No. 827,469. PATENTED JULY 31, 1906.

W. M. SCOTT.

AUTOMATIC MAGNETIC CIRCUIT BREAKER.

APPLICATION FILED OCT. 14, 1904.

5 SHEETS—SHEET 1.

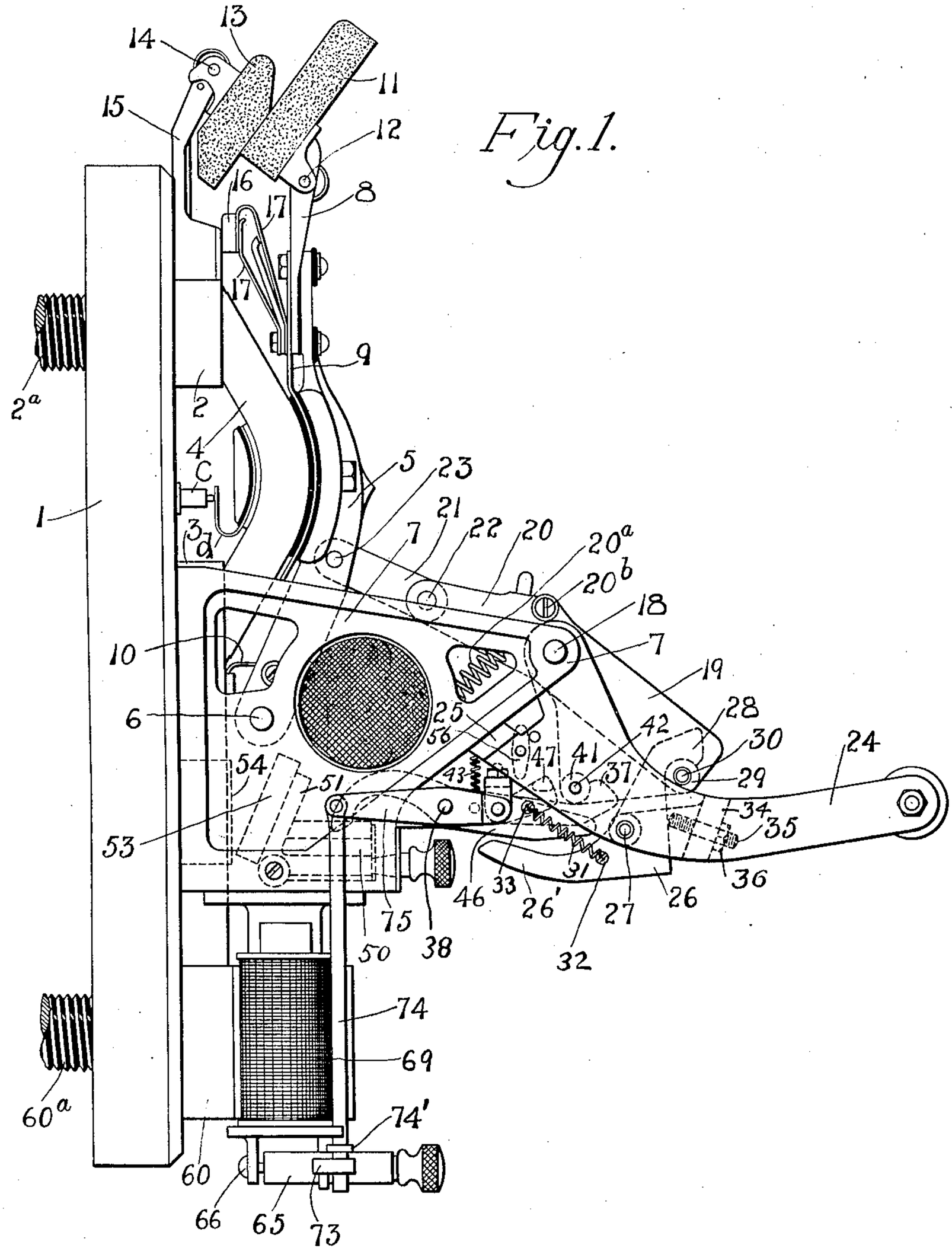

Fig. 1.

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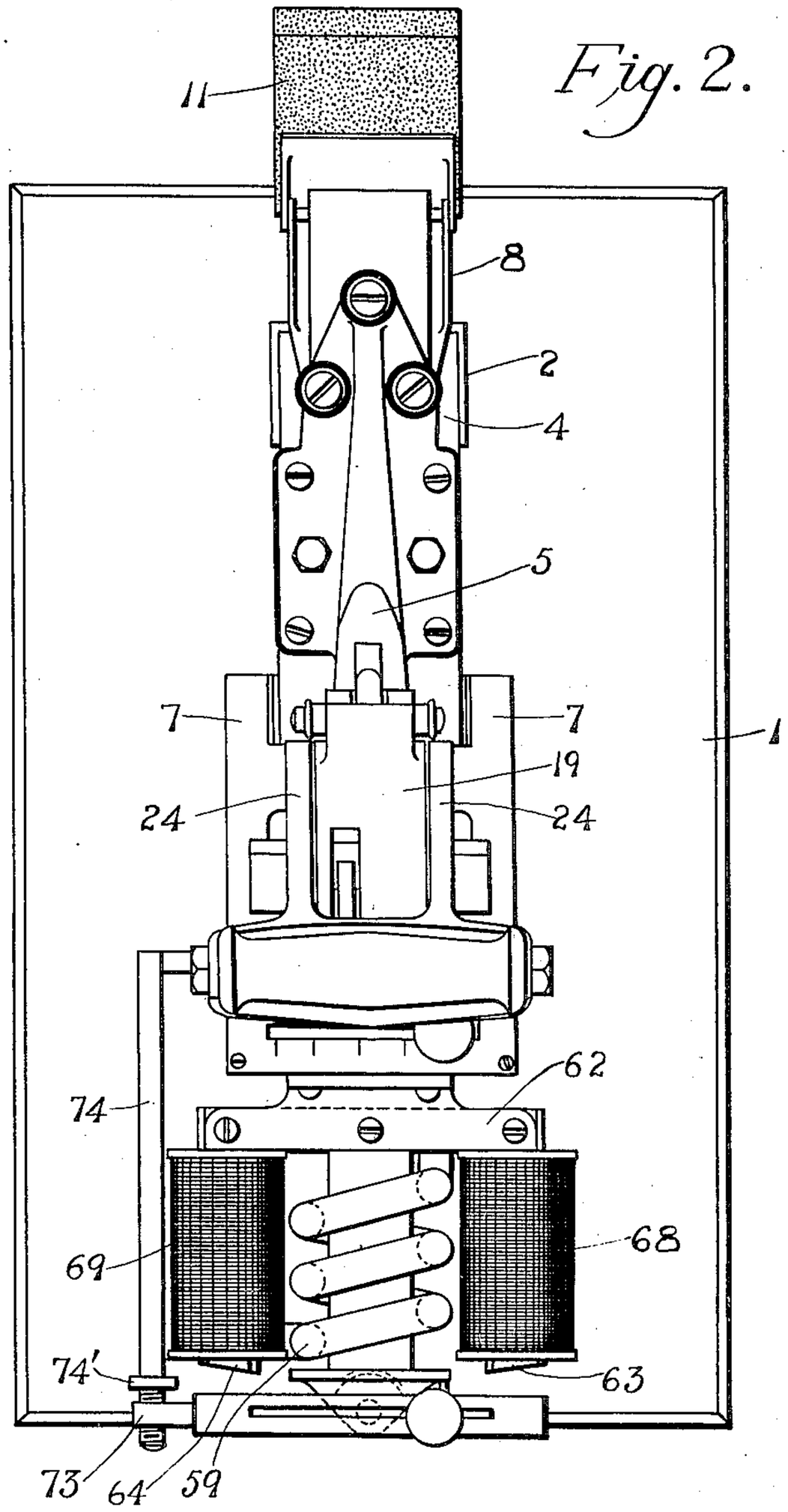
5 SHEETS—SHEET 2.

