No. 834,010. PATENTED OCT. 23, 1906.

D. LARSON.

ELECTRICAL CONTROLLER.

APPLICATION FILED NOV. 4, 1905.

2 SHEETS—SHEET 1.

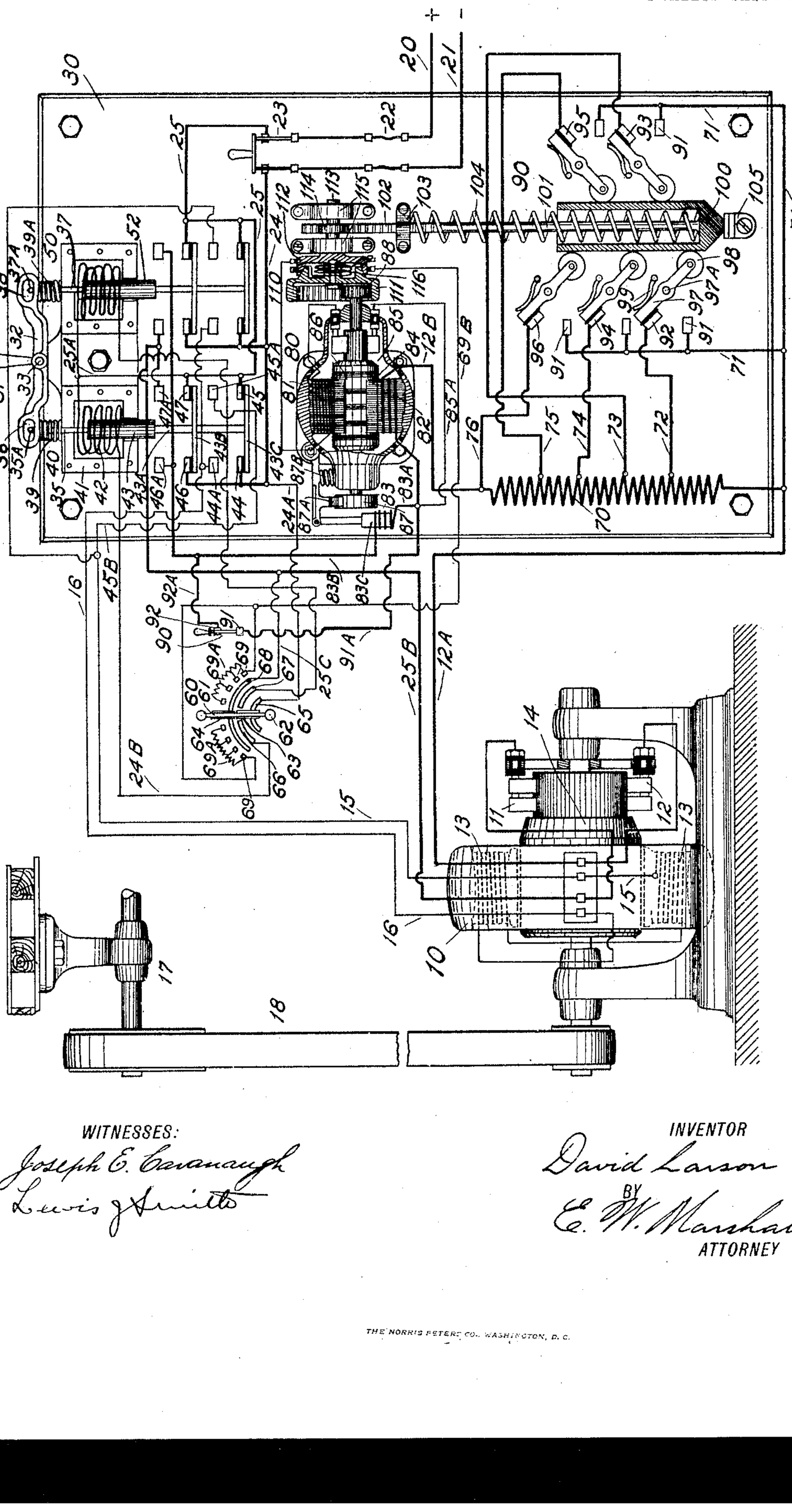


FIG. 1

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2 SHEETS—SHEET 2.

