(No Model.)

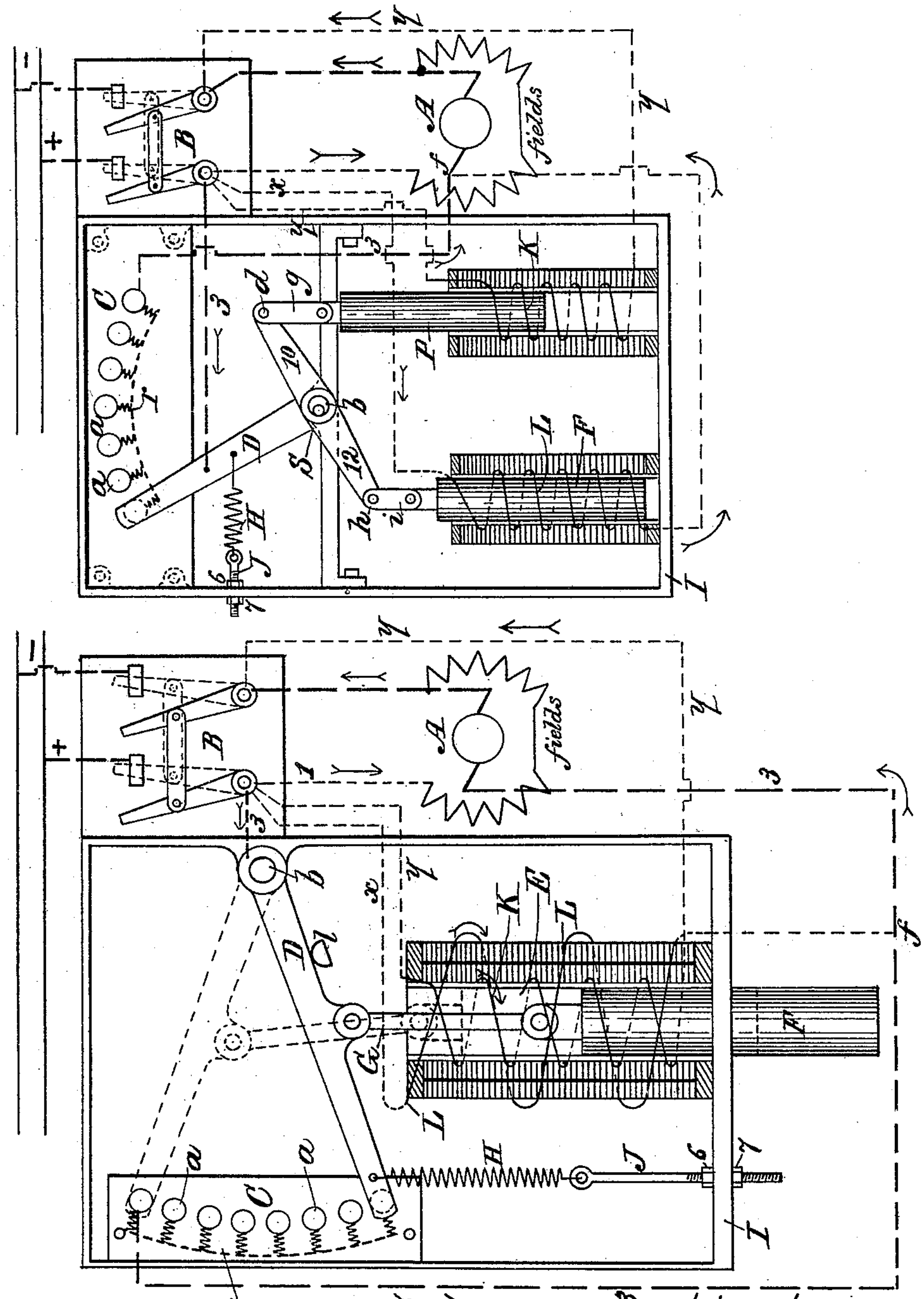
J. W. MOORE.

STARTING AND CONTROLLING DEVICE FOR ELECTRIC MOTORS.