Fig. 2.



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5 SHEETS—SHEET 3.

Fig. 3.

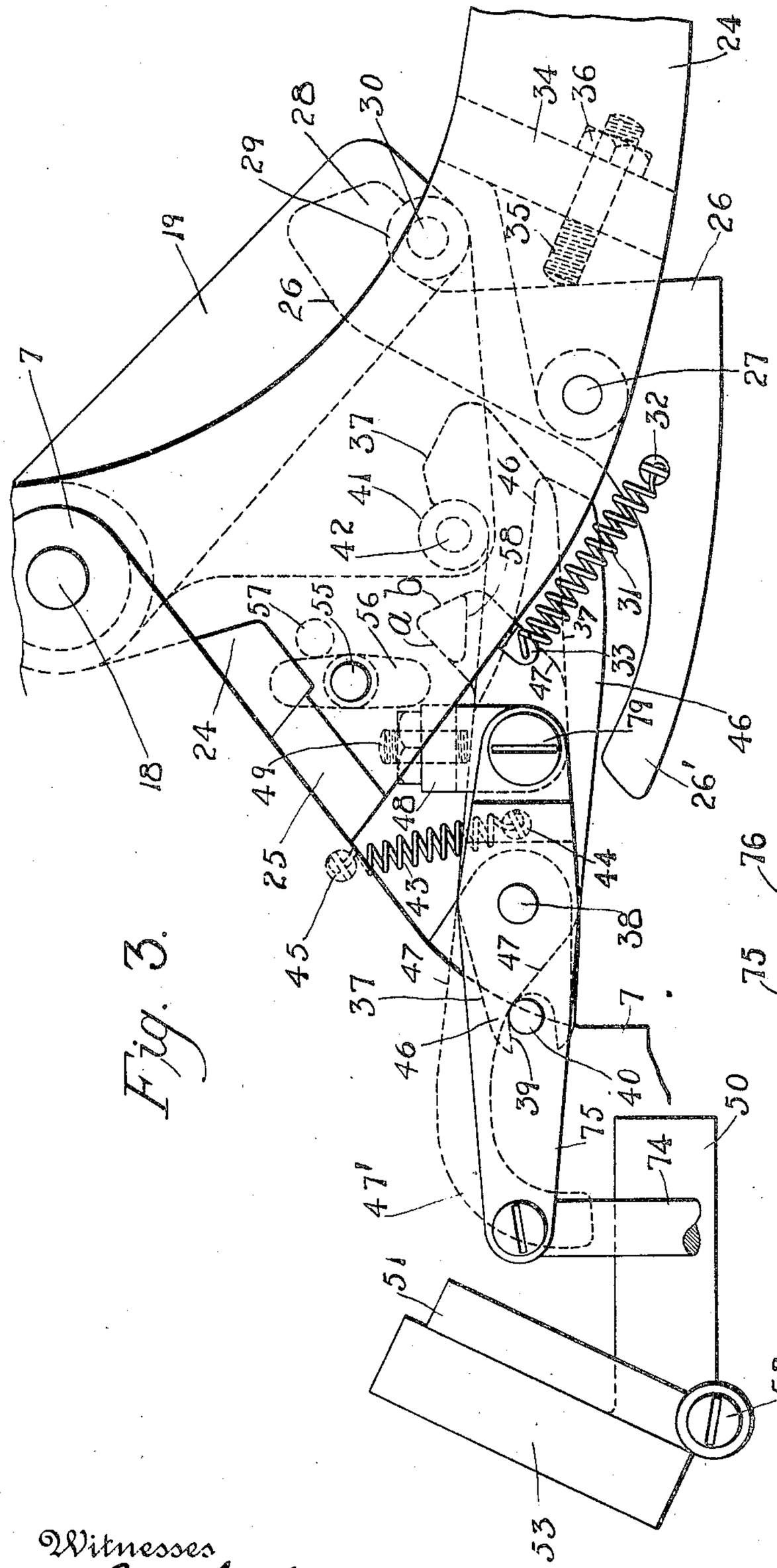
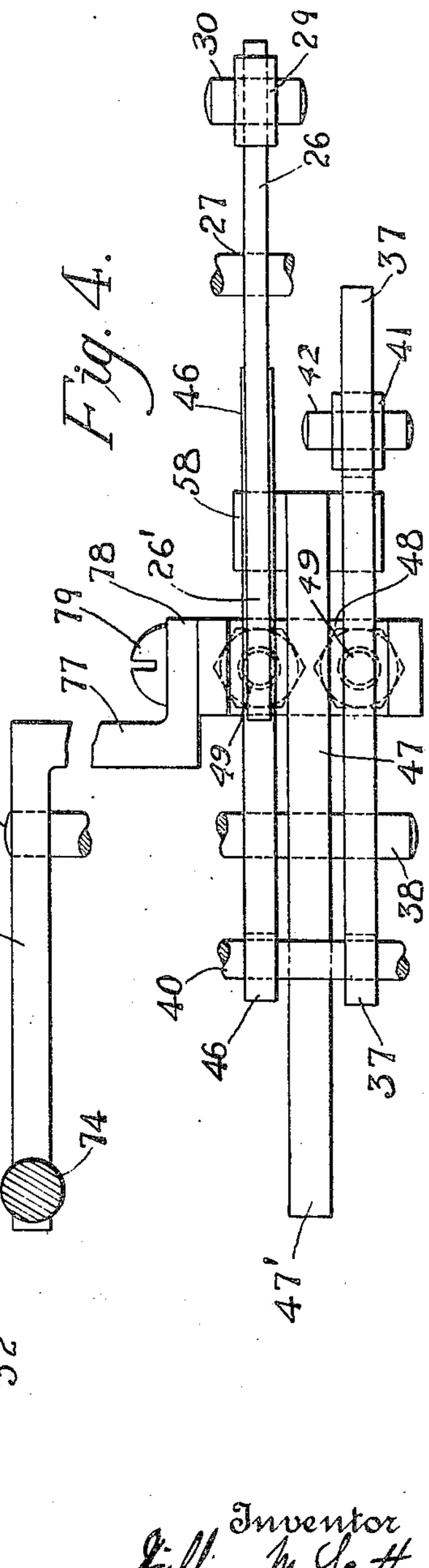


