No. 798,082. PATENTED AUG. 29, 1905.

A. SUNDH.

AUTOMATIC CONTROLLER FOR ELECTRIC CIRCUITS.

APPLICATION FILED FEB. 7, 1903.

4 SHEETS—SHEET 1.

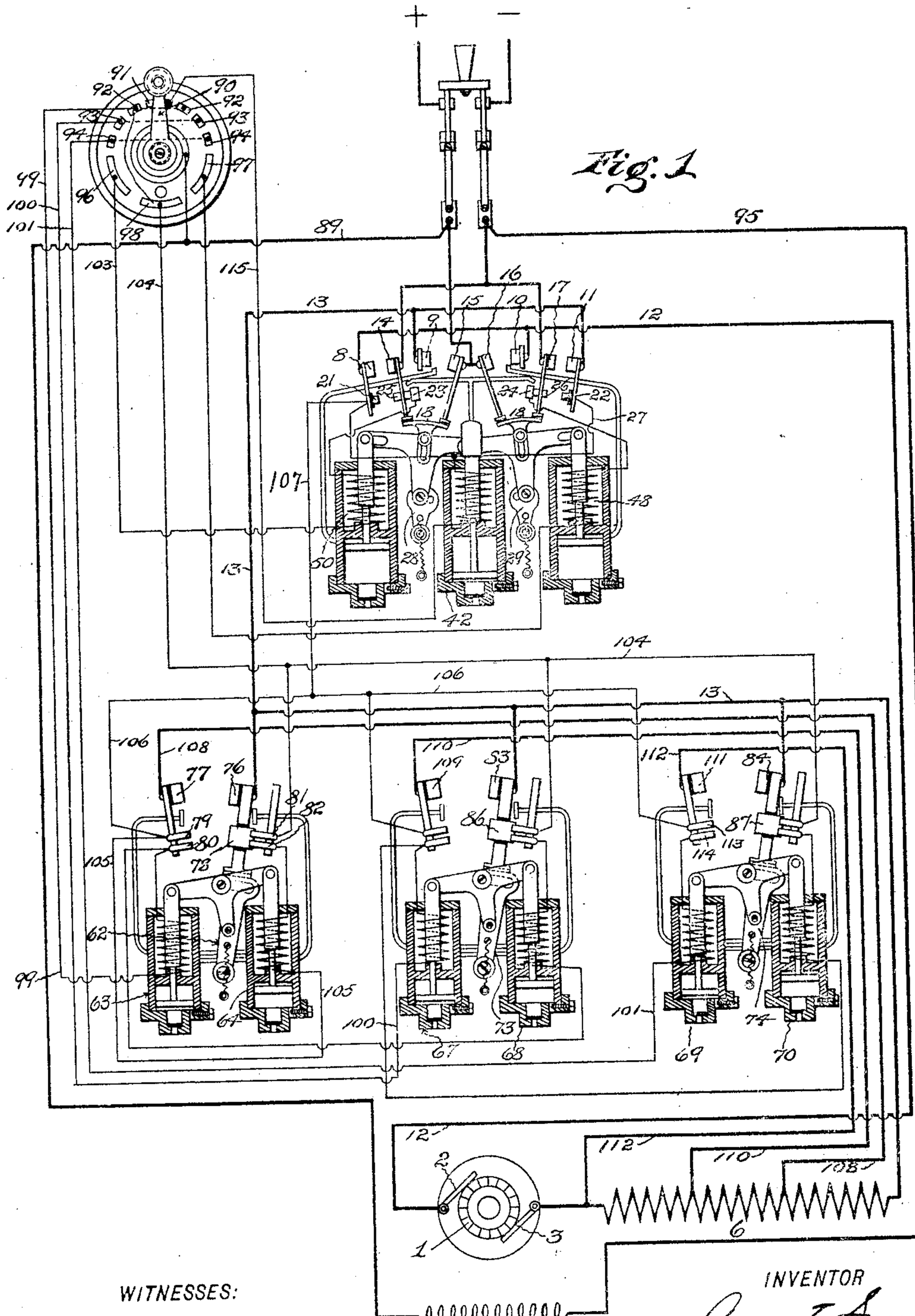

Fig. 1

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4 SHEETS—SHEET 2.

Fig. 2.

