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ELECTRIC MOTOR STARTING DEVICE.

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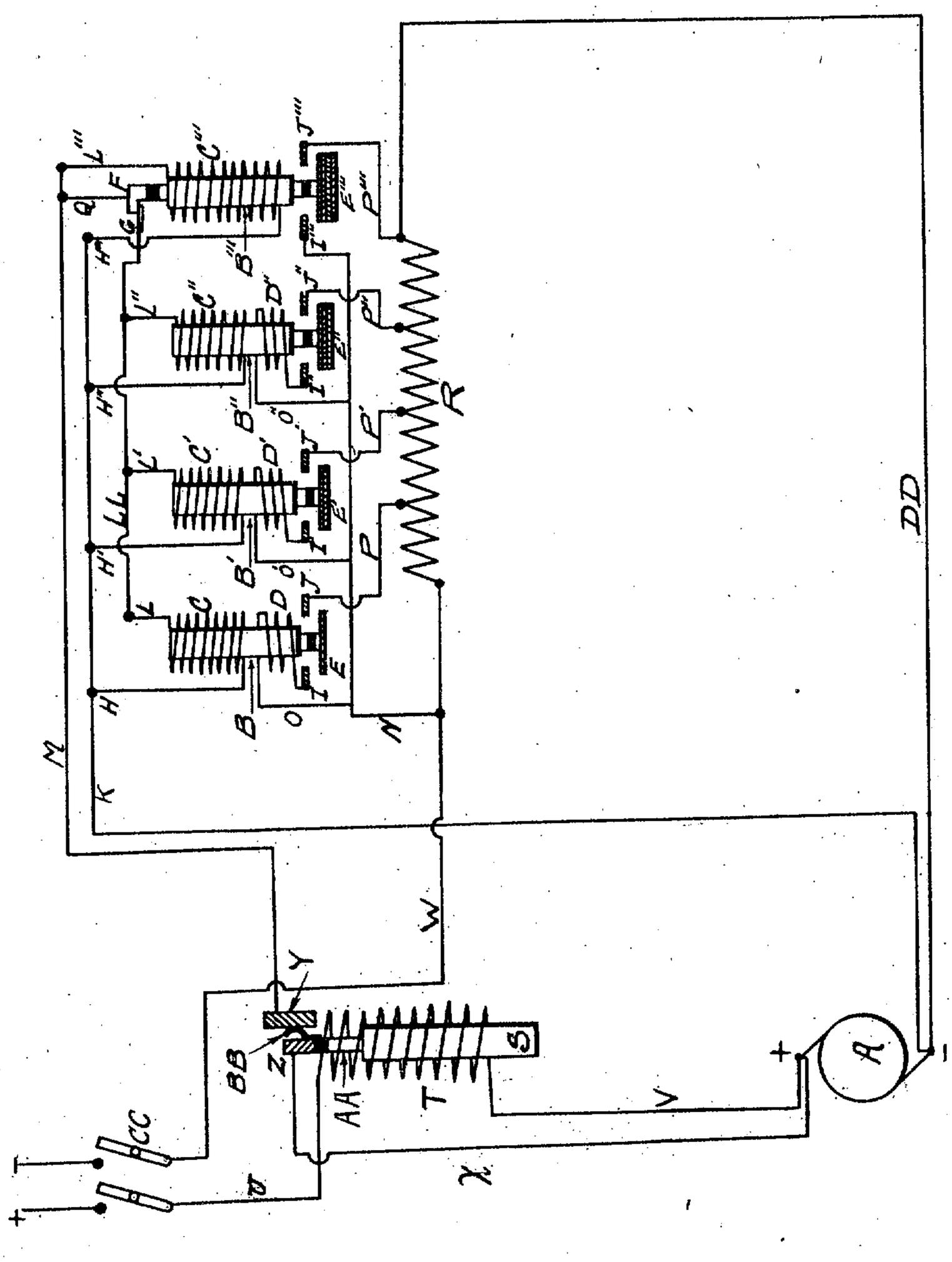

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UNITED STATES PATENT OFFICE.

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ELECTRIC-MOTOR-STARTING DEVICE.

No. 850,165. Specification of Letters Patent. Patented April 16, 1907.

Application filed December 7, 1906. Serial No. 346,748.

