J. N. KELMAN.

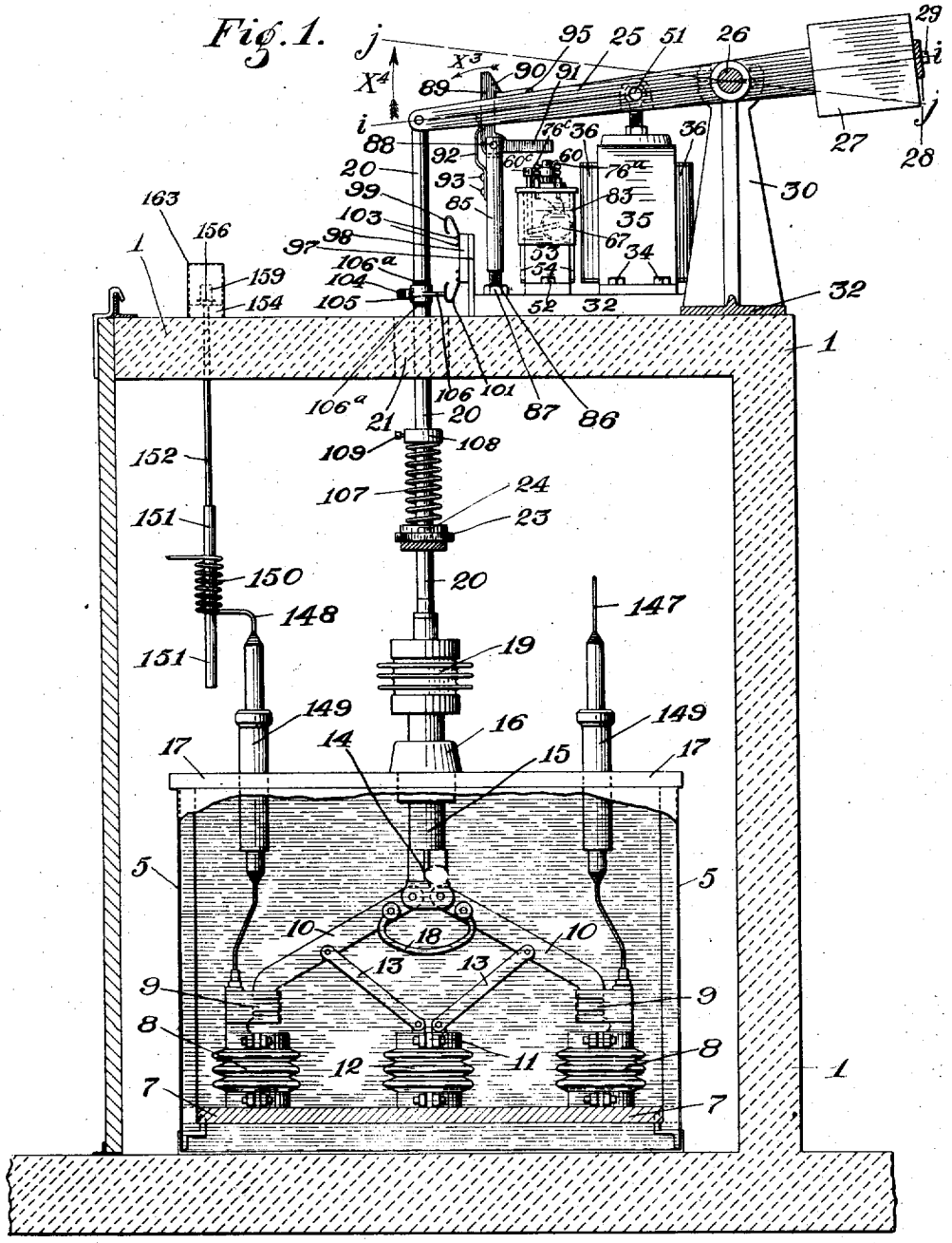
SWITCH AND CIRCUIT BREAKER FOR HIGH POTENTIAL CIRCUITS.

APPLICATION FILED JULY 29, 1908.

971,847. Patented Oct. 4, 1910.

7 SHEETS—SHEET 1.

Fig. 1.



Witnesses

Rich. D. McMillan

Ida M. Daskam

Inventor

Joseph Nelson Kelman.

By Sol. John Day.

Attorney.

J. N. KELMAN.

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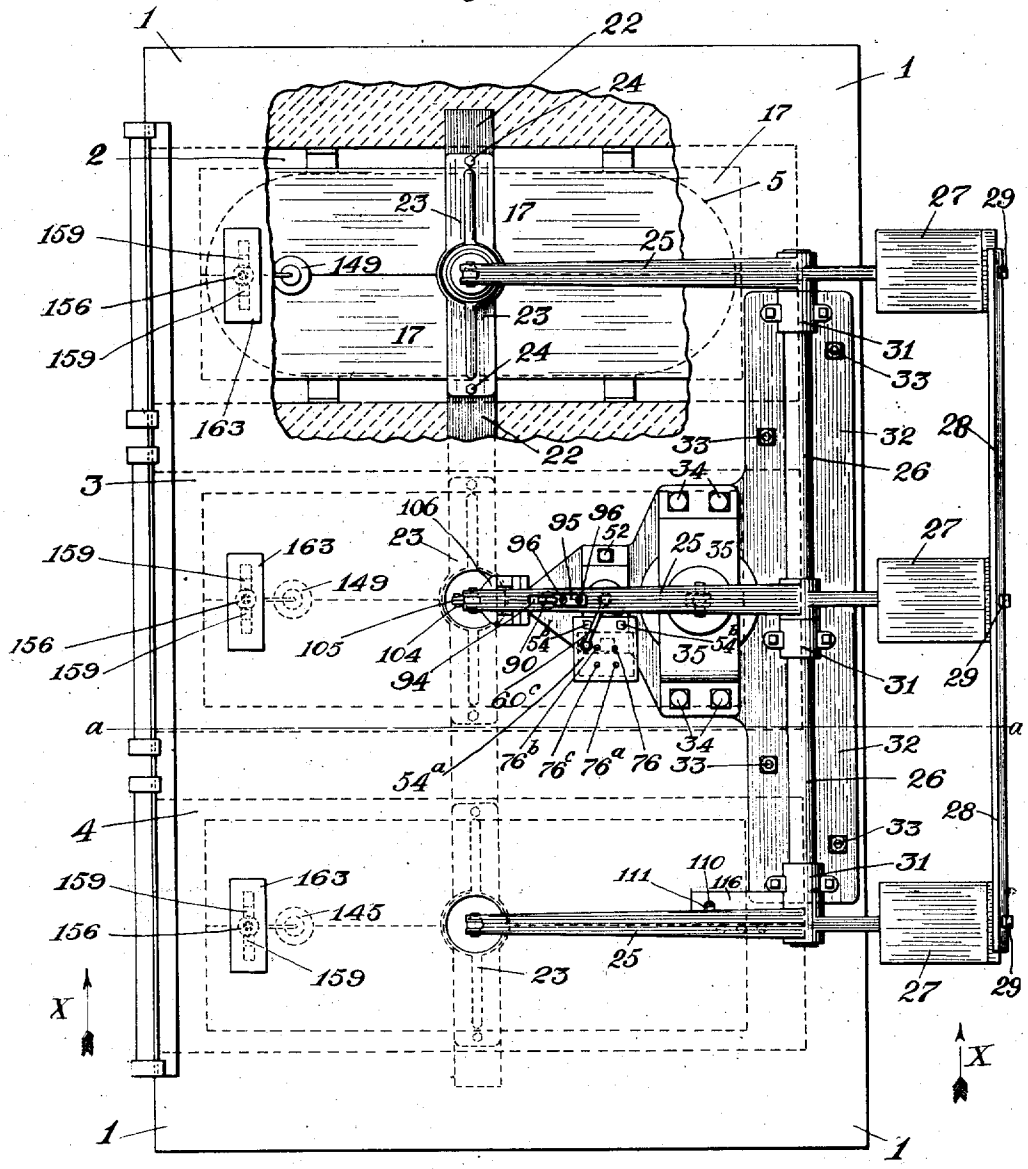
7 SHEETS—SHEET 2.