Fig. 4.



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5 SHEETS—SHEET 4.

Fig. 5.

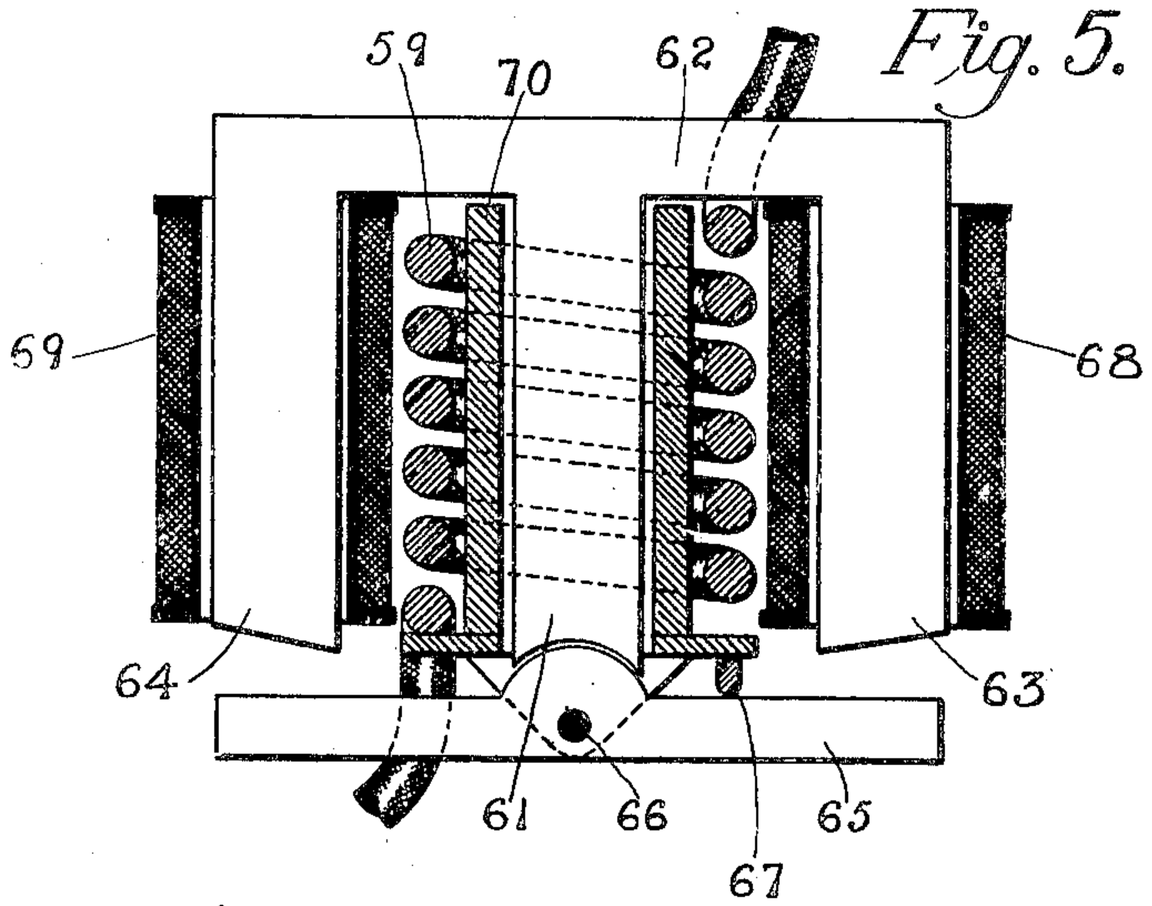
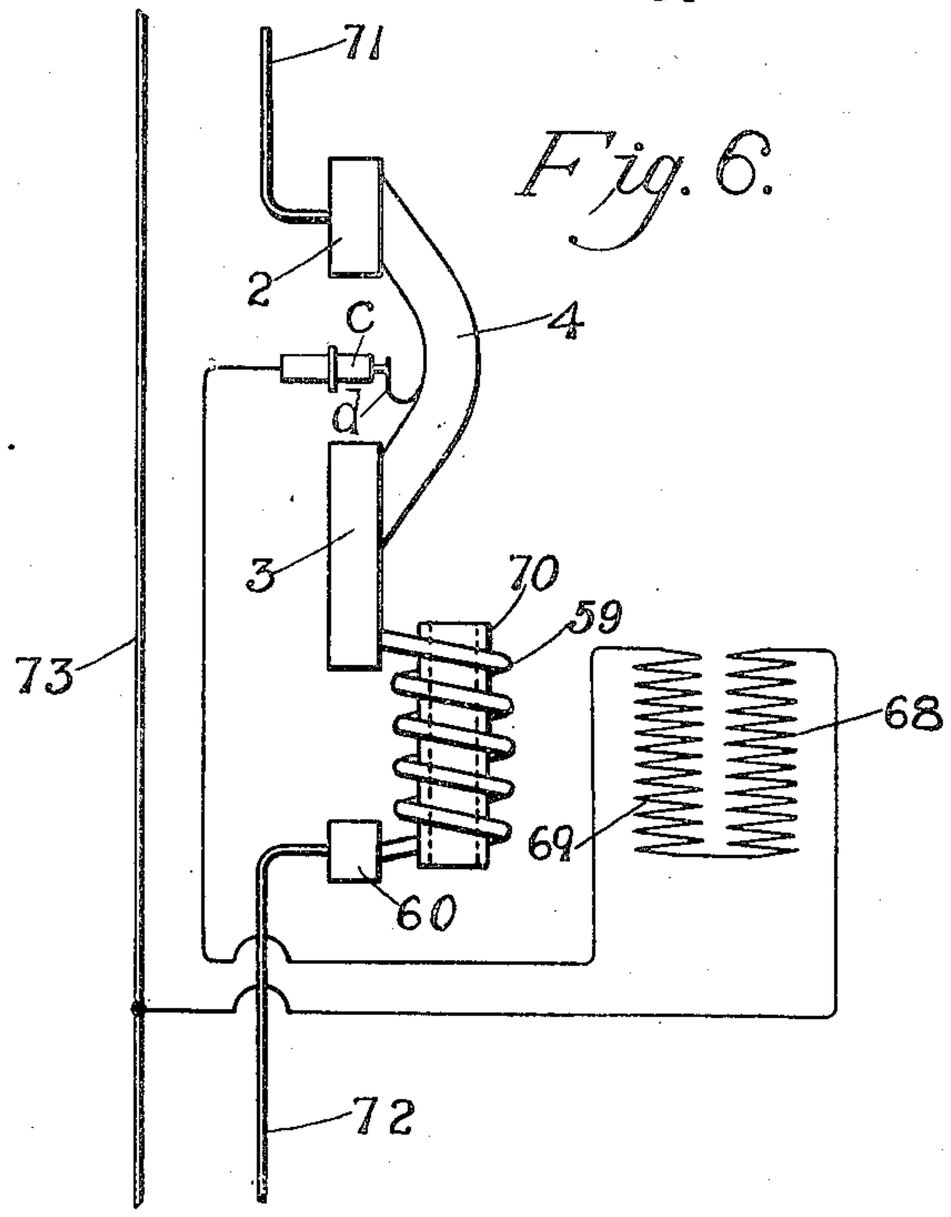


