No. 812,880. PATENTED FEB. 20, 1906.

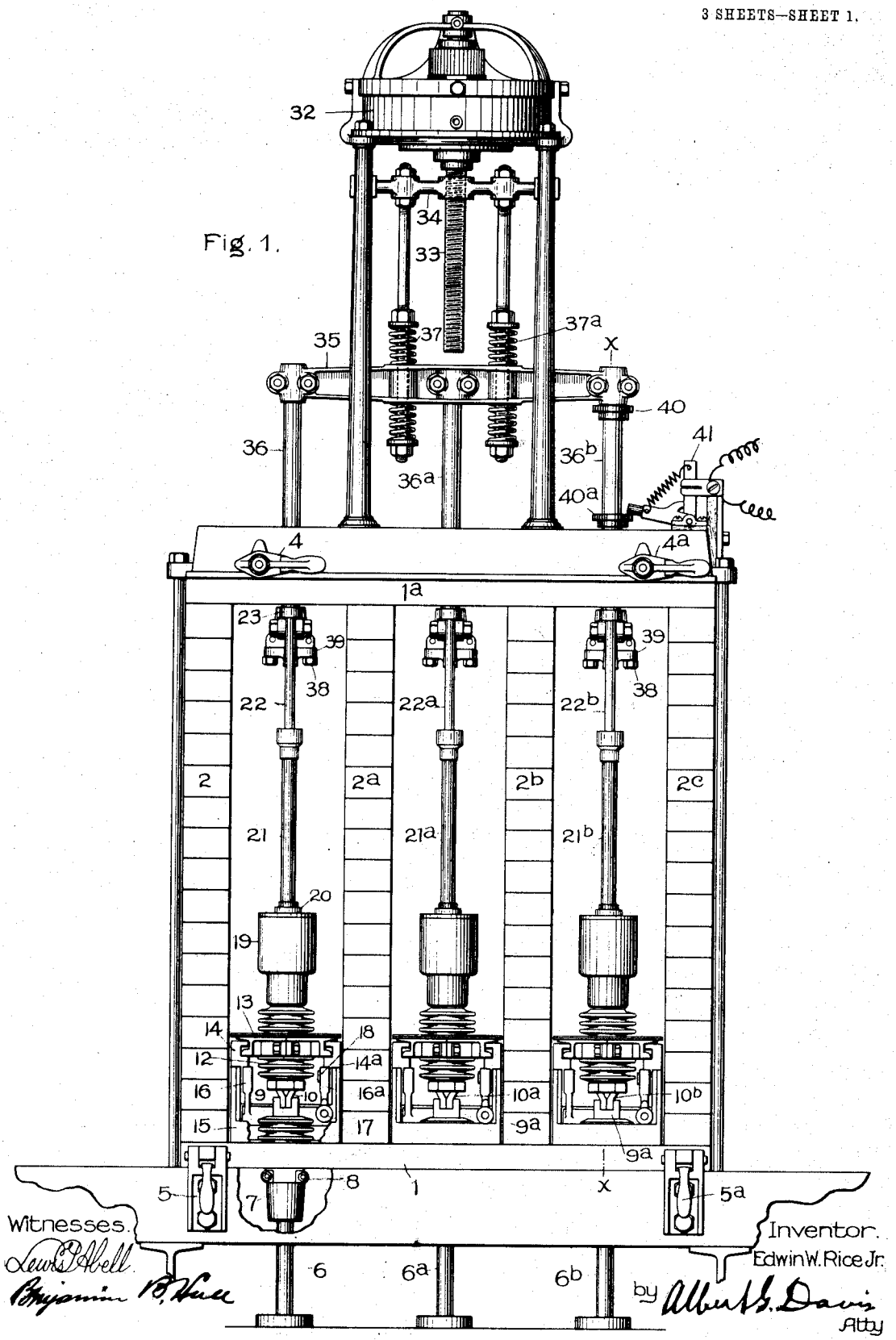
E. W. RICE, JR.

SWITCH OR CIRCUIT BREAKER FOR HIGH POTENTIAL CIRCUITS.

APPLICATION FILED DEC. 30, 1899.

3 SHEETS—SHEET 1.

Fig. 1.



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3 SHEETS—SHEET 2.

Fig. 2.

