T. E. BARNUM.

MOTOR CONTROLLER.

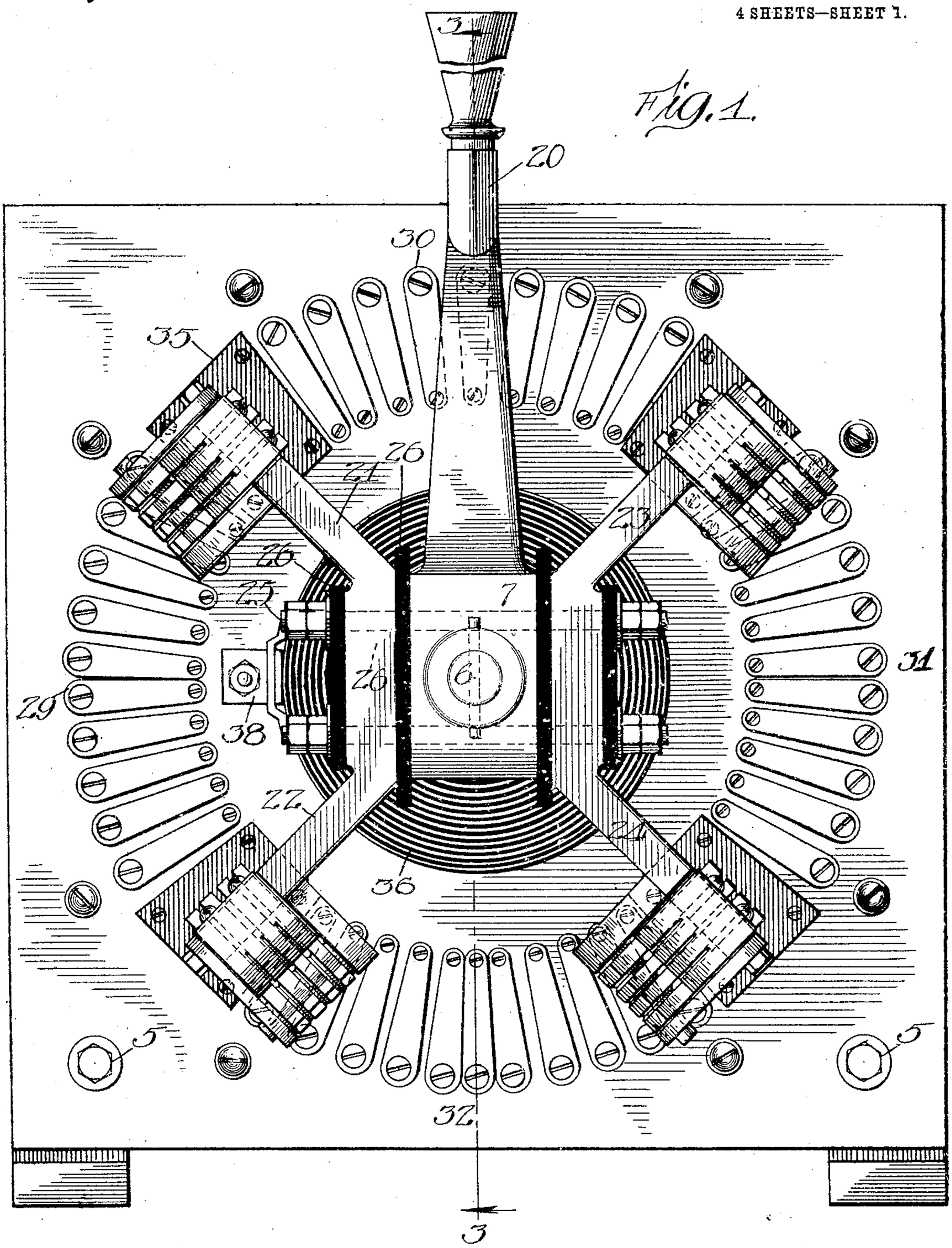
APPLICATION FILED MAR. 14, 1907.

959,907.

Patented May 31, 1910.

4 SHEETS—SHEET 1.

Fig. 1.