Fig. 6.



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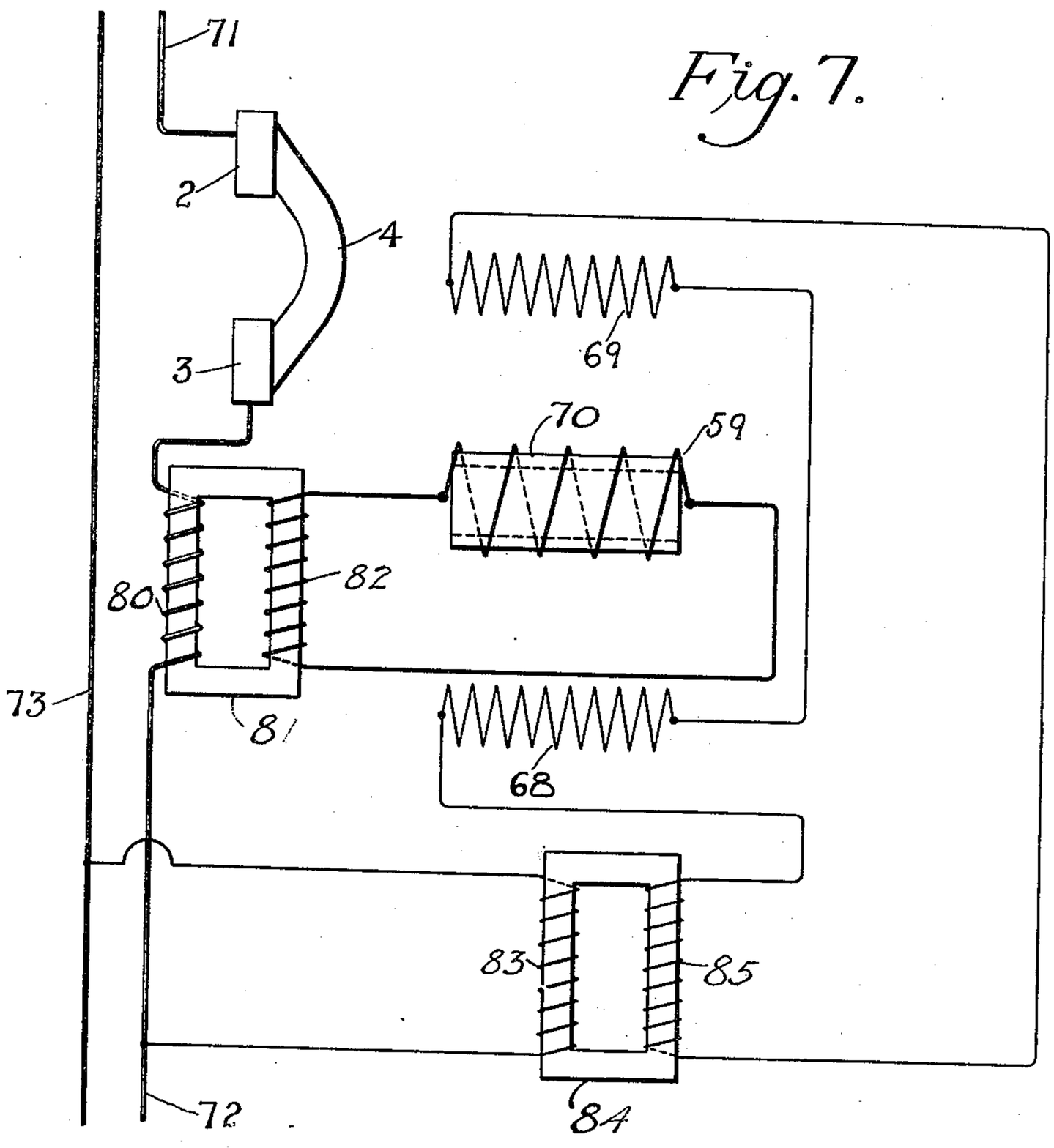
AUTOMATIC MAGNETIC CIRCUIT BREAKER.

APPLICATION FILED OCT. 14, 1904.

5 SHEETS—SHEET 5.

Fig. 7.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC MAGNETIC CIRCUIT-BREAKER.

No. 827,469. Specification of Letters Patent. Patented July 31, 1906.

Application filed October 14, 1904. Serial No. 228,394.

To all whom it may concern:

Be it known that I, WILLIAM M. SCOTT, a citizen of the United States, residing in the city and county of Philadelphia and State of Pennsylvania, have invented a new and useful Automatic Magnetic Circuit-Breaker, of which the following is a specification.

My invention relates to electrical switches for heavy currents and high voltages, especially to the automatic type adapted to control a circuit or circuits either by the rupture or closure of said circuit or circuits upon the occurrence of predetermined electrical conditions—as, for example, either an abnormally great or small flow of current, abnormally high or low voltage or pressure, or upon a reversed flow of energy or of current.