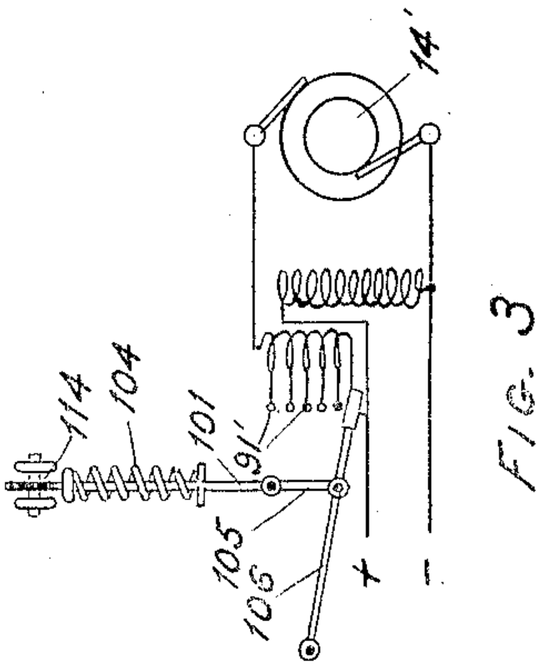


FIG. 3

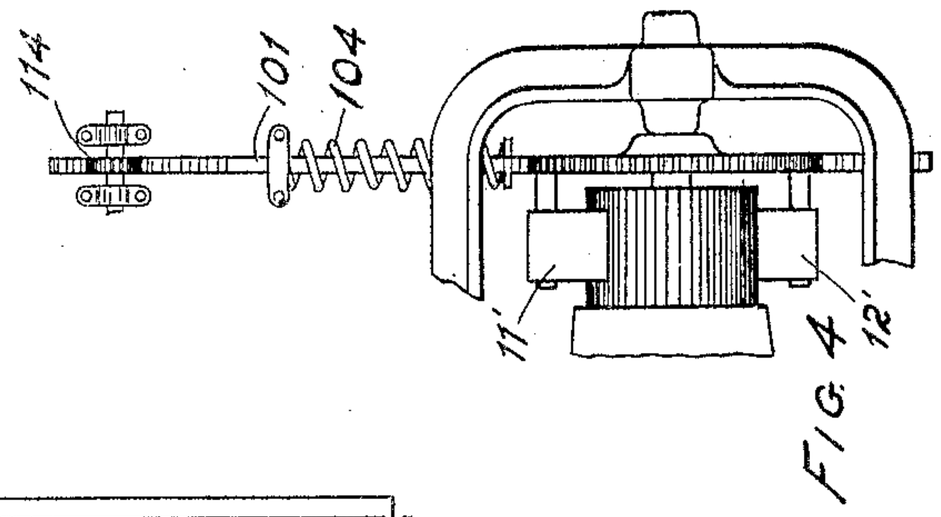


FIG. 4

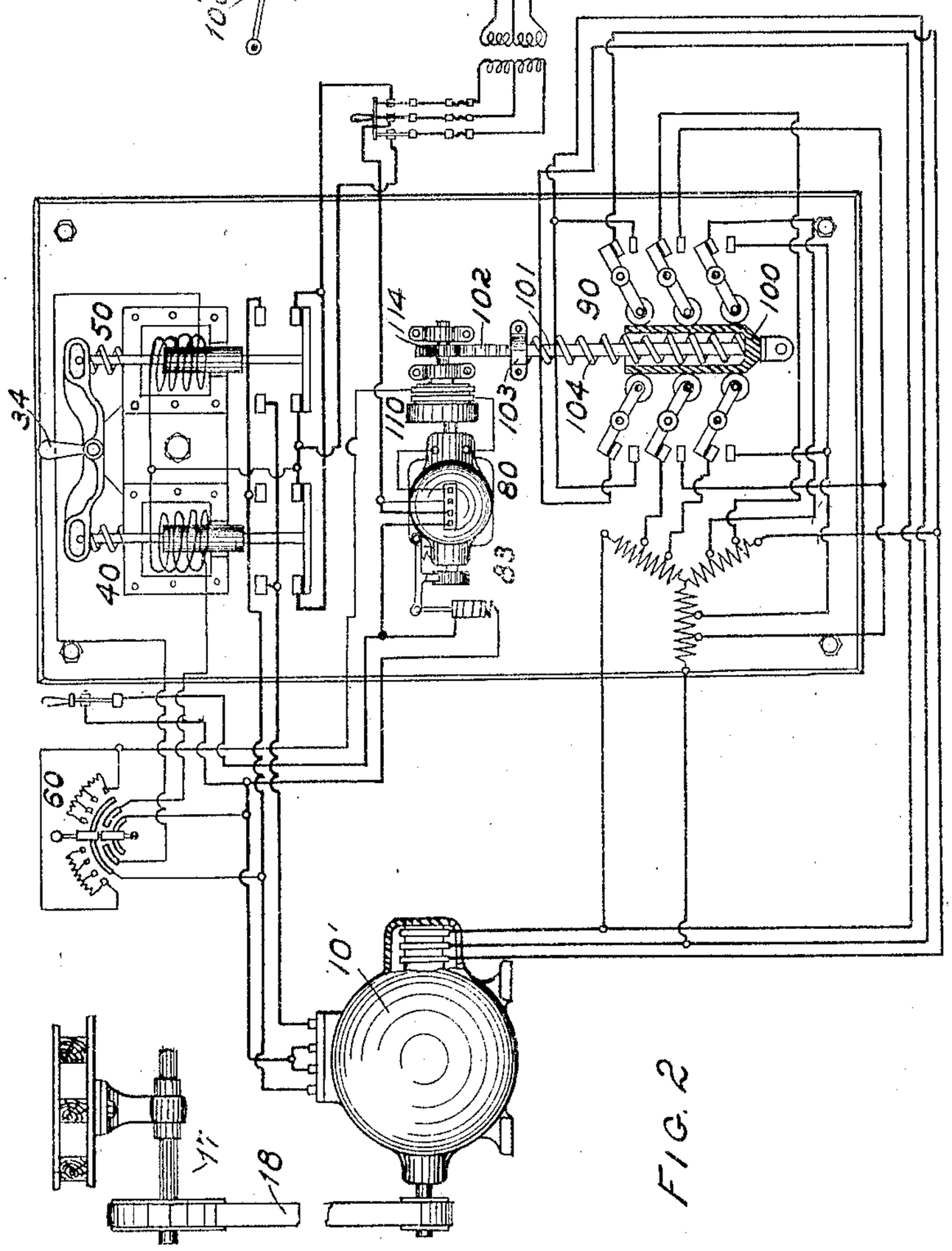


FIG. 2

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# UNITED STATES PATENT OFFICE.