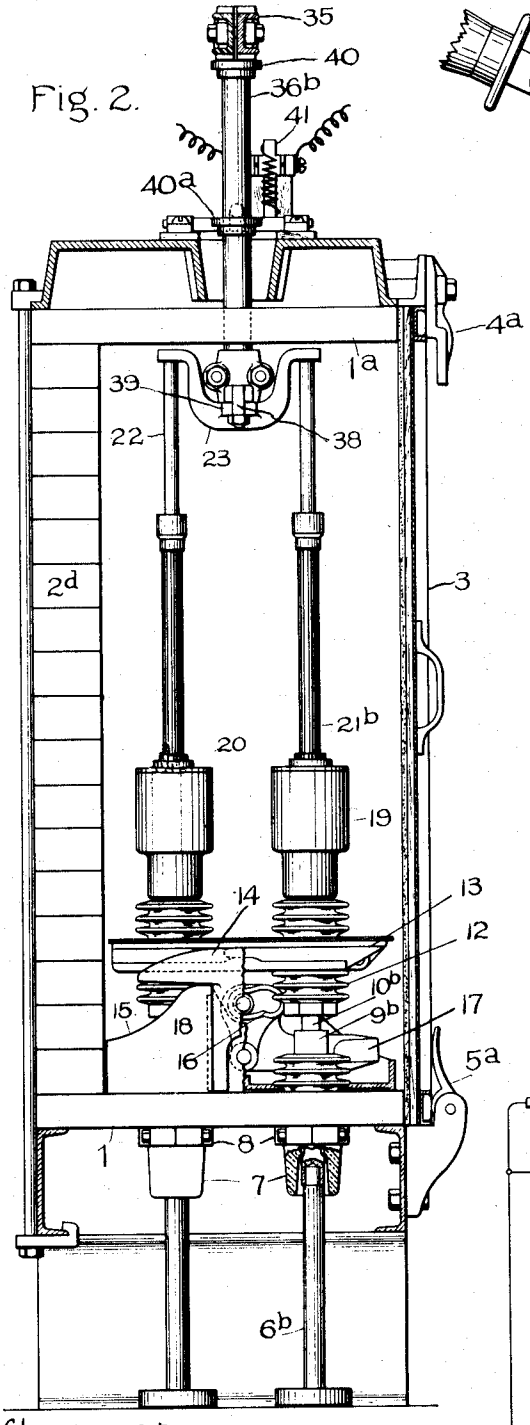
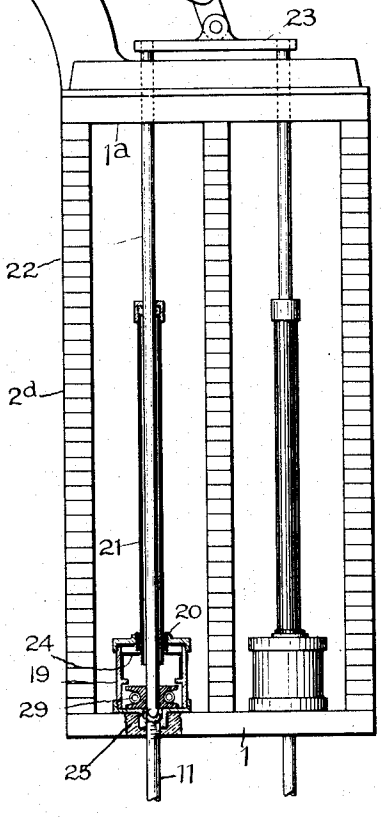


Fig. 3.



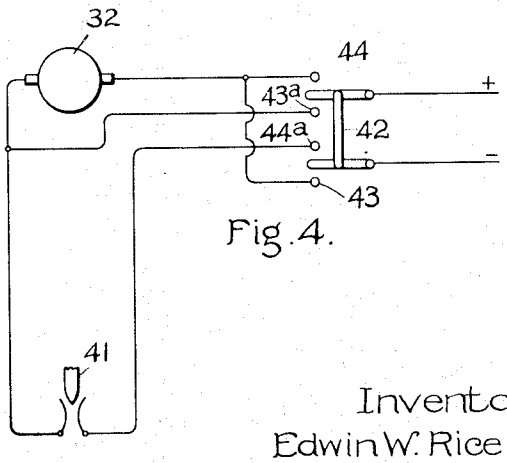


Fig. 4.

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3 SHEETS—SHEET 3.