Fig. 2.



Witnesses

Rich. D. N. Myston

Ida M. Daskam

Inventor

Joseph Nelson Kelman.

By Sr. John Day

Attorney

J. N. KELMAN.

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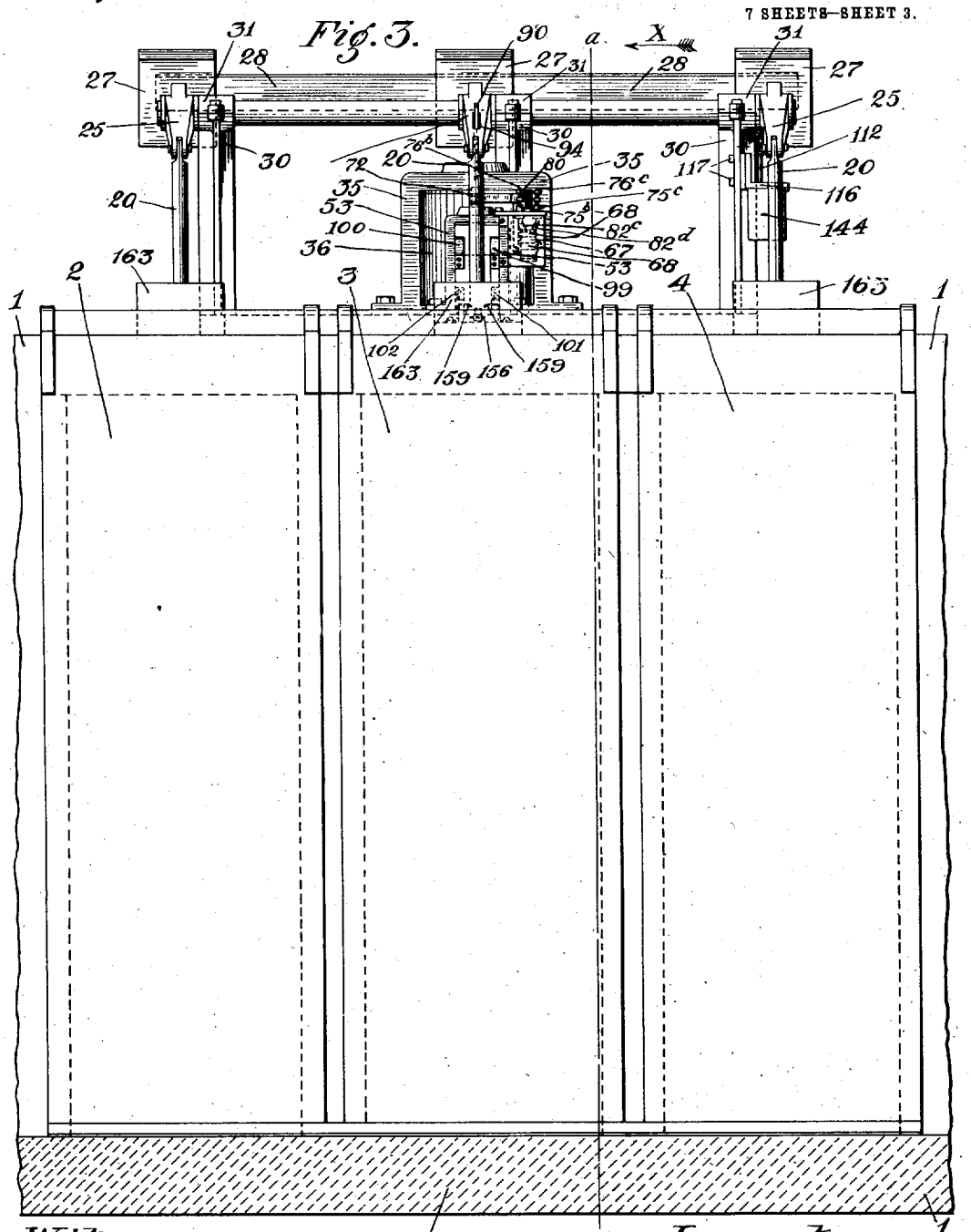
7 SHEETS—SHEET 3.

Fig. 3.



Witnesses

Richd. G. Mylton

Ida M. Daskam

Inventor

Joseph Nelson Kelman.

By John Day

Attorney.

J. N. KELMAN.

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7 SHEETS—SHEET 4.

Fig. 6

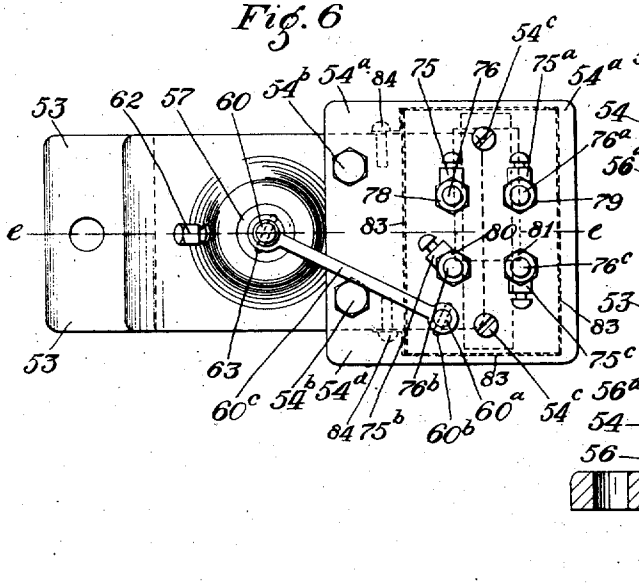


Fig. 7.

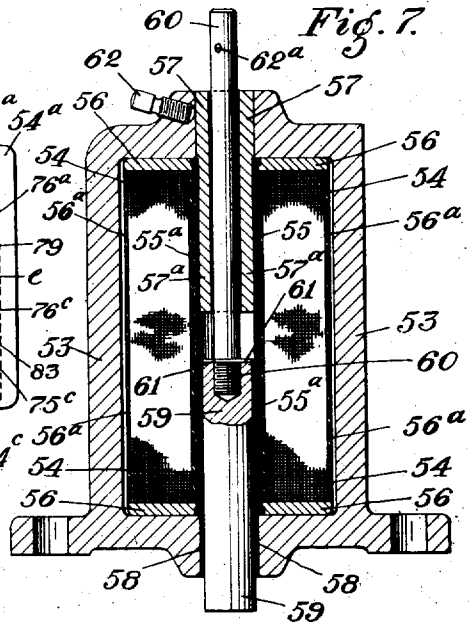


Fig. 4.

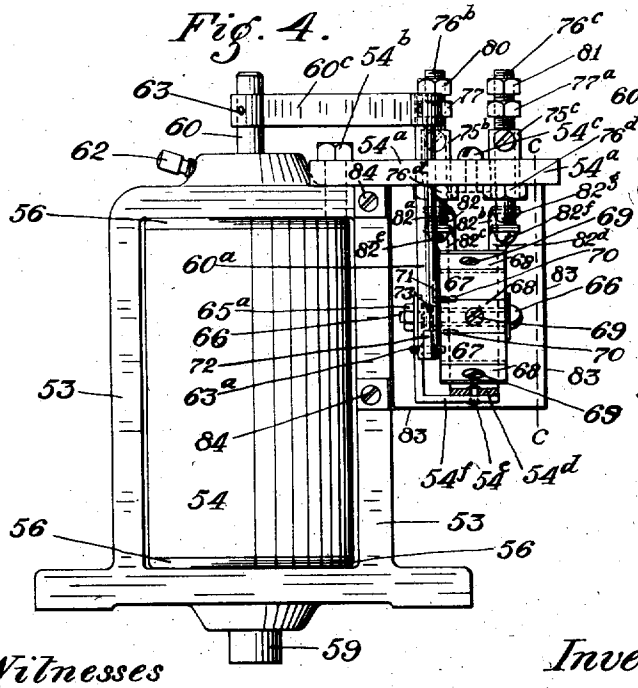
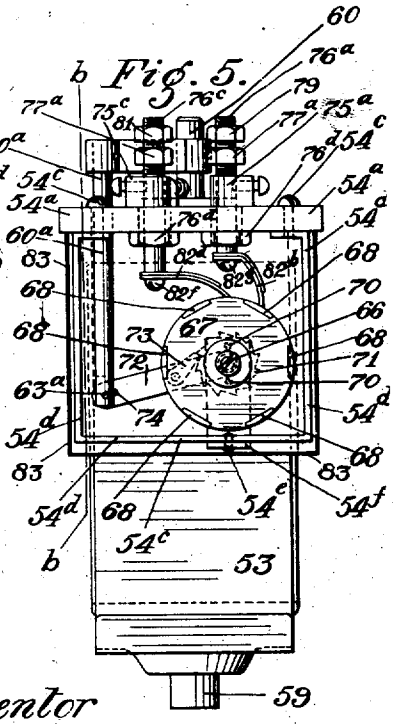


Fig. 5.