No. 523,586. Patented July 24, 1894.

Fig. 2.

Fig. 1.



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STARTING AND CONTROLLING DEVICE FOR ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 523,586, dated July 24, 1894.

Application filed April 25, 1894. Serial No. 508,998. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH W. MOORE, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Starting and Controlling Devices for Electric Motors, of which the following is a specification.

My invention relates to certain improvements in controlling devices for electric motors, and is adapted particularly for use on electric motors for constant potential circuits employed for operating elevators where the motor is started and stopped at the will of the operator from the car or platform.

It is well known that in shunt-wound motors the armature is of very low resistance, making it necessary to interpose in the armature-circuit a variable resistance which can be gradually cut out as the motor gets up to speed. In starting, there is enough resistance in the rheostat to keep the current down within the capacity of the armature wires, and as the armature starts and accelerates in speed, the counter-electro-motive force increases and permits of the cutting out of the said armature resistance. Should there be no outside resistance in the armature-circuit, or should the resistance be cut out faster than the acceleration of the speed of the armature and consequently faster than the counter-electro-motive force (which is dependent on the speed of the armature) could generate and keep down the current within the safety limit, the safety catches would fuse, causing the inconvenience and expense of replacing them, or possibly causing injury to the armature or to the insulation on the line. Of course this difficulty is easily overcome in the case of stationary motors where the attendant can stand at the rheostat within sight of the motor and by watching the motor, cut out the resistance by hand at the same rate at which the armature gets up to speed; but where the conditions are such that the motor is not in sight of the operator, which is the case in the controlling of electric motors on elevator machinery, it is apparent that some automatic device is necessary for retarding the operation of cutting out said resistance in such a manner that the operator cannot by cutting out the resistance too rapidly cause an abnormal amount of current to be admitted to the armature-circuit, thus causing a jumping of lights which may be on the same circuit with the motor, or otherwise injuring the service on the circuit. In order to overcome these difficulties and to accomplish the desired results stated above, many devices have been invented which are more or less defective.

I will here mention some of the devices which have for their object to properly start and control shunt-wound constant potential motors, and call attention to some of the points wherein they fail to accomplish the result sought.

A resistance connected to blocks, said resistance being cut out successively on said blocks by the contact of brushes attached to an arm and leading the current off to the armature of the motor, is common to all. Now it becomes necessary to automatically move the said arm across the said contact-blocks and to retard its movement so that the motor will have sufficient time to accelerate in speed as fast as the resistance is being cut out. One, among the various ways of accomplishing this, is to have the operator by means of a rope or lever connected with the machine, release a weight, which by gravity gives motion to a rheostat arm, the movement of said weight being retarded by an oil dash-pot or air suction or compression, or by equivalent means. In other devices a solenoid is employed, whereby the operator in the usual manner applies by means of a rope or lever, the current to said solenoid, which in turn actuates the rheostat arm, the action of the solenoid being retarded by a dash-pot, a balance wheel or a centrifugal or other mechanical device.

In the cases mentioned it is obvious that when the rheostat arm is released or the automatic device given control of the rheostat, provided the device operates as intended, the rheostat arm will continue its motion until the resistance is all cut out, and should the motor be too heavily loaded or for any other cause refuse to start, the current would exceed the safety limit and blow out the fuses or burn out the armature, which is obviously a serious defect.

In the devices where oil retarders are employed, other defects are apparent inasmuch as the oil wastes away, causing the resistance to be cut out too rapidly, or is influenced by the weather, congealing when cool and causing the apparatus to stick and stop.

In view of the above named facts it is evident that an automatic starting and controlling device for electric motors, to be perfect, must cut out the resistance only at such a rate that the safety limit of current cannot be exceeded, or in other words the rheostat arm must keep pace with the increasing speed and consequent increasing counter-electromotive force of the motor, and should the motor refuse to start or cease to accelerate, the rheostat arm should remain at the point reached when acceleration ceases.

