

E. A. SPURR.
ELECTRIC CONTROLLER.
APPLICATION FILED JUNE 5, 1914.

1,275,780.

Patented Aug. 13, 1918.

3 SHEETS—SHEET 1.

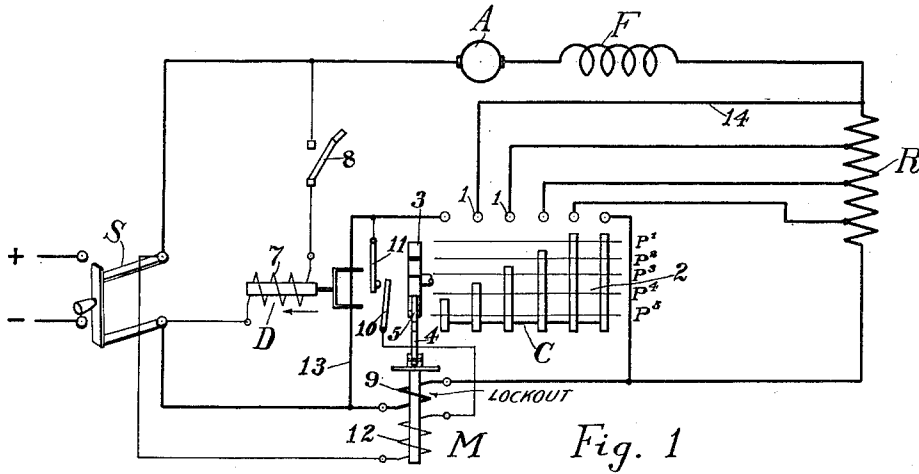


Fig. 1

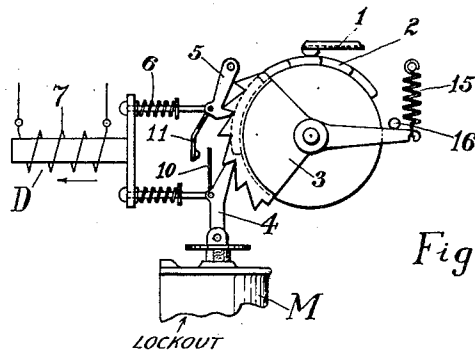


Fig. 2

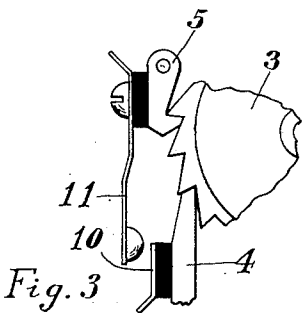


Fig. 3

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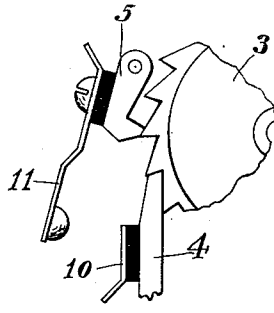