To all whom it may concern:

Be it known that we, DAVID R. KNAPP and HOWARD E. CADE, citizens of the United States, residing, respectively, at Philadelphia, in the county of Philadelphia, and at Pencoyd, in the county of Montgomery, both in the State of Pennsylvania, have invented certain new and useful Improvements in Electric-Motor-Starting Devices, of which the following is a specification.

Our invention relates to improvements in electric-motor-starting devices; and our objects are, first, to provide an automatic means for starting an electric motor after power has been supplied to the same through a resistance and means for cutting out the said resistance in steps as the motor increases in speed; second, to provide means to allow a safe amount of current to flow to the motor upon starting from rest in case the load on the motor would otherwise cause excessive current-flow with detrimental results; third, to provide automatic means for opening the motor-circuit when the motor is running in case the load-current became excessive enough to be detrimental, and automatic means for closing the same and allowing only a desired amount of current to flow to the motor in order to maintain its static torque, and means provided to allow the motor to start after the load has been so reduced as not to cause an excessive amount of current to flow through same. We attain these objects by the mechanism illustrated in the accompanying drawing, in which—

Figure 1 is a view showing diagrammatically the connections and mechanism.

Similar letters refer to similar parts through the view.

A is the motor, which is desired to be started and controlled.

B, B′, B″, and B‴ are magnet-cores energized, respectively, by the windings C, C′, C″, and C‴. The windings C, C′, and C″ are assisted by their auxiliary windings D, D′, and D″, respectively. The cores B, B′, B″, and B‴ carry, respectively, the insulated contacts E, E″, and E‴. These contacts engage with contacts I J, I′ J′, I″ J″, and I‴ J‴. The weights of the above-mentioned insulated contacts can be varied, and the distance of the pull of the cores can be varied. On the upper end of the core B‴ there is attached the insulated contact F, which engages with the spring or flexible contact G.

H, H′, H″, and H‴ are leads connecting, respectively, one side of magnet-windings C, C′, C″, and C‴ to line K. L L′ L″ are leads connecting to the other side of the respective windings C, C′, and C″ to line LL. Lead L‴ connects line M to the other side of winding C‴, that is connected by line H‴, previously mentioned. Lead Q connects line M to the insulated contact F.

O, O′, and O″ are leads connecting one side of the respective windings D, D′, and D″ to the lead N, the other side of the windings D, D′, and D″ being respectively connected to contacts I, I′, and I″.

P, P′, P″, and P‴ are leads connecting the different sections of resistance R to the respective contacts J, J′, J″, and J‴, the windings D, D′, and D″ being completed from the line M to the line P, P′, and P″ through the respective contacts I E J, I′ E′ J′, and I″ E″ J″. Lead P‴ is connected to contact J‴ and one end of the resistance R. Line N is connected to the contact I‴ and to the line P‴ through the contacts I‴ E‴ J‴.

S is a magnet-core energized by the winding T, which is in series with the motor. Lead U connects one side of winding T to one side of the line through switch C C. Line V connects other side of winding T to one side of the motor. Lead W is connected to other side of aforesaid switch C C and is connected to lead N and one side of the resistance R. Lead D D is connected to the other side of the aforesaid mentioned resistance R and to the opposite side of the motor than line V is connected to.

A A is an arm attached to the magnet-core S and carries an insulated terminal Z. The terminal Z carries the spring-contact B B, which engages with the contact Y. Lead K is connected to the line D D or the same side of the motor that D D connects to. Line M is connected to terminal Y. Line X connects to the terminal Z and to the same side of motor as line V connects to.

The terminals Z and Y engage each other through the spring-contact B B. The winding D is wound so as to produce the same direction of magneto-motive force as winding C, D′ the same as C′, and D″ the same as C″. The magnet-winding T is in series with the motor, also the windings D, D′, and D″ when

