E. M. HEWLETT & T. E. BUTTON.

HIGH POTENTIAL SWITCH.

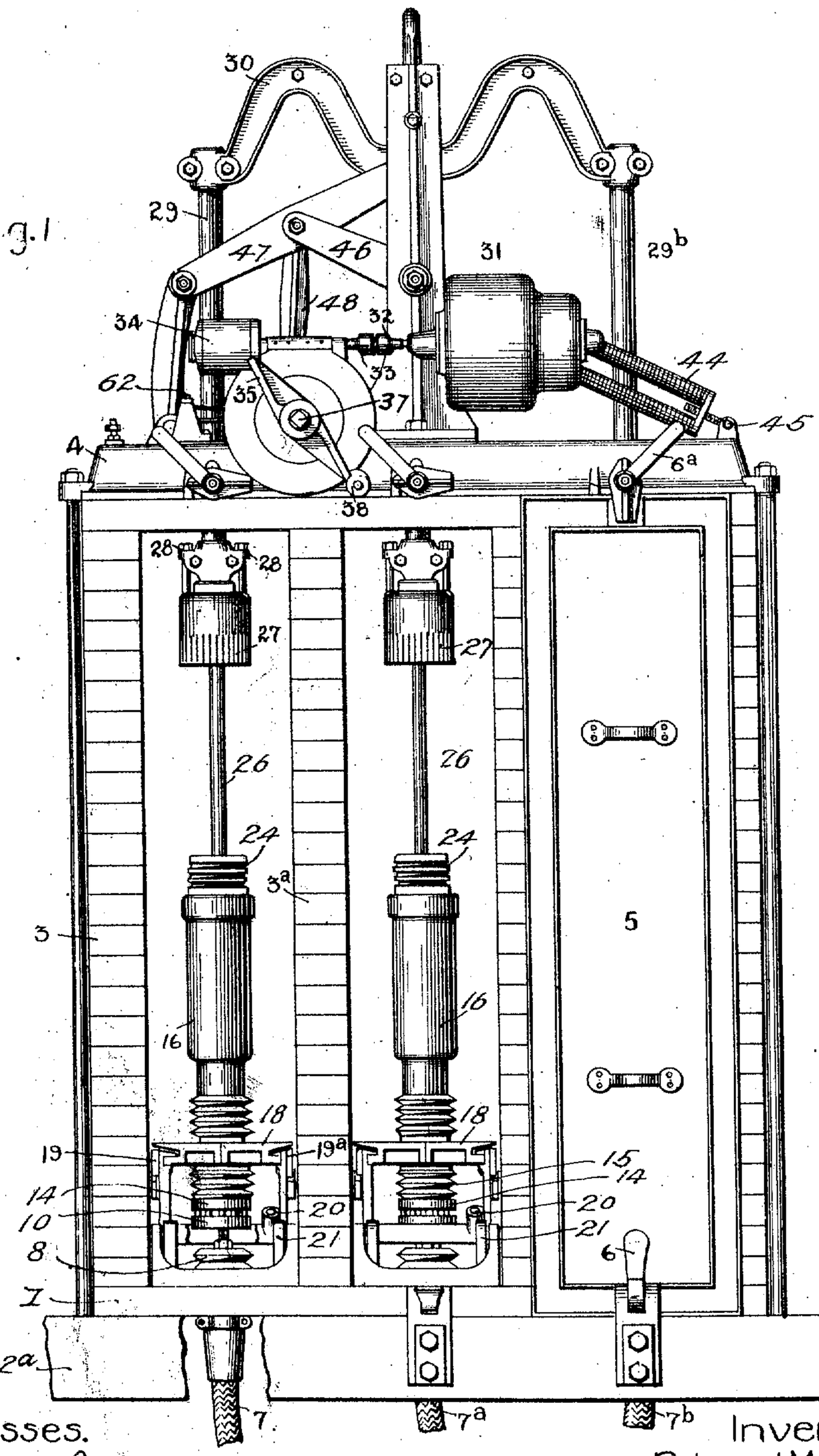
APPLICATION FILED JAN. 7, 1902.

973,657.

Patented Oct. 25, 1910.

4 SHEETS—SHEET 1.

Fig. 1



Witnesses.

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4 SHEETS—SHEET 2.

Fig. 2.

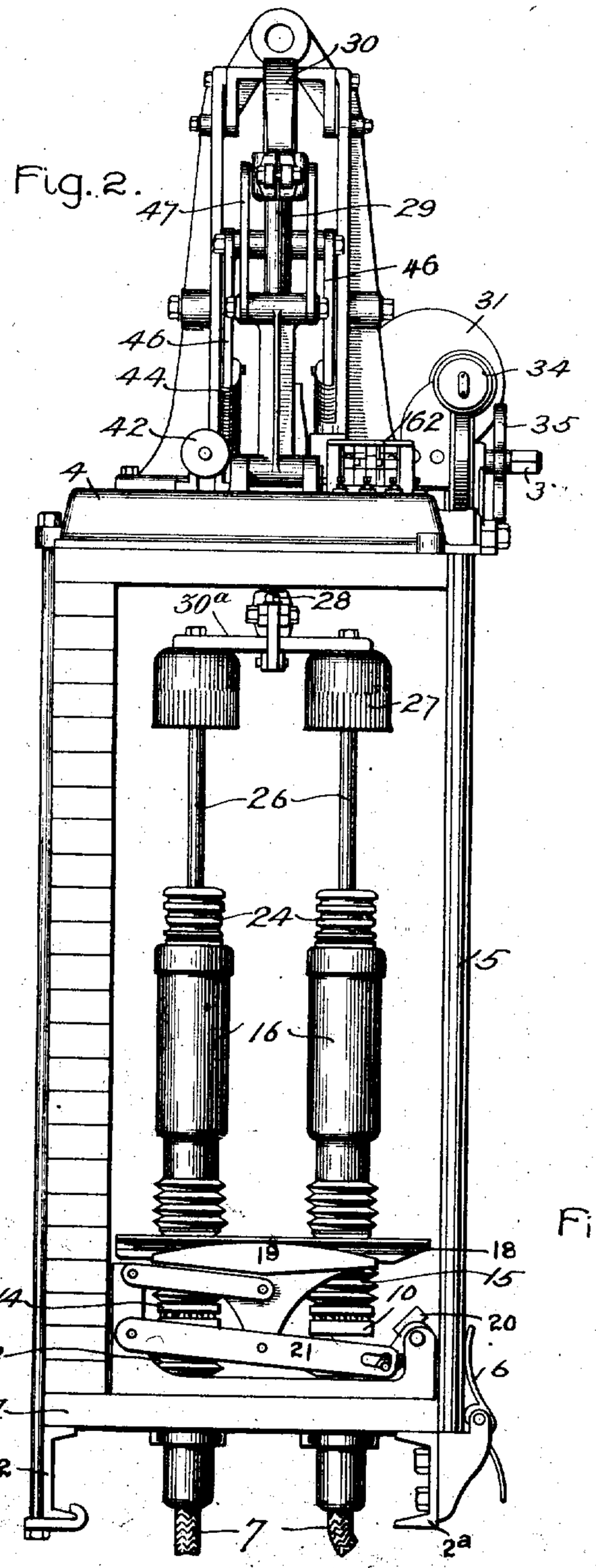


Fig. 3.