My invention resides in a structure and disposition of parts whereby it shall be impossible for an operator during the existence or continuance of predetermined electrical conditions to actuate the switch member of the circuit-breaker to lock the same or to hold the same in a position from which undesired results might follow in virtue of such predetermined electrical conditions.

In one of its aspects my invention consists of an automatic circuit-breaker which cannot be brought to complete circuit-closing position by an attendant during the existence or continuance of predetermined electrical conditions.

My invention resides also in a structure and arrangement of parts whereby a switch may be tripped, unlocked, or released by a comparatively slight movement of the actuating handle or member. In an automatic circuit-breaker such capacity of the operating-handle or equivalent member to trip the circuit-breaker independently of the electromagnetic or other automatic means is a decided advantage inasmuch as the circuit-breaker can then be actuated similarly to an ordinary mechanical switch, it being unnecessary for the operator to grasp the tripping mechanism, as has heretofore been the more common practice.

My invention resides also in automatic tripping mechanism particularly adapted for use in connection with alternating-current circuits to cause the switch to be released or tripped upon the reversal of the energy or current flow. A switch or circuit-breaker provided with such means is adapted to control a circuit or circuits which are in either inductive or conductive relation with balancing-transformers, rotary converters, or any other apparatus capable under any or certain conditions of causing reversed current or energy flow.

For an illustration of one of the numerous forms which my invention may assume reference is to be had to the accompanying drawings, in which—

Figure 1 is a side elevational view of a circuit-breaker in circuit-closing position. Fig. 2 is a front elevational view of the circuit-breaker shown in Fig. 1. Fig. 3 is a side elevational view, on an enlarged scale, of the tripping mechanism. Fig. 4 is a plan view taken from the under side of Fig. 3 of a part only of Fig. 3. Fig. 5 is a vertical elevational view, partly in section, of the electromagnet adapted to trip the circuit-breaker upon reversed energy-flow or substantial change in potential. Fig. 6 is a diagrammatic view illustrating the circuits of the instrument. Fig. 7 is a diagrammatic view of the circuits when the switch is used on circuits of high potential.

Referring to said drawings, and more particularly to Figs. 1 and 2 thereof, 1 represents a base or switchboard of marble or any other suitable insulating material. Secured to the front of this base and arranged one vertically above the other with their contact-faces in practically the same plane are the main fixed terminals 2 and 3, consisting of blocks of copper or other suitable conducting material.

4 is a laminated bridging member consisting of a bundle of copper leaves which are adapted to engage with their beveled ends upon the contact-faces of the fixed terminals 2 and 3. This laminated bridging member 4 is secured to and insulated from the vertically-extending arm 5, pivoted at 6 in the frame or housing 7, secured to the base 1.

8 is a metallic member secured to the upper extension of the arm 5 and insulated from said arm.

9 is a conducting-strip extending downwardly and held between the bridge 4 and the arm 5, and the lower end of said member 9 is maintained in electrical communication with the terminal 3 by means of the flexible connection 10.

11 is the movable carbon shunt contact-piece, pivoted to 8 at 12 and adapted to engage the fixed carbon shunt contact-piece 13, pivoted at 14 to the bracket 15, which is mechanically secured with the upper terminal 2 and in electrical communication therewith.

16 is a metallic shunt contact-piece in electrical communication with the member 9 and secured at the upper end of the arm 5 through the medium of the supporting-springs 17. 16 engages a portion of the bracket 15, which is practically flush with the engaging face of the terminal 2.

Pivoted at 18 in the bracket or arm 7 is the lever 19, having a portion 20 extending beyond the pivot 18. 21 is a link or bar pivoted at 22 to the member 20 and at 23 to the pivoted arm 5, which carries the laminated bridging member 4. The members 20 and 21 constitute a toggle for cramping the laminated bridging member 4 into engagement with the fixed terminals 2 and 3. With the parts in circuit-closing position the pivot 22 falls slightly short of coincidence with the imaginary straight line passing through both pivots 18 and 23.

24 is an operator's handle or actuator, also pivoted at 18 in the bracket 7. The rotation of the lever 24 about its pivot 18 in a clockwise direction, as viewed in Fig. 1, is limited by the stop 25, forming a portion of lever 24 and adapted to engage against the under side of the bracket 7.

26 is a latch pivoted at 27 on the lever 24. The hook end 28 of this latch is adapted to engage the roller 29, pivoted at 30 in the lever 19.

31 is a spring connected at one end at 32 to the latch 26 and at the other end at 33 to the lever 24. This spring being under tension tends to rotate the latch 26 in a clockwise direction about its pivot 27, as viewed in Figs. 1 and 3. The lever 24 is bifurcated, and between its two arms extends a web 34, through which extends the adjusting-screw 35, which limits the clockwise rotation of the latch 26.

36 is a check-nut for locking the screw 35 in any desired position.

37 is a latch pivoted at 38 to the housing or bracket 7. The member 37 extends to the left of the pivot 38 as viewed in Figs. 1 and 3, a jaw or slot 39 being formed therein and adapted to engage a pin 40, secured in the bracket 7. The pin 40 is of a diameter less than the width of the slot 39, thus permitting a limited oscillation of the latch 37 about its pivot 38. The extent of this oscillation is, however, sufficient to allow the latch 37 to fully engage the roller 41, pivoted at 42 in the lever 19, on the one hand, and, on the other hand, to swing to such position that the roller 41 is completely freed. 43 is a spring connected at 44 to the latch-lever 37 and at its other end at 45 with the bracket or housing 7. This spring 43 is under tension and tends to hold the latch 37 with its hook end in its uppermost position. 46 is a lever also pivoted at 38 and adapted to oscillate about such pivot through a small angle similarly to the latch 37. The lever 46 also has a jaw at its rear end which embraces the pin 40, as heretofore described. The clockwise rotation of the lever 46 about its pivot 38, as viewed in Figs. 1 and 3, is sufficient to engage the tail 26′ of the latch 26. 47 is another lever also pivoted at 38 and located between and parallel with the lever 37 and the lever 46.

48 is a bar or saddle member integral with the lever 47 and extending transversely thereto and across above both the latch 37 and the lever 46. Extending downwardly through this saddle 48 are two adjusting-screws 49, one adapted to engage the top of latch 37 and the other to engage on the top side of the lever 46. The tail 47′ of the lever 47 curves downwardly and is adapted to be engaged from the under side by the extension 50, integral with or secured to the bracket 51, pivoted at 52 in the bracket 7.