their respective sections of resistance is cut in the line, the windings D, D′, and D″ function being merely to assist the windings C, C′, and C″ and not strong enough to hold their respective cores up. The magnet-winding T is so designed that a predetermined amount of overload current will raise the plunger or core S sufficiently high to open the contact B B on Y, which will open the magnet-circuit M K. The inductive spark at B B will be blown out, due to the magnetic flux of the core S. Upon the lifting of the core B‴ the contact G upon F will be broken, which will open the circuit upon magnet-windings C, C′ and C″. This inductive spark will also be blown out, due to the magnetic flux from the core B‴. The weighted contacts E, E′ E″, and E‴ are all of different weights. It is obvious then that the amount of magnetism that is just required to pick up the core O will not pick up core O′ and that amount which is just required to pick up O′ will not pick up core O″, &c. The same effect can be produced by varying the ampere-turns of the windings C, C′, C″, and C‴ or by varying the distance of the travel of the plunger, thereby increasing their gap. The voltage of the line M K will be from zero to nearly one hundred per cent. of the line voltage, or depending on the amount of resistance cut out of the circuit and the back electromotive force of motor A. The windings C, C′, C″, and C‴ are each of high enough resistance to safely be connected across the line voltage; but magnet-winding C is so designed to pick up core B when, say, ten per cent. of number of voltage has been applied; magnet-winding C′, designed to pick up B′ when, say, forty per cent. of number of voltage has been applied. Magnet-winding C″ is so designed to pick up core B″ when, say, sixty-five per cent. of number of voltage has been applied, and magnet-winding C‴ is so designed to pick up core B‴ when, say, eighty per cent. of the number of voltage has been applied.

The method of operation is thus: Suppose that the switch C C is closed, thereby supplying power to the circuit, current will then flow to line U, magnet-winding T, lead V, through motor A, lead D D, resistance R, lead W, and out on opposite side of line. It will be assumed that the full-load current of the motor A is thirty amperes and its resistance is one-half ohm. It is obvious then that there will be a drop in voltage of fifteen volts on the motor A, due to the ohmic resistance, which will cause the aforesaid voltage of fifteen to exist in the line M K. This voltage will be sufficient to cause enough current to flow through magnet-winding C to pick up its core B, thereby closing contact I E J and shunting part of the resistance R. This will immediately cause a greater amount of current to flow and also increase the voltage of the line M K. This increase in voltage will not be sufficient to pick up core B′; but as the motor speeds up and develops its additional back electromotive force the voltage of line M K will obviously increase the same amount. This additional electromotive force of the motor at this speed will cause sufficient current to flow in magnet-winding C′ to pick up the core B′, thereby closing the contacts I′ E′ J′ and cutting out a further section of resistance. A similar cycle of operation will take place in magnet-winding C″ and its corresponding parts. The windings D, D′, and D″ divide their current and merely assist respective windings C, C′, and C″. When the electromotive force will have increased to such an extent as to cause enough current in magnet-winding C‴ to pick up core B‴, the following results will take place: The contacts I‴ E‴ J‴ will be closed, thereby shunting the last section of resistance, which will mean all of the resistance cut out of the line. The contacts G and F will disengage, causing the circuit of magnetic windings C, C′, and C″ to open and allow the cores B, B′, and B″ to return to the normal starting position. The magnet-winding C‴ will have the full potential of motor A and will hold up, and the circuit will be as follows: Lead U, magnet-winding T, lead V, motor A, lead D D, lead P‴, contacts J‴ E‴ I‴, lead N, lead W, and out on the opposite side of the line, the aforesaid movements thus accomplishing the first aforesaid objects of our invention.

In case the load on the motor was sufficient to cause a detrimental amount of current to flow upon starting, the circuit would be upon starting the same as aforesaid first object. The voltage of line M K would be that which is caused by the ohmic drop of the motor A, as previously stated, which would be sufficient to cause enough current to flow in magnet-winding C to pick up core B, thereby closing contacts I E J and cutting out or shunting that section of resistance, which will immediately cause an increased amount of current and increased amount of voltage along the line M K. If the load on the motor A is excessive, it will not respond in the manner of starting. The stated increased voltage of the line M K, due to the ohmic resistance of the motor and the increased current, will not be sufficient to operate winding C′ and its corresponding parts. Therefore the amount of current is limited to that which is allowed to flow after the first section of resistance is cut out and the motor will attain the corresponding torque, due to that amount of current so long as the load on the motor is excessive enough to not allow it to start, thereby accomplishing the aforesaid second object of our invention.