Fig. 4

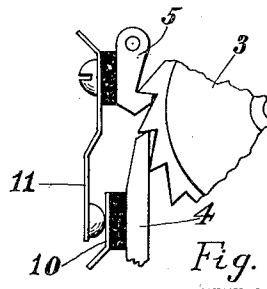


Fig. 5

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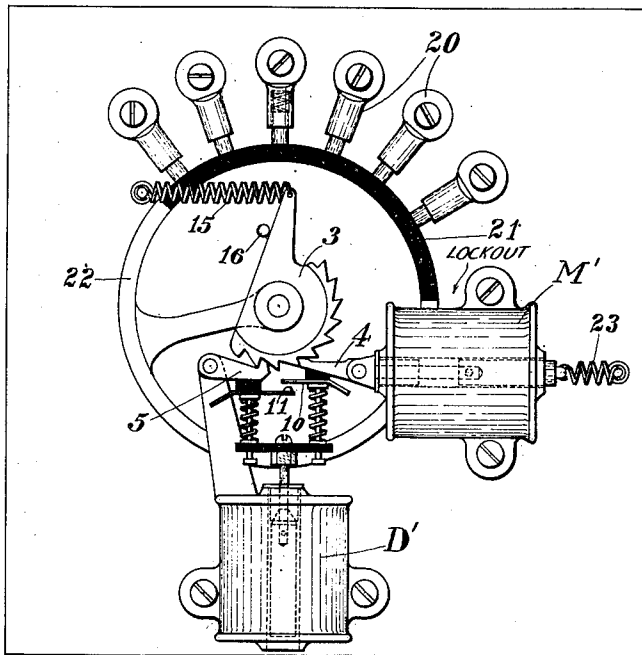
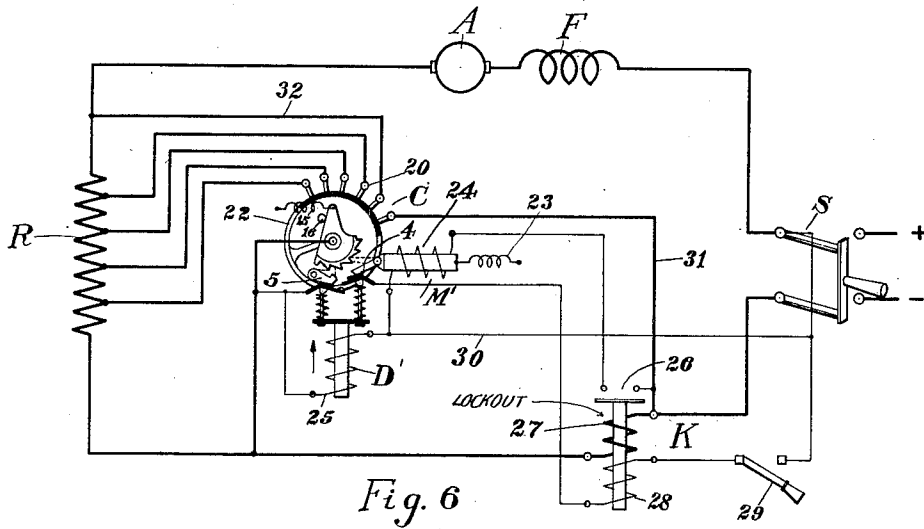
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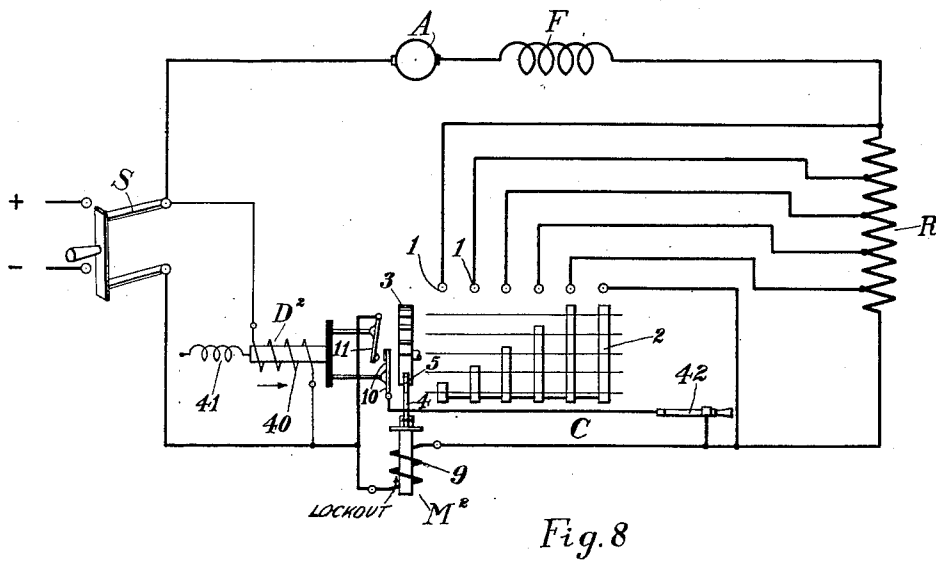
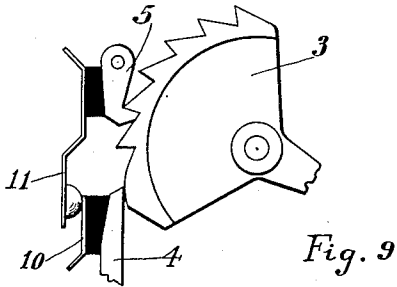
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UNITED STATES PATENT OFFICE.

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ELECTRIC CONTROLLER.

1,275,780.

Specification of Letters Patent. Patented Aug. 13, 1918.

Application filed June 5, 1914. Serial No. 843,168.