DAVID LARSON, OF YONKERS, NEW YORK.

## ELECTRICAL CONTROLLER.

No. 834,010. Specification of Letters Patent. Patented Oct. 23, 1906.

Application filed November 4, 1905. Serial No. 285,836.

*To all whom it may concern:*

Be it known that I, DAVID LARSON, a subject of the King of Sweden, and a resident of the city of Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Electrical Controllers, of which the following is a specification.

My invention relates to electrical controllers for use with either direct or alternating currents; and it consists in the construction and arrangement of parts herein shown and described and the novel features whereof are set forth in claims.

Referring to the drawings, Figure 1 is a diagrammatic representation of an electric motor, an electrical controller, and certain electrical connections which are used in carrying out my invention. Fig. 2 is a modification showing the invention applied to an alternating-current motor. Figs. 3 and 4 illustrate modifications of certain details.

Like characters of reference designate corresponding parts in all of the figures.

10 designates an electric motor.

20 and 21 designate mains from a suitable source of electrical supply of practically constant pressure or voltage. These may pass through fuses 22 and a manually-operated main-line switch 23 and then by conductors 24 and 25 to other apparatus, which will be pointed out later.

30 designates a base, of slate or other suitable material, upon which the various parts of the controller may be mounted.

31 designates a reversing-switch. It comprises two magnets 40 and 50. These two magnets are substantially alike in construction, so that I will describe but one of them specifically.

41 designates a magnet-frame, preferably constructed of laminated magnetic material.

42 is a coil or winding arranged to energize the magnet, and 43 is the core or armature of the magnet.

Four insulated movable contacts 44, 45, 46, and 47 are connected by a rod $43^A$ and cross-arms $43^B$ and $43^C$ to move with core 43 until they come into contact with corresponding stationary contacts $44^A$, $45^A$, $46^A$, and $47^A$. Magnet 50 comprises similar parts.

Above magnets 40 and 50 a horizontal arm 32 may be placed, pivoted at 33 and provided with an operating-handle 34. A rod 35, attached to core 43, extends upward and terminates in a projection $35^A$ within a slot 36 in arm 33. A similar rod 37 is attached to core 52, and this terminates in a projection $37^A$ within slot 38 in the other end of the arm 32. Springs 39 $39^A$ may be provided to keep the arm 32 and its connected parts in their central or off position.

60 designates a manually-operated control-switch or master-switch. It comprises an arm 61, pivoted at 62, which has carried upon but insulated from it two contact-plates 63 and 64. Contact-plate 63 bears upon stationary segmental contact 65 and is arranged to be moved to the left or right to connect the latter either to stationary contact 66 or stationary contact 67. Contact-plate 64 bears upon stationary segmental contact 68 and is arranged to be moved to the left or right to connect the latter with one or another of a series of stationary contacts 69, which are connected together through a resistance $69^A$.

Before proceeding farther with the description of the apparatus I will trace out some of the electrical circuits and describe the operation of the parts already described.

It may be seen that the minus main 21 is connected by conductors 24 and $24^A$ to stationary segmental contact 63 on switch 60. If an operator moves arm 61 to the left, contact-plate 63 will connect stationary contacts 65 and 66, and a circuit will be closed thereby through conductor $24^B$, magnet-winding 42, conductors $25^A$ and 25 to the positive main line 20. Magnet 40 will thus be energized and will raise its core 43 and its connected parts, and contacts 44, 45, 46, and 47 will be moved up against contacts $44^A$, $45^A$, $46^A$, and $47^A$ and will close certain circuits, which will now be traced. Beginning at main-line conductor 25, a current will flow through contacts 47 $47^A$ and conductor $25^B$ to brush 11 of motor 10, thence through motor-armature 14 and out at brush 12 and by conductor $12^A$ to one side of a starting resistance 70, through this resistance and by conductor $12^B$ through the series winding 82 of a controlling-motor 80, which will be described later, thence by two paths (conductor $83^A$, brake-coil 83, and conductor $83^B$ and conductor $91^A$, switch 90, and conductor $92^A$) to contact $46^A$, which is now closed with contact 46, to which main-line conductor 24 is connected. Another circuit is at the same time completed from main-line conductor 25 through contacts 45 $45^A$, conductors $45^B$ and 15 to the shunt-field 13 of motor 10, through

the field and by conductor 16, contacts 44[A] and 44 to main-line conductor 24. Thus the motor-armature and field will receive current from the main line, and the armature will begin to rotate in one direction. The motor may be stopped by bringing the switch-arm 61 back to its central position. If the operator had moved arm 61 of switch 60 to the right, the result would have been similar; but in this case magnet 50 would have been energized and the contacts below it would have been closed. This would have supplied the shunt-field of motor 10 with current from the line in the same direction, but the armature with current in the opposite direction, and the motor would have begun to rotate in the opposite direction.