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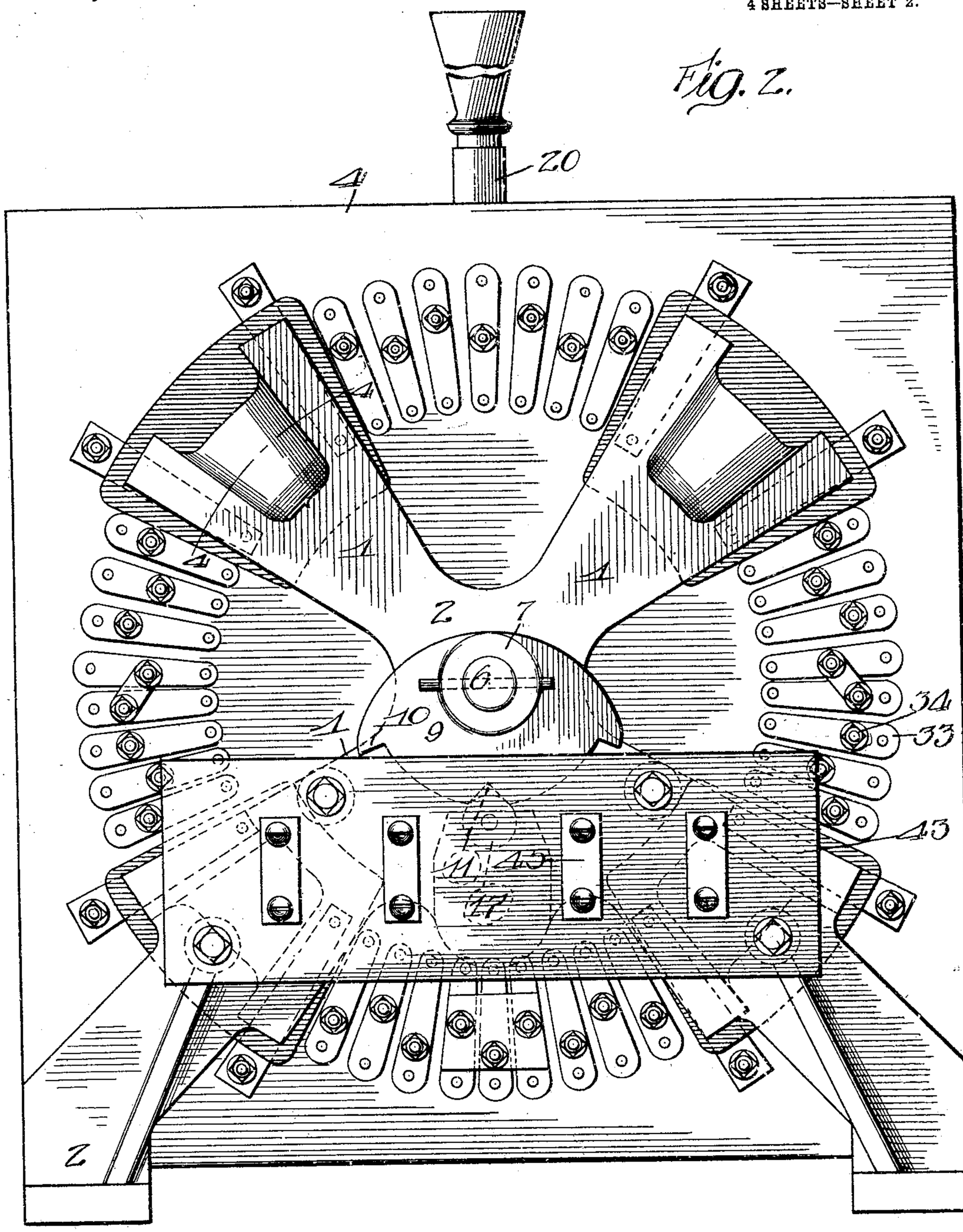
4 SHEETS—SHEET 2.

Fig. 2.



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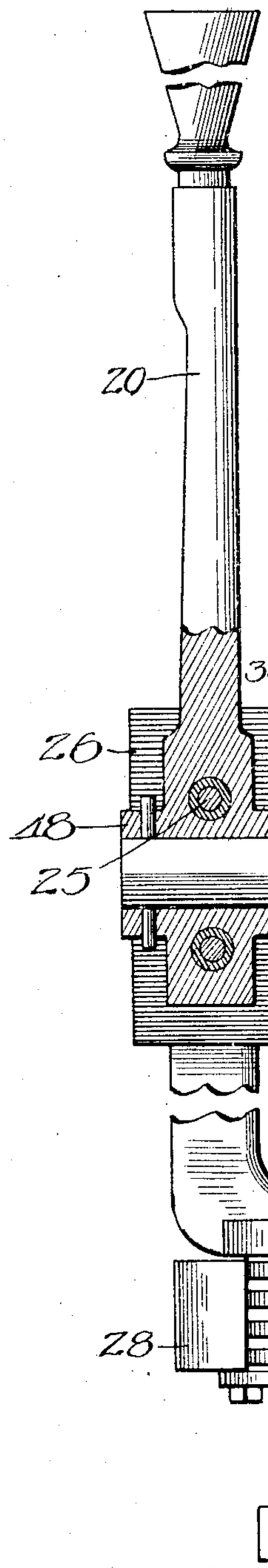

Fig. 3.