To all whom it may concern:

Be it known that I, EDGAR A. SPURR, a citizen of the United States, residing at Euclid, in the county of Cuyahoga and State of Ohio, have invented new and useful Improvements in Electric Controllers, of which the following is a specification.

My invention relates to electric motor-control apparatus, particularly to that type thereof in which the motor is automatically brought up to speed in accordance with the current in the motor circuit.

One of the objects of my invention is to provide a motor-control apparatus by which a plurality of speed points may be secured by the use of a single actuating magnet. Another object is to secure automatic variation of the resistance in accordance with the current in the motor circuit, the resistance in the motor circuit being preferably reduced only when the current in the motor circuit is below a predetermined value. Other objects and advantages of my invention will appear in the course of the following specification, in which I have shown my invention in concrete form for the purposes of illustration.

In the accompanying drawings, Figure 1 is a diagrammatic representation showing one form of my invention. Fig. 2 is an end elevation of the operating mechanism of the controller shown in Fig. 1. Figs. 3, 4, and 5 are fragmentary views, illustrating the positions occupied by the movable parts of the controller as the same is advanced. Fig. 6 is a diagrammatic representation of another form my invention may assume. Fig. 7 is an elevation of the controller mechanism shown in Fig. 6. Fig. 8 is a diagrammatic representation of a third form which my invention may assume. Fig. 9 shows a detail of a portion of the controller shown in Fig. 8.

The motor to be controlled is shown with the armature A and the field winding F. Current is admitted to the control system from a suitable source by the closure of the switch S. The controlling apparatus is indicated at C, being arranged to vary the resistance R in the motor circuit to change the speed of the motor.

As shown in Fig. 1, the controller, which is of the usual drum type, is provided with the stationary contacts 1 adapted to be engaged by the set of movable contacts 2, arranged on the drum. Associated with the

movable contacts is a segment 3, the notches or teeth of which are adapted to be engaged by the pawls 4 and 5. In the form shown in Figs. 1 and 2, the pawls 4 and 5 are normally held in engagement with the teeth by the springs 6. The pawls may be disengaged at any time by the energization of the winding 7 of the magnet D, by the closure of the switch 8. For operating the movable contacts, the pawl 4 has associated with it a magnet M having a winding 9 energized by current in the motor circuit. This magnet is constructed so as to hold its armature in its initial position when the current in the winding exceeds a predetermined value, and operates to move its plunger for operating the contacts when the current has diminished to the predetermined value. This form of magnet is well known, and is described in Eastwood's Patent, No. 1,040,292. Associated with the pawls, and insulated therefrom, are the contacts 10 and 11. These contacts are normally in open position, as shown in Figs. 1, 2 and 3. When the operating magnet M raises its plunger and advances the contacts 2, the contacts 10 and 11 are more widely separated by the action of the pawl 5 rising on the tooth with which it coöperates, as indicated in Fig. 4. When the magnet M has completed its stroke, moving the contacts 2 a full step, the pawl 5 engages the next tooth and causes the contacts 10 and 11 to engage one another, as shown in Fig. 5. These contacts establish a circuit through the winding 12 of the magnet M, the winding 12 being arranged when energized to neutralize the effect of the winding 9, thereby permitting the plunger of the magnet M to descend and the pawl 4 to engage a lower tooth. The relative positions of the pawls and contacts 10 and 11 then assume their normal positions, as shown in Fig. 3, the contacts 10 and 11 being open.

The operation of the controller shown in Fig. 1 is as follows: With the switch 8 open, the springs 6 hold the pawls 4 and 5 in engagement with the teeth of the segment 3. Upon closure of the switch S, current is admitted to the motor circuit including the winding 9 and the resistance R, whereupon the motor starts in the usual manner. The magnet M is so adjusted that the first rush of current in the winding 9 locks the plunger in its initial position, thereby preventing any movement of the plunger of the