It is evident that the reversing-switch contacts may be operated by hand, for if the handle 34 is moved to the right the contacts under magnet 40 will be closed thereby, or if it is moved to the left the contacts under magnet 50 will be closed.

It is desirable in starting an electric motor to have its acceleration gradual and proportional to the load it is driving. I will now describe the apparatus I have invented for automatically accomplishing this result.

An opposition element in the form of a starting resistance 70 may be placed in the motor-circuit to limit the amount of current which can pass through the motor. A mechanical device 90 is shown, the purpose of which is to short-circuit this resistance in a number of steps. This device comprises a plurality of stationary contacts 91 91, which are connected together and to the lower end of resistance 70 by a conductor 71 of low resistance. A plurality of movable contacts 92 93 94 95 96 are mounted upon pivoted arms, which will be described presently, and are connected to various points on resistance 70 by conductors 72, 73, 74, 75, and 76. Movable contact 92 is insulated from but mounted upon one end of a pivoted arm 97, which is pivoted at 97[A] and the other end of which may be provided with an antifriction-roller 98. A sliding cam 100 bears upon this roller 98 and keeps the arm 97 in the position shown in the drawings when the apparatus is at rest. The cam 100 may, however, be raised out of contact with roller 98, in which case the arm 97 will move until its contact 92 rests upon stationary contact 91, and thereby short-circuits that portion of resistance 70 which is between conductors 71 and 72. A spring 99 is sometimes provided to assist this operation. The other movable contacts are mounted upon similar pivoted arms, and as cam 100 is moved up it moves out of contact with other rollers and allows the other movable contacts to be closed against their corresponding stationary contacts and short-circuits the rest of resistance 70 in a number of steps.

A rod 101 extends upward from cam 100 and terminates in a rack 102. This rod is guided by a stationary bracket 103. A spring 104 bears upon this bracket and upon cam 100, which may be made hollow, as shown, to take this spring and tends to keep the cam in its lower position against a stop-piece 105.

80 designates a secondary or controlling motor of novel construction or arrangement, by means of which mechanical motion is obtained automatically in proportion to the voltage and current in an electrical circuit. It may be an electric motor of ordinary construction; but I prefer to have its magnetic field 84 of laminated magnetic material, so that it may be used as well with alternating as with direct currents. It is provided with two field-windings, one of which, 81, is connected in shunt with the mains or with the circuit to be controlled, which in this case is motor 10, and the other of which, 82, is in series with the same circuit. These coils are arranged to oppose each other. The motor has a revoluble armature 85, the coils 86 of which are connected in series with shunt field-winding 81. To one end of the armature-shaft is attached a brake-pulley 87, and to the other end is attached a pinion 88. A brake-shoe 87[A] is arranged to coact with brake-pulley 87. It is normally held off from pulley 87 by a spring 87[B], but may be brought into engagement with the pulley by a brake-solenoid 83, acting upon its core 83[C].

110 designates an electromagnetic clutch. It comprises a main portion 111, which is provided with gear-teeth into which pinion 88 meshes, and a secondary portion 112, the whole mounted upon a shaft 113 and supported by stationary brackets 115. Between the parts 111 and 112 is an exciting-coil 116, which may be, as shown, in series with the shunt field-winding and the armature. A pinion 114 is mounted upon the clutch-shaft 113 and meshes with rack 102.

The switch 60 may be used only for the purpose of starting and stopping the motor 10. If, however, the operator moves the pivoted arm 61 to its extreme left or right position, he thereby connects stationary segmental contact 68 with one of the outer ones of stationary contacts 69, which when either side of the reversing-switch 31 is closed connects shunt field-winding 81, armature 85, and clutch-winding 116 across the line. I will suppose the operator has moved the switch-arm 61 to the left and will trace these circuits. Beginning at main-line conductor 25 a current will flow through contacts 47 47[A], conductors 25[B] 25[C], contact-plate 64, stationary contact 69, conductor 69[B], through clutch-winding 116, shunt field-winding 81, armature 85, conductor 85[A], brake-coil 83, and conductor 83[B] to and through contacts 46[A] 46 to main-line conductor 24. The

shunt field-winding and the armature of motor 80 will thus be energized in proportion to the voltage between the mains 20 21. It has already been shown that the current passing through armature 14 of motor 10 also passes through series field-winding 82. The two opposing field-windings are so proportioned that when the current passing through motor 10 is its normal starting-current the two opposing field-windings will neutralize each other, and the armature 85 of motor 80 will remain at rest. As the armature 14 begins to rotate and to thereby reduce the amount of current passing through it the effect of series field-winding 82 will be reduced, and the shunt field-winding will energize the fields of motor 80 a sufficient amount to cause armature 85 to rotate in a direction to raise cam 100. This it will do through the mechanism already described and the electromagnetic clutch 110, which is now energized. The movement of cam 100 causes some of resistance 70 to be short-circuited, which allows more current to pass through series winding 82 and motor 10. The effect of series winding 82 will then be to counteract the effect of shunt field-winding 81 to retard or stop the rotation of armature 85 or to cause it to rotate in the opposite direction if the current in series field-winding 82 is sufficiently strong. This of course will check the upward movement of cam 100 or may even cause it to be driven down again. As the motor accelerates this operation will be repeated until all of resistance 70 has been cut out. The acceleration of motor 10 will be proportional to the load it is driving, which in the drawings is represented by a shafting 17, connected to the motor by a belt 18. It is evident that this arrangement will automatically control the supply-current to the motor in proportion to its acceleration and that this automatic control depends for its action upon the voltage supplied to the motor and upon the current consumption of the motor and that it does not act upon or materially affect the voltage from the source of supply.