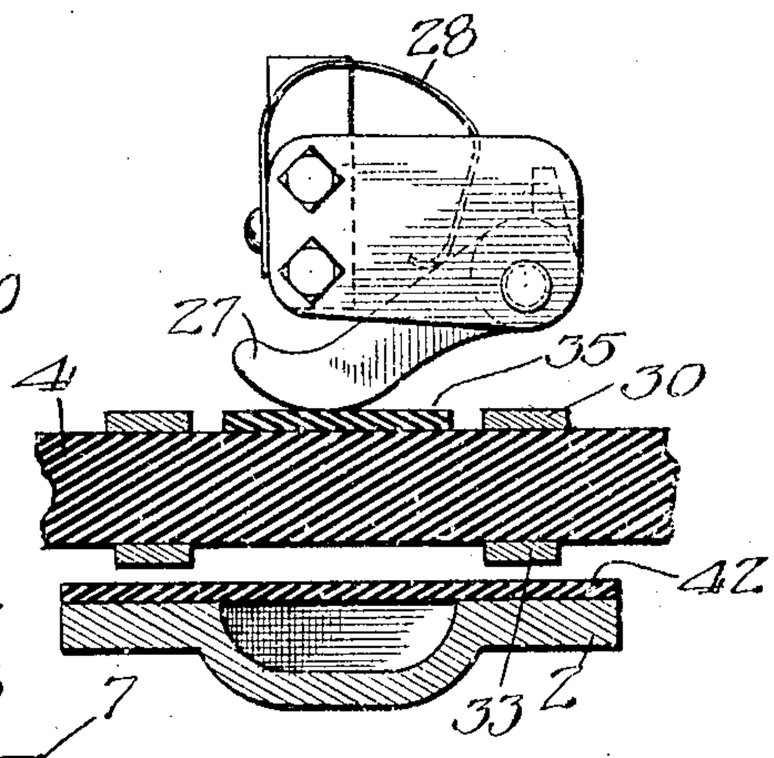

Fig. 4.

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4 SHEETS—SHEET 4.