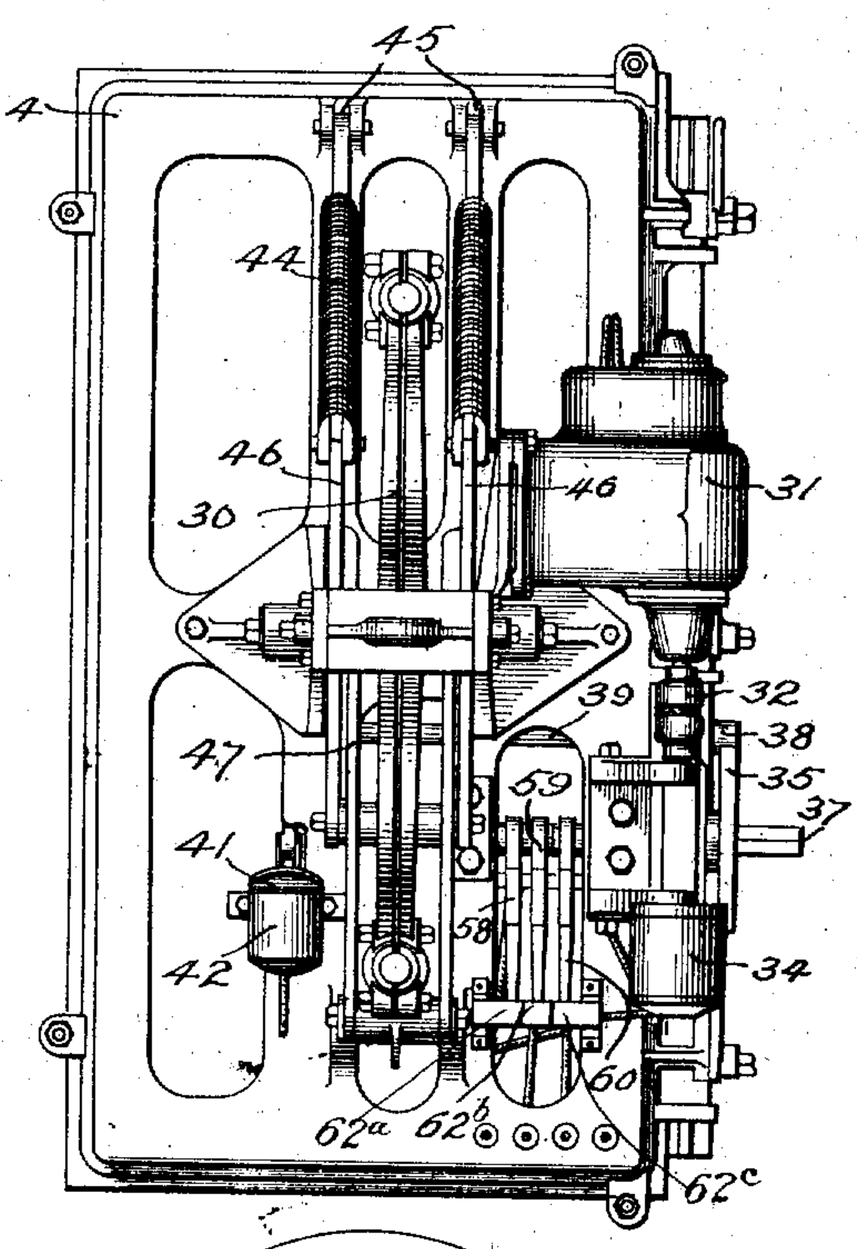
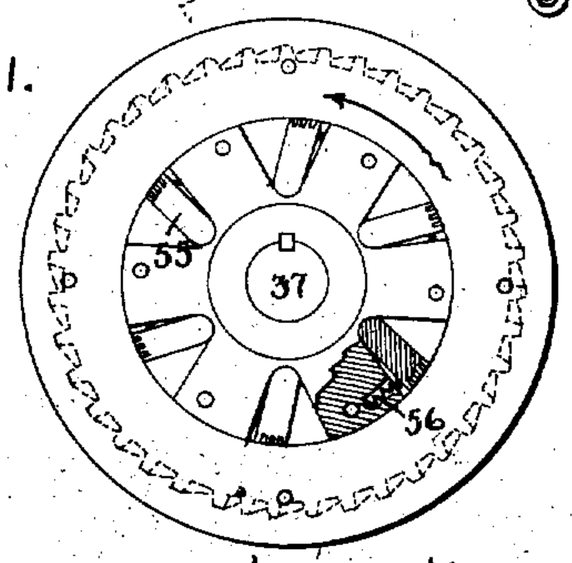


Fig. 11.



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4 SHEETS—SHEET 3.

Fig. 4.

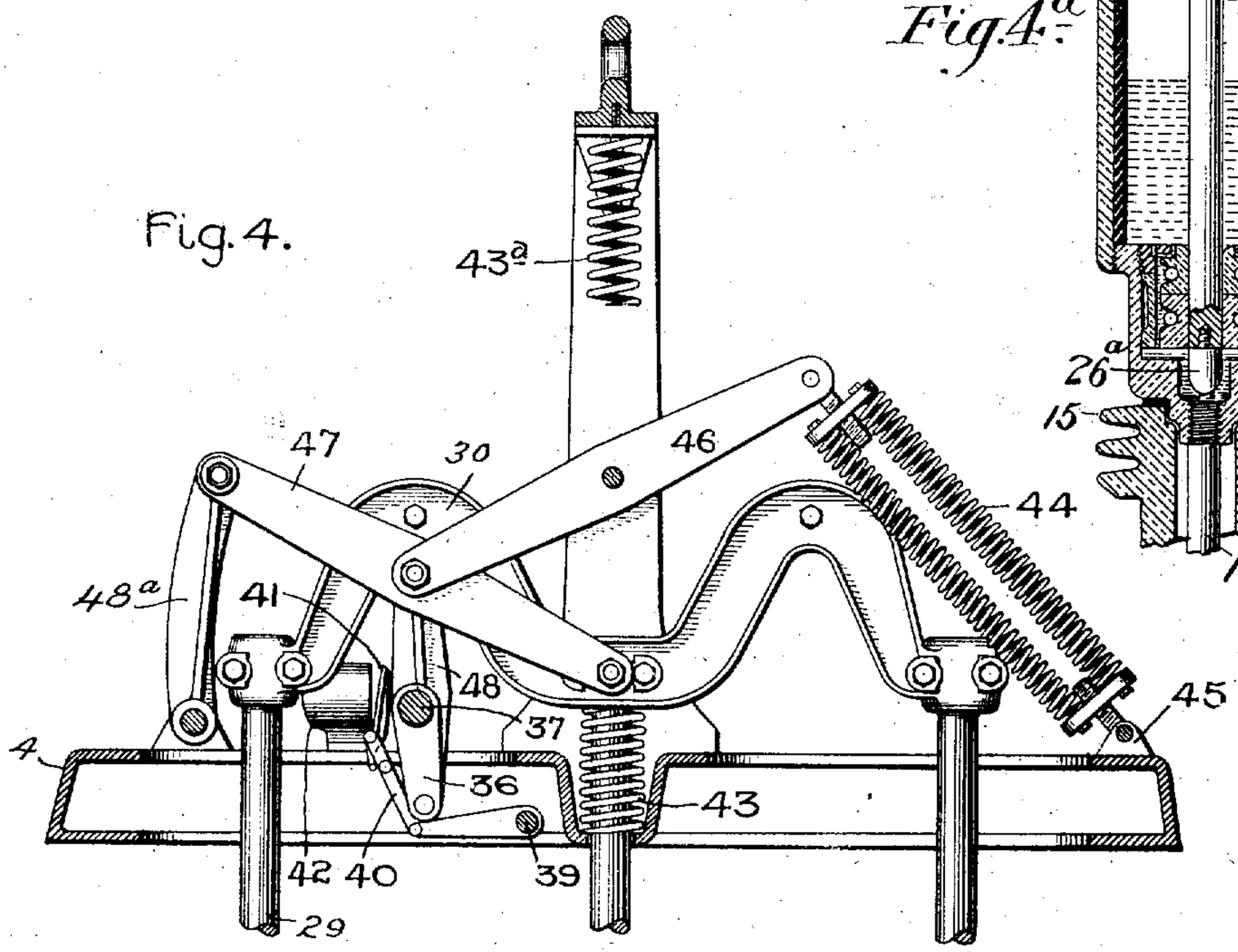


Fig. 4a.

