F. L. SESSIONS.

CURRENT CONTROLLER.

APPLICATION FILED JAN. 7, 1904. RENEWED FEB. 23, 1909.

973,885. Patented Oct. 25, 1910.

5 SHEETS—SHEET 1.

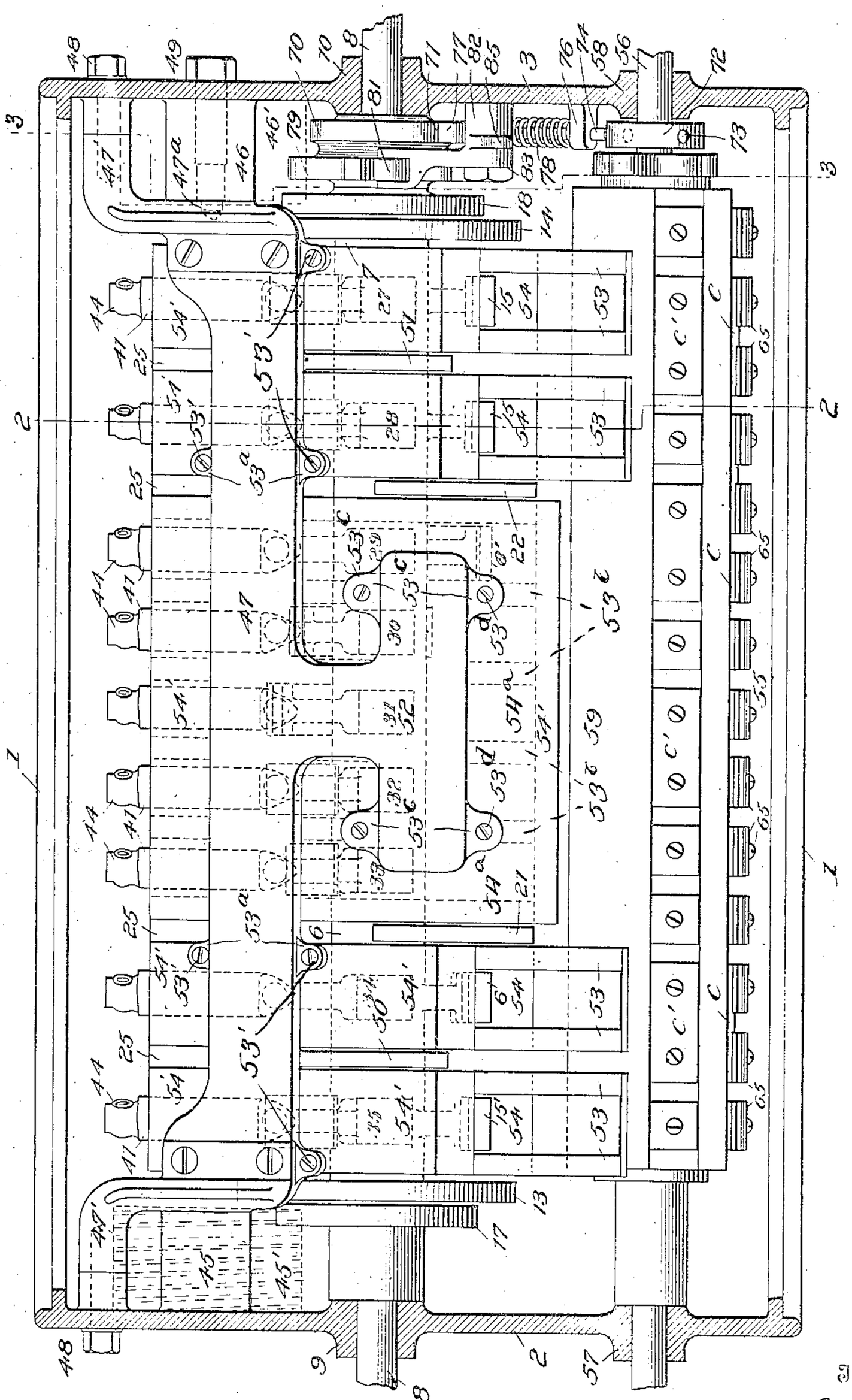

FIG. 1.

Witnesses

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5 SHEETS—SHEET 2.

Fig 2.

