

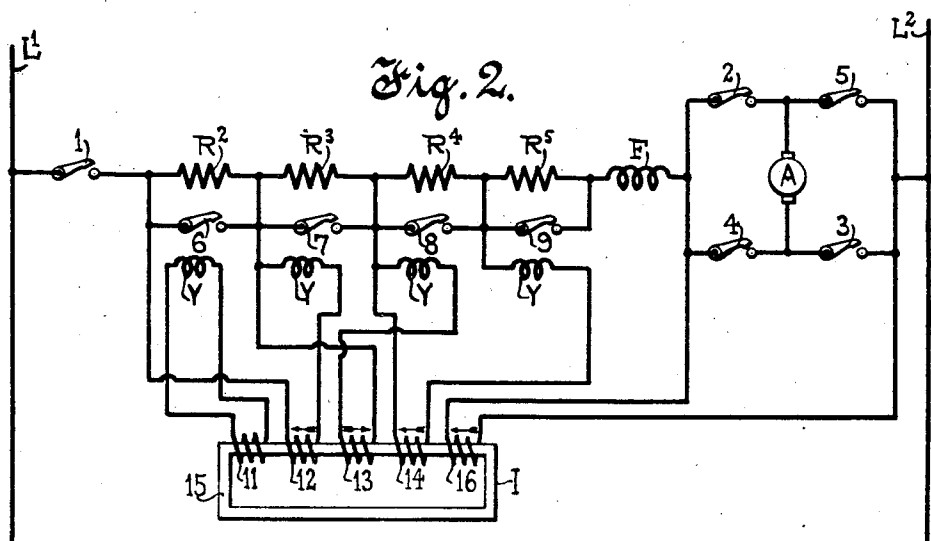
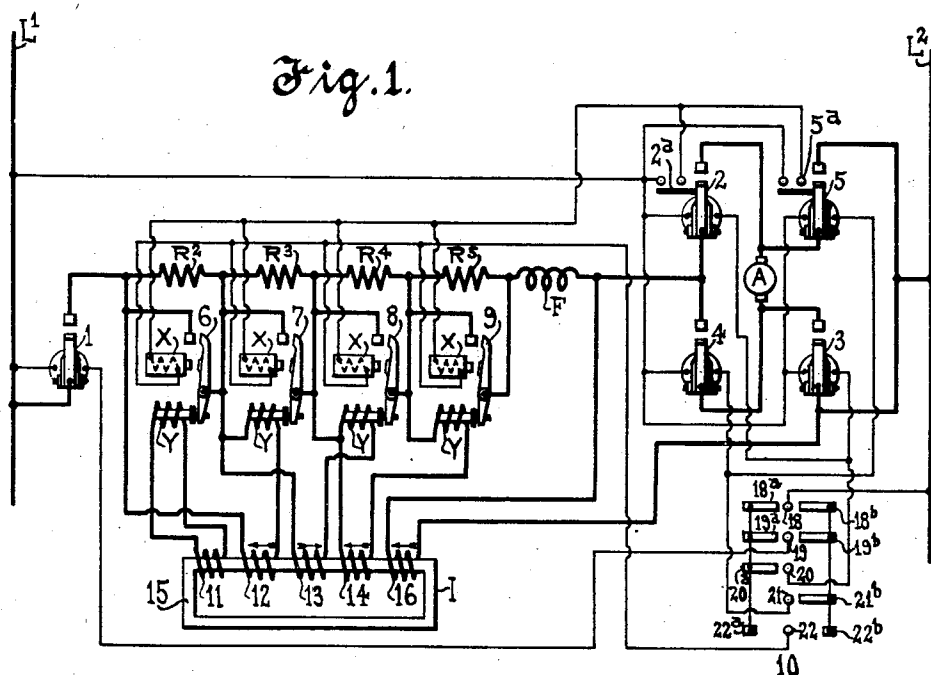
May 21, 1929.