Witnesses

Rich. H. Mylius

Ida M. Daskam

Inventor

Joseph Nelson Kelman.

By . S. John Day

Attorney.

J. N. KELMAN.

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7 SHEETS—SHEET 5.

Fig. 8.

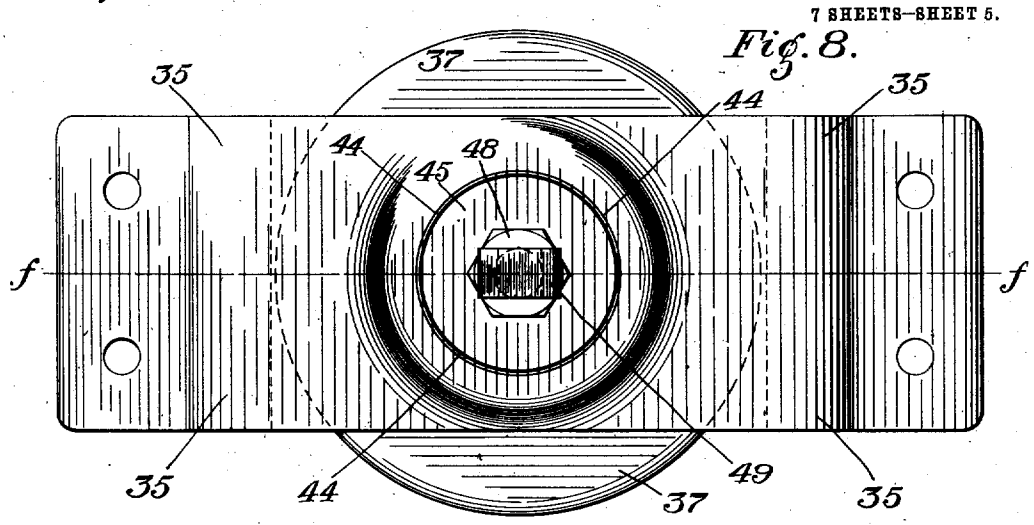
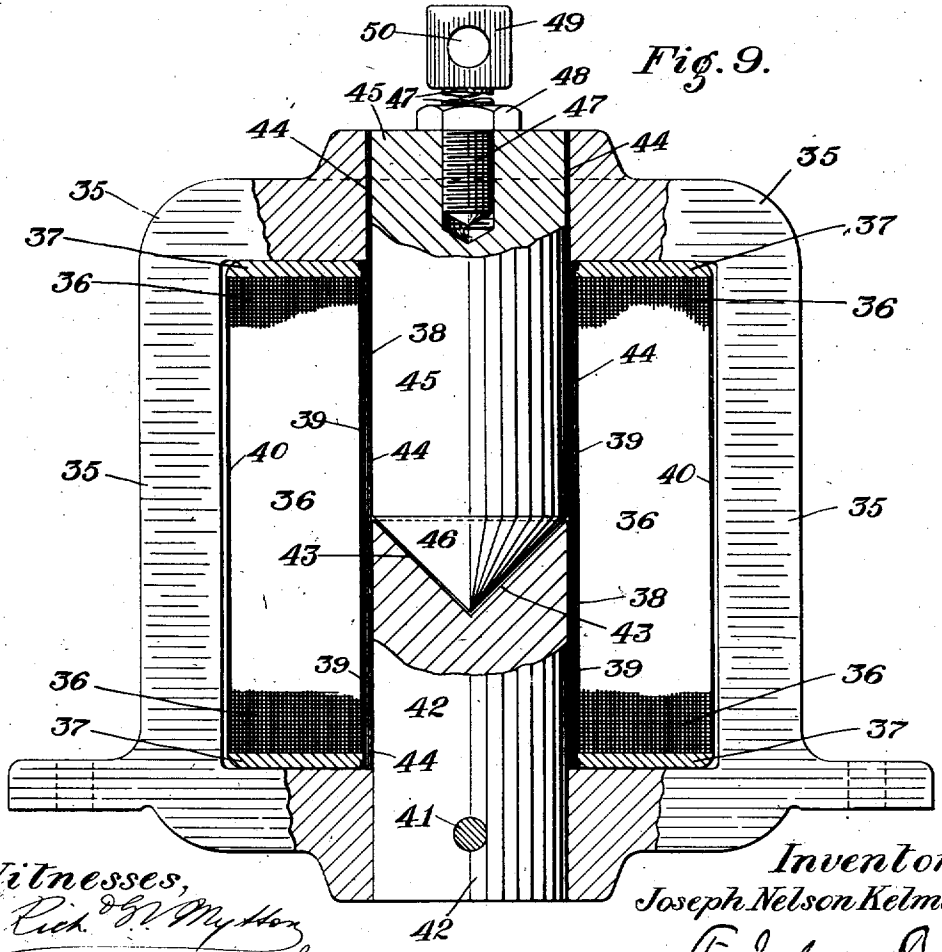


Fig. 9.



Witnesses,
Rich. V. Mytton
Ida M. Daskam

Inventor
Joseph Nelson Kelman.

By F. John Day
Attorney.

J. N. KELMAN.

SWITCH AND CIRCUIT BREAKER FOR HIGH POTENTIAL CIRCUITS.

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971,847. Patented Oct. 4, 1910.

7 SHEETS—SHEET 6.

Fig. 14.

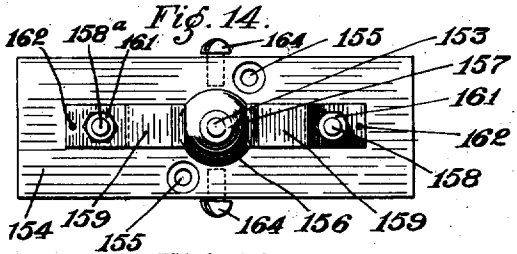


Fig. 13.

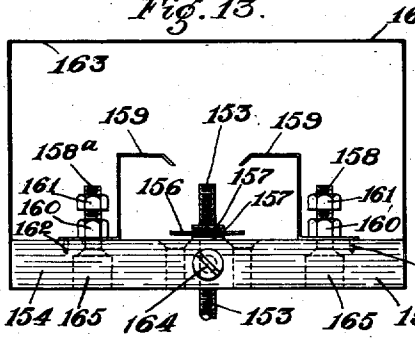


Fig. 12.

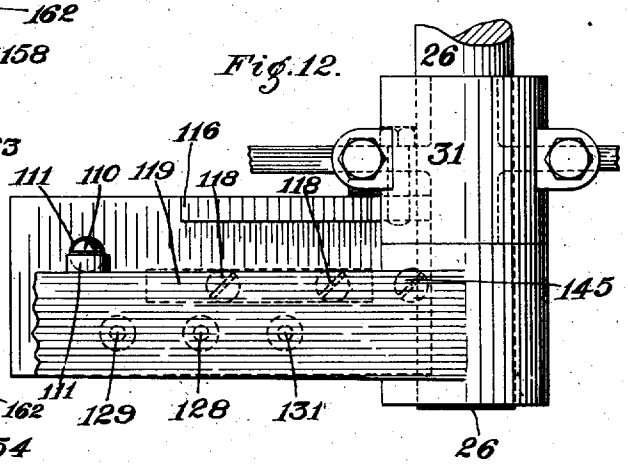


Fig. 11.