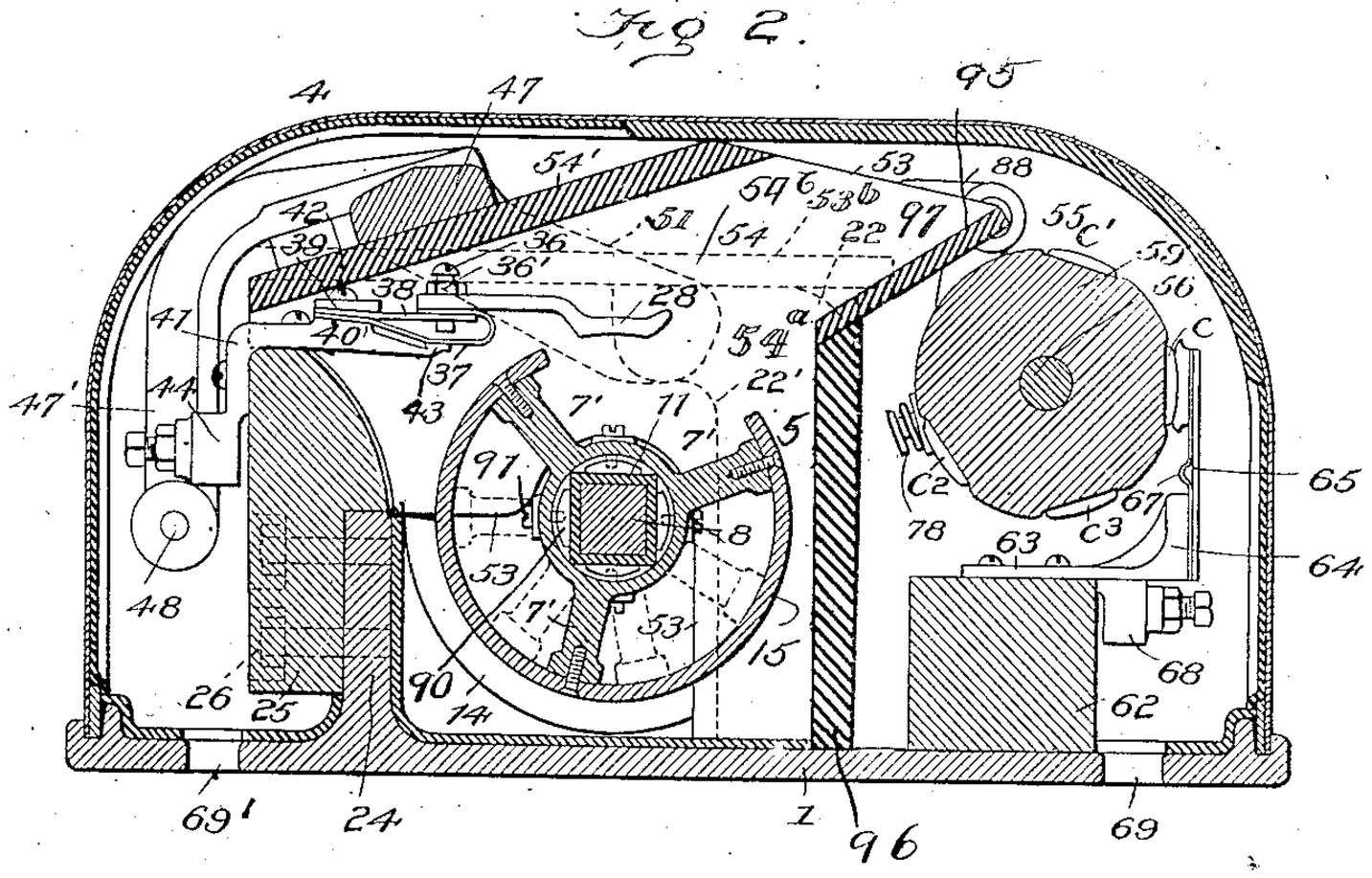


Fig. 3

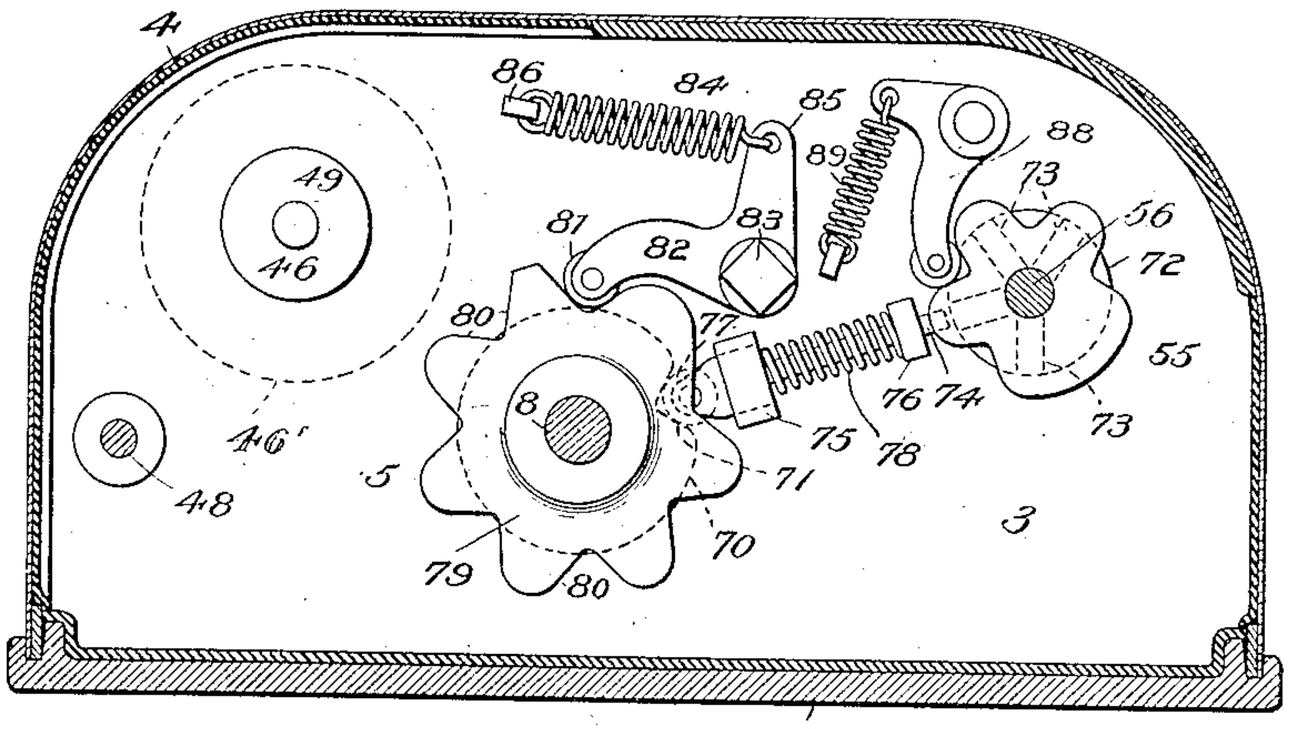
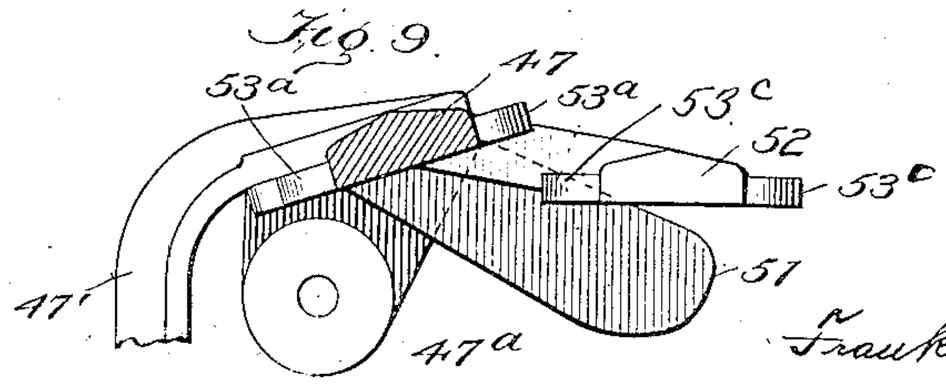


Fig. 9.



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5 SHEETS—SHEET 3.

Fig. 4.