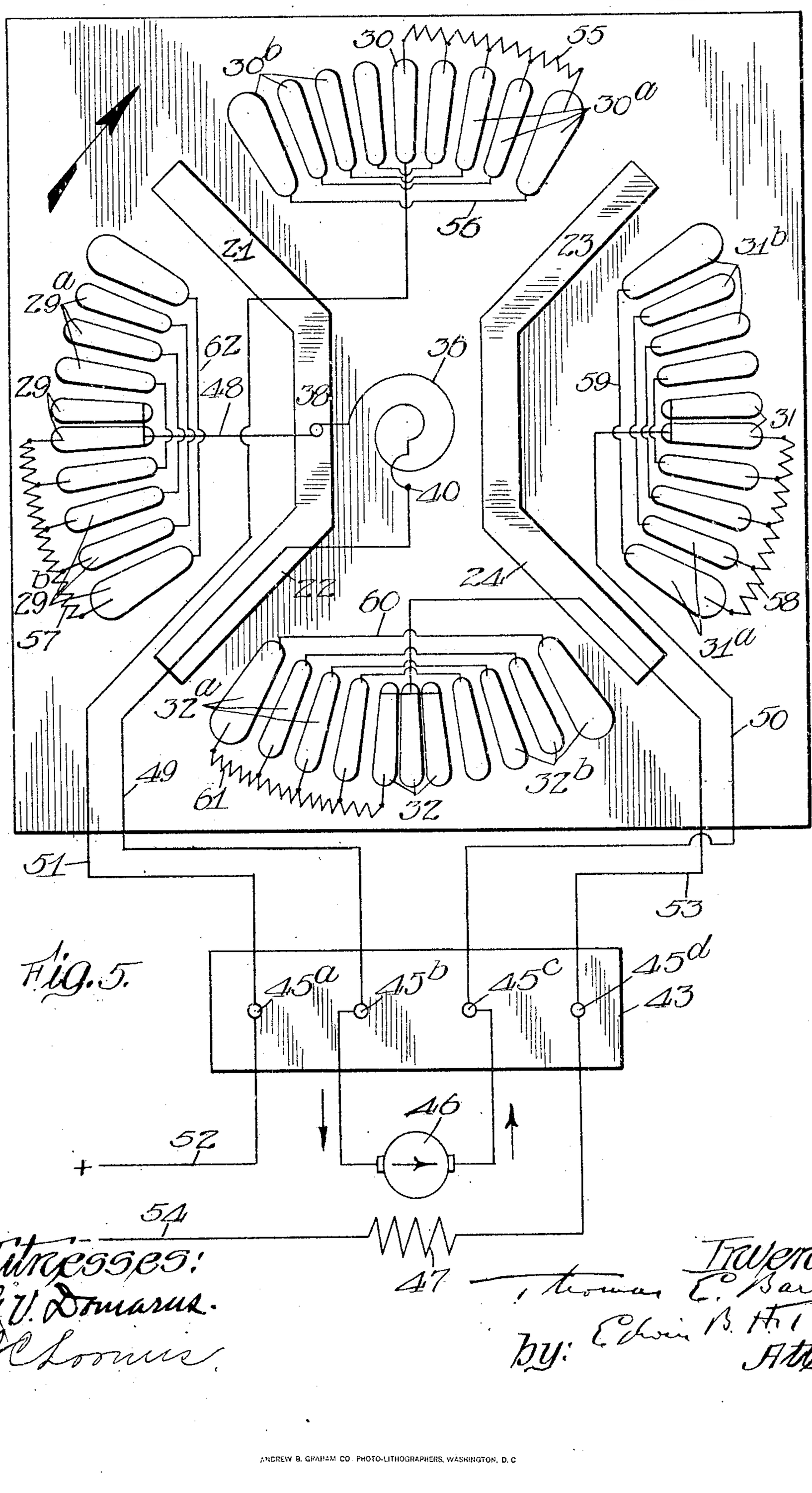

FIG. 5.

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UNITED STATES PATENT OFFICE.

THOMAS E. BARNUM, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO THE CUTLER-HAMMER MANUFACTURING COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

MOTOR-CONTROLLER.

959,907. Specification of Letters Patent. **Patented May 31, 1910.**

Application filed March 14, 1907. Serial No. 362,354.

To all whom it may concern:

Be it known that I, THOMAS E. BARNUM, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Motor-Controllers, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to improvements in motor controllers, and it applies particularly to controllers that perform the function of both a rheostat and a reversing switch.

The object of my invention is to provide a controller of the character stated that will produce better results in practice than those heretofore devised.

One phase of my invention contemplates certain electrical relations between the parts of the controller. Another phase thereof contemplates a certain location of the blow-out coil and certain formation of the parts of the controller to provide pole pieces adjacent to the zone of the arc that occurs upon opening the circuit.

In the accompanying drawings I have illustrated a controller that I have worked out in practice in accordance with my invention, and I shall now describe the same. It will be understood, however, that other controllers embodying my invention may be devised.

Figure 1 is a front view of the controller. Fig. 2 is a back view thereof. Fig. 3 is a sectional view on the line 3—3 of Fig. 1. Fig. 4 is a sectional view taken generally on the line 4—4 of Fig. 2. Fig. 5 is a diagram of the electrical connections and relations of the parts of my controller.

The controller is preferably provided with a supporting frame which preferably consists of an integral structure made of magnetic material, and comprising four radial arms 1, two feet 2, and a bearing sleeve 3. The four arms extend radially from a common center. These arms are equidistant apart and are arranged in the same plane. The sleeve is formed at the juncture of the four arms and its axis extends transversely to the plane of said arms. The feet 2 are formed, one upon each of two arms, and are adapted to rest upon or be attached to a suitable support. The frame supports a face plate or base 4 made of insulating or other suitable material. The face plate is preferably attached to said support at the bottom by means of bolts 5.

A shaft or spindle 6 extends through the bearing sleeve 3. The rear end of the shaft is provided with a collar 7 fastened thereto by suitable means and bearing against the back of the frame to prevent axial displacement of the shaft. A cam 9 is preferably formed upon the collar 7, and is provided with two stop lugs 10, one arranged at each end of an arc concentric with the axis of the shaft. The shaft may be turned through an arc corresponding to the distance between the lugs 10. The surface of the cam between the stops is provided with a notch 11, which is located midway between said lugs.