Having explained the objects to be attained and some of the most serious defects of existing apparatus, I will proceed to describe my invention which obviates the difficulties referred to and attains the desired results above stated.

Figure 1 is a side elevation of my improved starting and controlling device, showing the motor and wiring in diagram. Fig. 2 is a side elevation representing a modification of my invention.

A represents the motor shown in diagram. 3 is the main armature circuit and 1 is the field circuit.

B is a switch by which the circuits of said motor are opened and closed at the will of the operator.

C is the customary rheostat interposed in the armature circuit and consisting of the contact-blocks *a*, *a*, connected to the resistance *r* and mounted on slate or other material insulating them from each other.

D is the rheostat-arm pivoted at *b* and held in the position shown in Fig. 1, by the stop 1 to include the total resistance in the circuit.

E, Fig. 1, is a differentially wound solenoid, its core F being connected with the arm D by means of the link G. The arm D is also connected to the frame I by the tension spring H and threaded rod J provided with nuts 6, 7.

The differentially wound solenoid E consists of two helixes K and L. The helix K is connected at the switch B by the line *y* in a circuit preferably leading directly from the positive to the negative side of the main line. The helix L is connected by the line *x* at the switch B in a branch of the main armature-circuit connecting therewith at *f*, Fig. 1, said branch including said helix in parallel with the resistance *r*, and in series with the armature of the motor, thus making the current in said helix dependent on the speed of the armature and consequent counter-electro-motive force generated by the motor, and independent of the strength or the current in the armature-circuit.

It is to be particularly noticed that in the operation of my device the strength and operation of the retarding helix are not dependent on the strength of the current in the armature-circuit, inasmuch as that branch of the armature-circuit in which the helix L is interposed is of constant resistance and independent of the variable resistance *r*; therefore the current in said helix and consequently the force of the same is also constant until the armature starts, independent of the strength of the current which flows to said armature; and after starting, the current will gradually diminish in the helix L until the motor attains its maximum speed, said motor not attaining full speed until the resistance *r* is entirely cut out.

To show if possible more clearly that the strength of the helix L is not dependent on the strength of the armature current, let it be supposed that the resistance *r* is cut out exactly at the same rate as the acceleration of speed of the armature, then the current in the armature circuit would remain constant from the time the armature started; and notwithstanding this fact the current in the helix L would gradually weaken at the same rate of acceleration of the armature until the resistance *r* was entirely cut out and the helix L practically short circuited, showing conclusively that the weakening of the said helix was entirely due to the influence of the increasing counter-electro-motive force generated by the armature.

Supposing that the switch B is thrown to the position shown by the dotted lines, the current would then pass through the different circuits of the apparatus in the following manner: starting at the switch B, the current passes by the line *i* through the field-wire of the motor and energizes the fields. By line 3 it passes through the arm D, the whole of the resistance *r*, through the armature and through switch B to the negative side of the main line. By the line *y* it passes through the helix K and thence directly to the negative side of the main line; and by the line *x* it passes through the helix L and thence to the line 3, uniting with the armature-circuit at *f*.

The helixes K and L are so wound or connected that the current is made to pass through them in opposite directions, and they are so proportioned that the action of one upon the core F is neutralized by that of the other upon said core so long as the armature of the motor remains stationary.

The resistance *r* is such that when the switch is thrown as above stated, sufficient current will pass through the armature circuit to start the motor, and as soon as the motor armature commences to rotate then the strength of the current in the helix L will be diminished by the influence of the counter-electromotive force thus generated, and the strength of the current in said helix will continue to decrease at the same rate that the speed of the motor accelerates, thus allowing the helix K, the current in which remains constant, to act upon the core F of the solenoid E with correspondingly increased strength, moving the arm D across the contacts *a*, *a*, and overcoming the resistance of the spring H and the weight of the core F until the resistance *r* is all cut out and the motor has attained its maximum speed. To secure a uniform movement of the arm D, I adjust the spring H to the desired tension by means of the threaded rod J and nuts 6 and 7.