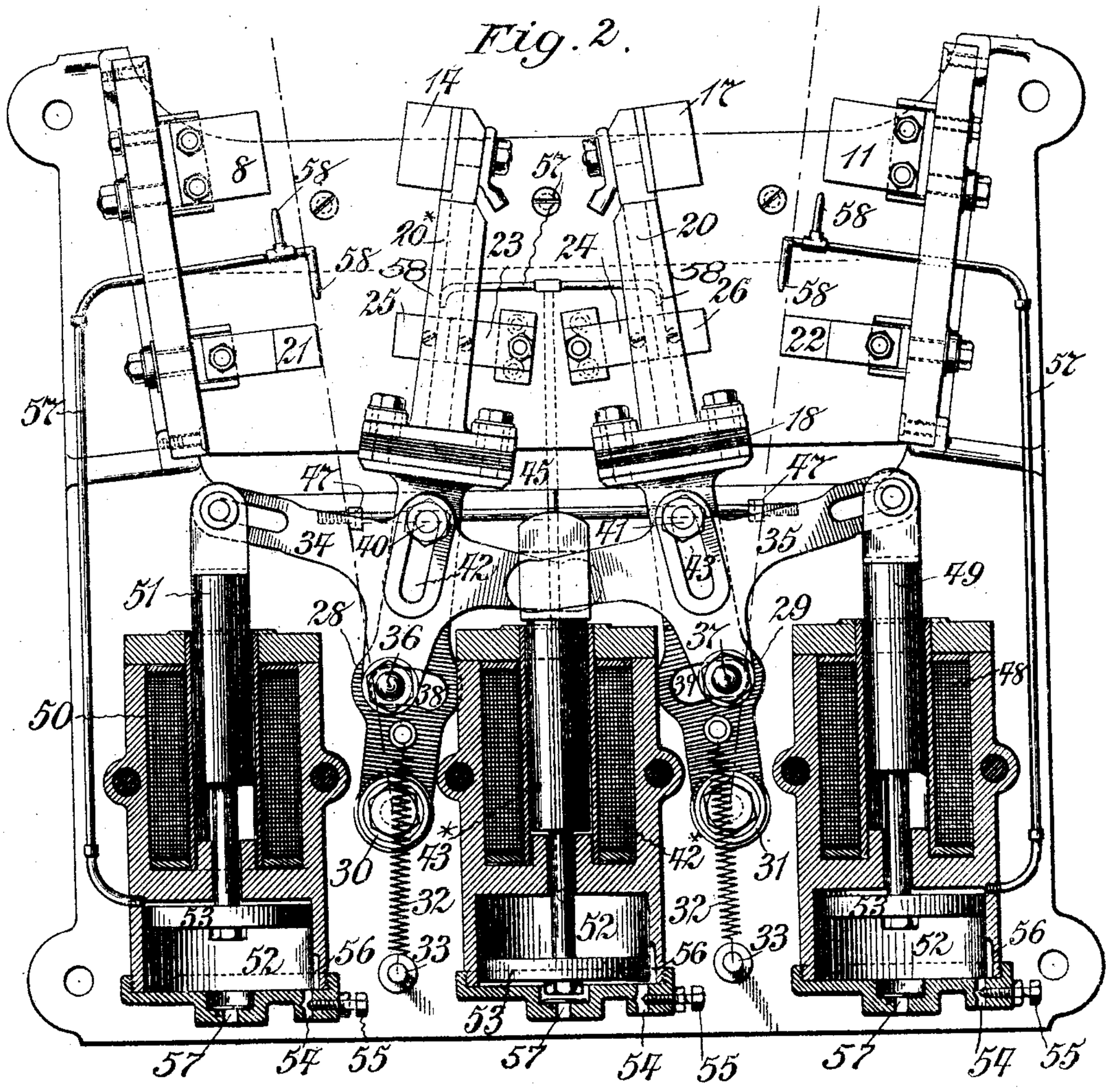


Fig. 3.

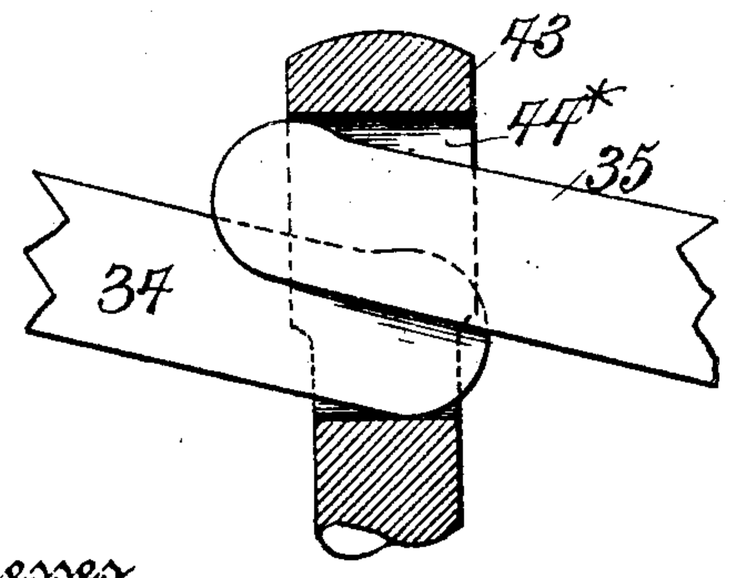
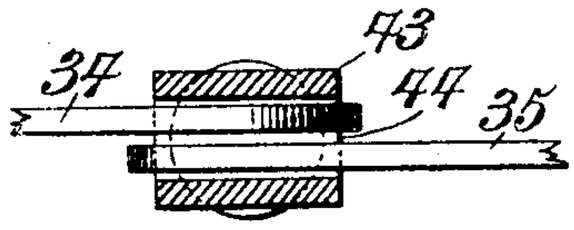


Fig. 4.