N. L. MORTENSEN

1,713,777

MOTOR CONTROLLER

Filed Nov. 10, 1926



INVENTOR.
Niels L. Mortensen
BY
Paul H. Hubbard
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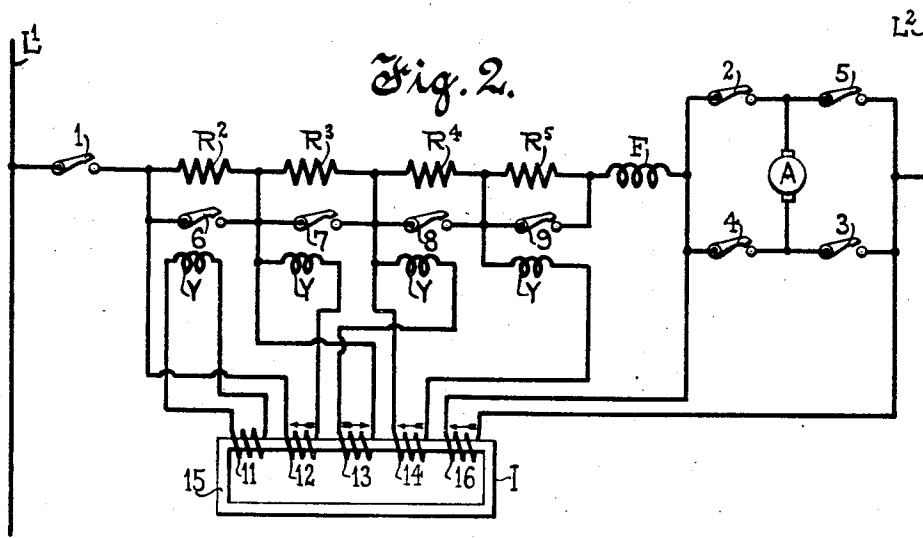
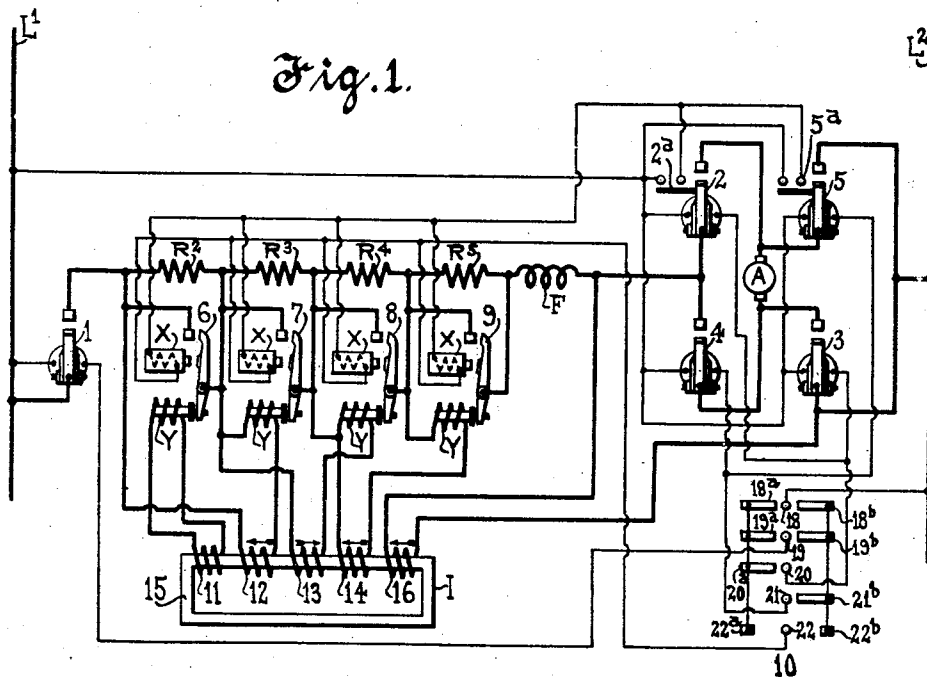
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UNITED STATES PATENT OFFICE.

NIELS L. MORTENSEN, OF WHITEFISH BAY, WISCONSIN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO CUTLER-HAMMER INC., OF MILWAUKEE, WISCONSIN, A CORPORATION OF DELAWARE.

MOTOR CONTROLLER.

Application filed November 10, 1926. Serial No. 147,463.

This invention relates to controllers for electric motors, although certain features thereof may be advantageously employed in other relations.

5 The invention is particularly applicable to controllers of the character disclosed in the application of Frank J. Russell, Serial No. 112,845, filed June 1, 1926. The controller disclosed in said application includes
10 a plurality of accelerating switches each having a restraining winding associated therewith and an inductor for supplying the restraining windings of said switches with inherently transient currents to delay operation thereof. The inductor is provided with
15 a plurality of windings one for each restraining winding, and said windings are arranged in a mutually inductive relation and each is connected in series with its associated restraining winding and in shunt with a given
20 part of the motor circuit. The delay in closure of the accelerating switches is influenced to a large extent by the design of the inductor, and in practice it has been found that if the
25 inductor is designed so that the delay in closure of the first accelerating switch is longer when the motor is plugged than when the same is started from rest, the delay in closure of the other accelerating switches will be influenced to a large extent by the accelerating
30 current and by the load on the motor.

The present invention has among its objects to provide an improved controller of the character disclosed in the aforementioned
35 application in which the delay in closure of the first accelerating switch is influenced to a large extent by the relation between the line voltage and the C. E. M. F. of the motor armature, while each of the other accelerating
40 switches is adapted to operate after a given period of delay which is substantially uninfluenced by the relation between the line voltage and the C. E. M. F. of the motor armature.