Fig. 2 represents a modification of my invention which is identical with the construction shown in Fig. 1, excepting that the arm D forms a part of a T-shaped lever S pivoted at *b*, and that the helix K is made to control a separate core P connected to the arm 10 of the lever S at *d* by the link *g*, while the core F of the helix L is connected at *h* to the arm 12 of the lever S by a link *i*. It is obvious that the result is the same as if both helixes were arranged one within the other, and adapted to control a single core as shown in Fig. 1, the helix L acting as before described in opposition to the helix K, and exerting a retarding influence on the actuating force of the rheostat arm D.

The principal feature of my invention is the employment of two helixes, one of which, K, furnishes the actuating force of the rheostat arm and the other of said helixes L being adapted to neutralize the effect of the helix K until the motor has attained sufficient speed to permit of a further cutting out of the rheostat-resistance.

I do not wish to confine myself to the arrangement of the helix circuits exactly as shown, as it is evident that the helix K could be included in any circuit, the current of which would act with sufficient force to move the arm D and not diminish at so fast a rate as the current in the helix L.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a starting and controlling device for electric-motors, the combination of an armature-circuit divided into two branches or lines, a rheostat consisting of a variable resistance included in one of said branches and a contact-arm adapted to cut in and out said variable resistance, a helix or solenoid included in the other branch of said armature-circuit, said helix being connected in parallel with said variable resistance and in series with the armature, and a second helix or solenoid connected with and adapted to actuate said contact arm to cut in and out said variable resistance, but controlled by the first named helix, substantially as set forth.

2. In a starting and controlling device for electric motors, the combination of the armature-circuit divided into two branches or lines, a switching device for closing and opening the circuit through which the current passes to the motor, a variable resistance in the armature-circuit, a contact-arm adapted to cut in and out said variable resistance, a helix or solenoid included in a shunt of the armature-circuit and having its core connected with said contact-arm to control the movement of the same, and a second helix or solenoid controlled by the first named helix, the latter being dependent on the influence of the counter-electro-motive force of the armature and entirely independent of the strength of the current in the armature-circuit, substantially as set forth.

3. In a starting and controlling device for electric motors, the combination of an armature-circuit divided into two branches or lines, a variable resistance or rheostat included in one of said branches, a differentially wound solenoid consisting of two helixes, one of said helixes being included in the other branch of the armature-circuit and connected in parallel with said variable resistance and in series with the armature, and the other helix being included in another circuit and controlled by the first named helix, and a contact-arm connected to the core of the said solenoid and adapted to cut in and out said variable resistance, the movement of said contact-arm being controlled by said solenoid, substantially as set forth.

4. In a starting and controlling device for electric motors, the combination of the armature-circuit divided into two branches or lines, the switch B for closing and opening the circuit through which the current passes to the motor, a variable resistance in one of the branches of the armature-circuit, the pivoted contact-arm D adapted to cut in and out said variable resistance, the spring H connected with the contact-arm, a helix or solenoid L included in a shunt of the armature-circuit and having its core F connected with the contact-arm D, whereby said solenoid is adapted to control the movement of the same, and a second helix K included in another circuit and adapted to be controlled by the helix L, substantially as described.

5. In a starting and controlling device for electric motors, the combination of the armature-circuit divided into two branches or lines, the switch B for closing and opening the circuit through which the current passes to the motor, a variable resistance in one of the branches of the armature-circuit, the pivoted contact-arm D adapted to cut in and out said variable resistance, the spring H connected with the contact-arm, and a differentially wound solenoid E having its core F connected with the contact-arm D, and consisting of two helixes K, L, the helix L being included in the other branch of the armature circuit and connected in parallel with the said variable resistance and in series with the armature, and the helix K being included in another circuit and being controlled by the helix L, whereby the contact-arm is operated to cut out the resistance in proportion as the speed of the motor increases, substantially as set forth.

Witness my hand this 20th day of April, A. D. 1894.

JOSEPH W. MOORE.

In presence of—
P. E. TESCHEMACHER,
J. S. F. HUDDLESTON.