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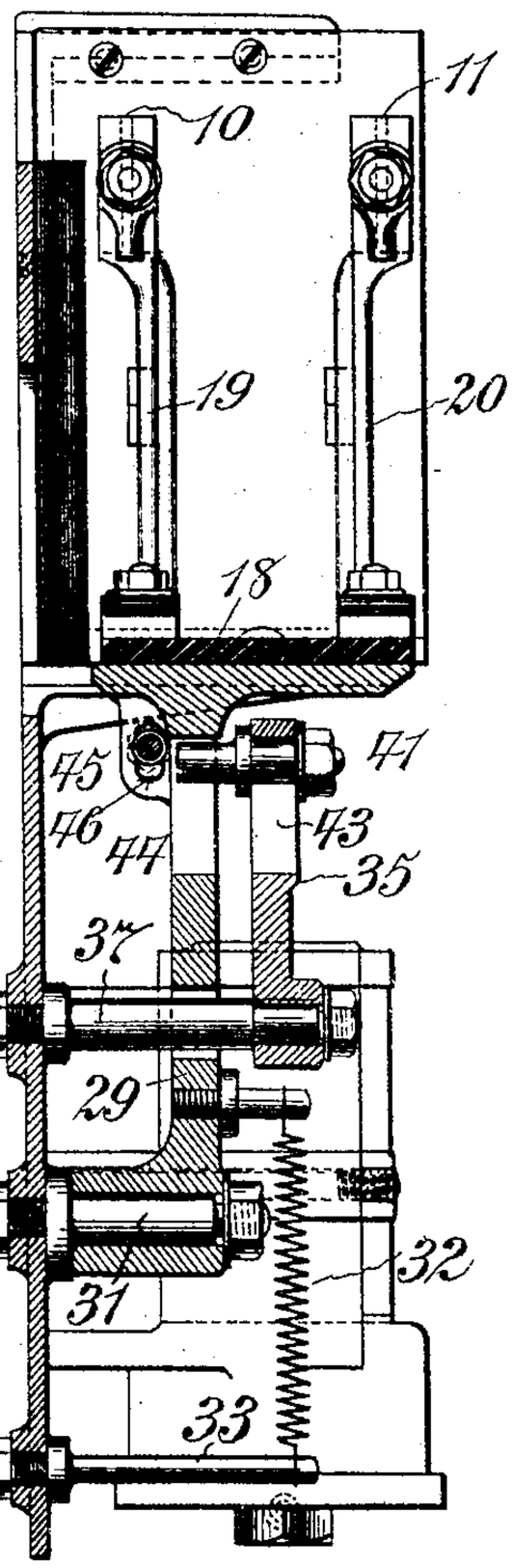
4 SHEETS—SHEET 3.

Fig. 5.