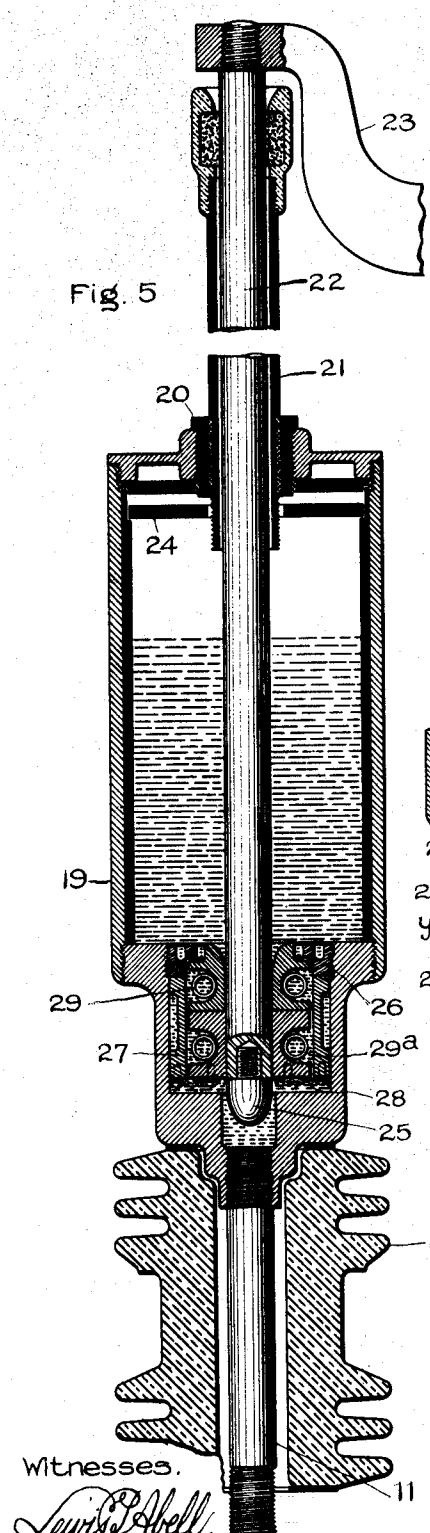

Fig. 5

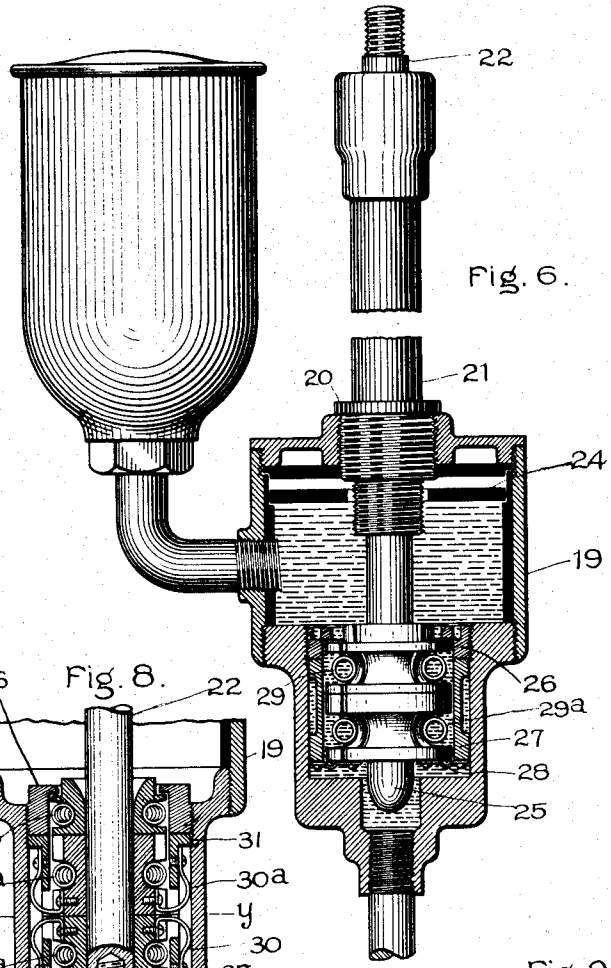

Fig. 6.

Fig. 8.

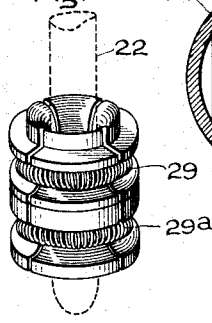

Fig. 7.

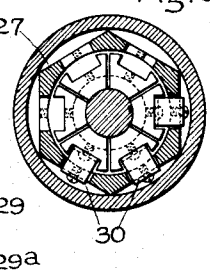

Fig. 9.