The frame is provided with a projection 12 which is arranged in the path of the movement of the lugs so that the lugs may strike against the same to limit the arc through which the shaft may be turned. When the shaft stands in its initial position, each lug is equidistant from said projection. Extending vertically through the projection 12 is a circular hole in which is arranged a slidable cylindrical block 13 having a downwardly extending tail rod 14. In the lower portion of the hole a ledge is formed, and below the ledge the diameter of the hole is just sufficient to admit the tail rod. A bearing is thus provided for the tail rod. The lower end of the tail rod is provided with a vertical slot through which passes a pin 15 to prevent said rod from turning. The cylindrical block 13 is pressed upward by a spring 16 arranged between the bottom of said block and the ledge in the hole, and surrounding said tail rod. The block 13 carries a roller 17 which engages the edge of the cam 9.

When the parts of the controller are in the initial or "off" position, the roller 17 is pressed into a notch 11 in the cam. The parts are thus held against accidental movement. The outer end of the shaft 6 carries a hub 18 from which extends a handle or lever 20 for operating the controller. The hub carries two pairs of contact arms, one pair having arms 21 and 22 and the other arms 23 and 24. These arms extend radially and are equidistant apart. The arms of each pair are preferably integral and are pref-

erably made of cast iron which is adapted to serve as both an electrical and a magnetic conductor. The two pair of arms are fastened to the hub by means of suitable bolts 25. Insulating material 26 is placed between the arms, the hub, and the bolts so as to electrically insulate one pair of arms from the other. The outer end of each contact arm preferably carries pivoted fingers or contacts 27, made of copper or other suitable material adapted to engage certain stationary contacts that will be hereinafter described. These fingers are preferably pressed into engagement with the stationary contacts by a spring 28.

The face plate carries four groups or sets of contacts 29, 30, 31, and 32, arranged concentrically with the axis of the shaft 6. These contacts are preferably what is known in the art as face plate or radial contacts. The four groups of contacts are arranged one group in each of four arcs of equal length and equal radius, the several arcs being equidistant apart and having a common center. Each contact is preferably held in place by means of screws, the heads of which are countersunk in the face of the contact. The screws pass through the face plate and are threaded into a plate 33 upon the back thereof, and said plate preferably carries a binding screw 34 by means of which electrical connection is made to the conductors and resistances hereinafter set forth.

Each group of contacts preferably comprises a center contact and several contacts on each side of said center contact, the several contacts on each side of said center contact preferably being equal in number. In some instances the center contact may comprise several electrically connected contact plates as in groups 29, 31, and 30.

In each of the four spaces between the four groups of contacts is preferably arranged an insulating block 35. When the controller arms are in the initial or "off" position, the same are arranged one upon each of the four insulating blocks 35.

The blowout coil 36 preferably consists of a strip or band of conducting material wound in the form of a spiral and having suitable insulation wound therewith to insulate the convolutions from each other. It is preferably wound upon a tube or spool 37, made of brass or other non-magnetic material. The inner end of the coil is attached to the spool. The outer end thereof is attached to a binding post 38 mounted upon the face plate. The spool is provided with a terminal extension 39 which is fastened to the face plate by means of a bolt 40 forming a binding post or terminal upon the back of the face plate. The extension 39 is preferably insulated from the blowout coil by means of a block of insulating material 41. It will be seen that the circuit of the blowout coil extends from the bolt 40 through the extension 39, spool 37, blowout coil 36 to the binding post 38. The spool 37 is mounted upon an insulating tube 42 which surrounds the sleeve 3.

The contact arms 21, 22, 23 and 24 and the arms 1 of the frame form pole pieces for the blowout magnet. The four contact arms and the four arms of the frame form four pairs of poles, one pair at each point where an arc forms on opening the circuit. The contact at each end of each group of contacts is preferably larger than the intermediate contact as the circuit is opened and closed on that contact. The plate 33, to which the end contact is fastened is preferably made of magnetic material. The outer end of each arm 1 is preferably divided into two polar faces, one arranged back of each of the two magnetic plates 33. An insulating plate 42^a is preferably placed over said polar faces to shield the same from the adjacent plates 33.

When the contact arms are returned to the initial position an arc tends to form between each contact arm and the adjacent end contact of the set of stationary contacts over which said contact arm has been moved. This arc is extinguished by the magnetic flux that passes between the pole pieces formed by the contact arm and the corresponding arm of the frame. The circuit or path of the magnetic flux that is created by the blowout coil extends from the sleeve 3 through radial arm 1 of the supporting frame, thence across the arc zone to the contact arm 21, for instance, and back through said arm and shaft 6 to the sleeve 3.