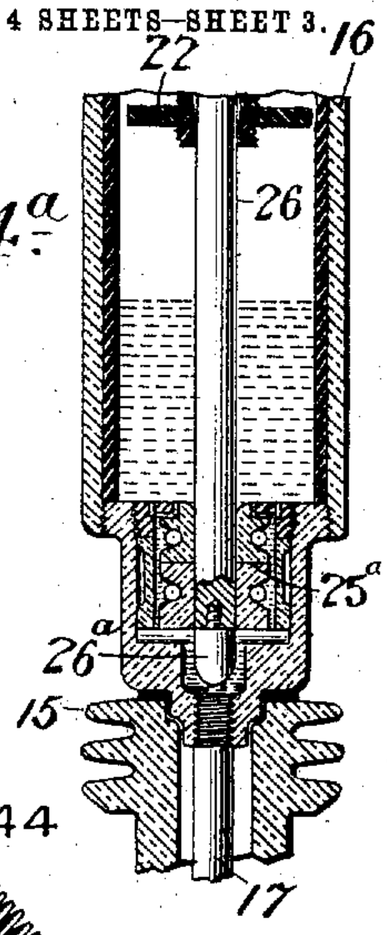
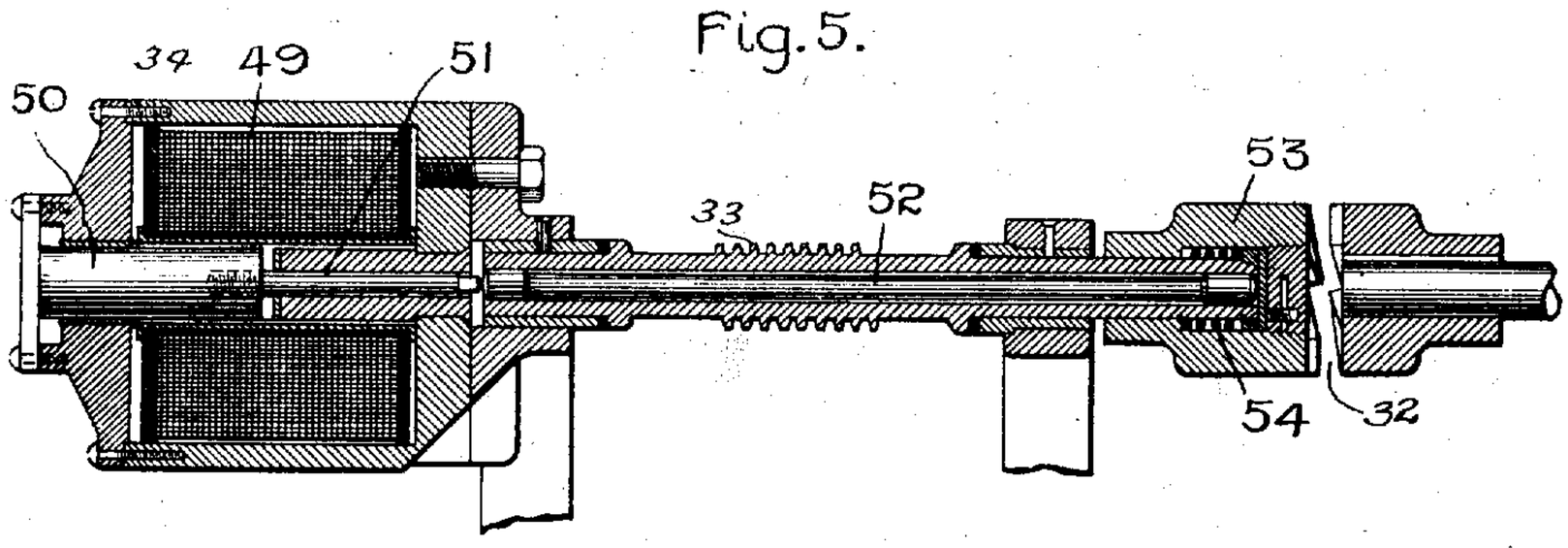


Fig. 5.



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4 SHEETS—SHEET 4.

Fig. 6.

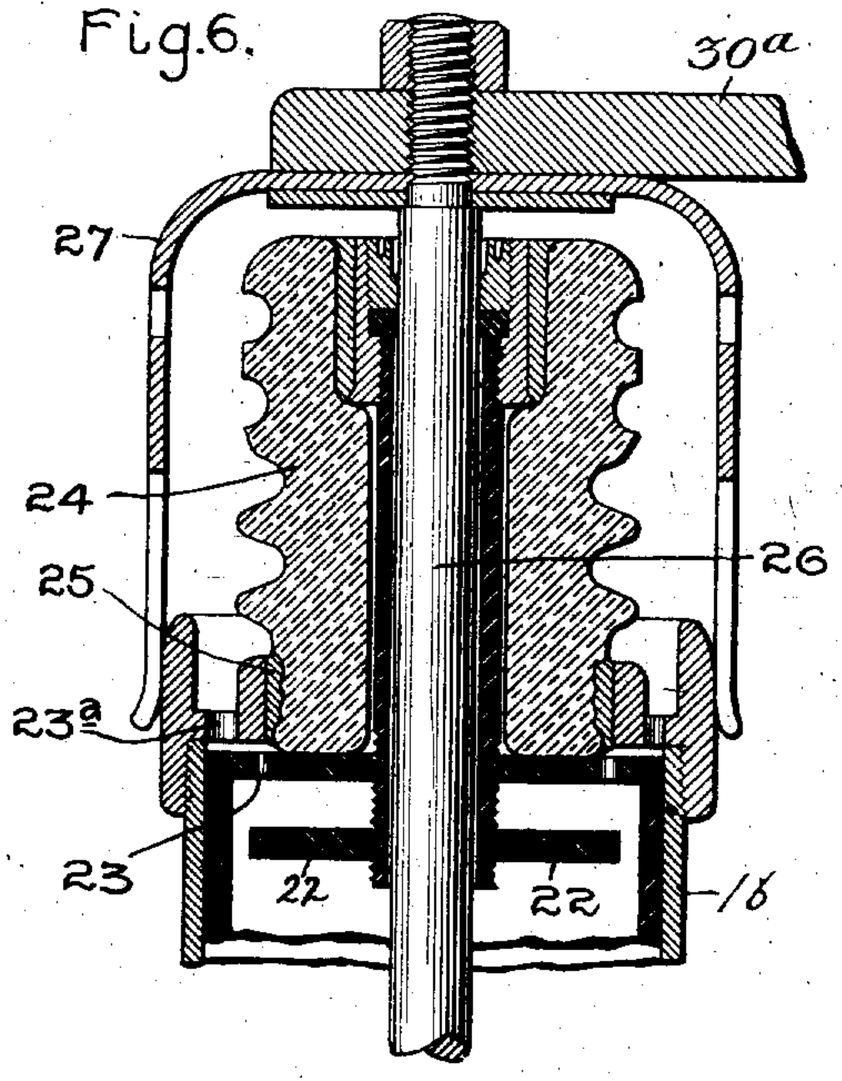


Fig. 7.