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UNITED STATES PATENT OFFICE.

EDWIN W. RICE, JR., OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

SWITCH OR CIRCUIT-BREAKER FOR HIGH-POTENTIAL CIRCUITS.

No. 812,880. Specification of Letters Patent. Patented Feb. 20, 1906.

Application filed December 30, 1899. Serial No. 742,124.

To all whom it may concern:

Be it known that I, EDWIN W. RICE, JR., a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Switches or Circuit-Breakers for High-Potential Circuits, of which the following is a specification.

This invention relates to means for opening and closing circuits carrying currents of high potential and large amperage. In rupturing currents of very high voltage, as from five thousand to forty thousand volts, particularly when the current exceeds one hundred or two hundred amperes, special provisions are necessary to guard against damage to the apparatus and surrounding objects from the large arc formed at the points of circuit rupture and to insure the safety of the operator who controls the apparatus. Various means have heretofore been provided for effecting this result, some of which involve a wide rapid separation of terminals inclosed between parallel barriers of insulating material and others of which involve a rapid separation of the terminals in a large reservoir of oil or insulating liquid; but prior devices have in general proven incapable of handling currents of the nature above described and have as a rule occupied a floor-space so large as to seriously embarrass designers and operators of generating stations, substations, &c. The great currents and high voltages of modern work have demanded switches of a better and more reliable character than anything heretofore devised, and my present invention aims particularly to provide a switch suitable for the largest alternating transmissions which shall be capable of opening positively and instantaneously a circuit carrying currents of the nature indicated above, while at the same time I am able to reduce the dimensions of the switch to reasonable limits.

An essential feature of my invention consists in inclosing the point of contact rupture within a small closed chamber, which may contain oil, air, or any other insulating medium and by means of which the heat of the arc is utilized to reduce the cross-section of the arc stream by means of the rapid increase of pressure when the circuit opens, thereby permitting the arc to be ruptured by a shorter range of movement than otherwise. Where oil or other insulating liquid is employed to surround the rupture-points, the range of movement is much shorter than when the surrounding medium is air or other insulating gas or vapor and the pressure developed by the heat of the arc forces the liquid to close in upon the arc or rather prevents the latter from increasing materially in cross-section and at the same time assures a rapid absorption of heat from the arc and assists in chilling the arc-vapor. A further advantage is afforded by the employment of oil in assuring throughout the arc stream the presence of a vapor of high insulating power, which also assures the rupture of the circuit within a shorter gap between the electrodes.

My improvements embody also means for operating the movable terminals without the presence of the operator in the immediate vicinity of the apparatus carrying the high-potential currents, thereby insuring his safety in manipulating it. To this end I provide some type of motor by which the movable electrodes may be operated with means for controlling it at a distance from the switch or circuit-breaker. I have found it convenient for this purpose to employ an electrical control-circuit, by which the closing and opening of the contact may be governed. I further increase the safety of the apparatus by employing multiple-pole contacts and separately inclosing each pair or group of contacts within insulating fireproof cells.

My invention also embodies improvements in the character of the contact by which better conductive relation is effected between the fixed and movable terminals, and repairs are facilitated.

Other novel features of the invention will be hereinafter described and will be definitely set forth in the claims appended hereto.

In the accompanying drawings, which illustrate the invention, Figure 1 is a front elevation, with the front cover removed, of an organization embodying my improvements adapted for a triphase alternating-current circuit. Fig. 2 is a sectional view on a plane at right angles to that indicated in Fig. 1. Fig. 3 is a view, partly in section and partly in elevation, of a modified form of switch or circuit-breaker. Fig. 4 is a diagram of the control-circuits employed for the apparatus shown in Fig. 1. Fig. 5 is a sectional view on the plane of the line X X of

Fig. 1. Fig. 6 is a sectional elevation of the parts at which the circuit is ruptured of a modified form of apparatus. Fig. 7 is a perspective view of an improved contact. Fig. 8 is a sectional view of a modified form of contact, and Fig. 9 is a section on a plane at right angles to that indicated in Fig. 8 and on the line *y y* of said figure.