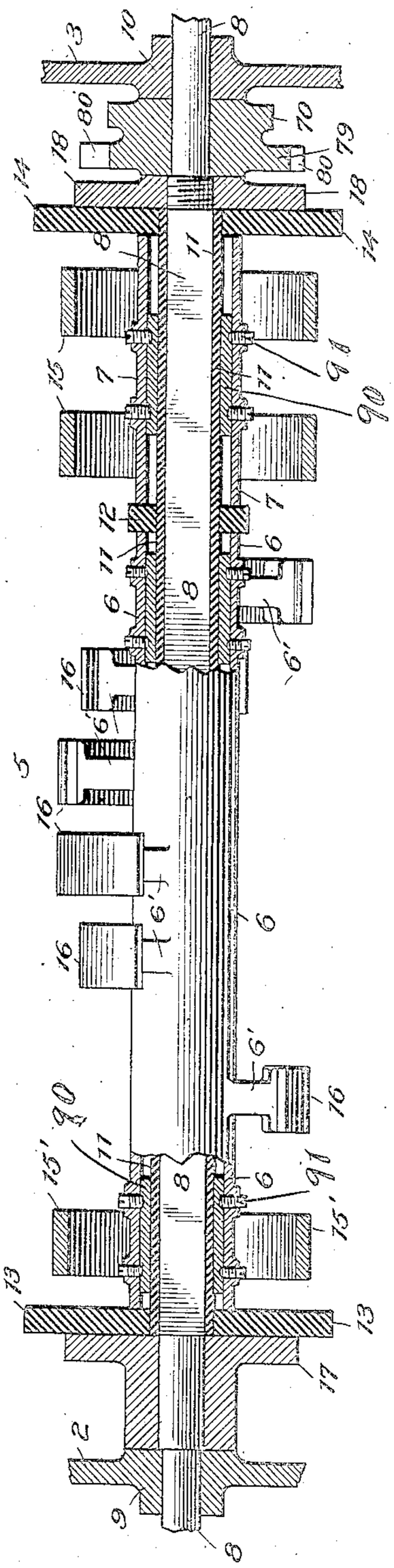
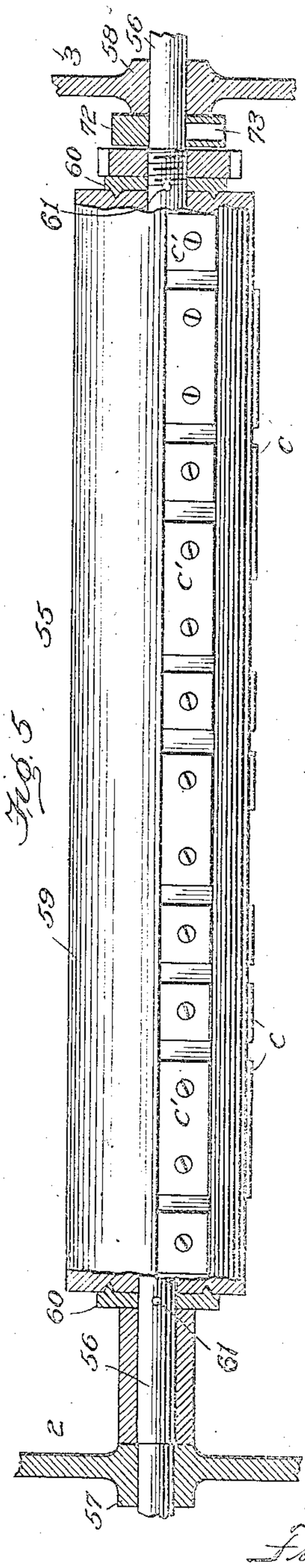


Fig. 5.



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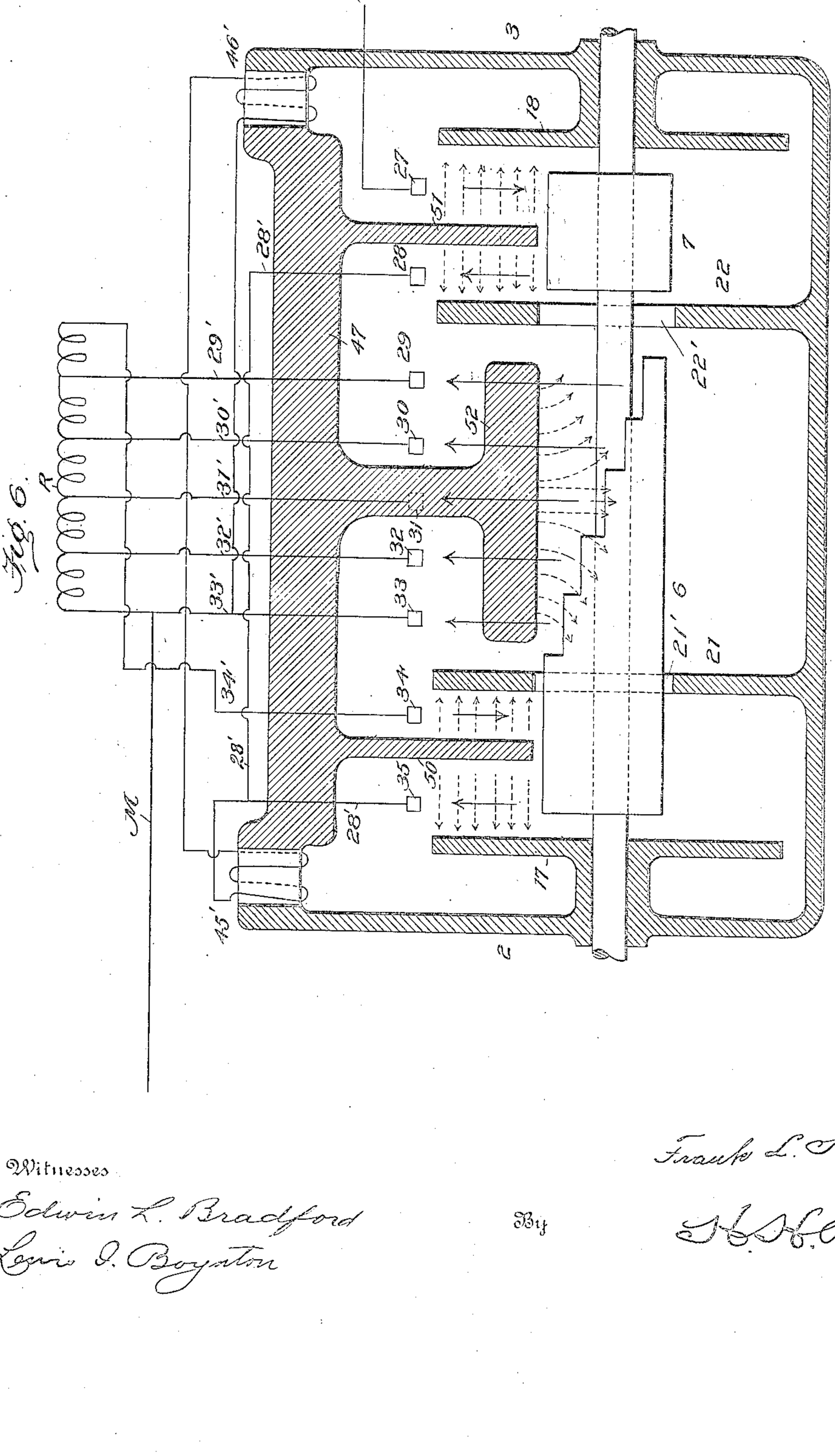

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5 SHEETS—SHEET 5.

Fig. 7.