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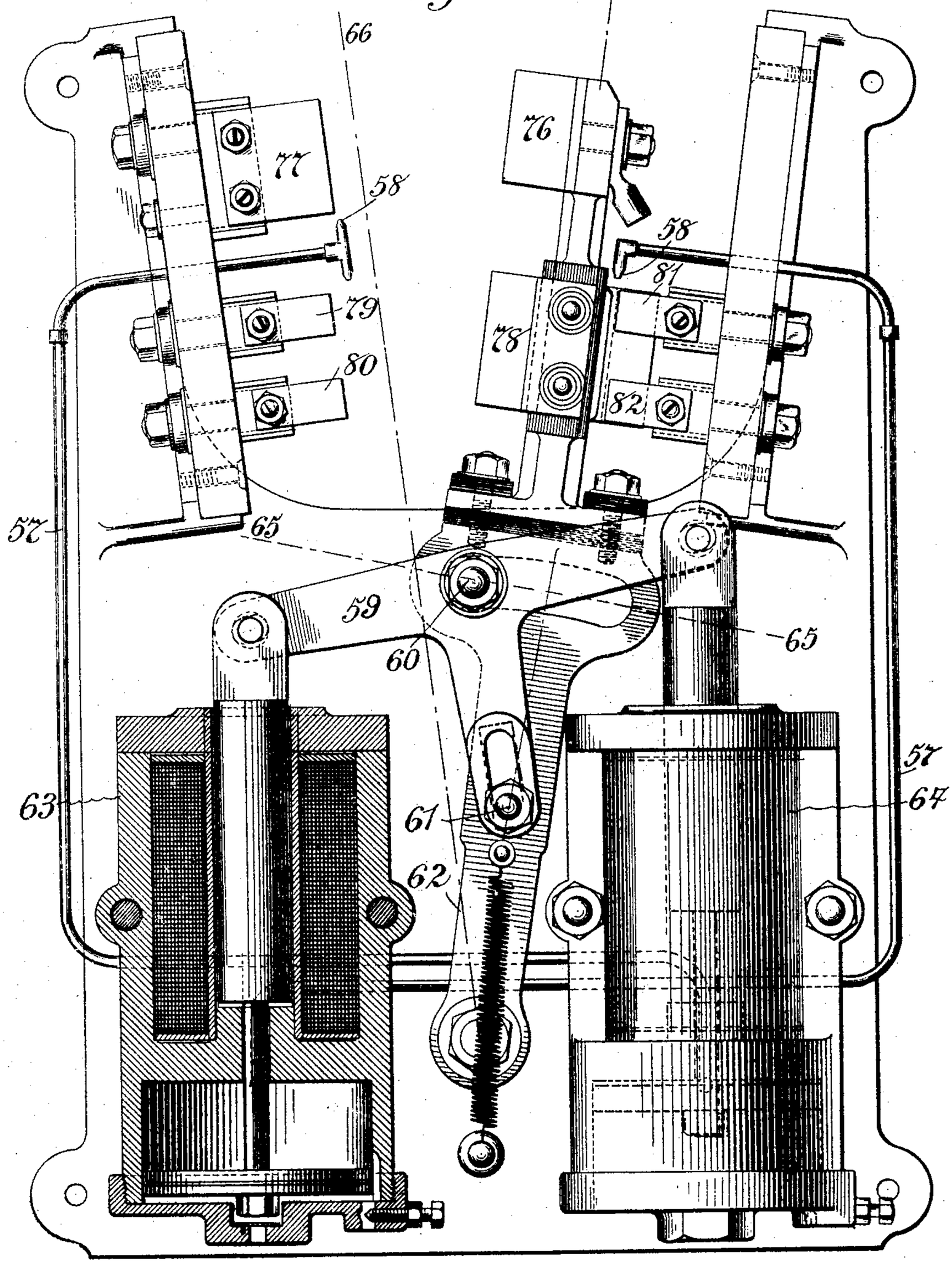
4 SHEETS—SHEET 4.

Fig. 6.



Witnesses
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UNITED STATES PATENT OFFICE.

AUGUST SUNDH, OF YONKERS, NEW YORK, ASSIGNOR TO OTIS ELEVATOR COMPANY, OF EAST ORANGE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

AUTOMATIC CONTROLLER FOR ELECTRIC CIRCUITS.

No. 798,082. Specification of Letters Patent. Patented Aug. 29, 1905.

Application filed February 7, 1903. Serial No. 142,427.

To all whom it may concern:

Be it known that I, AUGUST SUNDH, a citizen of the United States, residing in the city of Yonkers, in the county of Westchester and State of New York, have invented a certain new and useful Improvement in Automatic Controllers for Electric Circuits, of which the following is a specification.

My invention is an electromagnetic circuit-controller designed more particularly for electric motors.

The invention consists, first, in the construction and arrangement of the electromagnets for closing and opening the contacts whereby they use current only during the time said contacts are being moved; second, in the construction and arrangement whereby through electromagnetic devices the resistance in the circuit is automatically varied; third, in the construction and arrangement whereby the successive resistance-controlling devices may be timed to operate successively and during such periods as may be chosen, so as to secure a predetermined interval between the successive operations; fourth, the construction permitting of reverse action of all or some of the main switches at will; fifth, an improved form of reversing-switch particularly adapted for use with other parts of my device; sixth, certain improved means for interrupting the arcs at points of circuit rupture, and, seventh, the means whereby gradual movement of adjustable velocity is attained in each main switch while at the same time a rapid action is insured at the moment of making circuit, thus insuring good contact at the point of closing.

My device is especially intended for use with translating devices actuated by alternating currents, and more especially with alternating-current motors. It is, so far as I know, the first in the art wherein the current to the electromagnetic operating means is cut off as soon as the operation of said means is insured. Ordinarily the current continues in said means, thus wasting energy and causing needless expense, all of which is here saved. Again, the current alternations always cause chattering and other noises in continuously-energized devices. This also is here wholly avoided; and, again, owing to the very brief and momentary employment of the current heavier currents may be used in my device without danger of overheating.

A preferred form of this invention is illustrated in the accompanying drawings, wherein—

Figure 1 is a diagram of switches, solenoids, and circuits as used in said invention. Fig. 2 is a side view of my preferred reversing-switch, showing the solenoids in section. Figs. 3 and 4 are vertical and horizontal sections of details. Fig. 5 is a sectional view of one member of the reversing-switch in upright position, and Fig. 6 is a side view of one of the main-circuit closers.

Referring to Figs. 1 to 5, the preferred reversing-switch will be first described as related to a motor, since it will often be found best to combine the relay switch-contacts which prepare the circuits for the automatic main switches with the reversing-switch of a motor to be controlled by all of said switches. At 1 is shown a motor-commutator on which bear the brushes 2 and 3. The shunt field-coil is shown at 5. Resistance-coils are shown at 6.