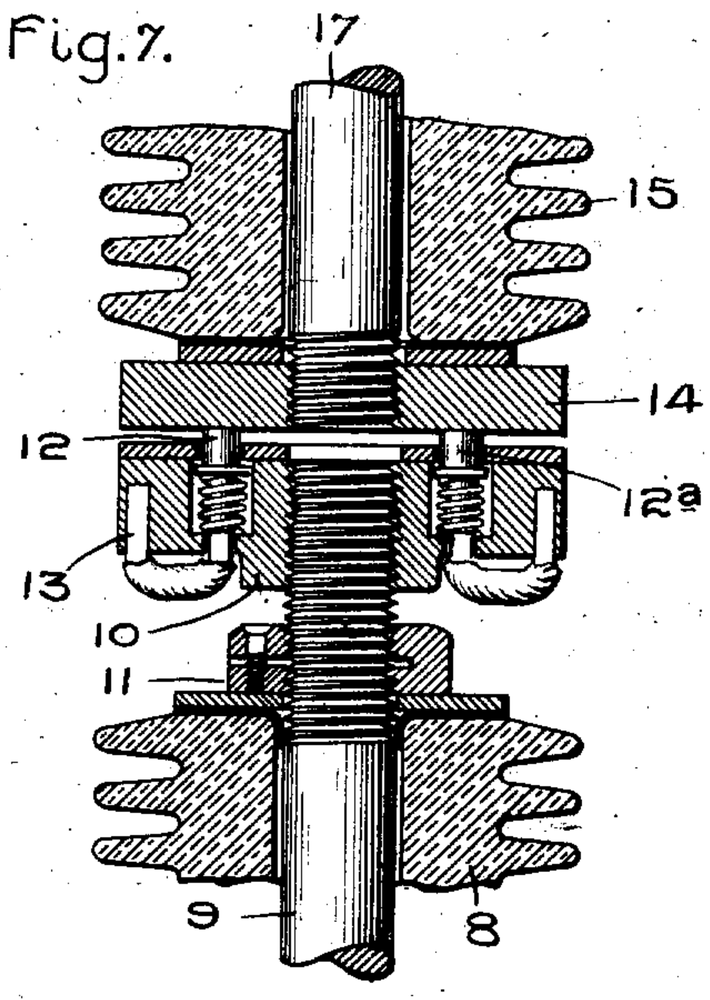


Fig. 8.

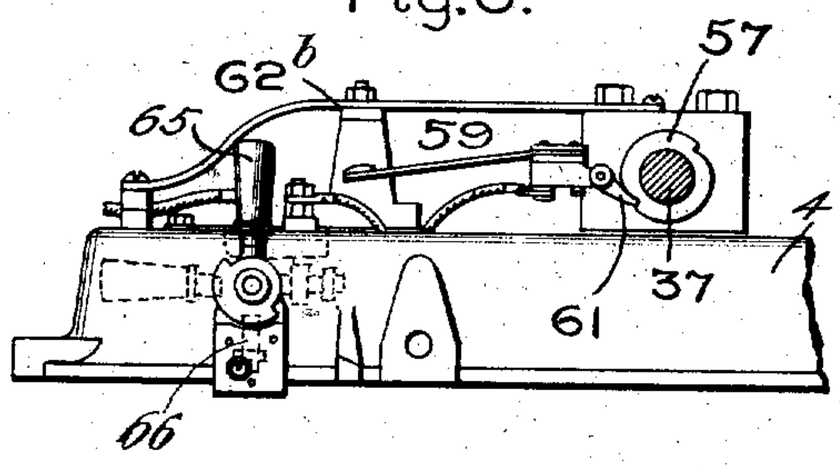


Fig. 9.

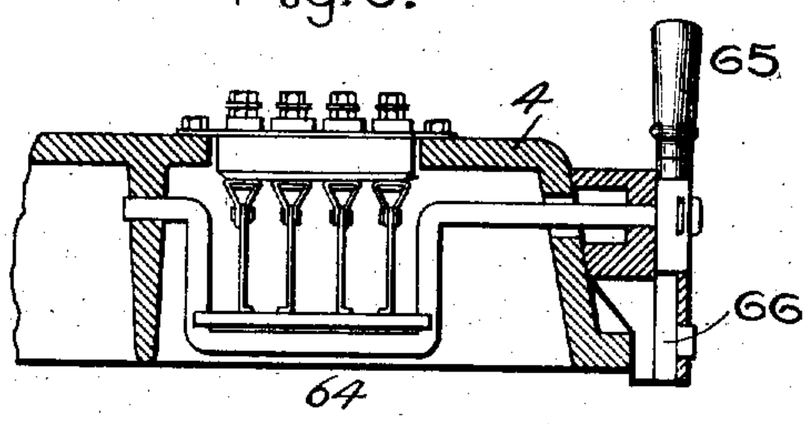
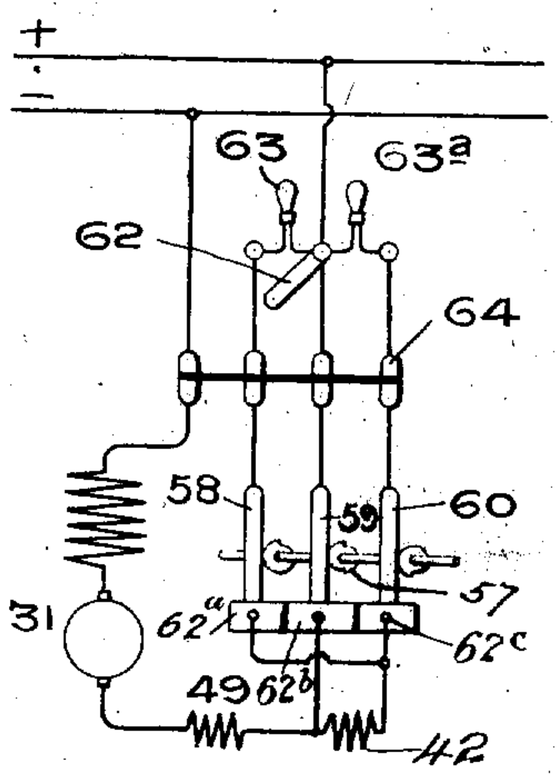


Fig. 10.



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UNITED STATES PATENT OFFICE.

EDWARD M. HEWLETT AND THEODORE E. BUTTON, OF SCHENECTADY, NEW YORK, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

HIGH-POTENTIAL SWITCH.

973,657. Specification of Letters Patent. **Patented Oct. 25, 1910.**

Application filed January 7, 1902. Serial No. 88,757.

To all whom it may concern:

Be it known that we, EDWARD M. HEWLETT and THEODORE E. BUTTON, citizens of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in High-Potential Switches, of which the following is a specification.

