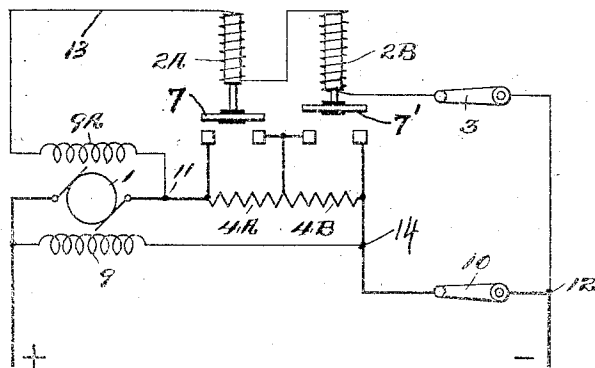


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 MEANS FOR CONTROLLING ELECTRIC CURRENTS.  
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Patented Oct. 6, 1914.



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# UNITED STATES PATENT OFFICE.

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## MEANS FOR CONTROLLING ELECTRIC CURRENTS.

1,112,784.

Specification of Letters Patent.

Patented Oct. 6, 1914.

Original application filed May 1, 1905, Serial No. 258,378. Divided and this application filed December 18, 1905. Serial No. 292,120.

*To all whom it may concern:*

Be it known that I, ERNEST L. GALE, Sr., a citizen of the United States, residing in the city of Yonkers, in the county of Westchester and State of New York, have invented a new and useful Improvement in Means for Controlling Electric Currents, of which the following is a specification.

My invention relates to apparatus for controlling electric currents, and more particularly those used for starting and controlling electric motors.

This application is a division of my co-pending application Serial No. 258,378, filed May 1, 1905, for an improvement in current controlling apparatus.

One of the objects of my invention is the provision of simple and efficient means for starting an electric motor.

Another object of my invention is the provision of improved and simplified construction for starting and operating electric motors with minimum consumption of current.

Other objects of the present invention will appear hereinafter, the novel combinations of elements being pointed out in the claims.

The accompanying drawing is a diagrammatic view illustrating one form of my invention. It designates a controlling device, as for example, an armature of a direct current motor. I have herein shown, by way of illustration merely, an armature of a direct current motor, but I wish it to be understood that the term motor used in the claims is intended to cover a reciprocating motor such as an electromagnet, as well as a rotary motor, either direct current or alternating current.

4<sup>A</sup> and 4<sup>B</sup> designate a resistance element which is shown as an ohmic resistance, but may be inductive or capacity or other means for opposing or checking the flow of current, or, if desired may be comprised of an ohmic resistance alone or combined with an inductance. This resistance element is proportioned in a well-known way to prevent too much current from flowing through the motor upon starting the same. A switch 10 is placed in series with the motor-armature 1 and the resistance 4<sup>A</sup>, 4<sup>B</sup>. The mains are designated by + and - and are connected directly to the motor-armature and the switch 10, respectively, as shown. The

shunt field 9 may be connected to the positive main to the left of the motor-armature, and the motor-armature circuit between the resistance element 4<sup>A</sup>, 4<sup>B</sup> and the switch 10. The controlling circuit is in parallel with the resistance 4<sup>A</sup> and 4<sup>B</sup> and includes the extra field 9<sup>A</sup>, solenoids 2<sup>A</sup> and 2<sup>B</sup>, and a hand operated switch 3. The solenoids 2<sup>A</sup>, 2<sup>B</sup> are adapted when energized to lift their cores with the connected contact makers 7, 7', and thus insert a resistance 4<sup>A</sup>, 4<sup>B</sup>, in circuit with the motor armature 1.

In starting the motor, the switch 10 being opened, and the switch 3 closed, the main-line current is turned on, so that current will flow through the solenoids 2<sup>A</sup>, 2<sup>B</sup>, to excite the same and effect the lifting of their cores. The controlling circuit is preferably of comparatively high resistance and the current which passes through it will not be of sufficient strength to have any appreciable effect upon the motor-armature. After the solenoids 2<sup>A</sup>, 2<sup>B</sup> have operated, the switch 10 is closed. This closes a circuit to the shunt field 9 and also through the starting resistance 4<sup>A</sup>, 4<sup>B</sup>, which is in series with the motor-armature 1. It will be seen that the controlling circuit comprising the solenoids 2<sup>A</sup>, 2<sup>B</sup> and the extra field 9<sup>A</sup> is connected in shunt to the resistance elements 4<sup>A</sup> and 4<sup>B</sup>. After the motor starts, and its counter-electromotive force gradually increases to gradually decrease the current flow through the starting resistance, the potential between the points 11 and 12 gradually diminishes, until the current in the controlling circuit is weakened thereby to such an extent that the solenoids 2<sup>A</sup>, 2<sup>B</sup> release their cores and allow the bridge pieces or contact makers, 7, 7' to drop thus short-circuiting the starting resistance. This will allow the armature to receive the full potential of the line so that the motor will run to full speed. The controlling circuit, therefore, is itself controlled by the varying potential resistance 4<sup>A</sup> and 4<sup>B</sup>. When the contact makers 7, 7' drop they also short-circuit the controlling circuit including the solenoids 2<sup>A</sup>, 2<sup>B</sup>, so that the latter will take little if any current while the motor is running as desired. It is therefore seen that when the resistance element is short-circuited, the current in the controlling circuit is substantially eliminated. This I consider a valuable feature of my in-

vention. In other words, it is the variation of potential across the resistance element that is utilized to influence the controlling circuit and to cause the same to actuate and release means for varying the armature resistance or other current-opposing means.