53 is an iron armature adapted to coöperate with the pole-piece 54, forming a part of the iron of the magnetic circuit, coöperating with the lower terminal 3. This structure constitutes an overload tripping-magnet, which is adapted upon excessive flow of current to attract the armature 53, and thus strike the tail 47′ of the lever 47 an upward blow. This tripping-magnet is similar to that shown and described in prior patent, No. 754,505, granted to me on March 15, 1904.

The operation is as follows: With the parts in position shown in Figs. 1 and 3 and a predetermined amount of current flowing through the apparatus the pole-pieces 54 attract the armature-piece 53, causing the member 50 to rotate in a counter-clockwise direction about the pivot 52 and to deliver a blow to the tail 47′ of the lever 47. The lever 47 is thus caused to rotate in a clockwise direction about its pivot 38 and to deliver a blow to the latch 37 and simultaneously a blow to the lever 46 through the saddle 48 and the two adjusting-screws 49. In consequence the latch 37 releases the roller 41, and therefore the lever 19, and simultaneously the lever 46 engages the tail 26′ of the latch 26, causing it to rotate in a counter-clockwise direction about its pivot 27, thus releasing the roller 29, and therefore disengaging the lever 19 from the operating-handle 24. The lever 19 being now free from all restraint, the toggle comprising members 20 and 21 collapses under the influence of gravity and under the influence of the spring 20^a, which is connected at one end to the bracket 7 and at 20^b with the lever 20 and also due to the resiliency of the member 4. Accordingly the arm 5 rotates in a clockwise direction about its pivot 6 and carries with it the laminated bridging member 4, which first separates from the terminals 2 and 3. Later the contact-piece 16 separates from its coöperating fixed contact, and eventually the carbon 11 separates from the carbon 13, where the final arc occurs. During this opening process the

operating-lever 24 has remained in the position shown in Figs. 1 and 3. To again close the circuit-breaker, the operating-handle 24 is lifted upwardly until the latch 26 again engages the roller 29. When this has occurred, the operating-handle 24 is connected with the lever 19. Upon then depressing the lever 24 the toggle is extended and the laminated bridging member 4 approaches the terminals 2 and 3. Just as the laminated member 4 comes to complete circuit-closing position the latch 37 engages the roller 41, and thus locks the lever 19 in circuit-closing position, and the parts are again in the position shown in Figs. 1 and 3. Suppose, however, that the circuit-breaker is in open position and that such electrical conditions obtain in the circuit that were the circuit-breaker closed it would be automatically tripped. Then upon raising the operating-lever or actuator 24 the latch 26 engages the roller 29 and connects the operating-lever 24 with the lever 19, as heretofore described. Upon depressing the lever 24 to bring the parts to circuit-closing position the carbons 11 and 13 first engage and later the contact 16 engages its coöperating contact. At this time or before, and certainly before the laminated bridging member 4 comes to complete circuit-closing position, the armature 53 will be again attracted, deliver a blow, as heretofore described, to the lever 47, which in turn will deliver a blow through the lever 46 to the latch 26, and thus free the lever 19 from the operating-handle 24. This action will occur before the latch 37 again engages the roller 41 to lock the lever 19. At 55 on the lever 24 is pivoted the member 56, which is held in its position shown in Figs. 1 and 3 either by a spring or by gravity. 57 is a pin on lever 24, which prevents clockwise rotation of the member 56 beyond the position shown. The member 56 may, however, rotate in a counter-clockwise direction until its lower end strikes the lower side of the pin 57. The lower end of the member 56 is adapted to engage the inclined surface *a* of a transversely-extending portion 58 of the lever 47. With the parts in circuit-closing position, as shown in Figs. 1 and 3, the operating-lever 24 may be lifted slightly, thus causing the lower end of the lever 56 to engage the inclined surface of the lever, *a*, thus rotating the lever 47 in a clockwise direction about its pivot, thus disengaging the latch 37 from the roller 41, and, through the medium of lever 46, disengaging the latch 26 from the roller 29. The result is the release of the lever 19 with consequent opening of the circuit-breaker, as if it had been tripped automatically. In bringing the operating-lever 24 from open-circuit to closed-circuit position the member 56 rides over the inclined surface *b* of the portion 58 and drops down behind the inclined surface *a* as the lever 24 reaches circuit-closing position. From this construction it is seen that the switch or circuit-breaker may be opened by a slight upward or reversed movement of the operating-handle and without necessity for the operator to manually actuate the latches or tripping mechanism.

Referring to Figs. 5 and 6, 59 represents a series winding, connected between the lower terminal 3 and the terminal 60, which is also mounted on the front of the base 1. The winding 59 is shown to consist of several turns of coarse wire or heavy conductor for the sake of clearness. Frequently in practice and in a switch of the class herein described such series winding would consist of a much heavier conductor, making perhaps no more than a single turn. This winding 59 surrounds or embraces the middle limb 61 of a compound electromagnet. 62 is a yoke joining the middle limb 61 with the end limbs 63 and 64. 65 is an armature pivoted at 66 immediately in front of the limb 61 and separated from the same in all positions by a very narrow air-gap. 67 is a stop preventing the rotation of the armature 65 in a counter-clockwise direction. 68 is a fine-wire winding of many convolutions, embracing the limb 63, and 69 is a similar winding embracing limb 64. The windings 68 and 69 may be connected in series with each other or in shunt with each other, and in either case constitute a shunt-winding as distinguished from 59, which is a series winding. Within the winding 59 and embracing the middle limb 61 is a sleeve or tube 70, of copper or other suitable material, which is circumferentially continuous and constitutes a closed circuit of a single turn about the middle limb 61. This apparatus is designed principally for use with alternating currents, and therefore all parts of the magnetic circuit, as 61, 63, 64, and 65, are composed of laminated iron. It is to be understood, however, that this apparatus will operate satisfactorily on direct-current circuits also. These windings are connected as shown in Fig. 6. The current may be presumed to enter the apparatus through the conductor 71, thence through the bolt 2^a to the fixed terminal 2, through the bridging member 4, through lower terminal 3, through winding 59 to terminal 60, thence through bolt 60^a to conductor 72. The conductor 73 represents the other conductor of the circuit, the full potential of the circuit existing between the conductors 72 and 73.

The shunt-windings 68 and 69 being of relatively great number of turns cause considerable self-induction in this circuit which is shunted across the conductors 72 and 73. The winding 59 has relatively small self-induction, and therefore the current and electromotive force in the winding 59 are practically in phase with each other, while in the shunt-circuit 68 69 the current and electro-

motive force are considerably dephased. In consequence the magnetizing forces acting on the limbs 63 and 64 are considerably dephased with respect to the magnetizing forces acting on the limb 61. The result is a rather inefficient structure unless the closed circuit 70 is resorted to.