This invention relates to switches or circuit-breakers for electric currents, and is particularly designed for use in connection with high potential alternating currents of large capacity. Switches of this same general character are disclosed in patents issued to Edward M. Hewlett, one of the applicants in the present case, his Patent No. 755,771, dated March 29th, 1904, showing electrically actuated switch operating mechanism, and his Patent No. 815,824, dated March 20th, 1906, showing pneumatic switch operating mechanism, together with circuit-making and breaking terminals of the type employed in the present case.

The present invention relates principally to improvements in the operating mechanism by which the switch is rendered quicker in its action, permitting the movement of the parts to accomplish the opening or closure of the circuit to be effected in less time than heretofore after the control device has been manipulated.

The invention also comprises certain novel control circuit connections and other structural features including an improved oil pot construction and means for rendering the movable contact dead so as to permit handling the contact elements without danger to the operator.

In carrying out the present improvements the movable switch contacts are arranged to play to and fro with relation to the fixed contacts, being controlled mainly by stout compression springs. A motor, preferably electrically operated and electrically controlled from a distance to insure safety to the operator, is connected by levers with the movable switch member through a clutch which is in gripping relation for a half revolution with a clutch wheel or disk, and then is free to slip forward so that the spring which has been compressed can quickly throw the movable element of the switch, being assisted in this movement by an auxiliary spring which counterbalances the weight of the moving parts. The motor is connected with the movable element through a system of levers by which parallel motion of the moving element is effected, thereby dispensing with the necessity of fixed guides and permitting the latter to swing pendulously from a cross-head actuated by the motor. After being thrown by the spring a rebound is prevented by the motor which continues movement until the second spring is put under sufficient compression to accomplish the reverse movement, the motor revolving to a sufficient extent to shift the crank controlled by the clutch over center, leaving it in a position to instantly respond to the action of the strained spring when released, being locked in this position by a detent governed by an electromagnetically operated catch.

The various features and advantages of the invention together with its operation will be more fully understood upon reference to the following detailed description taken in connection with the accompanying drawings, in which—

Figure 1 is a front elevation of a switch embodying the improvements, two of the doors for the insulating cells being removed to show the construction; Fig. 2 is a side elevation in a plane at right angles to that shown in Fig. 1; Fig. 3 is a top plan; Fig. 4 is a detail view showing the position of the operating mechanism when the switch is closed; Fig. 4ª is a vertical section of the lower portion of an oil pot; Fig. 5 is a sectional view of the operating worm and magnetic clutch for connecting and disconnecting the driving motor therewith; Fig. 6 is a sectional detail view of the upper part of one of the oil pots; Fig. 7 is a sectional detail view of the oil pot support; Figs. 8 and 9 are views of the electrically controlled contacts governing the motor; Fig. 10 is a diagram of the control circuits; and Fig. 11 is a face elevation of the worm wheel clutch, the casing being removed.

Referring in detail to said drawings, 1 represents a foundation plate or base plate which may be of slate or similar insulating fire-proof material, mounted on steel or iron beams, as 2, 2ª, etc., which may be supported in any convenient manner on a suitable base. Fire-proof walls of brick, as 3, 3ª, are erected on the foundation and surmounted by a slate cover and a cap-plate 4 on which latter the motor and operating parts of the switch

are mounted. Thus there is formed by the brick walls a plurality of fire-proof inclosing chambers such as indicated in Figs. 1 and 2 in which are inclosed the oil pots arranged to provide a double break for each phase of the electric circuit. The switch illustrated is designed for triphase currents, and three cells are formed, as indicated in Fig. 1, in each of which a pair of oil-pots is mounted, as seen in Fig. 2. The open ends of the cells are covered by removable doors 5 held in place by latches 6, 6ª, thus completely inclosing and preventing any flashing or scattering of fire outside of the walls of the switch. The circuits are led to and from the switch by way of the cable leads 7, 7ª, 7ᵇ, which are connected to terminals supported in insulators 8 of porcelain (see Fig. 7) through which pass threaded rods 9 on which the terminals 10 are screwed. A split washer 11 may be screwed down firmly against the insulator 8 and clamped in position against the threads of the screw by a little set screw, as indicated in Fig. 7. The fixed terminal 10 consists of a plate provided with a number of sockets, in which contact studs 12, 12ª, arranged in circular order and spring pressed as indicated, nest. Each of these terminates in a metallic pigtail, the end of which is secured in the bottom of the plate, as indicated at 13. In operative relation to each fixed terminal is a contact plate 14 firmly secured to a second insulator 15 on which the oil pot 16 is mounted. A rod 17 extends downwardly from the bottom of the oil pot and terminates in a threaded exterior which screws into the plate 14. As indicated in Fig. 2, the insulators of each pair of oil pots are connected by a plate 18 against a flange of which bears a lifter 19 controlled by parallel links which may be raised or lowered by means of a wooden rod inserted in a socket 20. This socket is connected with a crank in which a pin (see Fig. 2) projects into a slot in one of the links 21, being locked in up or down position by means of a little recess in the slot, as indicated in the figure. Thus any particular pair of oil pots may be moved by simply inserting a rod in the proper socket 20 and bearing down on it thereby shifting the movable portion of the switch terminals upward away from the terminals 10 and carrying the oil pots upward, thus rendering them dead and permitting their removal from the cells for purposes of inspection or repairs. When so lifted they may be drawn laterally away from the lifters, as will be understood from an inspection of the latter, as seen at 19, 19ª in Fig. 1.

Each oil pot is made of metal and lined with fiber or similar material, as indicated in Figs. 4ª and 6, and provided at the top with a baffle-plate 22, to prevent scattering of oil, and perforated also with an annular range of small holes 23 to permit the escape of gas and reduce the pressure when the circuit is being broken. A similar range of holes 23ª is formed in a cap surrounding the oil pot out of line with the holes 23, so as to retard the escape of gas and prevent spattering of the oil. This range of holes is formed in a cap in which is supported an insulator guide 24 of porcelain or similar material. This guide is secured to the metallic cap by means of a joint of Babbitt metal or similar soft material as indicated at 25, this forming a weak spot which in case of undue pressure may yield and permit the plug to be blow out, preventing the explosion of the pots. Each pot is mechanically and electrically connected at its lower end to the upper end of one of the conducting rods 17 and in its lower cup-shaped portion is provided with a fixed contact in the form of one or more expansion rings 25ª adapted to receive the lower end of the movable contact 26. This rod is composed of brass, copper or other conducting material and is provided at its lower end with a removable contact tip 26ª. The upper end of each of these rods 26 is provided with a cup contact 27 adapted to electrically engage the upper end of the corresponding oil pot as indicated in Fig. 6. In order to insure good engagement, the contact 27 is slitted vertically so as to form a plurality of elastic tongues capable of yielding nicely when shifted home over the top of the oil pot. In operation each oil pot is filled with oil nearly to its top so that a small air space is left when the circuit is closed. Each rod 26 and its cup-shaped contact 27 may be removed from the fixed parts of the switch by detaching the bolts 28 at the top in a manner similar to that employed in the construction described in the application above referred to. Each pair of contact rods 26 is connected to the lower end of one of the wooden rods 29, 29ª and 29ᵇ which extend through the cap plate 4 of the fire-proof cell structure where they are connected by a yoke 30 which is actuated by the motor mechanism, located on the top of the cell structure, to reciprocate the contacts 26 into and out of engagement in their respective oil pots. The rods 26 of each phase are electrically as well as mechanically connected at their upper ends by a bar 30ª so that the circuit for each phase extends from one lead 7 through rod 9, plate 10, contact studs 12, 12ª, contact plate 14, rod 17 to the shell of the oil pot 16 and its fixed contact 25ª, thence to the connecting bar 30ª through two paths, one extending through the shell of the oil pot and the other through the contact rod 26. The path from the connecting bar 30ª to the other terminal 7 extends through the corresponding connections and parts of the other oil pot of the pair. In this organization when the circuit is broken

the parts are so arranged that the cup contacts 27 will pass out of engagement with the upper end of the oil pots 16 before the contact rods 26 leave the fixed contacts 25ª within the oil thus causing the final breaks in the circuit to take place within the oil pots where they can be cared for by the oil bath.