In Fig. 1 are shown four stationary motor-contacts in the reversing-switch, mounted upon bases of slate or other insulating material and numbered 8, 9, 10, and 11. Contacts 8 and 10 are connected electrically to each other and to the conductor 12, leading to the brush 2. Contacts 9 and 11 are also mutually connected and from them leads the conductor 13 to the outer ends of resistance-coils 6. Although in the diagram of Fig. 1 these various contacts 8 to 11 are shown separately placed, (and may be so arranged in practice, if desired,) yet it is preferred to arrange them side by side in pairs, 10 and 11 being together on one side and 8 and 9 on the other. This is made clear in Figs. 2 and 5, the contact 10 being hidden behind 11 and 9 behind 8 in Fig. 2. Corresponding to the fixed contacts 8 to 11 are four movable contacts or terminals 14, 15, 16, and 17, each carried on its own metallic lever, these levers being mounted in pairs on insulating-supports 18, as at 19 and 20. (See Figs. 2 and 5.) One terminal in each pair, as 14 and 17, is permanently in electrical connection with the negative feed-wire, while the other terminal of each pair, as 15 and 16, is connected to the positive feed-wire. Under the terminals 8 and 11 are placed the fixed in-

sulated relay-terminals 21 and 22, and opposite these are respectively fixed the relay-contacts 23 and 24. The movable knife-terminals 25 and 26 swing, respectively, between 21 and 23 and between 22 and 24, being fixed upon and electrically connected to the metallic levers 20, which carry the movable switch-contacts 14 and 17. The outermost fixed contacts 21 and 22 are electrically connected, as by a wire 27. (See Fig. 1.) The insulating-supports 18 are carried upon levers 28 and 29, pivoted, respectively, at 30 and 31. Springs 32, attached to pins 33, and at their opposite extremities to the pivoted levers 28 and 29, act in a well-known manner to hold said levers away from a middle or upright position, whether tilted to left or right. These springs impart a snap action to the switches. Separate three-armed levers 34 and 35 are used to impart motion to the levers 28 and 29. These levers are pivoted on pins 36 and 37, passing through slots 38 and 39 in the levers 28 and 29. The pins 40 and 41 are adjustable in the slots 42 and 43 and enter slots 44, Fig. 5, in the levers 28 and 29. It is evident that on tilting the three-armed levers one way or the other corresponding movement will be imparted to the levers 28 and 29, respectively.

In Figs. 1 and 2 the switch-levers 28 and 29 are shown inclined toward each other, and this position is produced by the action of the middle solenoid 42* and its core 43*. The inner arms of 34 and 35 overlap within a slot 44* in the core 43* near its upper end. (See Figs. 3 and 4.)

As shown in Fig. 2, when the core 43* is pulled down by the coil 42* it depresses both of the inner arms of the levers 34 and 35; but the slot 44* is so long that when one of the arms, as 35, is tilted upward and raises the core 43* (see Fig. 3) the other lever-arm, as 34, is left behind, the bottom of the slot 44* not rising high enough to move it.

Inspection of Fig. 1 will show that if the two levers 28 29 could be tilted away from each other, so as to close circuit simultaneously at 8, 9, 10, and 11, there would be a "dead short circuit" on the main line. Accidental occurrence of this position is prevented by the safety-rod 45 passing through openings 46 in the two levers 28 and 29 and carrying limiting-nuts 47. Consequently only three positions of the parts are possible: First, the two levers may tilt toward each other as shown; second, they may be both tilted to the left; third, they may be both tilted to the right. Movement of the lever 29 to the right is produced by the solenoid 48 and its core 49, connected, as shown, to the right-hand arm of the lever 35. Similarly the solenoid 50 and its core 51 act to tilt the lever 28 to the left. Beneath each of the solenoids 42*, 48, and 50 is a closed air-chamber 52, in which plays a plunger 53, connected to the solenoid core above it. Each chamber 52 communicates with the outer air below the plunger by means of a passage 54, the cross-sectional area of which is adjustable by means of a screw-valve 55. When the solenoid acts, the resulting downward movement of the core is retarded by the air compressed beneath the plunger, and the degree of this retardation is regulated by the valve 55. In the lower part of each of these air-chambers 52 is a valve 57, which allows the air to pass freely into the chamber when its plunger 53 is ascending, but is closed when 53 is descending, so that the retarding effect is only during the descending motion of the plunger 53. While I have shown pneumatic means in this connection as being most convenient, my invention covers the use of cylinders and plungers employed as described and claimed with any fluid.

By the means above described not only is the time of operation made adjustable, but a gradual movement of the movable terminals is secured which prolongs the period of operation of the switch. At the moment of making circuit, however, it is desirable that a quick strong action of the solenoid be permitted, so as to insure bringing the terminals together quickly and making good contact. For this purpose I prefer to provide a passage for transfer of the air or other fluid around the plunger 53 at the proper moment. This relieves all resisting pressure and allows the core to descend quickly at the moment the contacts come together. This passage may be variously arranged and is shown in the drawings at 56 as a recess in the main chamber 52.