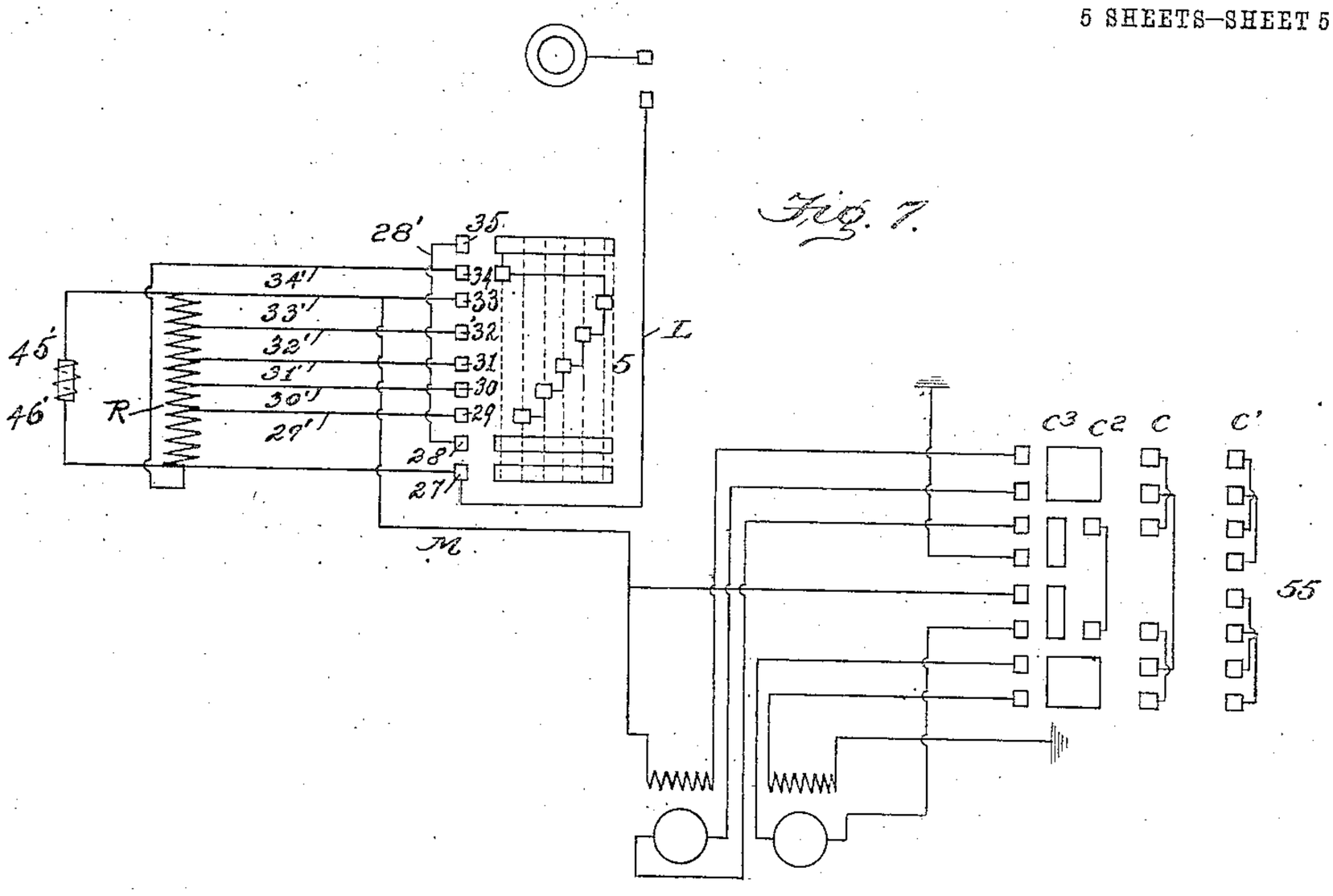
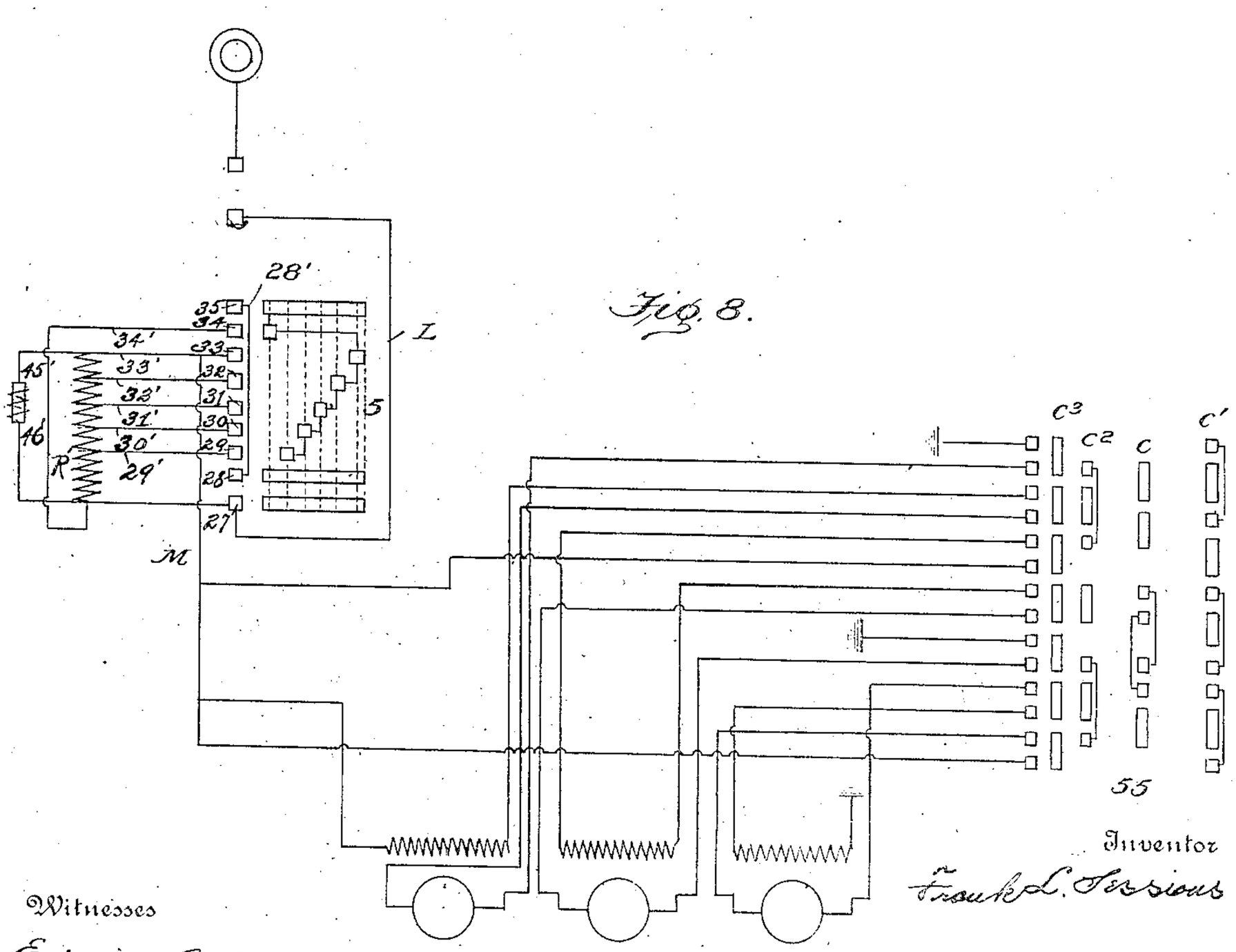


Fig. 8.



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UNITED STATES PATENT OFFICE.

FRANK L. SESSIONS, OF COLUMBUS, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE JEFFREY MANUFACTURING COMPANY, A CORPORATION OF OHIO.