Electric motors such as are used on railway-cars, elevators, and in similar service are usually capable of standing an overload. In such cases it is not desirable to have an excessive current in series field-winding 82 drive armature 85 backward and cause it to insert more of resistance 70 in the main motor-circuit. To prevent this, a brake-solenoid 83 may be provided in the main motor-circuit, which will pull down upon its core $83^{C}$ and apply brake-shoe $87^{A}$ to pulley 87 when its current reaches an amount greater than that necessary to neutralize the effect of shunt field-winding 81. This will prevent the armature 85 being driven backward unless motor 10 is getting an excessive overload of current, in which case the brake $87^{A}$ 87 will slip. A switch 90, arranged to connect contacts 91 and 92, which are connected to either side of brake-coil 83 by conductors $91^{A}$ and $92^{A}$, may be provided to short-circuit coil 83 and render the brake inoperative when desired.

Fig. 3 is a modification of a detail of construction. In this case the rod 101, which is actuated by pinion 114 in one direction and by spring 104 in the other direction, is connected by a link 105 to a pivoted arm 106, which slides over stationary contacts 91′, to which resistance 70′ is connected, and thereby controls the current to armature 14′.

It is evident that an operator may insert more or less of resistance $69^{A}$ in circuit with shunt field-winding 81 at will. Thus while he cannot increase the action of motor 80 he may control its action, retard it any desired amount, or entirely prevent its action. When plate 64 is moved off from contacts 69, the clutch 110 becomes deënergized, as well as the shunt field-winding and armature of motor 80, and spring 104 will act to immediately return cam 100 to its original position and to insert all of resistance 70 in the motor-circuit again.

Fig. 4 illustrates another method whereby the motion obtained by pinion 114 and spring 104 may be utilized to control an electric motor. In this case rod 101 is mechanically connected to shift the brushes 11′ and 12′ of a motor.

The controlling system herein shown and described is applicable to alternating-current as well as to direct-current systems. This may be seen by an examination of Fig. 2, in which 10′ designates an alternating-current motor and the circuits are somewhat modified to be applied to the control of such a motor, but which is similar to Fig. 1 in nearly every other respect.

This invention is applicable to many other uses than those herein shown and described. I have shown it applied to a motor-starting system, as this is one of its advantageous uses.

The controlled motor may be connected to run elevators, cranes, mill-tables, or railroad-cars or to any similar use where it is desirable to have a gradually-increasing current automatically applied to the motor and a current the amount of which may be controlled by an operator, but which cannot be increased beyond a safe amount by his carelessness. It may of course also be used in many other connections where it is desired to automatically or semi-automatically control the flow of an electric current.

It sometimes happens that in starting electric motors the fluctuations of current, due to cutting out of starting resistance, becomes considerable. A sudden inrush of current might cause motor 80 to drive back cam 100 and insert the part of resistance 70 which it

had a moment before short-circuited, and thus cause sparking at the contacts. An important function of brake 87 and 87[A] is to overcome this difficulty, as the effective pressure of the brake is strongest at just such moments.

What I claim is—

1. A source of electrical supply having a voltage practically constant in value, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having an armature, a winding for said armature, and two opposing field-windings, one of which is in shunt with said circuit and the other of which is in series with said circuit.

2. A source of electrical supply having a voltage practically constant in value, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having two opposing field-windings, one of which is energized by the voltage of said source of supply and the other of which is energized by the current in said circuit and a rotatable armature for the motor.

3. A source of electrical supply having a voltage practically constant in value, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having an armature-winding, two opposing field-windings, one of which field-windings is in shunt with said circuit and the other of which is in series with said circuit.

4. A source of electrical supply having a voltage practically constant in value, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having two opposing field-windings, one of which is in shunt with said circuit and the other of which is in series with said circuit, and a rotatable armature connected to said current-varying means.

5. A source of electrical supply having a voltage practically constant in value, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having two opposing field-windings, one of which is in shunt with said circuit and the other of which is in series with said circuit, and a rotatable armature connected to said current-varying means and controlled by the current in said field-windings.

6. A source of electrical supply having a voltage practically constant in value, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having two opposing field-windings, one of which is in shunt with said circuit and the other of which is in series with said circuit, and a rotatable armature having coils, said coils arranged to be supplied by current proportional in amount to the voltage of said source of supply.

7. A source of electrical supply, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having two opposing field-windings, one of which is in shunt with said circuit and the other of which is in series with said circuit; and a rotatable armature having coils, said coils arranged in series with said shunt-connected field-winding.

8. A source of electrical supply having a voltage practically constant in value, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having an armature and two field-windings, one of which windings is in shunt with the circuit and has a tendency when energized to cause the motor to rotate in one direction, the other of which windings is in series with the circuit and has a tendency when energized to cause the motor-armature to rotate in the opposite direction.