Referring first to Figs. 1 and 2, which show an organized apparatus adapted for use with currents of very high voltage and large amperage—such, for example, as a current of fifteen thousand volts and five hundred amperes—1 represents an insulating-base, of soapstone, slate, or other fireproof insulating material, supported upon an iron foundation composed of a channel-iron frame mounted on I-beams. Within fireproof insulating-cells mounted upon this foundation are inclosed the rupture-points of the circuits. The particular type of apparatus shown in Figs. 1 and 2 comprises a two-point break for each leg of a triphase-circuit, with masonry walls of fire-brick 2 2^a 2^b 2^c, inclosing the rupture-points for each leg of the circuit. On the rear side of the apparatus there is another masonry-wall of fire-brick, as indicated at 2^d. (See Fig. 2.) The front is adapted to be closed by a removable door 3, formed of wood and sheathed on the outside with iron and on the inside with asbestos and adapted to be clamped upon the apparatus, as will be presently described. On top of the fire-brick walls rests a slab of soapstone or other fireproof insulating material, as indicated at 1^a, and upon the top of this slab rests a hollow cap of cast-iron firmly clamped to the base by bolts, as seen in Figs. 1 and 2. Upon this cap are provided buttons 4 4^a, which may be turned to lock the door 3 in position when the latter is inserted in place. The door rests upon bottom supports bolted to the foundation and provided with hand-operated cam-catches, as indicated at 5 5^a. The fixed terminals of the circuit 6 6^a 6^b and a similar range behind these terminals, as seen in Fig. 2, lead through insulators, as 7, mounted in the base 1, and are clamped thereto by a split washer, as 8. These terminals further lead through insulators, as 7, and terminate within the fireproof cells containing the circuit-breaking device in a bifurcated block, which forms a socket for a movable piece leading into the chamber where the contact is ruptured. This block is shown at 9 9^a, &c., and may be placed in or out of electrical communication with a tip 10 10^a, screwed to the end of a rod 11, Fig. 5, which passes through a porcelain insulator 12 and connects with the metallic inclosure for the circuit-breaking contacts. The insulator 12 is supported in a split yoke 13, of metal, grooved on the lower side and capable of being moved up and down for a short length of movement by blocks 14 14^a, sliding in grooves in the metal frame 15 and controlled by cams 16 16^a, (see Fig. 2,) journaled in the frame 15 and provided with a socket 17 to receive a long wooden handle to lift the tip 10 of the lower terminal away from the fixed terminal 6 of the circuit. Each cam is provided with an inclined slot, through which passes a pin, as 18, (see Fig. 2,) and by which when the cam is tilted the pin is forced upward, thereby lifting the contact 10 away from the fixed point 9 and permitting manipulation of the upper parts of the apparatus without danger to the operator. The rod 11, which may be placed by the apparatus just described in communication with the lower fixed terminal of the circuit, is firmly secured to the inclosing chamber 19 for the contact-points of the switch or circuit-breaker. The inclosing chamber is provided with a removable cap connected by an air-tight joint, in which is an insulating-bushing 20, (see Fig. 5,) supporting a long insulating-tube 21 21^a 21^b, through which passes with slight clearance the movable member 22 22^a, &c., of the switch or circuit-breaker, a light packing being provided at the top of the tube to prevent spattering of oil. In the type of apparatus shown in the drawings each leg of the circuit is provided with a two-point break, two independent movable rods, each coöperating with independent arc-inclosing chambers, such as 19, being connected together by a metallic yoke 23, (see Figs. 2 and 5,) connected to suitable means for causing up-and-down motion of the movable contacts. Each contact-chamber is lined with insulating material, such as indurated fiber, to prevent leakage of the high-potential current across the points of contact when the circuit is open. An additional thickness of insulation or a separate plate, as 24, may be provided at the top to prevent possible access of the arc to the joint. This provision will be found advantageous, especially where the contact is ruptured, without the presence of oil in the inclosing chamber. The movable contact is a cylindrical rod of good conducting material, as copper, shod at the lower end with an arcing-tip 25 of brass, provided with a screw to connect and disconnect it with the movable rod.