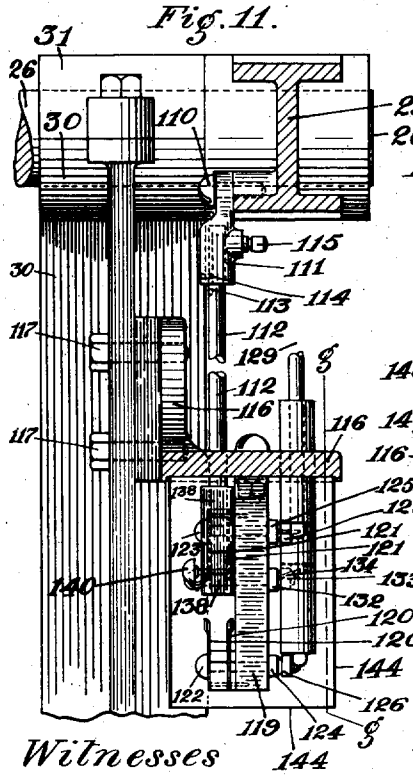
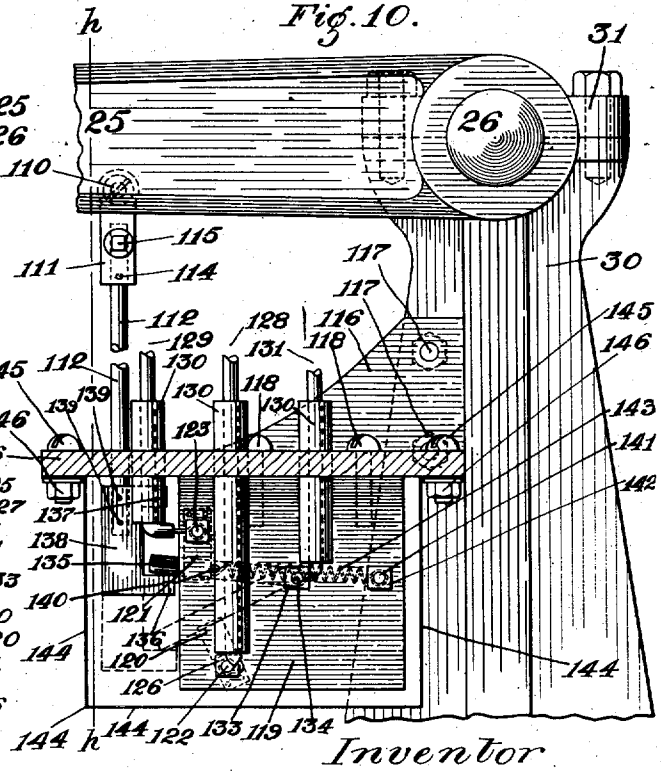


Fig. 10.



Witnesses

Richd. H. Mylton

Ida M. Daskam

Inventor

Joseph Nelson Kelman

By John Day.

Attorney.

J. N. KELMAN.

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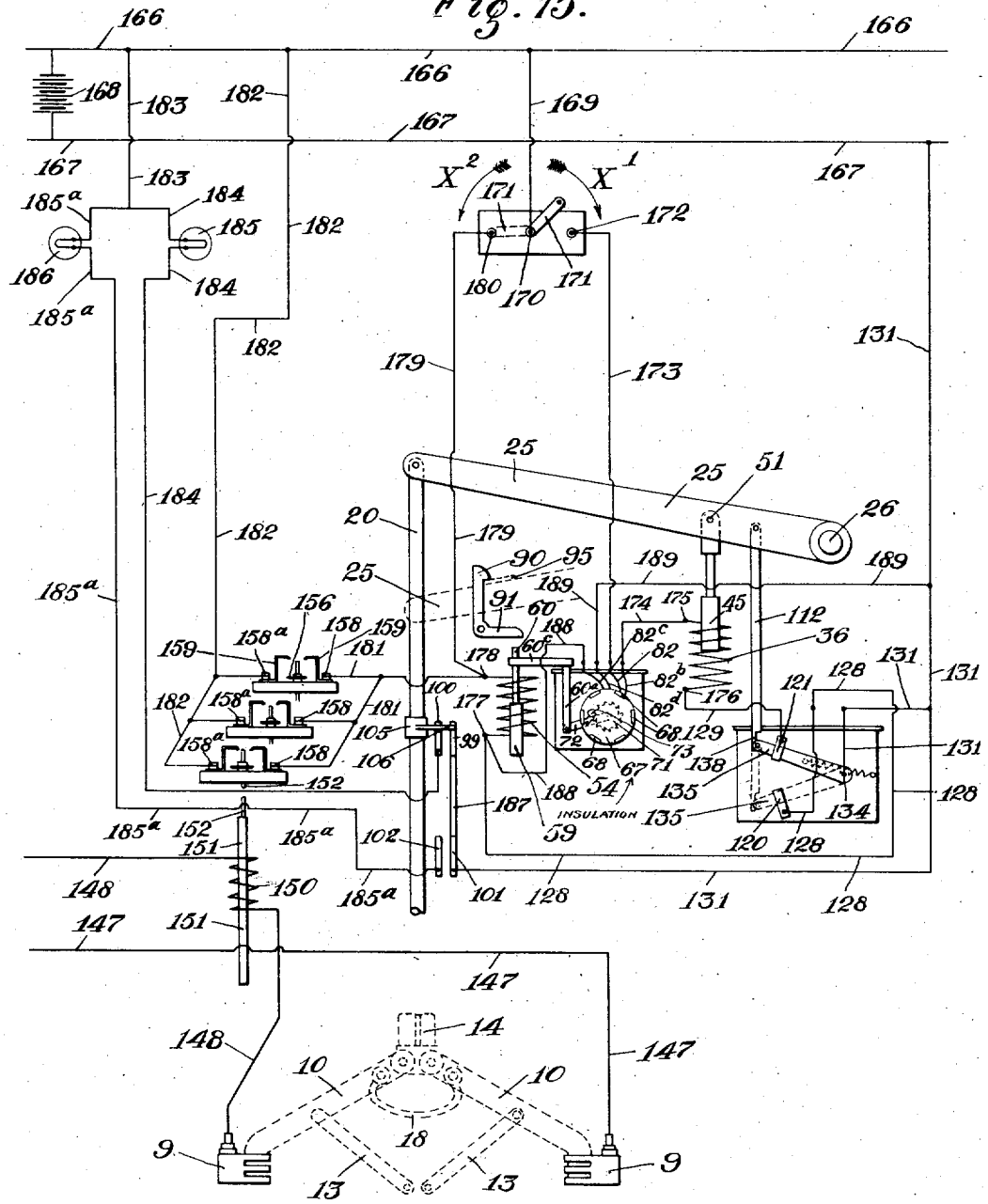
7 SHEETS—SHEET 7.

Fig. 15.



Witnesses

Rich. G. Mytton

Ida M. Dackeam

Inventor

Joseph Nelson Kelman.

By Sir John Day

Attorney.

UNITED STATES PATENT OFFICE.

JOSEPH NELSON KELMAN, OF LOS ANGELES, CALIFORNIA.

SWITCH AND CIRCUIT-BREAKER FOR HIGH-POTENTIAL CIRCUITS.

971,847. Specification of Letters Patent. **Patented Oct. 4, 1910.**

Application filed July 29, 1908. Serial No. 446,490.

To all whom it may concern:

Be it known that I, JOSEPH NELSON KELMAN, of the city of Los Angeles, in the county of Los Angeles and State of California, have invented a new and Improved Switch and Circuit-Breaker for High-Potential Circuits, of which the following is a full, clear, and exact specification, reference being had to the annexed drawings and to the figures and letters marked thereon.

The improved switch and circuit breaker for high potential circuits, constituting my present invention, is in part a development of switch and circuit breakers in respect of one of which Letters Patent have been issued to me, the said Joseph Nelson Kelman, and in respect of certain further improvements upon which I have filed another application for Letters Patent having the Serial Number 370,091, dated April 22nd, 1907.