Assuming that the motor is running under load and a sudden overload is applied, the said overload being sufficient to cause a detrimental amount of current to flow, the wind-

ing T, being in series with the motor-circuit, will receive also the additional current, which a predetermined amount will cause the core S to raise, thereby causing the contacts B B and Y to disengage, causing the circuit on winding C''' to open, which will allow the core B''' to drop to its normal or starting position, which immediately inserts in all the resistance R, which reduces the current to a safe amount. This reduction of the current will not be sufficient to hold up the core S so as to keep contacts B B and Y disengaged, but will allow it to drop to its normal position, thereby closing the contacts B B and Y and causing a small voltage to exist in the line M K, due to the ohmic resistance of the motor A, which will cause enough current to flow in magnet-winding C to pick up the core B. If the load has been decreased to a safe amount, the magnets will operate, as are hereinbefore-described first-mentioned object. If the aforesaid overload is still existing on the motor, the magnets will operate as described in our hereinbefore second object, thereby accomplishing the third hereinbefore-mentioned object of our invention.

The following-described apparatus is suitably mounted on an appropriate panel, and upon its being properly proportioned and connected throughout including the switch indicated on the drawing, all of which will be readily understood by those skilled in the art to which this invention relates.

Having thus described the nature and objects of our said invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In the combination of an electric motor and starting resistance, leads connected to the positive and negative side of the said electric motor, said leads forming a variable-voltage circuit, electromagnets each with variable weight-cores, said electromagnets being energized by the aforesaid variable-voltage distribution-circuit, and electromagnet having its windings in series with aforesaid electric motor, the core of the aforesaid electromagnet carrying the means to open the aforesaid variable-voltage distribution-circuit upon a predetermined movement of said core, all substantially as and for the purpose shown and described.

2. In a starting-panel of the character described in combination with an electric motor and a starting resistance, leads connected to the positive and negative side of the said electric motor, said leads forming a variable-voltage circuit, an electromagnet having its winding in series with the aforesaid electric motor, the core of the aforesaid electromagnet carrying means to open the aforesaid variable-voltage distribution-circuit upon a predetermined movement of said core, electromagnets each having a shunt and series winding, said each shunt-winding connected across the aforesaid variable-voltage distribution-circuit, said series winding being connected in shunt to a respective section of the aforesaid resistance through contacts, said contacts engaging upon the movement of the respective cores, all substantially as and for the purpose shown and described.

3. In a starting-panel of the character described in combination with an electric motor and its starting resistance, leads connected to the positive and negative side of the aforesaid electric motor, said leads forming a variable-voltage circuit, an electromagnet having its winding in series with the aforesaid electric motor, the core of the aforesaid electromagnet carrying means to open the aforesaid variable-voltage distribution-circuit upon a predetermined movement of said core, an electromagnet having a shunt-winding and electromagnets having each a shunt and series winding, said each shunt-winding being connected across the variable-voltage distribution-circuit, said each series winding of the magnets having each a shunt and series winding being connected in shunt to a respective section of the aforesaid resistance through contacts, said contacts engaging upon the movement of the respective cores, all substantially as and for the purpose shown and described.

4. In a starting-panel of the character described, in combination with an electric motor and a starting resistance, leads connected to the positive and negative side of said electric motor, said leads forming a variable-voltage circuit, an electromagnet having its winding in series with the aforesaid electric motor, the core of the aforesaid electromagnet carrying means to open the aforesaid variable-voltage distribution-circuit upon a predetermined movement of said core, electromagnets each having a shunt-winding, said shunt-winding being energized from the aforesaid variable-voltage distribution-circuit, one of the said cores of the aforesaid shunt-magnets carrying means to open the aforesaid shunt-windings, with the exception of its own, said opening of the shunt-windings taking place upon the movement of said core, all substantially as and for the purpose shown and described.

5. In a starting-panel of the character described the combination of an electric motor and starting resistance, leads connected to positive and negative side of said electric motor, said leads forming a variable-voltage circuit, a combination of electromagnets having a shunt-winding, and electromagnets having each a shunt and series winding, said each shunt-winding being connected across the aforesaid variable-voltage distribution-circuit, said electromagnets each having variable-weight cores, said cores of the electromagnets having each a shunt and series winding, each carrying means for short-cir-

cuiting a portion of the aforesaid resistance, through each of the above-mentioned series windings and suitable contacts, the core of the aforesaid shunt-winding magnet carrying means to short-circuit its respective section of resistance upon its movement through suitable contacts, and carry means to open each of the shunt-windings, on each of the aforesaid magnets, having each a shunt and series winding, all substantially as and for the purpose shown and described.