9. A source of electrical supply, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having an armature and two field-windings, one of which windings is in shunt with the circuit and has a tendency when energized to cause the motor-armature to rotate in one direction, the other of which windings is in series with the circuit and has a tendency when energized to cause the motor-armature to rotate in the opposite direction, and a brake in series with said series field-winding arranged to prevent the rotation of the armature under the influence of said series field-winding.

10. A source of electrical supply, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having an armature and two field-windings, one of which windings is in shunt with the circuit and has a tendency when energized to cause the motor-armature to rotate in one direction, the other of which windings is in series with the circuit and has a tendency when energized to cause the motor-armature to rotate in the opposite direction, a brake in series with said series field-winding arranged to prevent the rotation of the armature under the influence of said series field-winding, and means arranged to render said brake inoperative.

11. A source of electrical supply, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having an armature and two field-windings, one of which windings is in shunt with the circuit and has a tendency when

energized to cause the motor-armature to rotate in one direction, the other of which windings is in series with the circuit and has a tendency when energized to check the rotation of the motor-armature under the influence of the shunt field-winding.

12. A source of electrical supply having a voltage practically constant in value, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to actuate the current-varying means, said motor having a rotatable armature of laminated magnetic material, a field of laminated magnetic material and two opposing field-windings, one of which is in shunt with said circuit and the other of which is in series with said circuit.

13. A source of electrical supply, a circuit connected therewith, means for varying the current in said circuit, a motor having two opposing field-windings, one of which is in shunt with the circuit and the other of which is in series with the circuit, and a rotatable armature; and a magnetic clutch arranged to connect said armature to said current-varying means.

14. A source of electrical supply, a circuit connected therewith, means for varying the current in said circuit, a motor having two opposing field-windings, one of which is in shunt with the circuit and the other of which is in series with the circuit, and a rotatable armature having coils; and a magnetic clutch having an exciting-coil, said clutch arranged to connect said armature to said current-varying means; said shunt field-winding, armature-coils and clutch-exciting coil being in series with each other.

15. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having an armature-winding two opposing field-windings, one of which field-windings is in shunt with said circuit, the other of which is in series with said circuit, and manually-actuated means for controlling said motor.

16. A source of electrical supply, a circuit connected therewith, means for varying the current in said circuit, a motor arranged to automatically actuate the current-varying means in proportion to the current in said circuit and the voltage of said source of supply, said motor having two opposing field-windings, one of which is in series with said circuit, the other of which is in shunt with said circuit, a rotatable armature and a manually-operated switch arranged to control the action of said motor.

17. A source of electrical supply having a voltage practically constant in value, an electric circuit, an opposition element therein, and an electric motor arranged to automatically remove the opposition element from the circuit, said motor having two opposing field-windings, one of which is in shunt with said circuit, the other of which is in series with the circuit, and a rotatable armature.

18. A source of electrical supply having a voltage practically constant in value, an electric circuit, an opposition element therein, mechanical means for controlling the opposition element, a motor having a revoluble armature connected to said mechanical controlling means, said motor having two opposing field-windings, one of which is in shunt with said circuit and the other of which is in series with said circuit.

19. An electric circuit, an opposition element therein, mechanical means for controlling the opposition element, an electric motor having a revoluble armature, and an electromagnetic clutch arranged to connect and disconnect said armature to and from said mechanical controlling means, said motor having two opposing field-windings, one of which is in shunt with said circuit and the other of which is in series with said circuit.

20. A source of electrical supply having a voltage practically constant in value, a motor, means for automatically controlling the acceleration of the motor, said means comprising a secondary motor having two opposing field-windings, one of which is in shunt with said first motor and the other of which is in series with said first motor, and a rotatable armature.

21. A source of electrical supply having a voltage practically constant in value, a motor, a starting-switch therefor, means for automatically controlling the acceleration of the motor, said means comprising a secondary motor having a rotatable armature and two opposing field-windings, one of which is in shunt with said first motor and the other of which is in series with said first motor.

22. A motor, a reversing-switch therefor, means for automatically controlling the acceleration of the motor, said means comprising a secondary motor having two opposing field-windings, one of which is in shunt with said first motor and the other of which is in series with said first motor.

23. A motor, an electrically-actuated reversing-switch therefor, means for automatically controlling the acceleration of the motor, said means comprising a secondary motor having two opposing field-windings, one of which is in shunt with said first motor and the other of which is in series with said first motor, and a manually-operated switch arranged to control the reversing-switch.

24. A motor, an electrically-actuated reversing-switch therefor, means for automatically controlling the acceleration of the motor, said means comprising a secondary motor having two opposing field-windings, one of which is in shunt with said first motor and the other of which is in series with said first motor.

25. A motor, an opposition element in the

motor-circuit, means for gradually cutting said opposition element out of the motor-circuit in proportion to the acceleration of the motor, said means comprising a secondary motor having two opposing field-windings, one of which is in shunt with said first motor, and the other of which is in series with said first motor.

26. A motor, an electrically-actuated reversing-switch therefor, an opposition element in the motor-circuit, means for gradually cutting said opposition element out of the motor-circuit in proportion to the acceleration of the motor, said means comprising a secondary motor having two opposing field-windings, one of which is in shunt with said first motor, and the other of which is in series with said first motor, and a manually-operated switch arranged to control the reversing-switch.