The closed circuit 70, which may consist of a single turn, as described, or may be constructed of a greater number of turns of conductor of smaller cross-section and constituting a closed circuit, is in fact a closed secondary circuit of a transformer of which the winding 59 is the primary.

The action of the closed circuit 70 is therefore such as to cause a displacement of the magnetizing force acting on the limb 61 with respect to the current in the winding 59. This displacement is, however, of such a nature as to bring the magnetizing forces acting on the limbs 63 and 64 and the magnetizing force acting on the limb 61 more closely into the same phase relation. The result is that the mechanism becomes more efficient in that the several magnetizing forces act more closely in unison.

For different frequencies of alternating current the windings 68 and 69 and the closed circuit 70 may be differently designed; but the action in any event is in the direction indicated—namely, to bring the magnetizing forces acting on the several portions of the magnetic circuit into more nearly the same phase relations.

Windings 68 and 69 are so connected that the magnetism produced by them takes a path through limb 63, armature 65, limb 64, and yoke 62. With the energy-flow through winding 59 continuing in normal direction the armature 65 remains against the stop 67, as shown in Fig. 5. When, however, the energy or current flow in the circuit becomes reversed, the current at any instant in the winding 59 has become reversed with respect to the current-flow at the same instant in the windings 68 and 69, in which latter the current-flow is never relatively reversed, since said windings are connected in shunt with the main circuit. With this relatively reversed current-flow in the winding 59 the additional magnetization set up thereby causes a larger amount of magnetism in the limbs 61 and 64 and a less amount in the limb 63, thus causing the armature 64 to rotate in a clockwise direction, as viewed in Fig. 5. Upon the occurrence of this rotation of the armature 65 the vertically-extending rod 74 is raised, due to the engagement of the extension 73 on the armature 65 engaging the adjustable shoulder 74′ on said rod 74. This upward movement of the rod 74 (see Figs. 1 and 3) causes the clockwise rotation of the lever 75, pivoted on 76, which is concentric with and may be integral with the pivot 38. The lever 75 is cranked at 77, and the ear 78 is secured to the saddle member 48 by the screw 79. The result of the rotation of the armature 65 is therefore to rotate the lever 47 and to cause the operation of both the latches 26 and 37, as heretofore described. In other words, upon the occurrence of reversed energy-flow in the circuit the circuit-breaker is tripped and upon attempted closure of the circuit-breaker during the continuance or existence of electrical conditions causing or tending to cause reversed energy-flow the circuit-breaker cannot be brought to complete circuit-closing position, but is released from the control of the operator.

The windings 68 and 69 have connection with the conductor 72 through the reciprocating contact *c*, secured to the base or switch board and through the contact *d*, in electrical communication with and movable with the laminated bridging member 4. It is thus seen that when the circuit-breaker opens the circuit through windings 68 and 69 is broken.

In the case where the circuit-breaker is employed in connection with high-potential alternating current, in which case it would not be permitted to have the windings 59, 68, and 69 upon the front of the switchboard, I employ an arrangement shown diagrammatically in Fig. 7. In this case the windings 59, 68, and 69 are arranged, as heretofore described, on the front of the switchboard; but they are connected in relatively low potential circuits in inductive relation with the high-potential circuit or circuits to be protected. Thus the entire current passing through the circuit-breaker, or some predetermined fraction thereof, passes through the winding 80, constituting the primary of a transformer whose core is shown at 81 and whose secondary winding is shown at 82, in series with which is connected the winding 59. Similarly 83 is the primary winding of a transformer whose core is shown at 84 and in series with whose secondary winding 85 are connected the windings 68 and 69. Both of these transformers are located in the rear of the switchboard, while their secondary circuits lead to the front of the switchboard to the respective windings of the tripping mechanism. The circuit of the primary winding 83 may also be interrupted by contacts similar to *c* and *d*, as described in connection with Fig. 6. It is to be understood, however, that the reversed current or reversed energy-tripping mechanism herein described may assume other forms and arrangements without departing from the spirit of my invention, which has for its underlying principle the bringing into unison or approximate unison the magnetizing forces generated by the series and shunt windings. It is to be understood, also, that the latches and mechanism of the circuit-breaker, as herein described, may be operated by electroresponsive means of other types than herein illustrated—as,

for example, underload tripping-magnets, low-voltage or high-voltage tripping-magnets. It is to be understood, also, that the tripping mechanisms, both as to the electrical and mechanical features, may be applied to switches of types other than herein shown—as, for example, knife-switches or the like.

What I claim is—

1. In a tripping mechanism, a winding producing a magnetizing force dephased with respect to the impressed electromotive force, a winding producing a magnetizing force having a different phase relation with respect to the impressed electromotive force, and means for bringing said magnetizing forces more nearly into the same phase relation.

2. In a tripping mechanism, a winding producing a magnetizing force dephased with respect to the impressed electromotive force, another winding producing a magnetizing force dephased with respect to said first-mentioned magnetizing force, and a third winding associated with said windings for bringing said magnetizing forces more nearly into the same phase relation with respect to the impressed electromotive force.

3. In a tripping mechanism, a winding producing a magnetizing force dephased with respect to the impressed electromotive force, a winding producing a magnetizing force dephased with respect to said first-mentioned magnetizing force, and a closed-circuited winding associated with said windings for bringing said magnetizing forces more nearly into the same phase relation with respect to the impressed electromotive force.

4. In a tripping mechanism, a shunt-winding producing a magnetizing force dephased with respect to the impressed electromotive force, a series winding producing a magnetizing force dephased with respect to the magnetizing force produced by said shunt-winding, and a closed-circuited winding associated with said series winding for bringing said magnetizing forces more nearly into the same phase relation.

5. In a tripping mechanism, a magnetizable core, a winding associated therewith and producing a magnetizing force dephased with respect to the impressed electromotive force, a second winding associated with said core and producing a magnetizing force dephased with respect to said first-mentioned magnetizing force, and a closed-circuited winding associated with said second winding for bringing said magnetizing forces more nearly into the same phase relation.

6. In an electric switch, a base, a movable contact member, an actuator therefor, a latch for connecting said actuator with said contact member, a latch for locking said contact member to said base, and a plurality of electro-responsive devices operative under dissimilar electrical conditions, and each operative to simultaneously actuate both said latches independently of each other when said contact member is locked to said base, and for actuating said connecting-latch upon attempted operation of the switch during the existence or continuance of any of said dissimilar electrical conditions.

7. In an electric switch, a movable contact member, means for restraining said member in normal position, and means for controlling said restraining means comprising a winding producing a magnetizing force dephased with respect to the impressed electromotive force, a winding producing a magnetizing force dephased with respect to said first-mentioned magnetizing force, and a conducting-sleeve associated with said windings for bringing said magnetizing forces more nearly into the same phase relation with respect to the impressed electromotive force.