The switch and circuit breaker for high potential circuits to which my present invention is adapted, is an automatic apparatus or mechanism for opening or interrupting high potential circuits under any condition of overload or short circuit, and the switch or circuit breaker in connection with which I use my present improvements is preferably of the type of such devices wherein the opening or breaking, and closing parts of the circuit are contained in a tank, or tanks of oil, and in such manner that the opening or breaking of the circuit, and the closing thereof take place within the body or bodies of oil as a highly non-conductive liquid medium, contained in one, two, or more of such tanks.

In the apparatus constituting my present improvements, the switch and circuit breaker is automatically opened when the current in the main circuit has become sufficiently high to excite one, two, or more solenoid coils forming part of the main circuit, to an extent sufficient to move a soft iron core within each such solenoid coil, or when the current in either of the solenoid coils of the main circuit becomes excessive, due to a short circuit taking place. This movement of a soft iron core operates a circuit closer of an auxiliary circuit. At the instant when this closing of the auxiliary circuit takes place, a solenoid coil in that circuit becoming excited, operates upon a movable soft iron core within it, causing that soft iron core to release a retaining catch engaging with a pivoted lever against which a spiral spring presses upward. This disengagement of the catch releasing the lever permits the spiral spring to push said lever upward upon its pivot, while the spiral spring on moving upward pulls the movable blades of the high potential circuit breaker out of electrical contact with the fixed contact thereof, each pair of such contacts being immersed in a tank of oil, or the attendant may open the circuit breaker by closing the switch on the switch-board, thus energizing the opening solenoid coil.

In the auxiliary circuit there are placed telltale lamps observable by an attendant at the switchboard; which lamps may be respectively green and red lamps, so that the attendant may always know whether the circuit breaker is opened or closed according to the color of the lamp which is illuminated by the current in the auxiliary circuit.

Whenever the attendant requires or finds it necessary to reclose the main circuit, he moves the switch on the switchboard into a position wherein current passes into the coil of another solenoid, which instantly that it is thus excited pulls downward a soft iron core therein whose upper end is connected pivotally to the lever with which the catch operated by the opening solenoid engages. By this operation the outer end of said pivoted lever is again lowered and the spiral spring on the rod connecting it to the movable contact pieces on the switch is recompressed, while the retaining catch at the same time engages with the outer end of the lever and holds the switch in operative relationship with the main circuit and in readiness for the main circuit to be again broken in the event of sufficient rise of current therein to operate the soft iron core, or cores within the solenoid, or solenoids, forming part of the main circuit.

Upon the annexed drawings Figure 1, is a vertical section through a cell or division containing one of my high potential circuit breakers, this section being drawn upon the line *a*, *a*, of Figs. 2 and 3, viewed in the direction of the arrows X, Figs. 2, and 3, showing the operative parts of the circuit breaker inside the oil tank, the front of which is broken out, and also showing in end elevation the new operative parts for opening and closing the circuit breaker situated upon the top of the cell. Fig. 2, is a plan corresponding to Fig. 1, a portion of the upper part of one of the concrete cells being broken out so

as to expose in plan one of the seats and its supports, for carrying the opening springs which operate to open the circuit breaker. Fig. 3, is a front elevation of the cells containing the oil tanks, and circuit breakers, and showing the apparatus constituting my present invention as fastened to the top of the concrete cells. Fig. 4, is a front elevation upon a larger scale, of the solenoid coil and soft iron core for effecting the opening of the main circuit whenever the current carried thereby exceeds the limit of safety, or when the circuit becomes short circuited, the frame for this part of the apparatus, and a rotary switch attached to the frame; and showing the oil tank for said rotary switch in vertical section taken upon the line *b*, *b*, of Fig. 5. Fig. 5, is a side elevation of the parts whereof Fig. 4, is a front elevation and showing the oil tank for the rotary switch in vertical section on the line *c*, *c*, of Fig. 4. Fig. 6, is a plan corresponding to Fig. 4. Fig. 7, is a vertical section upon an enlarged scale, through the opening solenoid coil, the frame therefor, and connected parts, some of which, including portions of the magneto-electrically operative core are shown in elevation, the parts in section being taken upon the line *e*, *e*, of Fig. 6. Fig. 8, is a plan upon the same enlarged scale as Figs. 4, to 7, inclusive, the solenoid coil, and magneto-electrically operative core for effecting the reclosing of the main circuit after it has been opened, either by reason of a short circuit, or a rise of the current above the limit of safe operation, or by an attendant. Fig. 9, is in part a vertical section taken upon the line *f*, *f*, of Fig. 8, showing the fixed and movable cores partly in vertical section, and partly in elevation, the outer portions of the frame containing the solenoid coil, being shown in elevation. Fig. 10, is a side elevation, upon the same scale as Fig. 4, of an auxiliary automatic switch, showing the supporting bracket, and the oil tank for said switch, in vertical section taken upon the line *g*, *g*, of Fig. 11, and showing also part of one of the lever arms for the main circuit breaker and part of one of the bearings for the shaft thereof in side elevation; the counterweight portion of the said lever being omitted. Fig. 11, is a vertical section taken upon the line *h*, *h*, of Fig. 10, showing the automatic switch in front elevation. Fig. 12, is a plan corresponding to Fig. 10. Fig. 13, is a side elevation of the overload release switch showing the cover for same in vertical section. Fig. 14, is a plan corresponding to Fig. 13, but without showing the cover. Fig. 15, is a diagram illustrating the arrangement of wiring and apparatus for completing the various electrical circuits between the several operative parts of my improved switch and circuit breaker.

In the construction of my improved switch and circuit breaker, I prefer to mount the switches for the high potential circuits, in sets of three, all operative simultaneously by one set of electrically operated opening and closing devices; this arrangement being illustrated in Figs. 1, 2, 3, and 15, wherein is a box 1, preferably constructed of concrete, containing cells, 2, 3, and 4. Within each of the cells 2, 3, and 4, is a tank 5, for containing oil, wherein the high potential circuit breaker is immersed. The circuit breaker which I prefer to use is of the construction in respect of which Letters Patent of the United States, No. 874,601, have been granted to me, and which circuit breakers are supported within each of the tanks 5, respectively. Near the bottom of each tank 5, is a beam of wood 7, to which are attached the porcelain insulators 8, 8, carrying the stationary contact poles 9, 9, with one of each of which each of the switch arms 10, 10, is adapted to engage so as to insure good electrical connection. Pivotally attached at one end to a clamp 11, supported upon another porcelain insulator 12, midway between the insulators 8, 8, are links 13, 13, which are oppositely pivoted to the switch arms 10, 10. The adjacent ends of the switch arms 10, 10, are electrically connected by a cable 18, and pivoted to a metallic connection 14, which in turn is connected to a wooden rod 15, which passes through an insulator 16, supported upon the marble or slate top 17, of the tank 5. The said wooden rod 15, is capped by a porcelain insulator 19, which in turn is attached to a metallic rod 20, which passes upward through an opening 21, in the top of the cell. Embedded in the walls of the cells 2, 3, and 4, Figs. 2, and 3, and extending therefrom into the cells, are short straps of metal 22, constituting brackets upon which the ends of the bars 23, constituting the spring seats rest. These bars 23, are attached to the metallic straps 22, by bolts 24, and by unscrewing the nuts upon the bolts 24, and taking out the bolts 24, the bars 23, are removable.

The upper end of each of the rods 20, is pivotally attached to one end of a lever 25; and the several levers 25, are rigidly mounted upon a common shaft 26, beyond which they are prolonged for a short distance and provided with counterweights 27. A bar of metal 28, extends across the ends of the counterweights 27, and is secured thereto by bolts 29.

The shaft 26, is rotatably supported in bearings 30, having caps 31, and said bearings 30, are preferably provided with a common base 32, secured to the walls of the concrete cells 1, by means of anchor or hold down bolts 33.

Beneath the central lever arm 25, and attached to the base 32, by bolts 34, is a metal

frame 35, adapted to contain a solenoid coil 36, shown in detail in Figs. 8, and 9. In the preferred construction, this solenoid coil 36, is wound upon a spool or bobbin consisting of disk-shaped ends 37, of hard fiber, rubber, or analogous material, centrally connected by a thin tube 38, of non magnetic metal such as brass, the exterior of the tube 38, being wound first with insulating material 39, such as cambric saturated with shellac varnish, next with a number of layers of insulated wire 36, composing the coil itself, and finally with a layer of hard twine 40.