CURRENT-CONTROLLER.

973,885. Specification of Letters Patent. Patented Oct. 25, 1910.

Application filed January 7, 1904, Serial No. 188,085. Renewed February 23, 1909. Serial No. 479,514.

To all whom it may concern:

Be it known that I, FRANK L. SESSIONS, a citizen of the United States, residing at Columbus, in the county of Franklin and State of Ohio, have invented certain new and useful Improvements in Current-Controllers, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to improvements in controller mechanism used with electrical apparatus, it being particularly applicable for use in connection with electric motors employed for propelling locomotives and vehicles of that class.

Figure 1 is a view of the interior of the controller, the cover being removed. Fig. 2 is a section on line 2—2, Fig. 1. Fig. 3 is a section on the lines 3—3, Fig. 1. Fig. 4 is a view partly in section of the commutating cylinders. Fig. 5 is a view partly in section of the combined series parallel and reverse switch. Fig. 6 is an isometric projection of a section through the controller showing in diagram the magnetic circuits. Fig. 7 is a diagrammatic view of the system of wiring between a controlling mechanism embodying my invention and two motors. Fig. 8 is a diagrammatic view of the system of wiring between a controlling mechanism embodying my improvements and three motors. Fig. 9 is an end view of the pole piece of the blow-out magnets.

In the drawings: 1 represents the main frame work of the controller. It may be made of cast iron, steel or other material of high magnetic permeability.

2, 3, represent the end pieces or walls respectively, of the controller, which may be secured to the main frame 1 in any well known manner.

4 is a cover detachably secured to flanges on the main frame and the end pieces. The end pieces are also preferably made of a material of high magnetic permeability.

5 indicates the controlling switch as an entirety. It comprises the relatively long shell or cylinder 6, the relatively short cylinder 7 and the operating shaft 8. The latter is mounted in bearings 9 and 10 in the end walls of the mechanism. The shells or cylinders 6, 7, incase this shaft for the greater part of its length between the said end walls, the shorter cylinder 7 being arranged on the shaft near the end wall 3. The said shaft 8 is insulated from the cylinders on it by the insulating material indicated at 11. This insulating material may be arranged in any well known manner. The said commutating shells or cylinders 6, 7 are insulated from each other by the insulating disk 12 which is arranged between them on the shaft 8.

13 and 14 are insulating disks arranged at opposite ends of the cylinders 6 and 7 and adapted to insulate the said cylinders from those parts of the mechanism which are arranged on the shaft 8 near the opposite ends of said cylinders. The shells 6 and 7 are secured to the shaft 8 by means of the convexo-plano metallic plates 90 and set screws 91. The set screws have threaded engagement with the metal of the shells and bear upon the convex side of the metallic plates 90, holding them flatly against the plane faces of the insulation 11 surrounding the rectangular shaft 8.

6′ and 7′ indicate lugs on the commutating cylinders 6 and 7 respectively to which the commutating segments or contact members 15, 15′ and 16 are secured. The segments 15, 15 on the cylinder or shell 7 have the same peripheral length and are arranged similarly on the said shell or cylinder relative to the shaft 8. The commutating segment 15′ of equal length and similarly positioned relative to the shaft 8 as the segments 15 on the short commutating shell, is secured to the lugs 6′ at the other end of the long cylinder 6.

16 are short commutator segments which are secured to the lugs 6′ of the commutator shell or cylinder 6. The lugs 6′ on this cylinder are so arranged with respect to each other as to bring the segments 16 thereon successively into contact with their respective brushes as the cylinder is rotated.

17, 18 are collars mounted on the shaft 8 outside of the insulating disks 13, 14, respectively, and, as will be hereinafter described they serve as poles for the magnetic circuits. These collars are preferably made of a material possessing high magnetic permeability.

21, 22 are pole pieces extending at right angles to the frame 1 and arranged transversely of the shaft 8. They are composed of material of high magnetic permeability and may be formed integral with the frame if so desired. At 21′, 22′ they are notched or cut away to receive and partially surround the controller switch 5. 24 is a flange or rib extending longitudinally of the said frame. 25 is an insulating block or plate extending longitudinally of the said frame and secured by bolts 26 to the said flange or rib 24. This block or plate 25 serves as an insulating support for the brushes 27, 28, 29, 30, 31, 32, 33, 34 and 35 which are adapted to be engaged by the commutator segments on the commutating cylinders 6 and 7. These brushes may be held in position in any well known manner. For illustration I have shown them secured at their outer ends by means of adjusting screws 36 to the springs 38. These springs are secured at their outer ends between plates 39 and projections 40 on the brush holders 41 by means of screws 42.

37 are flexible conductors secured between the brushes and their springs 38 at one end, and between said springs and the brush holders 41 at their other ends. These flexible conductors are made of copper or other material which is a good conductor of electricity and are adapted to insure a good electrical connection between the brushes and the brush holders.

The springs 38 serve to hold the contact surfaces of their respective brushes in such positions as to effect a good contact between the said surfaces and their commutator segments as the latter are rotated into operative engagement therewith. The deflection of each spring and the wear of its brush may be varied and its corresponding segment be compensated by adjusting its screw 36 against the shoulder or abutment 43 on its holder. 36′ are locking nuts for securing the said screws in any position of adjustment. The brush holders 41 are secured to the insulating block 25 and have terminal sockets or binding posts 44 in which the electric conductors which lead to the brushes may be secured.

I provide a blow-out magnet for blowing out the arcs between the brushes and the commutator segments as the current is cut out between them.

45, 46 are projections or bosses on the end pieces 2, 3 respectively which serve as cores for the magnet coils 45′, 46′ respectively, indicated by dotted lines in Fig. 1. These cores may be formed integral with or separate from their respective end pieces, but in the latter case they should be secured rigidly in place.

47 is a blow-out magnet pole piece. It is arranged substantially parallel to the commutating cylinders 6, 7 and extends slightly beyond the opposite ends thereof. It is supported by the arms 47′, 47′ of non-magnetic material which are pivoted to the trunnion bolts 48, 48 secured to the opposite end walls 2, 3 of the mechanism. A bolt 49 extending through the core 46 and into the aperture 47ª in the adjacent pole arm 47′ serves to hold the said pole piece in proper working position.

50, 51 are projections on the pole piece 47 which extend toward the axis of the shaft 8 and are arranged between the pairs of brushes 27, 28 and 34, 35 respectively.

52 is an extended portion of the pole piece 47. It is arranged axially of the commutating cylinder 6 and substantially parallel to the contact surfaces of the brushes 29, 30, 31, 32 and 33. This pole piece 47 is pivotally hung as shown in order to provide for ready access when desired to the contact surfaces of the brushes and to the brush adjusting devices. In order to swing the said pole-piece out of its working position, it is only necessary to take off the cover 4, and remove the bolt 49 sufficiently to withdraw its end from the socket 47ª in the pole piece, when the latter may be swung about the trunnion bolts 48.