45 Various other objects and advantages of the invention will hereinafter appear.

The accompanying drawing diagrammatically illustrates an embodiment of the invention which will now be described, it being
50 understood that the embodiment illustrated is susceptible of modification without departing from the spirit and scope of the appended claims.

In the drawing,

Figure 1 is a diagrammatic view of a preferred form of the controller, and

Fig. 2 is an across-the-line diagram of certain of the circuits illustrated in Fig. 1.

Referring to Fig. 1, the controller is employed in connection with a direct current
60 motor having an armature A and a series field winding F, it being understood that the motor may be of any other preferred type.

The controller includes an electroresponsive main switch 1 and two sets of electro-
65 responsive reversing switches 2—3 and 4—5 for connecting the motor across lines L¹ and L² and electroresponsive accelerating switches 6, 7, 8 and 9 for controlling starting resistances R², R³, R⁴ and R⁵, respectively, in the
70 motor circuit. Each of the accelerating switches is of the two-magnet type, the same being provided with a shunt operating winding X and a restraining winding Y. A master switch 10 is provided for controlling the
75 main switch 1 and the two sets of reversing switches 2—3 and 4—5, and as hereinafter set forth said master switch is also provided with contacts for connecting the several shunt
80 operating windings X in parallel across lines L¹ and L². The accelerating switches tend to respond upon energization of their shunt operating windings, but each of said switches has its restraining winding normally ener-
85 gized to prevent response thereof.

More specifically the restraining windings Y of the resistance control switches 6, 7, 8 and 9 are associated with coils 11, 12, 13 and 14, respectively, of an inductor I, all of said
90 coils being mounted upon a core member 15. As best shown in Fig. 2 restraining winding Y of switch 6 is permanently connected across the terminals of coil 11 and also as shown in this figure inductor coils 12, 13 and 14 are
95 connected in series with their associated restraining windings Y and in shunt across the resistances R², R³ and R⁴, respectively. The core 15 of inductor I is also provided with an additional winding 16 for connection across
100 the motor armature upon closure of either set of reversing switches 2—3, or 4—5. Assuming that the main switch 1 and one set of reversing switches 2—3 or 4—5 are closed, the motor is connected across lines L¹, L² through resistances R², R³, R⁴ and R⁵. The
105 inductor coils 12, 13 and 14 are then ener-

gized by currents which are a function of the voltage across resistances R^2 , R^3 and R^4 , respectively, while the inductor coil 16 will be only slightly energized since there is only a slight voltage across the motor armature. As set forth in the aforementioned copending application of Frank J. Russell, the inductor coils may be arranged so that the magneto-motive forces thereof are additive, or the arrangement may be such that the magneto-motive force of certain of said coils acts in opposition to the magneto-motive force of certain other of said coils. In the embodiment illustrated it is assumed that the magneto-motive forces of the inductor coils are in the directions indicated by arrows and it is also assumed that the resistances are of such values that the magneto-motive force of coil 13 is substantially the same as the combined magneto-motive forces of coils 12 and 14. Thus upon starting of the motor from rest coil 11 will have little or no current induced therein and there will be only a very slight delay in closure of accelerating switch 6. Upon closure of accelerating switch 6 inductor coil 12 is short-circuited with the restraining winding Y of accelerating switch 7 and closure of said latter switch will be delayed for a period which is a function of the difference between the magneto-motive force of coil 13 and the combined magneto-motive forces of coils 14 and 16. Upon closure of switch 7 inductor coil 13 is short-circuited with the restraining winding Y of switch 8 to delay closure of said latter switch, such period of delay being influenced by the stored energy in the electromagnetic circuit of inductor I at the time of closure of switch 7 and also by the inductive effect of coils 14 and 16 on coil 13. In this connection it should be noted that upon short-circuiting of inductor coil 13 with its associated restraining winding the inductor coils 14 and 16 effect reversal of the flux in core member 15, which tends to prolong the delay in closure of switch 8. Upon closure of switch 8 inductor coil 14 is short-circuited with the restraining winding Y of switch 9 and after a given period determined by the stored energy in the core of inductor I and also by the inductive effect of coil 16 on coil 14, switch 9 closes to short-circuit resistance R^5 . The motor is then brought up to full speed and winding 16 is subjected to the full voltage across the armature A to maintain a flux in the core member 15 of inductor I.

Upon plugging of the motor all of the resistance control switches drop out prior to establishment of reverse power connections for the motor and assuming that the motor is operating at full speed its C. E. M. F. is opposed to and of substantially the same value as the line voltage impressed upon its armature. Therefore, upon plugging substantially twice the line voltage is instantaneously applied across the coil 16 to reverse the magneto-motive force thereof. A relatively wide flux change is thus obtained in the core 15 of inductor I whereby coil 11 will have a relatively large current induced therein to provide a prolonged delay in closure of the accelerating switch 6. The controller is preferably designed to prevent closure of switch 6 until the motor is brought to rest. Upon closure of switch 6 the controller again acts in the manner above described to bring the motor up to speed in a reverse direction.