Passing centrally through the base of the frame 35, and secured thereto by a pin 41, is a stationary core 42, of soft iron. The core 42, extends to a position about midway of the height of the solenoid coil 36, and is preferably constructed with a conical cavity 43, in the inner end thereof. Within the tube 38, and surrounding the stationary core 42, is another thin tube 44, of brass or similar metal, extending inwardly through a hole in the upper part of the frame 35, and fitting closely therein.

Within the tube 44, and slidable therein, is a movable core 45, of soft iron having a lower conical end 46, adapted to fit into the conical cavity 43, in the stationary core 42. This movable core 45, is internally screw-threaded at its upper end to receive and retain therein an adjustable eye-bolt having a screw-thread portion 47, provided with a jam-nut 48, and having a head 49, with a hole 50, therein, whereby it is pivoted by the pivot pin 51, (Figs. 1, and 2,) to the central lever arm 25, as shown.

Adjacent to the frame 35, and similarly attached to the base 32, by bolts 52, is a smaller frame 53, adapted to contain a solenoid coil of insulated wire 54, wound upon a spool formed of a central tube of brass 55, as shown in the enlarged section Fig. 7, fitting at each end into disks 56, of fiber, hard rubber, or analogous material. This solenoid coil is further insulated by shellac soaked cambric wrapping 55^a, or equivalent wrapping wound upon the tube 55, and exteriorly covered by a wrapping of hard twine 56^a.

Through a central hole in the top of the frame 53, there extends inwardly a hollow cylindrical stationary core 57, of soft iron having a reduced portion 57^a, upon which is fitted a thin tube of brass 58, which passes through the base of the frame 53, and forms a guide for a movable core 59, of soft iron having a stem 60, of brass, screwed thereinto, and a washer 61, of brass, separating the stationary hollow core 57, from the movable solid core 59. The core 57, is secured in the frame 53, by a set screw 62, or it may be otherwise equivalently secured therein, and the stem 60, is provided with a hole 62^a, for the pin 63, shown at Figs. 4, and 6.

To the upper part of the frame 53, is attached by cap screws 54^b, a plate 54^a, of fiber or other insulating material, and depending therefrom, and attached thereto by screws 54^c, is a U-shaped metallic frame 54^d, and attached to the said frame 54^d, by a rivet 54^e, is a metallic bracket 54^f, into the upper part of which, and secured by the jam-nut 65^a, is screwed a stationary axle 66, for carrying a rotatable roller 67, constructed of insulating material, provided with a brass contact piece 68, set into, and transversely of the rim thereof at equal intervals, and fastened by screws 69, as shown at Fig. 4.

Secured concentrically to one of the faces of the fiber roller 67, by pins 70, is a ratchet wheel 71, shown in dotted lines in Figs. 4, and 5, and adjacent thereto, pivoted at one end upon the stationary axle 66, is a lever 72, having a pawl 73, shown in dotted lines in Figs. 4, and 5, pivoted thereon, and engaging the teeth of the ratchet wheel 71. The opposite end of the lever 72, has a slot 74, therein, through which passes the pivot pin 63^a, upon the slotted lower end of a stem 60^a, which extends upwardly through the plate 54^a, and is connected by a pin 60^b, to a bar 60^c, which is oppositely connected to the stem 60, of the movable core 59, by the pin 63.

To the plate 54^a, are attached internally threaded blocks 75, 75^a, 75^b, 75^c, which are also externally threaded at their lower ends whereby they are secured to the said plate 54^a, by nuts 76^d, and within the blocks 75, 75^a, 75^b, and 75^c, are threaded studs 76, 76^a, 76^b, and 76^c, provided with jam nuts 77, and 77^a, and other nuts 78, 79, 80, and 81, for attaching wires thereto. At the lower ends of the said studs 76, 76^a, are attached by screws 82^a, 82^g, or otherwise attached thereto, laminated contact springs 82, 82^b, and to the lower ends of the studs 76^b, 76^c, are attached similar contact springs 82^c, 82^d, by screws 82^e, 82^f.

The lower ends of the contact springs 82, 82^a, 82^b, and 82^c, make contact with the surface of the roller 67, and are so situated that two of said springs 82, and 82^a, are simultaneously in contact with any one of the metallic contact pieces 68, when the remaining two springs 82^b, and 82^c, are simultaneously in contact with one of the insulating portions of the said roller 67, and conversely, when the two springs 82, and 82^a, are in contact with one of the insulating portions of the roller 67, the other two springs 82^b, and 82^c, are in contact with one of the contact pieces 68.

The teeth upon the ratchet wheel 71, are numerically equal to the sum of the metallic contacts 68, and the spaces between same, and successive upward strokes of the stem 60, by moving the lever 72, with its attached

pawl 73, rotate the roller 67, so that contact is made by the springs 82, and 82^a, alternately with one of the contacts 68, and the insulating portion of the roller 67, and the springs 82^b, and 82^c, alternate with the said springs 82, and 82^a, in making such contacts in the above described manner.

Surrounding the complete rotary switch is a tank 83, of thin metal for containing oil wherein the switch is immersed, the said tank 83, being secured to the frame 53, by screws 84.

Upon the base 32, Fig. 1, and adjacent to the frame 53, there is mounted a metal pillar 85, having a lower threaded portion 86, provided with a jam-nut 87, for securing vertical adjustment of the pillar 85, upon the base 32.

At the upper end of the pillar 85, and carried upon a pivot 88, is a bell crank lever having a vertical arm 89, provided with a detent catch 90, and having a horizontal arm 91, adapted to be struck by the stem 60, of the movable core 59, within the solenoid coil 54.

Bearing upon the arm 89, of the bell crank lever, is a spring 92, attached to the pillar 85, by screws 93. The bell crank arm 89, passes through a slot 94, in the central lever arm 25, and engages with a retaining plate 95, attached to the upper face of the lever 25, by screws 96, when the said lever 25, is in its lowest position, which is that position wherein it is shown in Fig. 1 and corresponding with that of its center line *i*, *i*. This position corresponds with the closed position of the high potential switch within the tank 5, as also shown in Fig. 1.

Attached to the base 32, and adjacent to the pillar 85, is a vertical metallic plate 97, Figs. 1, and 2, to which is attached a plate 98, of fiber or equivalent insulating material which carries spring contact pieces 99, 100, 101, and 102, secured to this plate by screws 103.

Above the concrete cell 3, there is fastened upon the rod 20, by the bolt 104, a clamp 105, having a fan-shaped projection 106, for electrically connecting the springs 101, and 102, in the lowest position of the said rod 20, and for similarly connecting the springs 99, and 100, in the highest position of the rod 20; the clamp 105, being insulated from the rod 20, by a band 106^a, of fiber or analogous insulating material.

Upon the spring seat 23, through which the rod 20, passes loosely, a helical spring 107, rests, this spring pressing upwardly against a set collar 108, secured by a set screw 109, to the rod 20.

At the lower part of one of the lever arms 25, there is a metallic socket 111, pivoted upon a pin 110, Figs. 10, and 11, which is screwed into the said arm 25, and there is slidably fitted a metallic rod 112, having a groove 113, therein, whereinto there projects a pin or key 114, for the purpose of providing vertical adjustment for the rod 112, but preventing said rod 112, from turning within the socket 111. When the rod 112, is properly adjusted vertically it is clamped within the said socket 111, by a set screw 115.

Upon the bearing 30, adjacent to the lever arm 25, to which the socket 111, is pivoted, a metal casting 116, is attached by bolts 117; and beneath the casting 116, and attached thereto by screws 118, is a block 119, of fiber or equivalent insulating material. Attached to this block 119, are two pairs of contact clips 120, and 121, respectively, secured thereto by screws 122, and 123, said screws being provided with nuts 124, 125, 126, and 127, for attaching the insulated terminal wires 128, and 129, of low tension circuit, which pass through insulators 130, which in turn pass through and are secured to the casting 116. A third terminal wire 131, is connected by nuts 132, and 133, to a screw 134, which forms a pivot upon the opposite side of the insulating block 119, for one end of a metallic contact lever 135, whose opposite end is capable of engagement by one or other of the projecting portions 136, 137, of a fiber block 138, connected by pins 139, to the lower end of the rod 112. Attached at one end by the pin 140, to the contact lever 135, and at the other end to the fiber block 119, by a bolt 141, and nut 142, is a helical spring 143; and inclosing the entire switch mechanism just described, is a tank 144, of thin metal secured to the casting 116, by bolts 145, and nuts 146; the said tank containing oil wherein the operative parts of the said switch are immersed.