6. In a starting-panel of the character described in combination with an electric motor and starting resistance, leads connected to positive and negative side of said electric motor, said leads forming a variable-voltage circuit, electromagnets having each a shunt-winding, said each shunt-winding being connected across the aforesaid variable-voltage distribution-circuit, said electromagnets each having variable-weight cores, said cores carrying means for short-circuiting a portion of the aforesaid resistance through suitable contacts upon a movement of each of the aforesaid cores, one of the said cores carrying means to open the aforesaid shunt-windings with the exception of its own, said opening of the shunt-windings taking place on the movement of said core, an electromagnet having its winding in series with the aforesaid electric motor, the core of the aforesaid electromagnet carrying means to open the aforesaid variable-voltage distribution-circuit upon a predetermined movement of said core, all substantially as and for the purpose shown and described.

7. In a starting-panel of the character described with a combination of an electric motor and a starting resistance leads connected to the positive and negative side of said electric motor, said leads forming a variable-voltage circuit, a combination of electromagnets having a shunt-winding and electromagnets having each a shunt and series winding, said each shunt-winding being connected across the aforesaid variable-voltage distribution-circuit, said electromagnets each having variable-weight cores, said cores of the electromagnets having each a shunt and series winding, each carrying means for short-circuiting a section of the aforesaid resistance through each of the aforesaid mentioned series windings and suitable contacts, the core of the aforesaid shunt-winding magnet carrying means to short-circuit its respective section of resistance upon its movement, through suitable contacts, and carry means to open each of the shunt-windings on each of the aforesaid magnets having each a shunt and series winding, an electromagnet having its windings in series with the aforesaid electric motor, the core of the aforesaid electromagnet carrying means to open the aforesaid variable-voltage distribution-circuit upon a predetermined movement of said core, all substantially as and for the purpose shown and described.

8. In a starting-panel of the character described in combination with an electric motor and a starting resistance, leads connected to the positive and negative side of the said electric motor, said leads forming a variable-voltage circuit, an electromagnet having its winding in series with the aforesaid electric motor, the core of the aforesaid electromagnet provided with means to open the variable voltage distribution-circuit upon a predetermined movement of said core, electromagnets connected across the aforesaid variable-voltage distribution-circuit, said electromagnets provided with electrical and mechanical means to cause the said cores to operate singly and consecutively as the voltage is increased from zero to one hundred per cent. of the voltage of the variable-voltage distribution-circuit, the windings of the aforesaid electromagnets connected across the aforesaid variable-voltage distribution-circuit each core carrying means for short-circuiting a respective section of the aforesaid resistance through suitable contacts, upon the movement of each of the aforesaid cores, one of the said cores carrying means to open the aforesaid magnet-windings connected across the variable-voltage distribution-circuit, with the exception of its own winding, said opening of the magnet-windings taking place upon the movement of the said core, all substantially as and for the purpose shown and described.

9. The combination with a motor having an armature, of a resistance, supply-mains and a controller for cutting out the said resistance step by step comprising a series of electromagnets one of the said magnets having a shunt-winding, the remainder having each a shunt and series winding, said series winding being connected in shunt to a respective section of the aforesaid resistance upon the operation of the core of the said magnets having each a shunt and series winding, through contacts, said shunt-windings being connected across a circuit, the said circuit being in parallel with the said armature, an electromagnet having its winding in series with the aforesaid motor, the core of the aforesaid electromagnet provided with means to open the aforesaid circuit which is in parallel with the armature upon a predetermined movement of said core, all substantially as and for the purpose shown and described.

10. The combination with a motor having an armature, of a resistance, supply-mains and a controller for cutting out said resistance step by step, comprising a series of electromagnets, one of the said electromagnets having a shunt-winding the remainder having each a shunt and series winding, said series winding being connected in shunt to a respective section of the aforesaid resistance

upon the operation of the core of the said magnets having each a shunt and series winding through contacts, said shunt-windings being connected across a circuit, the said circuit being in parallel with the said armature, one of the aforesaid electromagnets having a core, said core provided with means to open the aforesaid shunt-wound coils, with the exception of its own, upon a predetermined movement of said core, an electromagnet having its winding in series with the aforesaid motor, the core of the said electromagnet provided with means to open the aforesaid circuit in parallel with the armature upon a predetermined movement of said core, all substantially as and for the purpose shown and described.

In testimony whereof we have signed our respective names to this specification in the presence of two subscribing witnesses.

DAVID R. KNAPP.
HOWARD E. CADE.

Witnesses:
ALFRED B. BOTFIELD,
HERBERT M. WALTER.