magnet. When the motor has accelerated sufficiently to cause the motor current to decrease to the value at which the magnet M is adjusted to operate, the winding 9 will lift the said plunger, and rotate the segment 3 and the contacts 2 connected therewith, causing the contacts 1 to occupy the first position P' of the controller. During the advance movement of the pawl 4, the contacts 10 and 11 are more widely separated, as above described, and upon completion of the stroke the contacts 10 and 11 are brought into contact with each other, as shown in Fig. 5, whereupon the winding 12 is energized. The winding 12, having neutralized the action of the winding 9, permits the plunger of the magnet M to assume its normal position, as shown in Figs. 2 and 3, whereupon the winding 12 is deenergized because of the opening of the contacts 10 and 11. The first step of the controller short-circuits a portion of the starting resistance R, thereby increasing the current in the motor circuit. If the current in the motor circuit exceeds the value at which the magnet M is adjusted to operate, the winding 9, upon the deenergization of the winding 12, continues to hold the plunger of the magnet in the initial position until the motor has increased its speed and the current is again reduced to the value at which the magnet is adjusted to operate. When the current reaches this value, the winding 9 again raises the plunger and causes the movable contacts to advance to the second position, P², in the manner before described, when a second section of the resistance R is short-circuited. The action of the magnet M is repeated until the controller has been advanced step by step to the further positions P³, P⁴, and P⁵, the starting resistance R being, thereby, automatically cut out from the motor circuit, bringing the motor up to its normal speed. When the position P⁵ is reached the operating winding 9 of the magnet M is shunted by the wires 13 and 14. It is seen that in the full running position of the controller all of the magnet windings are deenergized.

When it is desired to stop the motor the operator momentarily closes the switch 8, whereupon the magnet winding 7 withdraws the pawls 4 and 5 from engagement with the notches of the ratchet segment 3, whereupon the spring 15 returns the controller to its initial position, a suitable stop 16 being provided to stop the contacts in the off position.

Referring to Figs. 6 and 7, the contacts 20 are shown engaging an insulating member 21 when they are in their normal off position. When the operating magnet M' advances the controller C' step by step, the contacts 20 engage the conducting segment 22, and thereby short circuit successive por-

tions of the resistance R in the well-known manner. The plunger of the magnet M' is retracted to normal position by the spring 23. The winding 24 of the magnet M' is a shunt winding, arranged to operate the plunger when the winding is excited. The winding D', when deenergized, operates by gravity or a spring to withdraw the pawls 4 and 5 from the teeth of the segment 3. When the magnet D' is energized, the pawls are held up in engagement with the teeth, as shown in Fig. 7. The winding 25 of the magnet D' is connected to the source of supply upon the closure of the switch S, and thereby holds the pawls in engagement with the ratchet teeth during the starting and running periods of the motor. This arrangement provides a no-voltage release for the controller, so that, in the event of a failure of voltage at the supply, the winding 25 becomes deenergized, and the pawls being thereby withdrawn from the notches of the ratchet allow the controller to return to its initial position.

The winding 24 is controlled by the contacts 26 of the relay K. This relay is provided with an operating winding 27, connected in the motor circuit and operates according to the principles of the winding 9 of Fig. 1 to hold the relay plunger in its initial position when the current in the winding exceeds a predetermined value, and operates to close the relay contacts when the current diminishes to the said value. The winding 28 is, when the switch 29 is closed, energized upon the closure of the contacts 10 and 11 to neutralize the action of the winding 27, causing the relay plunger to return to its initial position, thereby opening the contacts 26. The operator's switch 29 is shown in series with the winding 28, and may be used to open the circuit and cause the controller C to remain in any desired position at the will of the operator.

The operation of the system shown in Fig. 6 is as follows: Upon the closure of the switches S and 29, the windings 25 and 27 are energized, the winding 27 being in the motor circuit and the winding 25 receiving current through its individual circuit 30. The current in the motor circuit causes the motor to start in the usual manner, and the winding 27 locks the relay in its initial position until the motor has accelerated and the current diminished to the value at which the relay K is adjusted to operate. The winding D' causes the pawls 4 and 5 to engage the teeth of the ratchet, as shown in Fig. 7. When the winding 27 operates the relay K and closes the contacts 26, the winding 24 is energized and causes the pawl 4 to advance the controller C' a step. The contacts 10 and 11 are first more widely separated, as in the case of Fig. 1, and upon completion of the stroke they come into con-

tact, thereby energizing the winding 28, which neutralizes the effect of the winding 27. The relay K then opens its contacts, thereby deenergizing the winding 24. The pawl is retracted by the spring 23 and engages the next tooth of the wheel 3. The movement of the controller causes the short-circuiting of a portion of the starting resistance R, thereby increasing the current in the motor circuit and accelerating the motor in the usual manner. When the current has again diminished, due to the acceleration of the motor, the operating winding 27 of the relay K again operates the relay and causes the winding 24 to move the controller through another step. This action is repeated until the last step is reached, whereupon the winding 27 of the relay K is short-circuited by the conductors 31 and 32, and the relay thereupon remains in its open position. During the notching up of the controller the operator can stop the operation at any point by opening the switch 29, thereby removing the neutralizing effect of the winding 28 when the magnet M' has completed the stroke. The notching up of the controller will continue as soon as the switch 29 has been closed.