Each of the commutator segments 15, 15, 15′ and the lowermost segment 16 operates in a chamber 54 formed with the transversely arranged top and bottom plates 53 and the edge plates 54′, 95 and 96, all composed of insulating material. The walls of these chambers are secured together in any suitable manner and are fastened by screws 53′ to lugs 53ª on the pole piece 47, so that when the pole piece is swung about its pivots 48 to enable the operator to examine the commutator segments and brushes the walls of the chambers will be carried with it. Each of the remaining segments operates in a chamber 54ª formed with transversely arranged top and bottom plates 53ᵇ and the edge plates 54ᵇ and 96′. The walls of these chambers are suitably secured to each other by screws and are attached to the lugs 53ᶜ on the pole piece 52 by means of screws 53ᵈ. The walls of these insulating chambers 54ª are likewise swung with the pole piece 47 about the pivots 48. It will be observed that the two pairs of contact segments at either end of the controller operate in insulated chambers, each of which is provided with a chute or chimney 97 through which the hot gases, caused by the arcing between the contact segment and brush, can be driven, while the remaining contact segments operate in closed chambers, the relatively small size of the arcs which are formed therein not requiring a chimney or opening through which the hot gases may be expelled.

55 indicates as an entirety the series parallel reverse switch. 56 is the controlling

shaft for said switch. It is mounted in bearings 57, 58 in the end walls 2, 3 of the mechanism.

59 is a cylinder made of wood or other insulating material and secured to the shaft 56 by spurs 60 which are themselves secured to the said shaft by dowel pins 61. To this cylinder 59 are secured four sets or rows of contact plates. *c* indicates the contact plates of one set which are so connected to each other that when this series of contacts are in operative engagement with their brushes, the motors will be connected in series and will cause the car to move forward. *c'* indicates the second series of contacts on the said cylinder 59. They are so connected together that when this series is in operation the motors will be connected in parallel and the car will be caused to move forward. c^2 indicates the contacts of the third series on said parallel reverse cylinder. They are so connected, that when in operative engagement with their brushes, the motors will be connected in series and the car will be caused to move backward. The contacts of the fourth set on the cylinder 59 are indicated by c^3 and are so connected together that when they are in operative engagement with their brushes the motors will be connected in parallel and the car will be caused to move backward. The method of connecting up the contact plates in each of the four series just mentioned is shown in diagram in Fig. 7.

62 indicates a brush supporting insulating plate or block arranged longitudinally of the frame 1 and secured thereto. 63 are brush holders secured to the said block and arranged to hold their respective brushes so that their contact surfaces will be in the planes of rotation of the contacts on the series parallel reverse cylinder. 64 are projecting arms on the said brush holders. 65 are spring plates secured to the said arms and adapted to hold the brushes 66 so that they will yieldingly engage their respective contact pieces on the cylinder 59.

67 are flexible conductors secured between the brushes 66, the brush holders and the springs 65. They are made of copper or other metal which is a good conductor of electricity, and are adapted to provide good electrical contact between the brushes and their holders.

68 are binding posts on the brush holders 63.

69 are apertures in the frame 1 through which the conductors which are secured in the binding posts 68 extend. 69' are apertures in the said frame through which the conductors which are secured to the binding posts 44 extend.

In order to prevent the rotation of the series parallel reverse switch 55 excepting when the current is cut off from the motor, or in other words, when the controller switch 5 is rotated into its "off" position and likewise to prevent the rotation of the controller switch 5 excepting when the switch 55 is in one of its four operative positions, I provide an interlocking device between the shafts 8 and 56.

70 is a cam disk secured to the shaft 8. 71 is a recess in the periphery of said disk.

72 is a disk secured to the shaft 56 and having four sockets 73 therein.

74 is a locking pin mounted in bearings 75, 76 carried by the end wall 3. 77 is an anti-friction roller mounted at one end of said locking pin 74 and adapted to engage with the periphery of the cam disk 70 on the shaft 8.

78 is a spring abutting at one end against the bearing 76 and at its other end against a shoulder on the locking pin 74. The normal tendency of this spring is to force the locking pin toward the axis of the shaft 8. When the controlling switch 5 is in its "off" position the roller 6 is forced into the recess 71 on the disk 70 and the other end of the locking pin is withdrawn from the disk 72, so that the series parallel reverse switch may be rotated. It will be noted that the controlling switch 5 cannot be rotated until the switch 55 has been turned so that one of the sockets 73 on the disk 72 is positioned to receive the end of the locking pin 74.

79 is a wheel secured to the shaft 8.

80 are a series of recesses or notches in its periphery corresponding in number to the number of positions of adjustment for which the controller switch is adapted plus one.

81 is an anti-friction roller carried by one arm of the bell crank lever 82, which is pivoted at 83 to the end wall 3. The roller 81 is held in engagement with the periphery of the wheel 79 by means of a spring 84 secured at one end to the arm 85 of the bell crank lever and at its other end to the lug 86 on the end wall 3. This arrangement of parts insures that the switching cylinder 5 will be held against rotation by a sufficient force to prevent the accidental rotating of the said cylinder by jarring or the like and that the control which each particular recess or notch controls will be maintained until sufficient power has been applied to the shaft 8 to force the roller 81 out of said notch.

Referring to Figs. 6 and 7 the current from the line L enters the controller through the brush 27. From the brush 27 it is conducted by the shell 7 to the brush 28 and thence by the conductor 28' to the brush 35 at the far end of the shell 6. From the brush 35 the commutating cylinder conducts the current to the brush 34. This brush is connected by the conductor 34' with one end of the external resistance R. The other end of the said resistance is connected by a con-

ductor 33′ to the brush 33. The intermediate brushes 29, to 32 are connected by conductors 29′, 30′, 31′, and 32′ respectively to points in the external resistance R intermediate of its ends, as shown.

It will be understood that the showing of the external resistance in the drawings is purely conventional, and that in practice the resistance coils or their equivalent may be connected into the system in any desired way so as to attain the same results that are attained by the showing in the drawings.

M indicates the conductor which leads from the conductor 33′ to the motors.

The energizing coils for the magnets 45′, 46′ are wound oppositely on their respective cores 45, 46 and these coils are connected in parallel with the resistance coils R. This method of connecting said coils insures that they will be effective in blowing out the arcs between any of the series of brushes which are connected with the resistance and their commutating segments. And the said energizing coils are wound in order to so magnetize the parts of the controller mechanism that the pole piece 47 as an entirety, will be of one polarity while the end pieces 2, 3 and the frame 1 with its projections 21, 22 will be of the other polarity.

Assuming that, as shown in Fig. 6, the pole piece 47 and its extensions constitute the north magnetic pole of the magnetic circuits, the lines of force passing through the magnetic cores and the said pole piece meet in the center of the latter and are compelled to find their return circuits through the shortest paths of the main frame 1 and its end walls 2, 3, which may be considered the south pole of the magnetic circuit. The lines of force which blow out the arcs between the brushes 29, 30, 31, 32 and 33 and their respective commutator segments pass from the extended portion 52 of the pole piece 47 to the shaft 8 and thence through the end pieces 2, 3 to the magnet cores 45, 46. The lines of force leading from the said projection 52 to the commutating cylinder arrange themselves so as to blow out the arcs occurring within their field on lines substantially parallel to the axis of the cylinder.