In the structure shown in the drawing the circuit is broken at four points when the contact arms are returned to the initial position. The contact arms and the radial arms of the frame form pairs of poles for the blowout coil at each of these points. In consequence a magnetic flux is sent across each arc zone, thereby causing the arc to be extinguished. Inasmuch as each contact arm forms a pole piece of the blowout magnet, the magnetic flux is distributed at the points where it will be most effective in extinguishing the arcs that occur upon the opening of the circuit.

A panel or base 43 is preferably bolted upon studs 44 extending from the back of the frame. This panel carries binding posts 45 which are suitably electrically connected to the parts of the controller by means of conductors. These binding posts serve as means for connecting the controller to a motor and to a source of electrical energy.

The circuit relations of the parts of my controller are illustrated in Fig. 5 and I shall now describe the same. The controller may be used to control a motor having an armature 46 and a series field 47. It will,

of course, be understood that it may be used to control other forms of motors. In order to distinguish certain parts of the controller from one another in describing the various circuits, I shall use letters as exponents of the reference numerals that I have heretofore used.

In each group of contacts 29, 30, 31, and 32, each contact on one side of the center contact is electrically connected to the corresponding contact on the other side of said center contact by means of a cross connector. For example, in the group of contacts 29, each contact 29^a is electrically connected with its corresponding contact 29^b. The contacts 29^a and 29^b are thus electrically connected in pairs. Each group of contacts is connected to a resistance, which is divided into sections or steps, the number of steps being equal to the number of pairs of contacts. One end of the resistance is connected to the center contacts and the other end to the outer or end pair of contacts, the intervening sections of the resistance being connected to the intermediate pair of contacts. For instance the first section is connected between the outer or end pair of contacts and the second pair of contacts, the second section between the second pair of contacts and the third pair of contacts, and so on until the last section is connected between the fourth pair of contacts and the center contact. It will be noted that each group of contacts is electrically independent of the other groups of contacts. The center contact 29 is connected by conductor 48 to the outer terminal 38 of the blowout coil. The inner terminal 40 of the blowout coil is connected through conductor 49 to the binding post 45^b. The center contact 31 is connected to binding post 45^c by means of conductor 50. One terminal of the motor armature is connected to the binding post 45^b and the other terminal thereof to the binding post 45^c. The center contact 30 is connected to the binding post 45^a by means of conductor 51, said binding post being connected to the positive line 52. The contacts 30 are, therefore, positive. The center contact 32 is connected to the binding post 45^d by conductor 53, said binding post being connected through the series field 47 to the negative line or main 54. The contacts 32 are, therefore, negative.

As previously stated, the four contact arms are divided into two pairs, each pair being electrically insulated from the other. The arms of each pair are preferably made integral so as to electrically connect the fingers or contacts carried at the ends thereof. It will be noted that four movable contacts electrically connected in two pairs are thus provided and that these contacts are adapted to pass one over each group of stationary contacts. Of course I may electrically connect the four movable contacts in two pairs in a different way from that which I have shown.

If the contact arms be moved clockwise, the arm 21 will pass over the contacts 30^b, the arm 23 over contacts 31^b, the arm 24 will pass over contacts 32^b, and the arm 22 will pass over the contacts 29^b. When each contact arm comes into engagement with the first stationary contact in the course of its travel, circuit will be closed from the positive line 52, through binding post 45^a, conductor 51, center contact 30, resistance 55, first contact 30^a, cross-connector 56, first contact 30^b, arm 21, arm 22, first contact 29^b, resistance 57, center contact 29, conductor 48, terminal 38, blowout coil 36, conductor 49, binding post 45^b, armature 46, binding post 45^c, conductor 50, center contact 31, resistance 58, first contact 31^a, cross-connector 59, first contact 31^b, arm 23, arm 24, first contact 32^b, cross-connector 60, first contact 32^a, resistance 61, center contact 32, conductor 53, binding post 45^d, series field 47 to the negative line 54. As the arms pass over the successive contacts, the resistances will be removed from circuit step by step. When the arms reach the center contacts, all the resistance will be removed from circuit and the motor will be running at full speed. The circuit will then extend from the positive line 52, binding post 45^a, conductor 51, center contact 30, arm 21, arm 22, center contact 29, conductor 48, terminal 38, blowout coil 36, terminal 40, conductor 49, binding post 45^b, armature 46, binding post 45^c, conductor 50, center contact 31, arm 23, arm 24, center contact 32, conductor 53, binding post 45^d, and series field 47 to the negative line 54.