I have shown two solenoids 2<sup>A</sup>, 2<sup>B</sup>, for controlling the starting resistance, but it will be understood that a greater or less number may be employed if desired with a corresponding number of sections of resistance. The solenoids are preferably made to operate at different potentials. Such operation may be effected in various ways. As shown, the solenoid 2<sup>A</sup> has a smaller number of turns than the solenoid 2<sup>B</sup>. The solenoid 2<sup>A</sup> will therefore release its core before the solenoid 2<sup>B</sup> releases its core.

It will be seen that when the motor is started up with the resistance element in circuit, the extra field 9<sup>A</sup> will be fully energized since it receives current depending upon the potential across the resistance element or between the points 11 and 12. During the operation of this system, this potential gradually diminishes until it is practically negligible and therefore the current through this extra field 9<sup>A</sup> will die out as the motor approaches full speed.

The magnetic field coil of the motor may be excited in any desired manner and may comprise, for example, a shunt field coil 9 connected across the mains as shown. This by itself will maintain the magnetic field at its normal strength. When the main circuit is closed to start the motor, the extra field will increase the strength of the magnetic field due to the shunt coil 9, and this will increase the starting torque of the motor or make it possible to have the same starting torque with less current consumption in the armature. As the motor increases in speed, this extra field gradually diminishes in strength, and the decrease in strength effects a gradual increase in speed of the motor because as the opposition or resistance is reduced the current in the extra field is gradually and automatically reduced to practically zero. This, it will be noticed, is accomplished without any additional switches, which is an advantage over present practice.

It is evident that the motor may be started and stopped by the operation of the switch 10 alone if the continuity of the controlling circuit in series with the armature between the positive and negative mains is not interrupted, and the controlling circuit is of sufficient resistance to prevent enough current from flowing through the armature to effect the starting of the same. For instance, switch 3 may be kept closed and the source of supply cut off from the motor and the switch 10 opened. Now when the source of current supply is connected to

the motor the controlling circuit will immediately effect the operation of the switches, placing the resistance in such association with the armature that when the switch 10 is closed the main armature circuit will be closed and the motor may then start, and as it increases in speed the starting resistance will be gradually cut out as heretofore explained. In the event of depending upon the initial closure of a switch connecting the source of current supply to the positive and negative mains leading from the motor apparatus, the switch 3 may be entirely omitted or kept closed and only the switch 10 closed after the positive and negative terminals have been connected to the source of supply. This is true whether the motor armature starts up at once as soon as current flows in series through the motor armature and the controlling circuit.

Any suitable form of electromagnet may be used in the controlling circuit, but I have shown by way of illustration, a suitable form of electromagnet in my co-pending application 258,378, filed May 1, 1905, of which this application is a division.

Without limiting myself to any of the details of construction or arrangement of parts as herein disclosed, what I claim and desire to have protected by Letters Patent is:

1. In motor controlling apparatus, the combination with a motor-armature and a field circuit, of starting resistance, electromagnetic switches initially holding said starting resistance cut out, an extra field winding in series with the electro-magnets of said switches in a circuit in parallel to said starting resistance, and switching mechanism for closing said circuits.

2. In motor controlling apparatus, the combination with a motor-armature, of starting resistance in series therewith, a field winding for said motor, an extra field winding, a controlling circuit including said extra field winding, an electro-magnet in said controlling circuit, and means operated by said electro-magnet for controlling said starting resistance.

3. In current controlling apparatus, the combination with an electric motor, of starting resistance, a single controlling circuit, a series of switches connected to said resistance, a series of electro-magnets in said controlling circuit each having a single winding and automatically operated according to the varying potential across said starting resistance to control the said switches, an extra field winding in series with said electro-magnets, and means for controlling said electro-magnets.

4. In motor controlling apparatus, the combination with a motor-armature, of a field circuit, starting resistance in series with the motor-armature, a switch for controlling said starting resistance, an electro-

magnet for operating said switch, a controlling circuit connected across said starting resistance and including said electro-magnet, an extra field winding in series with said electro-magnet, and means for controlling the supply of current.

5. In motor controlling apparatus, the combination with a motor-armature and a field circuit, of starting resistance, an extra field winding, switches initially short-circuiting said starting resistance, electro-magnets for operating said switches to insert said resistance when energized and for then permitting the switches to close successively to gradually cut out said resistance as the armature increases in speed, a switch for closing the circuit including said extra field winding and said electro-magnets in series with each other in a circuit in parallel with the starting resistance and in series with the motor armature, and a switch for closing the main armature circuit including the motor armature and said starting resistance in series with each other.

6. In motor controlling apparatus, the combination with a motor-armature, of a shunt field winding therefor, starting resistance in series with the motor-armature and divided into sections, a plurality of switches connected to said sections, a plurality of electro-magnets one for each of said switches, an extra field winding in series with said electro-magnets in a controlling circuit across said starting resistance, a switch for initially closing the controlling circuit to open the switches and insert the starting resistance, and an additional switch for closing the main armature circuit, the electro-magnets then permitting said switches to close again to short-circuit the starting resistance.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

ERNEST L. GALE, SR.

Witnesses:

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ALFRED C. BECHET.