The yoke 30 and the contact supporting rods 29, 29ª, 29ᵇ move together without the assistance of guides to reciprocate the metallic contact rods 26 into and out of the oil-pots in right lines. The means of effecting this is a special system of levers, the yoke 30 being pivoted to the end of a pair of levers 47 controlled by a crank 36 which is operated directly or indirectly by an electric motor 31, and the free ends of the levers 47 to which the yoke 30 is pivoted describing a right line in their motion through the parallel links 48, 48ª, one of which is pivoted to the crank and the other to the frame. Other levers 46 of the same length as the levers 47 assist in this motion, being pivoted at a central point to a standard on the cap-plate of the switch mechanism and each controlled by a double helical spring 44 swiveled to a fixed point 45 of the frame and to the levers 46. When the switch is in a closed position these stout springs are extended and act with sufficient power when the detent is released to assist the main control spring 43 in rapidly throwing the switch. It will be seen from Fig. 4 that the springs 44 act at the initial movement of releasing the switch almost at right angles on the levers 46, thereby exerting a maximum pull and delivering a maximum amount of assistance to the main spring at the exact moment when such assistance is desirable. An essential advantage in the opening of all types of switches is a sudden break because it reduces the amount of metal volatilized and thereby renders the arc less difficult to extinguish. The main control spring 43 and the springs 44 conspire when the switch is opening to give a very rapid upward thrust to the movable switch member, throwing it clear through its path of traverse and into engagement with the opposite control spring 43ª. During the latter stages of this movement however the angle at which the springs 44 act with relation to the levers 46 changes so that the springs become less effective by reason both of their decreased tension and of their change of angular relation; and this is desirable inasmuch as after a sufficient motion has been given to extinguish the arc, the parts must be brought to rest and the decreasing effectiveness of the spring contributes toward this result.

From the above-description it will be seen that if the crank 36 is moved to dead center or approximately dead center and held there, the control spring 43, or 43ª, will be maintained under strain. If then the crank be free to move, the control spring will throw the movable switch element either to its closed or open position, as the case may be. For the purpose of rotating this crank 36 so as to compress the control springs 43, 43ª, any suitable motor mechanism may be employed but preferably we employ the electric motor 31 mounted upon the cap 4 of the fire-proof cell structure and adapted to be thrown into engagement with a worm shaft 33 by means of a clutch 32 controlled by an electromagnet 34 as hereinafter more fully described. The worm shaft 33 is in operative engagement with a worm gear provided with an interior ratchet clutch, as clearly illustrated in Fig. 11, by which its movement may be transmitted to the crank shaft 37. The ratchet clutch comprises an interior and an exterior member with intervening engaging dogs 55 which are concentrically mounted and free to rotate in their bearings at their inner ends and to bite into or disengage at their outer ends the circular wall of the worm gear. In operation, when the worm gear is driven in the direction indicated by the arrow in Fig. 11, these dogs are tilted and being shaped with an eccentric face bind on the worm gear thus locking the worm gear and the crank shaft together. It will be seen, however, that if the shaft itself were turned in the direction of the arrow no such obstruction to its rotation would be offered since the springs 56, one of which is placed behind each dog, permit the latter to yield sufficiently to allow the crank shaft to rotate. Thus it will be seen that when the parts are moved to the position in Fig. 4, when the crank is just a little off center with respect to the link 48, the interior clutch member can move forward and obey the impulse of the retaining spring 43 thus permitting the movable switch element to be tossed upward independently of the driving member, a movement which is accomplished with great rapidity by the strong spring and which results in opening the circuit before any great amount of oil has been volatilized. In order to hold the crank shaft 37 against rotation when the appropriate controlling spring has been compressed so that the switch may be held in either closed or open position, a movable dog 38 having a projection lying in the path of movement of an arm 35 keyed to the shaft 37, is provided. This dog is mounted on a shaft 39, which is connected by a crank with the locking toggle 40. This toggle is extended or collapsed by an armature 41 of a trip magnet 42 (see Fig. 4) which may be included in a control circuit operated at a distant point. Thus it will be seen that, assuming that the switch is closed, when the trip-magnet 42 is energized, the armature 41 is

drawn forward, collapsing the toggle 40 and permitting the partial rotation of the detent shaft 39, thereby freeing the bar 35 and permitting the spring 43 to expand, shifting the parts instantly upward into contact with the spring 43ª. This movement is, as previously noted, assisted by the counterbalancing springs 44, which in the closed position are stretched. As will more fully appear hereinafter, the same movement which operates the trip coil starts the motor which rapidly accumulates speed and reëngages the clutch, thus putting the top spring 43ª under compression and in a position to assist in the closing of the switch when this is necessary.

The clutching and unclutching of the motor with the worm shaft will be understood from Fig. 5, in which 49 represents an iron-clad coil forming part of the clutch magnet 34 containing a movable core 50 connected with a push-rod 51 adapted to push against a coöperating rod 52 passing through the hollow worm-shaft and engaging a spring-pressed sleeve 53. This sleeve contains a socket or opening larger in diameter than the tubular worm-shaft in which it is nested, a helical spring 54 normally tending to hold the clutch open as indicated in Fig. 5. When however the coil 49 is energized, the core 50 is drawn forward, pushing the rod 52 to the right, compressing the spring 54 and engaging the motor driven jaw of the clutch with the jaw 53 secured to the worm-shaft. Immediately on deënergization of the coil 49 however, the spring 54 reacts and pushes open the clutch-jaws, thus disconnecting the motor. In the operation of the switch, this is timed so as to happen after either the spring 43 or 43ª has been put under a sufficient degree of compression. In the operation of the switch the same closure of the circuit which operates the trip coil 42, operates the clutch 53, and starts the motor, but the gear clutch having been set when the parts were brought to rest from a prior movement in such a position that it could move independently, the spring acts much more quickly than the motor. This is a distinctive feature of the present form of switch, and since there is approximately no load on the motor when the switch is thrown into operation the parts are in condition for instantaneous action and their inertia is compensated for. In the opening movement the movable element of the switch is projected with great violence upwardly toward the companion spring 43ª, and the parts are so arranged that the energy of the spring is substantially expended when the yoke 30 is brought against the spring 43ª. The motor, however, having already started, instantly operates on the clutch shown in Fig. 11, and is always in proper relation to drive the same by the slightest leading movement and carries the movable element through the balance of its traverse, putting the spring 43ª under compression to effect a subsequent closing movement of the switch.