In Fig. 1, the parts of the high potential circuit 147, 148, connected to the fixed poles 9, of the circuit breaker are shown as passing out through insulators 149, in the cover 17, of the tank 5; and one of such parts 148, is wound as a solenoid coil 150, within which is supported a glass or porcelain tube 151, within which is a soft iron laminated core not shown on the drawings, but of the same construction as the soft iron core shown and described in my application for Letters Patent, Serial Number 370,091, filed April 22, 1907, and attached to the laminated core is a rod 152, of wood or other insulating material, to the upper end of which is attached an externally threaded tube of brass 153, Figs. 13, and 14, and which passes upward through a block 154, of fiber or other insulating material, which has holes 155, therein for screws or bolts whereby said block is attached to the upper part of the concrete cell 3. Above the insulating block 154, the tube 153, has placed thereon, a disk 156, of bronze, the position of which is adjustable upon the said tube 153, by means of milled thumb nuts 157.

To the fiber block 154, there are attached by deeply countersunk screws 158, and 158ª, contact clips 159, having their upper ends bent inwardly and downwardly in such manner that the bronze disk 156, will make contact with both of them simultaneously when the said disk is raised vertically. The screws 158, and 158ª, are provided with nuts 160, for clamping the clips in place, and also with nuts 161, for attaching the wires for the completion of the low tension circuit of which this switch forms a part. The clips 159, are further provided with dowel pins 162, for retaining said clips in their proper position. The parts just described form the overload release switch, and are inclosed by a cover 163, of thin metal, attached to the block 154, by screws 164. The holes wherein the screws 158, and 158ª, are countersunk are filled with wax plugs 165, after the said screws 158, and 158ª, are in position.

In the diagram Fig. 15, are shown wires, sometimes designated "bus bars" 166, and 167, for the low potential circuit, and the source of current is indicated by a battery 168. Connected to one of these wires 166, is a wire 169, whose opposite end is connected to one of the terminals 170, of a single pole double throw switch provided with a double throw lever 171. One of the poles 172, of this switch is connected by a wire 173, to one of the contact springs 82, of the auxiliary rotary switch. From the similar contact spring 82ᵇ, of this rotary switch there extends a wire 174, oppositely connected to one of the terminals 175, of the solenoid coil 36, for effecting the closing of the high potential switch. Another wire 129, leads from the opposite terminal 176, of the coil 36, to the upper contact clip 121, of the automatic switch Figs. 10, and 11. The terminal constituted by the bolt 134, whereon the lever 135, is pivoted, is connected by the wire 131, to the opposite wire or "bus bar" 167, of the low tension circuit. The lower contact clips 120, of the automatic switch, are connected by the wire 128, to one of the terminals 177, of the detent releasing solenoid coil 54, for allowing of the opening of the high potential switch. The opposite pole 178, of the solenoid coil 54, is connected by a wire 179, to the pole 180, upon the operator's switch board. A wire 181, leads from the terminal 178, of the solenoid coil 54, to the several terminals 158, of the overload release switches, which are connected in parallel as shown in Fig. 15; and whose several opposite terminals 158ª, are connected by a wire 182, to the "bus bar" 166. Another wire 183, connects the "bus bar" 166, to a wire 184, in the path of which wire is introduced a light 185, of one color, such as green, the said wire 184, being thereafter connected to the contact clip 100. The contact clip 102, is connected by a wire 185ª, to the wire 183, and into its circuit is introduced a light 186, of another color, such as red. The contact clips 99, and 101, are integral, being provided with a central connecting portion 187. To the terminal 177, of the solenoid coil 54, is attached another wire 188, which connects with the contact spring 82ᶜ, upon the rotary switch, and the similar contact spring 82ᵈ, is connected by a wire 189, to the wire 131.

When it is desired to excite the high potential circuit by closing the fixed poles 9, 9, of the circuit breaker by the movable switch pieces 10, being engaged therewith, the circuit so completed having been previously opened, the attendant moves the switch blade 171, on its pivotal connection 170, in the direction of the arrow X′, Fig. 15, and into the position wherein the said switch blade 171, makes contact with the fixed pole 172, upon the operator's switch board; the low tension current then flows from the battery 168, through the wire or "bus bar" 166, the wire 169, the switch blade 171, the contact 172, the wire 173, the contact spring 82, the contact plate 68, upon the rotary switch roller 67, constructed of fiber or equivalent insulating material, the opposite contact spring 82ᵇ, the wire 174, the closing solenoid coil 36, the wire 129, the contact clips 121, the switch blade 135, the wire 131, and the "bus bar" 167, returning into the battery 168. The solenoid coil 36, being thus energized by the passage of the current therethrough, the movable core 45, operated thereby is attracted downwardly therein, and by means of its pivotal connection 51, to the lever arm 25, draws the said lever arm downward into the position shown in Fig. 1, and partly in dotted lines in Fig. 15, the corresponding closed position of the high potential switch being also indicated in dotted lines in said Fig. 15, in which position it is automatically locked by the detent hook 90, engaging with the locking plate 95, by the action of the spring 92. The several lever arms 25, being rigidly connected to the shaft 26, and by the bar 28, partake of the same motion as that of the central arm 25, and their several pivotally connected rods 20, are likewise moved downward, compressing the several helical springs 107, between the set collars 108, attached to the said rods 20, and the stationary spring seats 23, attached to the walls of the cells 2, 3, and 4.

The downward motion of each of the metallic rods 20, is conveyed to its corresponding attached wooden rod 15, and metallic connection 14, and the ends of the pivotally connected switch arms or blades 10, by the spreading action of the links 13, as the rods 20, descend, are caused to move laterally into the position wherein they make electrical contact with the stationary pole pieces 9, and thus close the high potential circuit.

In order that the low tension current may be caused to cease to flow through the closing solenoid coil 36, after the high potential switch is closed, and the levers 25, locked by the detent 90, Figs. 1, and 2, in the position shown in Fig. 1; the circuit through the coil 36, is opened by means of the rod 112, pivoted upon the outer lever arm 25, which rod 112, partaking of the downward motion of the said lever arm 25, carries with it the attached fiber block 138. The upper projecting part 137, of the said block 138, during the latter part of such downward movement, strikes the blade 135, of the auxiliary switch, thus releasing said blade 135, from contact with the contacts 121, and thereby opening the aforementioned circuit at this point. As soon as the automatic-switch blade 135, is disengaged from the contact 121, the said blade 135, is thrown sharply into engagement with the contacts 120, by the action of the helical spring 143, which as aforesaid, is at all times in a state of tension. The blade 135, then occupies the position shown in dotted lines in Figs. 10, and 15, and wherein the circuit is closed through the opening solenoid coil 54, at this point.

When the operator desires to open the high potential circuit he moves the switch upon the switchboard in the direction of the arrow X^2, into the position wherein the blade 171, connects the terminals 170, and 180; which is that shown in dotted lines in Fig. 15. The low tension current then flows from the battery 168, through the "bus bar" 166, the wire 169, the switch blade 171, the wire 179, the opening solenoid coil 54, the wire 128, the contact clips 120, the auxiliary switch blade 135 the wire 131, and the "bus bar" 167, to the opposite pole of the battery 168. During the passage of the current therethrough, the opening solenoid coil 54, is energized, thereby attracting upwardly thereinto, the movable core 59, causing its attached stem 60, to strike the bell-crank lever arm 91, and thereby moving the detent 90, in the direction of the arrow X^3, Fig. 1, out of engagement with the lock plate 95. The compressed helical springs 107, upon the several rods 20, now react against the rigid collars 108, one on each rod 120, and move the said rods 20, together with the lever arms 25, in the direction of the arrow X^4, Fig. 1, and into the position wherein the center lines *i*, *i*, of the said lever arms 25, coincide with the center lines *j*, *j*, Fig. 1, and as shown in full lines in Fig. 15. The upward movement of the rods 20, by means of the connected parts, causes the high potential switch blades 10, to be withdrawn laterally from contact with the poles 9, thereof. The solenoid coil 54, having performed its function by releasing the detent 90, it is immediately thereafter deënergized by the opening of the circuit therethrough by means of the rod 112, pivotally connected to the outer lever arm 25, as shown at Figs. 10, and 11, the upward movement of which arm raises the said rod 112, with its connected insulating block 138, the lower projecting part 136, of which, carries the auxiliary switch blade 135, out of engagement with the contact clips 120, and into engagement with the other contact clips 121, shown in dotted lines in Figs. 10, and 11.