If it is desired to stop the motor, the switch S may be opened, whereupon the current is cut off from the motor. The magnet D' being deenergized, the pawls 4 and 5 are withdrawn from the notches of the ratchet and the controller is returned to its initial position by the spring 15.

In Fig. 8, the controller C has associated with it the operating magnet M² and the releasing magnet D². The releasing magnet D² has a winding 40 connected across the source of supply, and, when energized, tends to keep the pawls 4 and 5 in engagement with the teeth of the ratchet segment 3. When the winding 40 is deenergized the spring 41 withdraws the pawls from engagement with the teeth of the ratchet, allowing the controller to return to off position, thus providing a no-voltage release. The operating magnet M² has only a single winding 9 connected in series with the motor circuit, which is adapted, as before explained, to lock the magnet plunger in initial position when the current through the winding is above a predetermined value, and operates the plunger to advance the controller through a step when the current is reduced to the said value. The operation of the contacts 10 and 11 depends upon the movements of the pawls 4 and 5, as before explained. In Fig. 8, the winding 9 of the magnet M² is neutralized by short-circuiting it through the switch 42 and the contacts 10 and 11 when these contacts come together.

The operation of the device shown in Fig. 8 is as follows: When the switch S is closed, the winding 40 of the magnet D² causes the pawls to engage the ratchet teeth. Current is also established in the motor circuit including the armature A, the field F, the resistance R, and the winding 9 of the operating magnet M². The first rush of current causes the winding 9 to hold its plunger in its initial position until the current is reduced due to the speeding up of the motor. When the current is reduced to the predetermined value, the winding 9 by means of the pawl 4 advances the controller through one step. When the step is completed, the pawl 5 engages the next tooth, closing the contacts 10 and 11. The pawls 4 and 5 and the contacts 10 and 11 now occupy the positions shown in Fig. 5. The winding 9 is now short-circuited, which permits the plunger to return to its initial position, causing the pawl 4 to drop into the next tooth, thereby separating the contacts 10 and 11, as shown in Fig. 3. The winding 9 then becomes energized with the increased current flowing in the motor circuit due to the cutting out of a section of resistance, and the magnet plunger remains in its initial position until the current is reduced due to the speeding up of the motor. When the current again diminishes to the predetermined value, the magnet M² advances the controller another step. This action is repeated and the resistance is automatically removed from the motor circuit until the motor is connected directly across the source of supply, when it then attains its normal speed. When the controller makes its last step it is preferable to maintain the winding 9 short-circuited so as to prevent undue heating in the coils of the winding. I accomplish this by extending the length of the last tooth of the ratchet wheel, so that, when the magnet plunger returns to the initial position after the controller has taken the last step, the pawl 4 remains in its raised position, maintaining the contacts 10 and 11 in engagement. This arrangement is shown in Fig. 9.

To stop the motor the switch S is opened, whereupon the magnet D² is deenergized and the pawls 4 and 5 are disengaged from the ratchet segment 3, allowing the controller to return to its initial position ready for a restarting of the motor. In order to stop the progression of the controller at any point, at will, I provide a switch 42, by which the operator can at any time open the closed circuit which is made around the winding 9 by the contacts 10 and 11. By opening the switch 42 the winding 9 remains in circuit and maintains the controller in the position to which it is last moved by the magnet D² until the operator again closes the switch 42.

It will be understood by those skilled in the art that, although I have shown my invention as applied to a non-reversing series-wound motor, it can also be applied to other

types of motors, both reversing and non-reversing, by supplying the usual and well-known connections for these motors. It will also be understood that automatic switches can be added in connection with my invention for opening the motor circuit upon the failure of voltage or when the controller returns to its off position. These features are well known in the art and can be added in any of the well-known ways.

I claim—

1. In a motor-control system, a motor, a circuit therefor, resistances in the circuit, a controller having contacts in the circuit and movable step by step to vary at each step the resistance in the circuit, a magnet, means moved by the magnet for advancing the controller step by step only when the current in the motor circuit is below a certain value, and means for neutralizing the effect of the magnet when the controller has completed a step to permit the first means to be moved to its initial position.