In order to cut the motor and the clutch coil 49 out of circuit when the control spring is fully compressed, certain switch mechanism is provided. This mechanism is controlled by the movement of the crank-shaft 37. On this shaft, as seen in Fig. 8, are three cams, one of which is shown at 57. These cams coöperate with contact fingers 58, 59, 60 (see Fig. 10). The cam controlling the arm 59 has two notches in its engaging surface 180° apart and when either of them is in alinement with the finger 61, the contact 59 falls to the open position as shown in Fig. 8. When, however, the finger 61 is brought by the revolution of the cam out of the notches, contact 59 is raised into engagement with fixed contact 62ᵇ. The other contacts 58 and 60 have cams in which there is a single projection arranged relatively so as to bring the contacts alternately into engagement with similar fixed contacts 62ª, 62ᶜ.

The circuit relations will be understood from the diagram in Fig. 10, where plus and minus represent a source of current which may include a distant control switch.

The operating motor is indicated at 31 as a series motor, and 49 represents the clutch coil and 42 the trip coil.

62 represents a control switch which may be located at the switchboard or any other suitable point from which it is desired that the operator shall control the switch.

63, 63ª represent lamps which may be placed at a convenient point to show the operation of the switch.

64 represents a group of knife switches controlled by a lever 65 (see Fig. 9), by which they may be rocked into open or closed relation; in such relation they are adapted to be secured by means of a Yale lock, the bolt of which is shown at 66, and which may be controlled by a key. The knife switches 64 complete four contacts for the control circuit, so as to make or break the circuit connections from the mains plus and minus to the motor and cam-operated contacts 58, 59 and 60. In the normal condition of the switch when it is in working condition, this switch will be shifted into closed relation with these contacts, as indicated in dotted lines in Fig. 8, but when thrown to the open position may be locked by a key just referred to, thereby preventing accidents while the switch is under repair by absolutely disabling the switch from closing the circuit. Now assuming that the manual operating switch 62 is closed on the left-hand contact, then the circuit through the operating motor would be by way of contact arm 58 thus operating the clutch-coil 49, as also the trip coil 42, instantly releasing

the spring, and, say closing the switch. The motor which finishes the compression of the spring, carries the worm-wheel and the clutch with it around through a definite angle of rotation, thus again setting the crank-shaft off center in which position it is detained by the detent 38 under the control of the trip-coil 42. As the crank-shaft rotates it will rotate the cams which actuate the movable contact fingers 58, 59 and 60 and these will lie in contact with their respective contacts 62^a, 62^b or 62^c, or not, according to the position of these cams. In either the closed or open position of the main switch, the cam 57 will be in non-engaging position with the contact 62^b; but the other two cams keep their contact fingers in contact, one in the open and the other in the closed position of the switch. When the control switch 62 is thrown to the left to close the main switch, the cam which controls the contact finger 58 is pushing the latter by means of its projection against the contact 62^a, thereby closing the control circuit at the point 58. Thus current will be thrown into the motor when the switch 62 is closed, as just described, thereby operating the trip coil 42, starting the motor and clutching it to the worm gear. The position of the main switch is indicated by the burning of the indicating lamps 63, 63^a. In this instance it will be seen that prior to the throwing of the control switch 62, the circuit through the lamp 63 is closed at the contact finger 58 while that through the lamp 63^a is open at the contact finger 60, thus leaving the lamp 63 burning to show that the main switch is open. By the movement of the switch 62 however, the lamp 63 is short circuited and both lamps 63, 63^a are left extinguished. Immediately after the switch parts move, the motion of the cam 57 raises the finger 59 against the contact 62^b, thereby closing a branch circuit through the finger 59 which is maintained independently of the manual control switch 62, keeping the switch in operation and demagnetizing the trip coil 42. Thus a complete cycle of switch movement is guaranteed irrespective of any interference on the part of the operator. If the operator should close the manual control switch and then quickly open it, he could not interfere with the opening of the main switch. This is an extremely important result inasmuch as it puts beyond chance of accident the cyclic movement of the switch when once started. When the switch movement has been completed, the turning of the shaft has thrown off the cam which engages contact arm 59 and at the completion of the switch movement the contact arm 60 is moved by its cam into engagement with its contact 62^c, thereby permitting current to flow through the lamp 63^a, thus showing that the switch is set. The current passing through the lamp is too weak to operate the motor, magnet 49 or trip coil 42. When the switch is again to be thrown the manual switch 62 will be shifted to the right so as to short-circuit the lamp 63, when a strong current will be thrown through the motor and trip coil and the switch again operated.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An electric switch comprising a switch member mounted to move in one direction to make the circuit and in the reverse direction to break the circuit, a spring operating means for moving said member in both directions, a motor for storing energy in said spring operating means during the movement of said member in one direction to effect a movement of said member in the reverse direction and vice versa, and means for controlling said motor.

2. An electric switch comprising a movable switch member to open and close the circuit, a spring for closing the switch, an independent spring to open it, a motor to store energy in either spring prior to its action on said member, and means for controlling said motor.

3. An electric switch having a movable switch member, a spring to counter-balance the inertia of the movable parts, a motor for operating said switch, spring-opening and closing means strained when the switch is opened to effect a closing movement thereof and vice versa, and means for controlling said motor.

4. An electric switch comprising a reciprocatory switch member, a power operated crank governing its movement, means for locking the crank in a definite position, a spring to shift the movable switch member when the crank is released, means for releasing the crank, and means for automatically cutting off power from said crank.

5. An electric switch comprising a reciprocatory switch-member, spring operating means for throwing the same, a motor for straining the spring, a rotary member driven by the motor and a clutch governing the movement of the reciprocatory member adapted to be driven by the rotary member and means for releasing the clutch and freeing the spring.

6. In an electric switch the combination of a driving motor, spring operating means strained thereby for throwing the switch, a clutch for connecting the motor and the operating means, and means for disconnecting the clutch when the springs are put under sufficient compression.

7. An electric switch comprising a spring-actuated reciprocatory member, a motor for storing energy in the springs, a crank for shifting the reciprocatory member, a lock

detent to detain said crank in an off-center position, electro-magnetic means for releasing the lock and means for stopping said motor when sufficient energy is stored.

8. An electric switch comprising an operating motor, a clutch for connecting the same with the movable switch-member, spring operating means for shifting the said member from one to another of its operative positions, and means permitting the member to be moved independently of the inertia of the motor through the major part of its opening or closing movement.

9. A motor-operated switch comprising a movable switch member, spring-actuated operating devices for shifting said member from one to another of its operative positions, a motor in gear with the movable member, adapted when operated to strain the spring-operating devices, a magnetically operated clutch between the motor and gear, means for opening the clutch at a determinate point in the movement of the gear, and a trip magnet for releasing the spring-operating devices independently of motor movement.

10. A motor operated switch, comprising a movable member, an actuating spring lying in the path of movement of said member, a motor for reciprocating said member to compress said spring, means for cutting out the motor when the spring is compressed, a ratchet clutch between the motor and the member, a detent for holding the spring compressed, and a trip coil to release the detent.

11. An electrically operated switch comprising a driving motor, a movable switch member, a control circuit including a manual switch, and circuit connections dependent upon the operation of said motor for maintaining the motor in circuit after the manual switch has been closed until the electrically operated switch has completed its movement irrespective of the manipulation of the manual switch.

12. An electric switch comprising a movable switch member, an electric motor for operating said member, a manual switch for closing a circuit through said motor, and means operated by the rotation of the motor to close a branch circuit through said motor, whereby the operation of said motor may be completed irrespective of the manipulation of the manual switch.

