting device and an actuating coil therefor which is connected in said circuit, of electrically released mechanical means for preventing the closure of the switches other than in a predetermined order, and means dependent upon the limiting device for delaying the closure of the switches.

6. The combination with an electric motor, a starting resistance therefor, a plurality of manually operated independent switches for controlling the resistance in the motor circuit, and a limiting device that is actuated by the motor current, of mechanical stops or pawls for preventing the closure of the manually operated switches other than in a predetermined order, and means dependent upon the limiting device for delaying the closure of the switches.

7. A motor-starting device comprising a series of manually operated switches, electromagnetically actuated pawls for confining their order of closure to a predetermined sequence and for delaying their closure until the motor current falls below a predetermined amount.

8. The combination with an electric motor, a starting resistance, and a plurality of manually operated accelerating switches, of means comprising mechanical stops or pawls for preventing the closure of the switches except in a predetermined order, actuating magnets for said pawls which may only be energized when the current in the motor circuit falls below a predetermined amount.

9. The combination with an electric motor, a starting resistance, a plurality of manually operated accelerating switches, a limiting device which is energized when the current in the motor circuit exceeds a predetermined amount, of means comprising mechanical stops or pawls for preventing the closure of the switches except in predetermined order, and actuating magnets which may only



be energized when permitted by the limiting device.

10. A motor-starting device comprising a series of manually-operated switches, mechanical means for positively confining their closure to a predetermined sequence, and other means for delaying their closure.

In testimony whereof, I have hereunto subscribed my name this 31st day of October, 1906.

HENRY D. JAMES.

Witnesses:

EDWIN LEHR,  
BIRNEY HINES.