If the arms be turned in a counterclockwise direction, the arm 21 will pass over contacts 29^a, the arm 23 over contacts 30^a, the arm 24 over contacts 31^a, and the arm 22 over contacts 32^a. When each arm engages the first contact, circuit will be closed from the positive line 52, through binding post 45^a, conductor 51, center contact 30, resistance 55, first contact 30^a, arm 23, arm 24, first contact 31^a, resistance 58, center contact 31, conductor 50, binding post 45^c, armature 46, binding post 45^b, conductor 49, terminal 40, blowout coil 36, terminal 38, conductor 48, center contact 29, resistance 57, cross-connector 62, first contact 29^a, arm 21, arm 22, first contact 32^a, resistance 61, conductor 53, binding post 45^d and series field 47 to the negative line 54. Accordingly, current will flow through the armature in an opposite direction to which it did when the arms were moved clockwise, and, therefore, the motor will be started in a reverse direction. As the arms pass over the contacts 29^a, 30^a, 31^a, and 32^a, the resistances will be removed from circuit step by step.

When the arms reach the center contacts, all the resistance will be removed from circuit, and the motor will be running at full speed in the reverse direction.

Inasmuch as the contacts 30 and 32 are positive and negative respectively, as the contacts 29 and 31 are connected to opposite terminals of the armature, and as the contacts 29 and 30 may be connected by arms 21 and 22, and contacts 31 and 32 by arms 23 and 24, or the contacts 29 and 32 may be connected by arms 21 and 22 and contacts 30 and 31 by arms 23 and 24, the controller is enabled to perform the function of a reversing switch as well as that of a controller.

I am aware that the structure which I have shown and described in detail may be modified in various ways, both in regard to mechanical and electrical features without departing from my invention as defined by the claims appended hereto.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is—

1. In a controller, in combination, a plurality of sets of circumferentially arranged contacts, the contacts of each set being electrically connected in pairs and each set of contacts being electrically independent of the other sets of contacts, a resistance connected to each set of contacts, said resistance being divided into sections and each section being electrically connected to a pair of contacts, and a plurality of movable contacts electrically connected in groups, all of said movable contacts being arranged to simultaneously pass over different sets of contacts.

2. In a controller, in combination, a plurality of sets of circumferentially arranged contacts, the contacts of each set being cross-connected in pairs and each set of contacts being electrically independent of the other sets of contacts, a resistance connected to each set of contacts, said resistance being divided into sections and each section being electrically connected to a pair of contacts, and movable contacts electrically connected in pairs each pair of movable contacts being adapted to electrically connect different sets of contacts from those connected by the other movable contacts.

3. In a controller, in combination, a plurality of sets of circumferentially arranged contacts, each set of contacts consisting of a center contact and several contacts arranged on each side of said center contact, each contact on one side of said center contact being electrically connected to its corresponding contact upon the other side of said center contact and each set of contacts being electrically independent of the other sets of contacts, a resistance connected to each set of contacts, one end of said resistance being connected to the center contact and the other end to the end contacts, said resistance at intermediate points being connected to the contacts arranged between said center contact and said outer contact, and movable contacts arranged to pass one over each set of contacts.

4. In a controller, in combination, a plurality of sets of circumferentially arranged contacts, each set of contacts consisting of a center contact and several contacts arranged on each side of said center contact, each contact on one side of said center contact being electrically connected to its corresponding contact upon the other side of said center contact and each set of contacts being electrically independent of the other sets of contacts, a resistance connected to each set of contacts, one end of said resistance being connected to the center contact and the other end to the end contacts, said resistance at intermediate points being connected to the contacts arranged between said center contact and said outer contact, and movable contacts electrically connected in pairs and arranged to pass one over each set of contacts.

5. In a motor controller, in combination, four sets of contacts circumferentially arranged, two diametrically opposite sets being electrically connected to the terminals of the line and the other two diametrically opposite sets to the terminals of the motor, and movable contacts electrically connected in pairs and arranged to pass one over each set of contacts.

6. In a controller, in combination, four sets of circumferentially arranged contacts, each set of contacts being electrically independent of the other sets, a resistance connected to each set of contacts, two of the sets of contacts being electrically connected to the terminals of the line and the other two sets being electrically connected to the terminals of the motor, and four movable contacts electrically connected in pairs and arranged to pass one over each set of contacts.

7. In a motor controller, in combination, a face plate, four sets of face plate contacts arranged thereon, said sets of contacts being arranged one in each of four arcs equidistant apart on the same circumference, two diametrically opposite sets being electrically connected to the terminal of the line and the other two diametrically opposite sets being electrically connected to the terminals of the motor, cross connections connecting the contacts of each set in pairs, each set of contacts being electrically independent of the other sets of contacts, a resistance connected to each set of contacts, and four movable contacts arranged to pass one over each set of contacts.