13. An electric switch comprising a reciprocatory switch member, an electric motor for reciprocating said member, two parallel circuits including said motor, a manual switch for severally closing said parallel circuits, means operated by the initial closing of one of said parallel circuits to close a branch circuit through said motor, and means operated by said motor to break the circuit last manually closed and place the other in condition to be closed by said manual switch.

14. An electric switch comprising a movable member, means for storing energy to actuate said member, an electric motor for operating said means, electromagnetic means for releasing said energy comprising a tripping coil, a manual switch for controlling an electric circuit including said coil and motor, and means actuated by said motor to close a branch supply circuit through said motor and excluding said coil.

15. An electric switch comprising a movable member, means for storing energy to operate said member, an electric motor for operating said means, connecting means between said motor and member comprising an electromagnetic clutch, electromagnetic means for releasing the stored energy comprising a tripping coil, a manual switch for controlling an electric circuit including the tripping coil, clutch and motor, and means actuated by said motor to close a branch supply circuit through said clutch and motor.

16. An electric switch comprising a movable switch member, a motor for actuating said member, a supply circuit for said motor including a plurality of branches, lamps and circuits therefor operatively related to said branches, and means operated by said motor to change the lamp circuits so as to indicate by the lighted lamp the position of said switch member.

17. An electric switch comprising a movable contact, an insulating rod connected thereto, a lever pivoted to the rod, a crank shaft linked to the lever, means for imparting a right line motion to the movable contact, an operating motor for the crank shaft, a detent for arresting the crank shaft when shifted over center with respect to its connecting link, and a trip coil for releasing the detent.

18. In an electric switch, the combination with an oil vessel having restricted openings for the escape of gases, and separable contacts arranged to break in said vessel under oil, of a baffle plate mounted in said pot in front of said openings to deflect the oil put in motion by the pressure developed by the arc and prevent the oil entering said openings.

19. An electric switch, comprising separable contacts arranged to break under oil, and an oil vessel surrounding said contacts and having in one wall above the oil level a plurality of laterally displaced openings forming restricted passages for the escape of gases.

20. In an oil-switch, the combination of an oil-chamber and a cap or head therefor formed so as to be removable from the chamber by pressure within the chamber and secured to said chamber by a joint capable of yielding on undue pressure.

21. An oil switch provided with a fixed terminal, and a removable contact connected therewith by a plurality of independent spring actuated studs, each connected in metallic contact with said fixed terminal by a flexible connection.

22. An electric switch provided with a frame, a movable contact, a rock-arm from one end of which the contact is supported, a motor crank connected to the center of the rock arm, a lever pivotally connected at its center to a stationary point on the frame and at one end to the center of the rock arm, said lever being the same length as the rock arm, a tension spring connected between the opposite end of said lever and a fixed point on the frame, and means for permitting a lateral movement of the free end of the rock arm whereby the movable contact is reciprocated in a right line.

23. An electric switch comprising a reciprocatory switch member, compression springs for engaging said member in its extreme positions, a motor for moving said member to compress said springs, springs for counterbalancing the weight of said member and means for controlling said motor.

24. An electric switch comprising a vertically reciprocating switch member, vertically arranged compression springs for engaging said member in its extreme positions, means for moving said member into engagement with said springs to compress them, a lever connected at its center to a fixed point and at one end to said reciprocatory switch member, and counter-balancing springs connected between the other end of said lever and a fixed point.

25. An electric switch comprising a movable switch member, an operating crank therefor, means for storing energy to operate said crank, a dog for locking said crank against rotation, a toggle for rocking said dog into and out of engaging position, and electro-magnetic means for breaking said toggle to release said crank.

26. In an electric switch, the combination with relatively movable coöperating contacts biased to separate, of operating mechanism for said contacts, connections for moving said contacts comprising a clutch controlled by said mechanism whereby said mechanism during its continuous movement in one direction brings said contacts into engagement and at a predetermined point in its movement leaves them free to separate independently of said mechanism, and latching means for holding said contacts in engagement.

27. In an electric switch, the combination with relatively movable coöperating contacts biased to separate, and means for moving said contacts, of operating mechanism for said contacts, a clutch between said means and said mechanism for connecting said means to said mechanism during closing movement of the switch and to release said means from said mechanism after the switch is closed, and latching means for holding said contacts in engagement.

28. In an electric switch, the combination with relatively movable coöperating contacts biased to separate, of operating mechanism for said contacts, a rotatable member having a crank pin thereon, connections between said crank pin and said contacts for bringing said contacts into engagement, when said crank pin is near center, a clutch between said operating mechanism and said member for moving said crank pin over center and then permitting said member to rotate independently of said mechanism, and latching means for stopping said crank pin over center with said contacts in engagement.

29. An electric switch comprising a movable switch member biased to break the circuit when the switch is closed, an operating crank for holding said switch member in circuit closing position when said crank is near dead center, and latching means for stopping said crank off center with said switch member in circuit closing position.

30. An electric switch comprising a movable switch member, a crank shaft for actuating said member, an arm carried by said shaft, a crank on said shaft connected to said switch member to actuate it, a dog mounted in the path of movement of said arm to stop said shaft with said crank off center, and means for moving said dog into and out of engaging position.

31. An electric switch comprising a movable switch member, a crank connected to said switch member to actuate it, an arm rigidly connected to said crank, a dog mounted in the path of movement of said arm to stop said crank off center, and electromagnetic means for moving said dog into and out of engaging position.

32. An oil-pot for an electric switch having an insulator guide formed so as to be removable from the pot by pressure within the pot and secured to the upper end of the pot by means of a joint of soft metal.

33. An electric switch comprising a movable switch member, an actuating motor therefor, a clutch member secured to the motor shaft, a coöperating clutch member movable into engagement therewith and operatively connected to said member, and a fixed magnet coil for throwing the clutch members into engagement.

34. An electric switch comprising a movable switch member, separately operating springs for reciprocating said member, a motor for alternately straining said springs coincidently with the opening and closing movements of the switch, and means for al-

ternately releasing the springs and cutting in the motor both to open and close the circuit.

35. An electric switch comprising an oil pot of conducting material constituting a circuit terminal, a movable cup-shaped contact adapted to embrace the same, and other contacts located within the pot and adapted to break the circuit under oil.

36. An oil-pot for an electric switch having an insulator guide formed so as to be removable from the pot by pressure in the pot and secured to the upper end of the pot by means of a joint of Babbitt metal.

37. An electric switch comprising a reciprocatory switch member pendulously supported free from guides, parallel motion mechanism for giving the said member a right line motion, and oppositely disposed springs for projecting said member to and fro through its range of motion and a motor for storing energy in said springs.

38. An electrically operated switch comprising a driving motor, a movable switch member, a control circuit, a control switch in said circuit, and connections governed by the movement of the motor for holding the circuit closed through the motor for a determinate range of movement independently of the movement of the control switch.

39. An electrically operated switch comprising a driving motor, a movable switch member, a control circuit, a control switch in said circuit, a normally open shunt around said control switch, and means for closing said shunt by the operation of the motor and automatically opening it after a determinate range of motor movement.

In witness whereof we have hereunto set our hands this 6th day of January, 1902.

EDWARD M. HEWLETT.
THEODORE E. BUTTON.

Witnesses:
EDWARD WILLIAMS, Jr.,
ANNA E. BUTTON.