2. In a motor-control system, a motor, a circuit therefor, resistances in the circuit, a controller, a magnet having its energizing winding in the circuit, a movable member operable by the magnet for advancing the controller to vary the resistances step by step, and means operable by the magnet for causing the movable member to be retracted to its initial position when the controller has completed a step.

3. In a motor-control system, a motor, a circuit therefor, resistances in the circuit, a controller, a magnet, having an energizing winding, a movable member operable by the magnet for advancing the controller to vary the resistance step by step, and means operable by the magnet for causing the movable member to be retracted to its initial position without deenergizing the winding when the controller has completed a step.

4. In a controller for electric circuits, a plurality of contacts arranged to be operated progressively, a single magnet winding energized by the current through the contacts for operating the contacts step by step, and contacts operated at the completion of each of certain steps for temporarily neutralizing the operating effect of said winding.

5. In a controller for electric circuits, a plurality of stationary contacts, movable contacts coöperating therewith, a ratchet and pawl mechanism for moving the contacts step by step, a magnet energized by current through the contacts for operating the said mechanism, means for holding the ratchet and pawl mechanism in operating engagement, and means operated when the mechanism has completed a stroke for rendering the magnet ineffective to hold the said mechanism in the position to which the magnet has operated the same.

6. In a motor-control system, a motor, a

circuit therefor, resistances in the circuit, a plurality of contacts for controlling the resistances, mechanism for moving the contacts step by step to cut out the resistance, a magnet energized by the current in the circuit for operating the mechanism, and means operated at the end of each step for rendering the said magnet ineffective whereby the said mechanism may return to a position to initiate another step.

7. In a controller for electric circuits, a movable contact mechanism, a magnet for advancing the movable mechanism in successive steps, and a circuit closed by the movable mechanism when the controller has completed a step for rendering the magnet ineffective whereby it may, when again made effective, advance the said member another step.

8. In a controller for electric circuits, a movable contact member, a toothed device for the said member, a pawl engaging the said device for advancing the contact member step by step, a magnet for operating the said pawl, a second pawl for holding the contact member in stepped position, and contacts operated by the pawls for neutralizing the action of the magnet when a step is completed.

9. In a controller for electric circuits, a movable contact member, a toothed device attached to the said member, a pawl for engaging the device to advance the contact member a step, a magnet for operating the pawl energized by current through the contacts of the said member, a second pawl for holding the said member in stepped position, and contacts controlled by the pawls for deenergizing the magnet when the magnet has moved the contact member a step.

10. In a ratchet and pawl mechanism for operating electric controllers, a current controller, a toothed device for moving the controller, an operating pawl for engaging a tooth of the device to move it to a new position, a holding pawl for engaging a tooth of the wheel when it has been moved to its new position, and contacts operated by the pawls, the said contacts being normally in open position and arranged to close when the operating pawl has completed its movement and the holding pawl has engaged a tooth for holding the wheel in position.

11. In a controller for electric circuits, a movable contact member, a magnet energized by current in the circuit to be controlled for moving the said member in a step by step manner when the current in the circuit is below a predetermined value only, contacts for neutralizing the magnet, and means for closing the contacts when the contact member has been advanced a step.

12. In a controller for electric circuits, a circuit to be controlled, resistance in the circuit, contacts in the circuit movable step by

step to vary the amount of resistance in the circuit, an electro-responsive device having a movable member, a winding for the device energized by the current to be controlled
5 for delaying the movement of the movable member when the current in the winding is above a predetermined value and for permitting its movement when the current is below the predetermined value, and means
10 operated by the movement of the movable member for causing the contacts to be moved step by step.

13. In a motor control system, a motor, a circuit therefor, resistance in the circuit, a
15 controller adapted to be moved step by step to vary the resistance, an electro-responsive device having a movable member for operating the controller, and a winding for the device energized by the motor current for
20 delaying the movement of the movable

member when the current in the winding is above a predetermined value, and for permitting its movement when the current is below the predetermined value.

14. In a controller for electric circuits, a
25 plurality of contacts arranged to be operated progressively, means for operating the contacts step by step, and a single magnet winding energized by the current through the
30 contacts for delaying the operation of the means when the current in the winding is above a predetermined value, and for permitting its operation when the current falls to the predetermined value.

Signed at Cleveland, Ohio, this 3d day of
June A. D. 1914.

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Witnesses:

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