In order to blow out the arcs produced at the contacts when circuit is broken, I prefer to provide air-tubes 57, ending in jets 58, directed at the arcing-points, as shown. For driving the air through these tubes I employ the upward movements of the plungers 53, the tubes 57 being led to the tops of the chambers 52. Thus, for example, when solenoid 48 acts to break circuit at 24 26 air is forced through pipe 57 from the space beneath the solenoid 42*.

In the automatic main-switch devices (illustrated in detail in Fig. 6 and shown below the reversing-switches in Fig. 1) the operating mechanisms are in many respects similar to those above described.

From Fig. 6 it will be seen that the three-armed lever 59, which throws the lever 62, is pivoted at 60 above instead of below the pin 61. Each solenoid 63 64 therefore acts to tilt the lever 62 away from itself. The air-tubes 57 are carried past each other and across the switch, as shown, their operation remaining the same as above described. The dotted lines 65 and 66 in Fig. 6 indicate the directions given to 56 and 62, respectively, when 64 operates.

Referring now to Fig. 1, there are shown three pairs of solenoids 63 and 64, 67 and 68, 69 and 70. More pairs can be of course used

when more than three modifications of the main circuit are desirable. The three pairs of solenoids operate, respectively, the three switch-levers 62, 73, and 74. The lever 62 carries an insulated main-circuit terminal 76, adapted to coöperate with the fixed insulated terminal 77 and also carries an insulated relay-terminal 78, which always makes contact either with the mutually-insulated terminals 81 82 or with 79 80. The other levers 73 74 carry main terminals 83 84 and relay-terminals 86 87, which coöperate with the fixed terminals, as shown, in the same manner as above described for the extreme left-hand switch in Fig. 1.

A variety of forms of manipulator-switch may be employed with the apparatus so far described; but I prefer the simple hand-switch shown in Fig. 1, wherein current is carried by wire 89 to the lever 90 and by the latter to one of the terminals 91 92 93 and 94 96 97 98. Terminals 92 93 94 are shown in pairs and are electrically connected, respectively, to wires 99, 100, and 101. The switch thus connected when turned one way from the central stopping position shown acts to start the motor in one direction and when turned oppositely it acts to start the motor in the opposite direction. The gradual modification of motor-circuits is automatically accomplished by the adjustably-movable solenoids of the automatic main-switch devices.

The mode of operation is as follows: With the lever 90 in the position shown the motor is at rest and all the switches occupy the positions illustrated. To start the motor, the lever is turned to bear upon either 96 or 97, according to the direction of motion desired. The operation is essentially the same in either case, and for the purpose of describing it it will be assumed that the lever 90 is turned to the left until it bears upon contact 96. Current passes from the positive feed-wire by 89 and 90 to 96. Thence the wire 103 conducts it to solenoid 50 and by 23 25 to the terminal 14 and the negative feed-wire. This throws the lever 28 to the left, and it will remain in this position until further manipulation by the operator. In moving to the left the contact between 23 and 25 is broken and so no current will pass through the solenoid 50 after it has performed its function of moving the lever 28. When the lever 28 is in the position just described, the current reaches the motor as follows: from positive wire to terminals 15 and 9, thence by 13, resistances 6, brush 3, armature-coils, brush 2, wire 12, terminals 8 and 14, and out to negative wire. The shunt field-coils 5, as shown, are connected directly across the mains by wires 89 and 95. In practice the lever 90 will cause the above-described action as it sweeps over 96 and will finally rest upon 98, when the gradual automatic modifications of the motor-circuits begin. For this purpose the current entering 98 goes by wire 104 to the automatic main-switch devices, there being a branch from this wire to the solenoids 64, 68, and 70 of the three switches. The only branch closed at first, however, is that through 64, which goes from 81 to 82 by terminal 78, through solenoid 64, and by wire 105 to the common outgoing wire 106. This is connected to the negative feed-wire by wire 107 through terminals 21, 25, and 14. Solenoid 64 being thus energized, the lever 62 is tilted to the left, the solenoid 64 is cut out at 81 82, so that no energy is wasted in it, and two new circuits are formed. First, 76 and 77 are brought together, and the current coming in at 13 is thus carried by wire 108 to the resistance-coil 6, thus short-circuiting a portion of said coil, the remainder of the main circuit being as above first described; second, contact 78 closes the circuit between 79 and 80, and a branch circuit from 104 is established through the second solenoid 68, whereby said solenoid tilts the lever 73 to the left. The terminal 83 having been brought against 109, current from wire 13 now goes through wire 110 to the resistance-coil 6, thus short-circuiting another portion of the resistance. At the same time circuit of 68 is broken and the bridging-terminal 86 closes the circuit of solenoid 70. This brings 84 against 111, and current from 13 will now take wire 112, and the entire resistance-coil 6 will be short-circuited. It will be noticed that in each instance the automatic switch-solenoid has produced a change which under ordinary conditions tends to speed up the motor, while at the same time it has closed the circuit of the next solenoid in order. It is obvious that by suitably regulating the air-outlet beneath each solenoid core and plunger the time elapsing between the successive changes can be independently adjusted at will, and thus the entire regulation of circuits with respect to the operation of the motor is made automatic and is placed beyond the control of the person handling the lever 90. It is desirable that, if necessary, the motor-circuit can be instantly broken by movement of the lever 90. This is done by bringing said lever back to the position shown in Fig. 1, when current entering the terminal 91 takes wire 115 to solenoid 42 and out by 21, 25, and 14. This brings the lever 28 back to the position shown in Fig. 1, opening all motor-circuits, as well as breaking the circuit through 42* at 21. If, however, it is desired to stop the motor gradually, the lever 90 is first brought back to the terminal 94, when current passes by the wire 101 to solenoid 69, which causes the arm 74 to be thrown back to the right, and in so doing it breaks its own circuit at 113 114 and breaks the short circuit across the part of the resistance 6 between the wires 112 and 110. Successively bringing 90 over terminals 93 and 92 throws current into wires 100 and 99 and successively, but in re-