8. In a motor controller, in combination, a face plate, four sets of face plate contacts arranged thereon, said sets of contacts being arranged one in each of four arcs equidis-

tant apart on the same circumference, two diametrically opposite sets being electrically connected to the terminals of the line and the other two diametrically opposite sets being electrically connected to the terminals of the motor, cross connections connecting the contacts of each set in pairs, each set of contacts being electrically independent of the other sets of contacts, a resistance connected to each set of contacts, and four contact arms forming two pairs of arms, the arms of each pair being integral and said arms being adapted to pass one over each set of contacts.

9. In a motor controller, in combination, a rotatable member, four contact arms formed in two pairs, the arms of each pair being integral and each pair of arms being mounted upon said member and electrically insulated from the other pair, four sets of circumferentially arranged contacts over which said arms are arranged to pass, and a resistance for each set of contacts.

10. In a motor controller, in combination, a rotatable member, four contact arms formed in two pairs, the arms of each pair being integral, and each pair of arms being mounted upon said member and electrically insulated from the other pair, four sets of circumferentially arranged contacts over which said arms are arranged to pass, and a resistance connected to each set of contacts, two sets of contacts being electrically connected to the terminals of the line and the other two sets being electrically connected to the terminals of the motor.

11. In a motor controller, in combination, a face plate, four sets of face plate contacts mounted thereon, said sets of contacts being arranged one in each of four arcs substantially equidistant apart on the same circumference, cross-connections connecting the contacts of each set in pairs, each set of contacts being electrically independent of the other sets of contacts, a resistance electrically connected to each set of contacts, a rotatable member, four contact arms adapted to pass one over each of said sets of contacts, said arms being formed in two pairs, the arms of each pair being integral and each pair of arms being mounted upon said member and insulated from the other pair, and electrical connections connecting two sets of contacts to the terminals of the line and connecting the other two sets of contacts to the terminals of the motor.

12. In a motor controller, in combination, a rotatable contact member having a plurality of radially disposed arms, a plurality of sets of contacts arranged to be engaged by the arms of said contact member, a blow-out coil arranged substantially concentric with the axis of said contact member, and a plurality of pole pieces for said blow-out coil disposed radially to the axis of said member and having their extremities arranged contiguous to the contacts at which circuit is broken.

13. In a motor controller, in combination, a rotatable contact member having a plurality of radially disposed arms, a plurality of sets of contacts adapted to be engaged by the arms of said contact member, a blow-out coil arranged substantially concentric with the axis of said contact member, and a plurality of pole pieces for said magnet disposed radially to the axis of said contact member, the extremity of each of said pole pieces being contiguous to the end contacts of two adjacent sets of contacts.

14. In a controller, in combination, a rotatable contact member radially disposed to its axis, stationary contacts arranged to be engaged thereby, a blowout coil arranged substantially concentric with the axis of said member, a frame supporting said rotatable member, said frame and said member forming pole pieces for said blowout coil.

15. In a controller, in combination, a frame, a rotatable member mounted thereon, a plate arranged between said frame and said member, stationary contacts mounted upon said plate and arranged to be engaged by said contact member, and a blowout coil arranged substantially concentric with the axis of said member, said member and said frame forming pole pieces for said blowout coil.

16. In a controller, in combination, a plate, sets of contacts mounted upon the front of said plate, a frame arranged in the rear of said plate, a rotatable contact arm arranged in front of said plate and adapted to engage said sets of contacts, resistances connected to said sets of contacts, a blow-out coil arranged substantially concentric with the axis of said contact arms, said contact arms and said frame forming pole pieces for said blowout magnet.

17. In a controller, in combination, four rotatable contact arms, four sets of stationary contacts arranged so that one arm is adapted to pass over each set of contacts, a frame having four arms, a blowout coil arranged substantially concentric with the axis of said contact arms, said contact arms and the arms of said frame forming pole pieces for said blowout coil.

18. In a controller, in combination, sets of stationary contacts, a frame, contact arms adapted to pass over said stationary contacts, a spindle forming a journal for said contact arms, and a blowout coil surrounding said spindle, said frame and said arms forming pole pieces for said blowout coil.

19. In a controller, in combination, a face plate, a frame having four radial arms arranged in rear of said plate, four radial contact arms arranged in front of said plate and journaled on a suitable bearing, four