The lines of magnetic force which cross the arcs formed by the brushes 27, 28 and 34, 35 run parallel to the axis of the commutating cylinder and are carried in such directions as to force the arcs occurring within their field radially outward from the cylinder and away from the brushes. This blowing out of the arcs on lines radially of the cylinder materially increases the life of the brushes and the insulating walls which separate them beyond that obtained where the lines of force which are used for blowing out the arcs cross the contact surfaces in lines transverse to the axis of the commutating cylinder, since by driving the arc or flame away from the brush surface instead of along it, the flame or spark has less opportunity to attack the contact surfaces and is not forced violently against the insulations. As the arcing at the intermediate brushes 29, 30, 31, 32 and 33 is in no wise as severe as that at the other four brushes, the use of a magnetic field in which the lines of force do not run parallel to the axis of the commutating cylinder will suffice for all practical purposes.

While in the diagram in Fig. 7 I have shown but two motors in the controller circuit, it will be understood that my invention may be employed for controlling the current to any number of motors. The only change necessary where more motors are used is the addition of more contacts and brushes for the series parallel reverse switch. For illustration, in Fig. 8 I have shown in diagram a system of wiring where three motors are controlled by a current switching and resistance controlling mechanism embodying my improvements and it will be seen that the mere addition of contact segments in each series of contacts c, c', c^2, and c^3 of the series parallel reverse switch is the only change over the construction indicated in Fig. 7 in diagram which is necessary.

It will be seen that the sets of movable contact members on the series parallel reverse switch cylinder are so arranged that the sets for connecting the motors in series ahead and series reverse are adjacent to each other and that the sets for connecting the motors in parallel ahead and parallel reverse are outside of the sets for connecting the motors in series. This arrangement permits of the movement of the handle from the "off" position first to the series position then to the parallel position for the same direction of travel so that the operator becomes accustomed always to turn the series parallel reverse switch in one direction for forward motion of his car, and in the opposite direction for the rearward travel of his car. The final break of the circuit within the current switching and resistance controlling mechanism occurs at the pairs of stationary brushes 27—28 and 34—35 at the opposite ends respectively of the commutator switch 5. The disadvantageous arcing effect incident to the breaking of the electrical circuit is by this arrangement caused to occur at several points and less detrimentally than if the final break was made at a single contact.

I claim—

1. In a controller for electrical apparatus the combination of a current switching and resistance controlling mechanism, the resistance controlled thereby, and oppositely wound blow-out magnets arranged at either end of said current switching and resistance controlling mechanism, and having their

energizing coils connected in parallel with the resistance, substantially as set forth.

2. In a controller for electrical apparatus the combination with the resistance coils, of a series of stationary contacts connected therewith, a series of movable contacts for engaging with said stationary contacts successively and the blow-out magnets arranged at either end of the series of stationary contacts and having their energizing coils oppositely wound on their respective cores and connected in parallel with the resistance, substantially as set forth.

3. In a controller for electrical apparatus, the combination of a current-switching and resistance-controlling mechanism, a casing in which said mechanism is mounted, resistance controlled by said mechanism, and the blow-out magnets arranged near either end of said mechanism and having a common core and their energizing coils connected in parallel with said resistance.

4. In a controller for electrical apparatus, the combination with the resistance coils, of a series of stationary contacts connected therewith, a series of movable contacts for engaging with said stationary contacts, and stationary blow-out magnets for extinguishing the arcs formed at all of said contacts, mechanically independent of the movable contacts and having their energizing coils connected in parallel with said resistance coils.

5. The combination in controller for electrical apparatus of the frame work made of magnetizable metal, the pole piece arranged longitudinally between the end walls thereof, the magnet cores at the opposite ends of said pole piece and the pole pieces arranged transversely of and secured to said frame work between its ends, the latter pole pieces and the frame forming the return circuits for the lines of force which emanate from the longitudinally arranged pole piece, substantially as set forth.

6. The combination in a controller for electrical apparatus of the frame work made of magnetizable metal, the pole piece extending between the end walls of said frame and having inwardly extending plates or projections formed integrally therewith, the magnet cores arranged at the opposite ends of said pole piece, and the plates or pole pieces arranged transversely of and secured to the frame and on either side of said inward projections on the longitudinally arranged pole piece, substantially as set forth.

7. In a controller for electrical apparatus, the combination with the series of stationary contacts and the series of coöperating movable contacts, of the frame-work in which said contacts are mounted, the blow-out magnet having a pole piece provided with projections arranged to lie between certain of said stationary contacts, and the pole pieces connected with said frame-work and arranged to lie between other of said stationary contacts and to be of opposite polarity to the said projections on the first described pole piece.

8. In a controller for electrical apparatus, the combination with the frame work formed of magnetizable metal, a series of pairs of electrical contacts arranged therein, each pair comprising a movable member and a stationary one, of blow-out magnets arranged at either end of said series of electrical contacts having a pole piece extending between their respective cores and provided with integrally formed projecting plates which extend between the adjacent pairs of electrical contacts at either end of said series, substantially as set forth.

9. The combination in an electrical apparatus with the frame work and a series of pairs of electrical contacts arranged therein, each pair comprising a movable and a stationary member, of blow-out magnets arranged at either end of said series of electrical contacts and having a pole piece extending between their cores, said pole piece having an inward projection at either end thereof extending between the pairs of stationary members at the opposite end of said series of electrical contacts and an inward extension arranged adjacent to and substantially parallel with the contact surfaces of the intermediate stationary members of the series of electrical contacts, substantially as set forth.

10. In a controller for electrical apparatus, the combination with the series of pairs of electrical contacts, each pair comprising a movable and a stationary member, of blow-out magnets arranged at either end of said series of contacts and having a pole piece extending between their cores and provided with projections which extend between the pairs of stationary contacts at the opposite ends of said series of electrical contacts and with a T shaped projection arranged to have its longer arm lie adjacent to and substantially parallel with the contact surfaces of the stationary members intermediate of the two pairs of stationary contacts at either end of said series, substantially as set forth.

11. In a controller for electrical apparatus, the combination with a series of pairs of electrical contacts each pair comprising a movable and a stationary member, of the oppositely wound blow-out magnets arranged at either end of said series of electrical contacts and having a longitudinally arranged pole piece extending between their cores, said pole piece having integral projections arranged to extend between each member of the pairs of stationary members at either end of the series of electrical contacts, and the pole pieces arranged on opposite sides of said pairs of stationary mem-

bers at either end of the series of electrical contacts adapted to be of opposite polarity to the longitudinally arranged pole piece, whereby the lines of force in the magnetic fields set up between said extensions on said longitudinally arranged pole piece and their coöperating pair of pole pieces respectively, will run substantially parallel to the contact surfaces of the stationary contact members in their respective fields, substantially as set forth.