27. A motor, an electrically-actuated reversing-switch therefor, an opposition element in the motor-circuit, means for gradually cutting said opposition element out of the motor-circuit in proportion to the acceleration of the motor, said means comprising a secondary motor having two opposing field-windings, one of which is in shunt with said first motor, and the other of which is in series with said first motor, and a manually-operated switch arranged to control the reversing-switch and to retard the action of the secondary motor at will.

28. A motor, a resistance in the motor-circuit, mechanical means arranged to short-circuit the resistance in a number of steps, a secondary motor having a revoluble armature connected to said mechanical means, said secondary motor having two opposing field-windings, one of which is in shunt with said first motor, the other of which is in series with said first motor.

29. A motor, a resistance in the motor-circuit, mechanical means arranged to short-circuit the resistance in a number of steps, a secondary motor having a revoluble armature, an electromagnetic clutch arranged to connect said armature to said mechanical means, said secondary motor having two opposing field-windings, one of which is in shunt with said first motor, the other of which is in series with said first motor.

30. A motor, a resistance in the motor-circuit, mechanical means arranged to short-circuit said resistance in a number of steps, a secondary motor arranged to actuate said mechanical means in one direction, an electromagnetic clutch for connecting or disconnecting the secondary motor to or from said mechanical means, and a spring for actuating the mechanical means in the opposite direction, said secondary motor having two opposing field-windings, one of which is in shunt with said first motor and the other of which is in series with said first motor.

31. A motor, an electrically-actuated reversing-switch therefor, a resistance in the motor-circuit, mechanical means arranged to short-circuit said resistance in a number of steps, a secondary motor arranged to actuate said mechanical means in one direction, an electromagnetic clutch for connecting or disconnecting the secondary motor to or from said mechanical means, a spring for actuating the mechanical means in the opposite direction, said secondary motor having two opposing field-windings, one of which is in shunt with said first motor and the other of which is in series with said first motor, and a manually-operated switch arranged to control the reversing-switch, the electromagnetic clutch and the action of the secondary motor.

32. A motor, a reversing-switch therefor, electromagnets having laminated frames, for the reversing-switch, a resistance in the motor-circuit, mechanical means arranged to short-circuit the resistance in a number of steps, a secondary motor having a revoluble armature connected to said mechanical means, said secondary motor having two opposing field-windings, one of which is in shunt with said first motor, the other of which is in series with said first motor.

33. A motor, a reversing-switch therefor, electromagnets having laminated frames, for the reversing-switch, a resistance in the motor-circuit, mechanical means arranged to short-circuit the resistance in a number of steps, a secondary motor having a revoluble armature connected to said mechanical means, said secondary motor having fields of laminated magnetic material and two opposing field-windings, one of which is in shunt with said first motor, the other of which is in series with said first motor.

34. A motor, a reversing-switch therefor, electromagnets having frames and cores of laminated magnetic material for the reversing-switch, a resistance in the motor-circuit, mechanical means arranged to short-circuit the resistance in a number of steps, a secondary motor having a revoluble armature connected to said mechanical means, said secondary motor having fields of laminated magnetic material and two opposing field-windings, one of which is in shunt with said first motor, the other of which is in series with said first motor.

35. A motor, a reversing-switch therefor, electromagnets having frames and cores of laminated magnetic material, for the reversing-switch, a resistance in the motor-circuit, a mechanical device arranged to short-circuit the resistance in a number of steps, a secondary motor arranged to actuate said mechanical device in one direction, an electromagnetic clutch for connecting or disconnecting the secondary motor to or from said mechanical device, a spring arranged to actuate the mechanical device in the opposite di-

rection; said secondary motor having fields of laminated magnetic material and two opposing field-windings, one of which is in shunt with said first motor, the other of which is in series with said first motor; and a manually-operated switch arranged to control the reversing-switch, the electromagnetic clutch and the action of the secondary motor.

36. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having an armature with a winding, a field-winding on the motor, said armature-winding and field-winding being in shunt with the circuit, another field-winding on the motor in series with said circuit, said field-windings being arranged to create a variable magnetic field in the motor varied in strength and direction according to the current in said circuit and the voltage across said circuit.

37. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having an armature with a winding, a field-winding on the motor, said armature-winding and field-winding being in shunt with the circuit, said shunt-winding being arranged to create a magnetic field in the motor, proportional in strength to the voltage across the circuit, another field-winding on the motor in series with the circuit, and arranged to neutralize the effect of the shunt field-winding in proportion to the current passing through said circuit.

38. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having a revoluble armature, an armature-winding, a field-winding in shunt with said circuit, and a field-winding in series with said circuit; said field-windings being arranged to oppose each other's influence on the speed and direction of rotation of the armature.

39. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having a revoluble armature having a winding, and two opposing field-windings, and means for charging said armature-winding and said two field-windings simultaneously.

40. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having a revoluble armature having a winding, and two opposing field-windings, and means for charging said armature-winding and said two field-windings simultaneously from the source of supply, the connections of said motor-windings being so arranged that the speed and direction of rotation of the armature is automatically controlled by variation of current in the circuit.

41. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having an armature and an armature-winding, and two opposing field-windings, one of which is excited by a current of practically constant value, the other of which is excited by a variable current passing through said circuit.

42. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having an armature and an armature-winding, and two opposing field-windings, one of which is excited by a current of practically constant value, the other of which is excited by a variable current passing through said circuit, the magnetic effect of said two fields being arranged to control the speed and direction of rotation of the motor-armature.

43. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having an armature and an armature-winding, and two opposing field-windings, one of which is excited by a current of practically constant value, the other of which is excited by a variable current passing through said circuit, the magnetic effect of said two fields being arranged to control the speed and direction of rotation of the motor-armature, all of said windings being arranged to be charged simultaneously, one of said field-windings being arranged to oppose the effect of the other field-winding in proportion to the variation of current in the circuit.

44. A source of electrical supply, a circuit connected therewith, a motor arranged to control the current in said circuit, said motor having an armature, an armature-winding, and two field-windings, the armature-winding and one of the field-windings being connected in series, and of comparatively high resistance, the other field-winding being of comparatively low resistance, said windings arranged to be charged simultaneously, one of said field-windings being arranged to oppose the effect of the other field-winding in proportion to the variation of current in the circuit.

45. A source of electrical supply, a motor connected therewith, means for automatically controlling the current supplied to the motor in proportion to its own acceleration, said means comprising a secondary motor arranged to actuate the current-controlling means, said secondary motor having an armature-winding and two opposing field-windings, and means for simultaneously charging said windings and said controlled motor from the source of supply.

46. A source of electrical supply, a motor connected therewith, means for automatically controlling the current supplied to the motor in proportion to its own acceleration, said means comprising a secondary motor arranged to actuate the current-controlling means, said secondary motor having an ar-

mature-winding and two opposing field-windings, and means for simultaneously charging said windings and said controlled motor from the source of supply, and a manually-operated switch arranged to control the current through the armature-winding and one of the field-windings of said secondary motor.

47. A source of electrical supply, a motor connected therewith, a starting-switch, means for controlling the current supplied to the motor, a secondary motor mechanically connected to the current-controlling means, said secondary motor having an armature-winding and a field-winding in shunt with said first motor, a second winding in series with the first motor and arranged to oppose the effect of the shunt-winding, and contacts in said starting-switch arranged to simultaneously connect both motors with the source of supply.

48. A source of electrical supply, a motor connected therewith, an electrically-operated reversing-switch, means for controlling the current supplied to the motor, a secondary motor mechanically connected to the current-controlling means, said secondary motor having an armature-winding and a field-winding in shunt with said first motor, a second winding in series with the first motor and arranged to oppose the effect of the shunt-winding, contacts in said starting-switch arranged to simultaneously connect both motors with the source of supply, and a manually-operated switch arranged to control the starting-switch and the armature-winding and shunt field-winding, and to reduce the current in said windings at will.

49. A source of electrical supply, a circuit connected therewith, electromagnetic means, comprising a revoluble armature arranged to control the current in said circuit, a brake arranged to check the operation of said means, the pressure of said brake being proportional in strength to the amount of current in said circuit.

50. A source of electrical supply, a circuit connected therewith, electromagnetic means comprising a revoluble armature arranged to control the current in said circuit, an electrically-actuated brake arranged to mechanically act upon and thereby control the speed of said armature, a circuit for said brake, said circuit being in series with the controlled circuit.

51. A source of electrical supply, a motor connected therewith, means for varying the current in said motor, electromagnetic means comprising a rotatable armature arranged to automatically actuate the current-varying means in proportion to the acceleration of the motor, and a brake arranged to control the electromagnetic means, the controlling effect of said brake being proportional in strength to the current in the motor-circuit.

52. A source of electrical supply, a motor connected therewith, means for automatically controlling the current in said motor in proportion to its own acceleration, electromagnetic means arranged to actuate the current-controlling means, an electrically-actuated brake, a circuit for said brake, said brake-circuit being in series with the motor-circuit and arranged to affect the action of the electromagnetic controlling means.

53. A source of electrical supply, a circuit connected therewith, a motor arranged to control said circuit, said motor having a revoluble armature and an armature-winding and two field-windings of different current-carrying capacities, the winding of the least current-carrying capacity being supplied by current from a shunt-circuit, and arranged to cause the armature to rotate in one direction, the field-winding of the greatest current-carrying capacity being arranged to oppose such direction of rotation in proportion to the fluctuation and current consumption in said circuit.

54. A source of electrical supply, a circuit connected therewith, a motor arranged to control the circuit, said motor having a rotatable armature and an armature-winding, and a field of laminated magnetic material, adapted for direct or alternating currents, and having two opposing field-windings of different current-carrying capacities, one of said field-windings being in shunt with the circuit, the other of said windings being in series with the circuit.

55. An electrical controller adapted for direct or alternating currents, said controller comprising an electrically-actuated reversing-switch, magnets having fields of laminated magnetic material for said reversing-switch; and a motor having fields of laminated magnetic material and a shunt-winding upon said fields, and a series winding also upon said fields, and arranged to oppose said shunt-winding.

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

DAVID LARSON.

Witnesses:
ADRIAN M. POTTER,
ERNEST W. MARSHALL.