In connection with the foregoing it should be noted that the connections of winding 16 may be varied to obtain other results than those above described. For example, the same may be connected across the motor armature and all or part of the starting resistance. Also, if desired the size of the inductor core and the connections of coils 12, 13 and 14 may be varied, as set forth in the aforementioned copending application, to vary the delay in closure of the accelerating switches associated with said coils.

As before stated, a master switch 10 is provided for controlling the main switch 1 and the two sets of reversing switches 2—3 and 4—5. The master switch 10 comprises stationary contacts 18 to 22, inclusive, and two sets of cooperating movable contacts, one set including contacts 18^a , 19^a , 20^a and 22^a and the other including contacts 18^b , 19^b , 21^b and 22^b . Also the reversing switches 2 and 5 are provided with normally open auxiliary contacts 2^a and 5^a for controlling the energizing circuit of the shunt operating winding X of the accelerating switches 6 to 9, inclusive. Upon movement of the master switch 10 towards the right, switch 1 is energized through the medium of contacts 18, 18^a , 19 and 19^a , while reversing switches 2 and 3 are energized through the medium of contacts 18, 18^a , 20 and 20^a . Also, upon closure of reversing switch 2 all of the restraining windings X of switches 6 to 9, inclusive, are energized through the medium of contacts 18, 18^a , 22 and 22^a and the auxiliary contacts 2^a associated with reversing switch 2. With the master switch 10 in its right hand position main switch 1 is energized through the medium of contacts 18, 18^b , 19^b and 19 while reversing switches 4 and 5 are energized through the medium of contacts 18, 18^b , 21^b and 21. Also, upon closure of reversing switch 5, the operating windings of switches 6 to 9, inclusive, are energized through the medium of contacts 18, 18^b , 22^b and 22 and the auxiliary contacts 5^a associated with reversing switch 5.

What I claim as new and desire to secure by Letters Patent is:

1. In a motor controller, in combination, resistance varying means including a plugging resistance and a switch for controlling the same, said switch having a restraining

winding associated therewith and means for supplying said restraining winding with an inherently transient current to delay operation of said switch, said latter means comprising an inductor having a plurality of coils arranged in a mutually inductive relation, one of said coils being connected across the terminals of said restraining winding and another being connected across a part of the motor circuit including the motor armature.

2. In a motor controller, in combination, a plugging resistance, a control switch therefor and means to delay operation of said switch comprising an inductor having a plurality of windings arranged in a mutually inductive relation, one of said windings being connected across a part of the motor circuit including the motor armature and being adapted to induce a current in another of said windings.

3. In a motor controller, in combination, a plugging resistance means for establishing reverse power connections for the motor, including said resistance and means for delaying exclusion of said resistance upon establishment of power connections for the motor, said means including an inductor having a plurality of windings, one being arranged across a part of the motor circuit including the motor armature and the other being arranged in an inductive relation with the former winding to have a current induced therein which is a function of the C. E. M. F. of the motor armature.

4. In a motor controller, in combination, means for establishing reverse power connections for the motor, resistance varying means including a plugging switch having a restraining winding associated therewith, and means providing for differentiation of the delay in closure of said switch upon starting of the motor from rest and upon plugging

thereof, said means including an inductor having a winding connected across the terminals of the restraining winding of said switch and a second winding connected across a part of the motor circuit including the motor armature.

5. In combination an electric motor, accelerating units therefore affording starting resistances for the motor, said units each including an electroresponsive switch operative switch operative to accelerate the motor and restraining means for said switch comprising an inductor coil, the inductor coils of said units being in series with one another and with said motor and being arranged in a mutually inductive relation, and a coil inductively related to said former coils and connected across a given part of the motor circuit including the motor armature for rendering the operation of certain of said accelerating units dependent upon C. E. M. F. conditions of the motor armature.

6. The combination with an electric motor, having a resistor associated therewith, of a plurality of switches for controlling said resistor, each of said switches having a restraining coil associated therewith and an inductor having a plurality of windings arranged in a mutually inductive relation and each connected in shunt across different parts of the motor circuit, certain of said windings being connected in series with the restraining coils of said switches and being adapted to supply transient currents to said coils to delay operation of said switches, and another of said windings being arranged to render the action of certain of the former coils dependent upon the C. E. M. F. of the motor armature.

In witness whereof, I have hereunto subscribed my name.

NIELS L. MORTENSEN.

CERTIFICATE OF CORRECTION.

Patent No. 1,713,777.

Granted May 21, 1929, to

NIELS L. MORTENSEN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 53, claim 5, strike out the words "switch operative"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 17th day of December, A. D. 1929.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.