8. In an electric switch, a movable contact member, means for restraining said contact member in normal position, an electroresponsive means for controlling said restraining means comprising a shunt-winding producing a magnetizing force, a series winding producing a magnetizing force dephased with respect to the magnetizing force produced by said shunt-winding, and a conducting-sleeve associated with said windings for bringing said magnetizing forces more nearly into the same phase relation.

9. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means comprising a magnetizable mass, a winding associated therewith and producing a magnetizing force dephased with respect to the impressed electromotive force, a second winding associated with said mass and producing a magnetizing force dephased with respect to said first-mentioned magnetizing force, and a conducting-sleeve associated with said mass for bringing said magnetizing forces more nearly into the same phase relation.

10. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means comprising a magnetizable mass, a shunt-winding associated therewith, a series winding, and a conducting-sleeve for bringing the magnetizing forces produced by said shunt and series windings more nearly into the same phase relation.

11. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means comprising a magnetizable mass having a plurality of limbs, a shunt-winding upon a limb, a series winding upon another limb, and a conducting-sleeve upon a

limb for bringing the magnetizing forces produced by said shunt and series windings more nearly into the same phase relation.

12. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means comprising a plurality of windings producing magnetizing forces dephased with respect to each other, and a closed circuit associated with said windings for bringing said magnetizing forces more nearly into the same phase relation.

13. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means comprising a shunt-winding producing a magnetizing force, a series winding producing a magnetizing force dephased with respect to the magnetizing force produced by said shunt-winding, and a closed circuit associated with said windings for bringing said magnetizing forces more nearly into the same phase relation.

14. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means, upon reversed energy-flow, comprising a magnetizable mass, a shunt-winding associated therewith, a series winding, and a closed circuit for bringing the magnetizing forces produced by said shunt and series windings more nearly into the same phase relation.

15. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means, upon reversed energy-flow, comprising a magnetizable mass having a plurality of limbs, a shunt-winding upon a limb, a series winding upon another limb, and a closed-circuited conductor upon a limb for bringing the magnetizing forces produced by said shunt and series windings more nearly into the same phase relation.

16. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means, upon reversed energy-flow, comprising a potential-winding, a series winding, and means for bringing the magnetizing forces produced by said windings more nearly into phase with each other.

17. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means, upon reversed energy-flow, comprising a potential-winding, a current-winding, and means for causing said windings to produce an increased resultant magnetizing force, said current-winding being included in a circuit inductively connected with the main circuit.

18. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means, upon reversed energy-flow, comprising a potential-winding, a current-winding, and means for causing said windings to produce an increased resultant magnetizing force, said potential-winding being included in a circuit inductively connected with the main circuit.

19. In an electric switch, a movable contact member, means for restraining said contact member in normal position, and electroresponsive means for controlling said restraining means, upon reversed energy-flow, comprising a potential-winding, a current-winding, and means for causing said windings to produce an increased resultant magnetizing force, said potential-winding and current-winding being included in circuits inductively connected with the main circuit.

20. In an electric switch, a movable contact member, an actuator therefor, a latch for restraining said movable contact member in normal position, a latch for connecting said actuator with said movable contact member, and an independent lever for actuating said latches, whereby said movable contact member is released and disconnected from said actuator.

21. In an electric switch, a movable contact member, an actuator therefor, a latch for restraining said movable contact member in normal position, a latch for connecting said actuator with said movable contact member, an independent lever for directly actuating said restraining-latch and for indirectly actuating said connecting-latch.

22. In an electric switch, a movable contact member, an actuator therefor, a latch for restraining said movable contact member in normal position, a latch for connecting said actuator with said movable contact member, an independent lever for actuating said latches, and electroresponsive means for actuating said lever.

23. In an electric switch, a movable contact member, an actuator therefor, a latch for restraining said movable contact member in normal position, a latch for connecting said actuator with said movable contact member, an independent lever for actuating said latches, means responsive to predetermined electrical conditions for actuating said lever, a second independent lever for actuating said latches, and further means responsive to different predetermined electrical conditions for actuating said second lever.

24. In an electric switch, a movable contact member, an actuator therefor, a latch for restraining said movable contact member

in normal position, a latch for connecting said actuator with said movable contact member, an independent lever for actuating said latches, an overload tripping-magnet for actuating said lever, a second independent lever for actuating said latches and means responsive to reversed energy-flow for actuating said second lever.

25. In an electric switch, a movable contact member, an actuator therefor, a latch for restraining said movable contact member in normal position, a latch for connecting said actuator with said movable contact member, an independent lever for actuating said latches, and electroresponsive means for actuating said lever whereby said movable contact member is released and disconnected from said actuator upon the occurrence of predetermined electrical conditions when said contact member is in normal position, and for disconnecting said contact member from said actuator upon attempted movement to normal position during the existence or continuance of predetermined electrical conditions.

26. In an electric switch, a movable contact member, an actuator therefor, a latch for restraining said movable contact member in normal position, a latch for connecting said actuator with said movable contact member, an independent lever for actuating said latches, a tripping-magnet for actuating said lever, a second independent lever for actuating said latches, a tripping-magnet responsive to different electrical conditions for actuating said second lever, whereby said movable contact member is released and disconnected from said actuator upon the occurrence of different electrical conditions, whereby said movable contact member is disconnected from said actuator upon attempted movement to normal position during the existence or continuance of any one or both of different electrical conditions.

27. In an electric switch, a movable contact member, an actuator therefor, a latch for restraining said movable contact member in normal position, a latch for connecting said actuator with said movable contact member, an independent lever for actuating said latches, and means upon said actuator for operating said lever upon reversed movement of said actuator.

28. In an electric switch, a movable contact member, a latch for restraining said movable contact member in normal position, an independent lever for actuating said latch, an actuator, and means upon said actuator for operating said lever upon reversed movement of said actuator, whereby said contact member is released.

29. In an electric switch, a movable contact member, a latch for restraining said contact member in normal position, an independent lever for actuating said latch, an actuator, a member pivoted on said actuator for operating said lever upon reversed movement of said actuator, whereby said contact member is released.

30. In an electric switch, a movable contact member, a latch for restraining said contact member in normal position, an independent lever for actuating said latch, an actuator, a member pivoted on said actuator, and means for limiting the movement of said pivoted member, whereby said member operates said lever upon reversed movement of said actuator and fails to operate said lever upon direct movement of said actuator.

WM. M. SCOTT.

Witnesses:
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