verse order, reverses the steps above described for starting up the motor. In each instance the solenoids acting to slow up the motor at once break their own circuits, and each interrupts possible circuit to the similar solenoid in the next pair of solenoids to the right in Fig. 1, thus preventing all possibility of again changing the motor-circuits save in the correct order of steps and in the prearranged allowance of time.

A variety of modifications may be made in the individual switch constructions herein shown, as also in the relative arrangement and the electrical connections thereof, without departing from my invention, and I am not to be understood as limiting myself to the details herein shown and described.

What I claim is—

1. In a controller for electric motors, a plurality of electromagnetic devices successively operating to vary the strength of the current in said motor, and automatic means for deënergizing said devices, upon the operation of each, substantially as described.

2. In a controller for electric motors, a plurality of electromagnetic circuit-closers and automatic means for cutting each out of circuit, after closing of its contact-terminals shall have been insured, substantially as described.

3. In a controller for electric motors, a plurality of electromagnetic circuit-closers, means for successively actuating the same and automatic means for cutting each out of circuit after closing of its contact-terminals shall have been insured, substantially as described.

4. In a controller for electric motors, a plurality of movable contacts, a plurality of corresponding fixed contacts, electromagnets actuating said movable contacts, and means for controlling the current to said magnets; whereby said magnets are energized only while actuating said movable contacts, substantially as described.

5. In a controller for electric motors and in the motor-current, a plurality of resistances, a plurality of electromagnetic circuit-closers associated respectively with said resistances, and automatic means for successively cutting said circuit-closers out of circuit after closing of their contact-terminals shall have been insured, substantially as described.

6. In a controller for electric motors, a plurality of electromagnetic devices successively operating to vary the strength of current in said motor, means for timing said devices and automatic means for deënergizing said devices upon the operation of each, substantially as described.

7. In a controller for electric motors, a plurality of electromagnetic devices successively operating to vary the strength of current in said motor, means for varying the period of operation of each device with reference to that of the others, and automatic means for deënergizing said devices upon the operation of each, substantially as described.

8. In a controller for electric motors, an electromagnetic circuit-closing device, an independent electromagnetic device operating to open said circuit, and automatic means for deënergizing said devices upon the operation of each, substantially as described.

9. In a controller for electric motors, a series of resistances in the motor-circuit, electromagnetic devices for cutting out said resistances step by step, and automatic means for deënergizing said devices upon the operation of each, substantially as described.

10. In a controller for electric motors, a hand-switch, an electromagnetic current-reversing device, a series of resistances in the motor-circuit, electromagnetic devices for cutting out said resistances step by step, and automatic means for deënergizing said current-reversing device and said resistance-controlling devices upon the operation of each, substantially as described.

11. In combination with a plurality of switch-levers, a plurality of dash-pots associated therewith and means for regulating the fluid resistance in each dash-pot; whereby the periods of operation of said levers may be relatively timed, substantially as described.

12. In combination with a magnetic switch, means operatively connected to the switch for retarding its movement when closing the circuit, and for producing air-pressure when breaking the circuit and means for leading the air thus compressed to the terminals of the switch, substantially as described.

13. In combination with a switch, means for closing and opening the same, a cylinder, a piston in said cylinder connected to said switch closing and opening means, said piston arranged to retard the closing movement of the switch and to compress air in the cylinder upon the opening movement of the switch and a tube leading from said cylinder to the switch-terminals and adapted to convey the compressed air to said terminals, substantially as described.