When the circuit breaker is opened automatically due to the current in the high potential circuit rising by reason of overload, or by the short circuiting of the electric current in the said circuit, one or two, or all of the solenoid coils 150, being thereby excited sufficiently to raise the soft iron core within the glass tube 151, and the wooden rod 152, attached to the said soft iron core being thereby raised so as to bring the attached metallic disk 156, into electrical contact with the clips 159, low tension current then flows from the battery 168, through the "bus bar" 166, the wire 182, the clips 159, the disk 156, the opposite clip 159, the wire 181, the solenoid coil 54, the wire 128, the clips 120, the switch blade 135, and the wire 131, to the "bus bar" 167, and thence to the opposite pole of the battery 168. During the passage of the current through the solenoid coil 54, the said solenoid coil being thereby excited attracts the movable soft iron core 59, upwardly thereinto and its stem 60, striking the bell-crank arm 91, the detent 90, is disengaged from contact with the locking plate 95, upon the lever 25, which together with the other levers 25, is then forced upward by the spring 107, thereby opening the high potential switch in the manner previously described.

Whenever the attendant closes the high potential switch after the said switch has been opened either by an overload, or by a short circuit in the main circuit, it will thereafter be opened by the action of the solenoid coil 150, as hereinbefore described, whenever the current in the main circuit again reaches an excess of current, or the said main circuit becomes short-circuited, and will remain open so long as such main circuit is short-circuited, or overloaded, and this, notwithstanding the fact that the attendant may not have removed the switch blade 171, from contact with the pole 172, upon the switchboard, which is the position wherein it is placed for closing the main circuit. This result is accomplished by the action of the rotary switch which causes the closing coil circuit to be opened at that point, thus preventing the closing of the switch upon the main circuit by the action of the automatic mechanism.

The action of the auxiliary rotary oil switch is in detail as follows: The roller 67, upon the first upward movement of

the soft iron movable core 59, within the solenoid coil 54, is rotated by the pawl 73, pivoted upon the lever 72, by the upward movement of the stem 60, and connecting bar 60^c, so that the contact springs 82, and 82^b, for completing the circuit through the solenoid coil 36, are caused to rest upon one of the insulating portions of the said roller 67, thereby opening the closing coil circuit at this point. At the same time the contact springs 82^c, and 82^d, are caused by the same rotation of the roller 67, to rest upon one of the contact pieces 68, upon the said roller 67, thus closing the opening coil circuit at this point.

When the operator desires to again close the high potential switch, he moves the switch lever 171, in the direction of the arrow X^2, Fig. 15, and low tension current then flows from the battery 168, through the "bus bar" 166, the wire 169, the switch lever 171, the wire 179, the solenoid coil 54, the wire 188, the contact spring 82^c, the contact piece 68, the contact spring 82^d, the wire 189, and the wire 131, to the opposite "bus bar" 167, and thence to the opposite pole of the battery 168. The resulting excitation of the solenoid coil 54, causes the movable core 59, to make another upward stroke whereby the roller 67, is again rotated so as to bring the springs 82^c, and 82^d, of the opening coil circuit in contact with one of the insulating surfaces of the roller 67, and so as to bring the springs 82, and 82^b, of the closing coil circuit again in contact with one of the contacts 68, upon the roller 67, thereby opening the opening coil circuit, and closing the closing coil circuit at this point.

In order that the attendant may be able to observe whether the high potential switch be open or closed, the pilot lights 185, and 186, are provided, the green light 185, indicating that the switch is open, and the red light 186, indicating that the switch is closed.

When the blade 106, upon the clamp 105, which is attached to the rod 20, makes contact with the clips 99, and 100; which occurs when the high potential switch is open, current flows from the battery 168, through the "bus bar" 166, the wire 183, the wire 184, the contact 100, the blade 106, the contact 99, the wire 131, and the "bus bar" 167, to the opposite pole of the battery 168, illuminating the green lamp 185, in its passage therethrough.

When the high potential switch is closed, the blade 106, connects the clips 101, and 102, and low potential current flows from the battery 168, through the "bus bar" 166, the wire 183, the wire 185^a, the clip 102, the blade 106, the opposite clip 101, the wire 131, the "bus bar" 167, and thence to the opposite pole of the battery 168, and in its passage illuminating the red lamp 186, and thus indicating to the attendant that the high potential switch is closed.

I claim as my invention.

1. In a high potential switch and circuit breaker, wherein the parts for opening and closing the circuit are operated from a rotatable shaft, said rotatable shaft carrying a counterweighted lever rigidly keyed thereon, a retaining catch for holding said lever and shaft in the closed position of the circuit breaker, a solenoid coil and soft iron core for releasing said retaining catch whereby compressed springs react to open the high potential circuit, another solenoid coil and soft iron core connected to said lever operating to close the circuit, both of said solenoid coils being excited by a circuit separate and distinct from the high potential circuit to be opened or closed, a rod attached to the lever on the rotatable shaft, a spring upon said rod, said spring being compressed between a shoulder on said rod and a stationary bridge piece, said rod passing through said bridge piece, and connected insulatedly to the opening and closing arms of the circuit breaker, said spring operating to open the circuit when the opening solenoid releases the retaining catch holding the counterweighted lever, a portion of the main circuit wound as a solenoid coil, which when the current in the main circuit becomes too high, or the main circuit becomes short circuited operates a soft iron core carrying a non-conducting lifting rod with contact piece for closing the circuit of the opening solenoid coil, a rotating switch in the solenoid circuits operated by the soft iron core of the opening solenoid, an automatic switch in the solenoid circuits operated by the counterweighted lever on the rotatable shaft, said solenoid coils being connected to a double-throw manually operated switch on the switchboard, the opening and closing members of the circuit breaker being immersed in oil.

2. In a high potential switch and circuit breaker, wherein the parts for opening and closing the circuit are operated from a rotatable shaft, said rotatable shaft carrying a counterweighted lever rigidly keyed thereon, a retaining catch for holding said lever and shaft in the closed position of the circuit breaker, a solenoid coil and soft iron core for releasing said retaining catch whereby compressed springs react to open the high potential circuit, another solenoid coil and soft iron core connected to said lever operating to close the circuit, both of said solenoid coils being excited by a circuit separate and distinct from the high potential circuit to be opened or closed, a rod attached to the lever on the rotatable shaft, a spring upon said rod, said spring being compressed between a shoulder on said rod and a sta-

tionary bridge piece, said rod passing through said bridge piece, and connected insulatedly to the opening and closing arms of the circuit breaker, said spring operating to open the circuit when the opening solenoid releases the retaining catch holding the counterweighted lever, a portion of the main circuit wound as a solenoid coil, which when the current in the main circuit becomes too high, or the main circuit becomes short circuited, operates a soft iron core carrying a non-conducting lifting rod with contact piece for closing the circuit of the opening solenoid coil, a rotating switch in the solenoid circuits operated by the soft iron core of the opening solenoid, an automatic switch in the solenoid circuits operated by the counterweighted lever on the rotatable shaft, said solenoid coils being connected to a double-throw manually operated switch on the switchboard, the opening and closing members of the circuit breaker being immersed in oil, said apparatus having a circuit operated from the separate circuit with telltale lamps therein.

In testimony whereof, I have hereunto set my hand and seal at the city of Los Angeles aforesaid, in the presence of two subscribing witnesses.

JOSEPH NELSON KELMAN. [L. S.]

Witnesses:
ST. JOHN DAY,
J. D. CORY.