12. In a controller for electrical apparatus the combination of a controller switch having a series of electrical contact segments thereon, a series of stationary contact members with which the said segments on the controlling switch are adapted to engage, the stationary contacts being connected up substantially as described whereby the final break of the circuit when the current is cut off will occur between the members of the pairs of stationary contact members and their contact segments at either end of the series, the oppositely wound blow-out magnets arranged near either end of the series of stationary contact members and having a pole piece longitudinally arranged between their respective cores, said pole piece having projections at either end which extend between the contacts of each pair of stationary contact members at opposite ends of the series of contact members, and pairs of pole pieces arranged transversely of said switching cylinder on either side of the said end pairs of stationary contacts, whereby the lines of force in the magnetic fields in which the arcs occur when the current is entirely cut out, run in lines substantially parallel to the axis of said cylinder, substantially as set forth.

13. In a controller for electrical apparatus, the combination of a controller switch having a series of contact segments thereon, a series of stationary contacts with which the said segments on the controlling switch are adapted to engage respectively, the stationary contacts being connected into the circuit substantially as set forth, whereby the final break of the circuit when the current is cut off will occur between the members of the pairs of stationary contacts and their respective segments at either end of the series, and the blow out magnets associated with said stationary contacts.

14. In a controller for electrical apparatus, the combination of a rotary controller switch having a series of contact segments thereon, a series of stationary contact segments with which the said segments on the controlling switch are adapted to engage respectively, the stationary contacts being connected in the resistance circuit substantially as set forth, whereby the final break of the circuit when the current is cut off will occur between the members of the pairs of coöperating contacts at either end of the series, and the blowout magnets arranged near either end of the said series of stationary contacts.

15. In a controller for electrical apparatus, the combination of a controller switch having a series of contact segments thereon, a series of stationary contacts with which the said segments on the controlling switch are adapted to engage respectively, a blow-out magnet, and a pole piece for said blow-out magnet extending longitudinally of said series of said stationary contacts and having a series of integrally formed projections extending between said stationary contacts to the region in which arcs occur between them and the movable contact segments.

16. In a controller for electrical apparatus, the combination of a controller switch having a series of contact segments thereon, a series of stationary contacts with which the said segments on the controlling switch are adapted to engage respectively, and a blow-out magnet having a pivotally mounted pole piece extending longitudinally of said series of stationary contacts and having a series of integral projections extending between said stationary contacts to the region of arcing between them and the movable contacts.

17. In a controller for electrical apparatus, the combination with a casing, a controller switch mounted therein and carrying a series of contact segments, and a series of stationary contacts with which said movable segments are adapted to engage respectively, of a blow-out magnet having a pole piece extending longitudinally of said stationary contacts and provided with an integral projection adapted to lie adjacent to the arcing region of certain of said coöperating pairs of contacts, and a series of integral projections arranged to extend between certain of said stationary contacts to the region of arcing, and pole pieces carried by said frame and arranged to extend between certain of said stationary contacts into the region of arcing and to coöperate with the adjacent projections carried by the pole piece for the blow-out magnet.

18. In a controller for electrical apparatus, the combination with a framework and current switching and resistance controlling mechanism mounted therein, of a blow-out magnet comprising a coil and a pole piece, the pole piece being pivotally connected with the framework on a line eccentric to the axis of the coil and arranged to be swung into position opposite the end of the coil, and means for holding the pole piece in the latter position, substantially as set forth.

19. In a controller for electrical apparatus, the combination with a framework and current switching and resistance controlling mechanism mounted therein, of a blow-out

magnet comprising a pair of coils supported at the opposite ends of the framework and in line with each other, and a pole piece pivotally connected with the frame on a line eccentric to the axis of said coils and arranged to be moved into position between the said coils, and means for holding the pole piece in the latter position, substantially as set forth.

20. The combination in a controller for electrical apparatus, of a rotary shaft of polygonal cross section, insulating facing plates upon the sides of the said shaft, a cylindrical sleeve surrounding the shaft and insulating plates, convexo-plano metallic plates interposed between the insulating plates and the sleeve, and resting flatly against the said insulating plates, means carried by the sleeve for forcing the said convexo-plano plates against the insulating plates, contact segments carried by the sleeve, and stationary contact brushes adapted to engage the said contact segments.

21. The combination in a controller for electrical apparatus, of the rotatable shaft polygonal in cross section, the insulating facing surrounding said shaft, the sleeve disposed about the shaft and clamping plates interposed between the insulating facing and the sleeve, contact segments carried by the sleeve, and stationary contact brushes adapted to engage with the contact segments.

22. The combination in a controller for electrical apparatus, of a rotatable shaft of polygonal cross section, a sleeve surrounding said shaft and having a cylindrical interior surface, means interposed between the sleeve and shaft for preventing relative rotation of the sleeve with respect to the shaft and for securing the sleeve to the shaft, contact segments carried by the sleeve, and stationary contact brushes adapted to engage with the said contact segments.

23. The combination in a controller for electrical apparatus, of a rotatable metallic shaft of rectangular cross section, a hollow rectangular insulating sleeve snugly fitting over the said rotatable shaft, a sleeve surrounding said insulating sleeve having an interior cylindrical surface, clamping plates bearing upon the insulating sleeve, means carried by the outer sleeve for forcing the clamping plates against the insulating sleeve, contact segments carried by the outer sleeve, and stationary contact brushes adapted to engage with the contact segments.

24. The combination in a controller for electrical apparatus, of a rotatable shaft, two sleeves mounted upon the shaft and insulated therefrom and from each other, two contact segments carried by one of the sleeves and two stationary contact brushes co-acting therewith adapted to provide two breaks in the circuit as the controller is turned to the off position, a plurality of contact segments mounted upon the other sleeve, a plurality of contact brushes suitably connected with resistance and adapted to engage with the said contact segments to vary the resistance in the circuit, two of said plurality of contact segments being adapted to engage with the said contact segments to break engagement with their corresponding contact brushes simultaneously with the contact segments upon the first mentioned sleeve, said two contact segments being mounted at the end of the second sleeve farthest removed from the said first mentioned sleeve.

25. The combination in a controller for electrical apparatus, of resistance coils, a series of stationary contacts connected therewith, a series of movable contacts for engaging the said stationary contacts, a pair of arc dividing contacts, a pair of movable contacts mounted rigidly with the said series of movable contacts and adapted to engage with said arc dividing contacts, means for blowing out the arcs formed between said stationary and movable contacts, a frame work of plates of insulating material forming chambers around the places where the said arcs occur and mounted pivotally on an axis parallel to the axis about which the said movable contacts rotate, the insulating chambers formed about the arc dividing contacts being provided with openings through which the arc is adapted to be blown, and the insulating chambers formed about the resistance varying contacts being closed upon all sides.

In testimony whereof I affix my signature in presence of two witnesses.

FRANK L. SESSIONS.

Witnesses:
CARL D. SLOCTEMYER,
L. E. HAMILTON.