14. In combination with a switch adapted to close circuits in its two extreme positions, a separate means for throwing the switch both ways, a separate cylinder and piston connected to each of said means each adapted to compress air for retardation on one side of the piston and for arc extinguishment on the other, and a separate tube leading from the latter-named side of each piston to the appropriate contacts of the switch and conveying compressed air thereto, substantially as described.

15. In an automatic switch, a pivoted switch-lever, two electromagnets for swinging the same on its pivot in relatively opposite directions and a pivoted three-armed lever having two of its arms respectively connected to the armatures of said magnets and having a pin

carried on the third arm and engaging the switch-lever for moving it, substantially as described.

16. In a switch system, two swinging pivoted levers, means for swinging either of said levers in either direction and means for preventing simultaneous inclination of the two levers in opposite directions, substantially as described.

17. In a switch system, two swinging pivoted levers, means for swinging either of said levers in either direction and a tie-rod passing through both levers and carrying stops at its ends for limiting the degree of said separation of said levers, substantially as described.

18. In a switch system, two swinging pivoted levers, a three-armed pivoted lever for operating each switch-lever, said latter levers each having one arm projecting toward the other lever, a solenoid operatively connected to said latter-named arms and a separate solenoid operatively connected to the free arm of each three-armed lever, substantially as described.

19. In a switch system, two switch-levers, a separate operating means for each, a solenoid having a core so connected to said operating means as to tend to move both together when moved in one direction and, when moved by one of said means, to leave the other one unmoved, substantially as described.

20. In a switch system, two swinging pivoted levers, a solenoid having a core carrying an open slot, a separate lever for operating each switch-lever, said latter levers each having an arm projecting into said slot, the levers being so placed with regard to said solenoid and so proportioned relatively to said slot, substantially as described, that when the core is raised by movement of one lever the other lever remains stationary and that the operation of the solenoid on one or the other lever always results in bringing them both to the same position, substantially as described.

21. In combination with an electrical translating device a controller comprising a hand-switch, an electrically-operated reversing-switch for the translating device controlled by said hand-switch, a number of automatic switches for said translating device and terminals in said reversing-switch for preparing the circuits of said automatic switches, substantially as described.

22. In combination with an electrical translating device an electromagnetic reversing-switch, a hand-switch for controlling the same, a number of automatic switches for modifying the circuits of said translating device, a common positive and a common negative wire for all of said automatic switches, a terminal in said hand-switch for conveying current to one of said common wires and terminals in said reversing-switch controlling admission of current to the other of said common wires, substantially as described.

23. In combination with an electrical translating device, two main circuit-closing switches, a common means for opening circuit at both, separate means for causing each to close circuit, automatic switches for modifying the circuits of the translating device and a hand-switch having a movable member adapted to convey current to four fixed terminals also in said switch, one of said terminals leading to the common circuit-opening device, a second to all of the automatic switches and the other two respectively to the two main circuit-closing devices, substantially as described.

24. Two main circuit-closing switches, separate electromagnetic circuit-closing motive devices for each, a common electromagnetic circuit-opening means for both, a series of automatic switches and circuits modified thereby; in combination with a hand-switch having diametrically-placed contacts respectively connected to the common main circuit-opener and all the automatic switches, and between these two contacts on the hand-switch in each direction, individual contacts for each automatic switch and a contact for one of the main circuit-closing means, substantially as described.

25. In combination with circuits to be modified, a series of electromagnets operating-switches for said circuits, electric connections whereby when the first switch is thrown forward the others are thereupon also successively thrown forward, automatic means for cutting each magnet out of circuit when it moves its switch and means for establishing an operating-circuit for the first switch in the series, substantially as described.

26. In combination with circuits to be modified, a series of switches for said circuits, separate electromagnetic means for throwing each switch respectively forward and backward, means whereby each forward-throwing means energizes the next in series, a hand-switch for energizing the first forward-throwing means and terminals in said switch whereby the backward-throwing means may be energized one by one at will, substantially as described.

27. In combination with circuits to be modified, a series of switches for said circuits, separate electromagnetic means for throwing each switch respectively forward and backward, a circuit-breaker in series with each of said means, each operated by the identical electromagnetic means with which it is in circuit, a piston and cylinder connected to each switch and adapted to compress air on one side of the piston for retarding each forward-throwing means, and to compress air on the other side of the piston for arc extinguishment and tubes leading from the latter-named side of each cylinder to the points of current rupture, electric connections whereby when the first forward-throwing means operates the others are thereupon successively operated and means for establishing circuit through the first for-

ward-throwing means in the series, substantially as described.

28. In combination with circuits to be modified, a series of switches for said circuits, electromagnetic means for operating each, a circuit-breaker in series with each of said means, each operated by the identical electromagnetic means with which it is in circuit, electric connections whereby, when the first switch is operated, the others are thereupon also successively thrown forward and means for establishing an operative circuit for the first electromagnetic means in the series, substantially as described.

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

AUGUST SUNDH.

Witnesses:
C. EMMETT WILSON,
ERNEST W. MARSHALL.