In order to effect a good contact, I provide the fixed terminal of the switch with an elastically-yielding socket for the movable element and mount the parts in such a way that the jaws of the socket spread on the entrance of the movable terminal at all parts of its length in a plane transverse to the contact, thus assuring a contact-surface of large area and high conducting power. An effective way of accomplishing this result is shown in Figs. 5 and 7, in which a plurality of segments formed by radially cutting a metal ring are inclosed within an annular helical spring. As many pairs of such rings as desired may be employed. In Fig. 5 two are shown resting

loosely in a socket formed in the base of the inclosing chamber and when contracted having an opening smaller than the diameter of the movable terminal. The upper ring may be flared to permit easy entrance of the movable terminal. The rings may be locked from displacement in the socket by an interiorly-flanged nut 26. The split rings are mounted so as to have a slight lateral play in their seat to compensate for any changes of alinement of the fixed and movable parts. The sections of the lower ring may be connected by screws, by metal strips 28, or otherwise, with a metal sleeve 27, closely fitting the socket in the bottom of the chamber. With this organization it will be seen that the helical springs 29 29[a] bind the segments of the ring firmly against the movable contact and hold the parts of the same with uniform pressure, affording uniform conductivity at all points over the surface of the joint.

In Figs. 8 and 9 a modification of the contact is shown which is somewhat more elaborate, but affords better electrical connection between the several parts. In this case the sleeve or shell 27 is connected with each of the separable contacts by means of an electrical conductor, as indicated at 30 30[a], &c., and a better conductive relation between the socket and shell may be provided by permitting the former to be screwed into the latter, as indicated at 31.

The operation of the switch may be controlled in any suitable manner. I have shown in the drawings as a typical method an electric motor 32, adapted to be operated from a distance by a control-circuit, the motor-armature carrying a vertical screw 33, engaging a nut in the cross-head 34, connected to a beam 35, in which are secured the rods 36 36[a], &c., to which the movable elements of the switch are connected. Between the cross-head 34 and beam 35 are compression-springs 37 37[a], acting as a cushion when the terminals of the circuit are closed and holding them in firm contact and when the circuit is first opened permitting a rapid movement for a short distance to assist disruption of the arc.

I provide a convenient means for detaching the operative parts of the circuit-breaker from the motor and from the base. Part of these have been already described, the connection between the movable elements and the reciprocating rods 36 being effected by pivoted clips, as 38, Fig. 2, engaging slotted lugs, as 39, at each side of the yoke 23 and provided with a tightening-nut for clamping the yoke to the rod. Thus to disconnect the upper part of the movable element the nut may be loosened and the link swung outwardly, permitting the rod 22 to drop, the cam 16 having first been raised, clearing the connection at the point 9 of the base, thus permitting the parts to be safely handled and withdrawn from the inclosing cells. Any suitable provision for making and reversing the circuit of the motor and cutting it out at the proper moment may be provided. As a typical means I have shown in the drawings two collars 40 40[a], fixed to the rod 36[b] and acting upon a snap-switch 41 to break the circuit at the proper instant. In downward movement when the circuit is closed the collar 40 engages a pivoted arm spring-connected with the switch-blade 41 and causes a rapid rupture of the control-circuit. The control-circuit, as will be understood from an inspection of Fig. 4, may be then in position to reverse the motor when the hand-operated switch 42, located at a distant point, is shifted. Thus after the motor has closed the main circuit the switch-blade 41 will have been withdrawn from the clip, thereby breaking the control-circuit. The latter, however, may be completed in a direction to reverse the motor by throwing downwardly the hand-operated control-switch 42 to engage the contacts 43 43[a]. The motor will then reverse and open the main circuit, and in so doing the collar 40[a] will close the snap-switch in the control-circuit. When the main circuit has been opened, the motor is stopped by the movement of the switch 42 to the position shown in Fig. 4, which breaks the control-circuit. In the arrangement shown the switch is moved by the operator; but it is evident that means could be provided to stop the motor automatically when the main circuit has been opened. When the snap-switch in the control-circuit is closed, the movement of the switch 42 into engagement with contacts 44 44[a] will start the motor 32 in the proper direction to move the beam 35 downward, and thereby close the main circuit. I prefer to give the movable element of the switch a range of movement sufficient to withdraw it from the arc-inclosing chamber and carry it through a considerable range of movement within the fiber tubes 21, &c. This is especially desirable where the arc is not broken under oil or where a very small oil-chamber is employed.

In Fig. 6 I have shown a modification of my invention in which the oil-chamber is reduced in size and is connected to a reservoir of greater capacity, thus preventing the necessity of frequent change of oil by reason of carbonization, and in Fig. 3 I have shown an organization in which each pole of the double-pole switch is inclosed in an independent fireproof cell and in which a very small oil-chamber is used and is connected with a long fiber tube, through which the movable electrode may be carried. In such cases if the oil should fail to extinguish the arc before reaching the tube it will be quickly extinguished after the tip of the terminal enters the tube by the rapid increase of resistance of the arc stream.

A feature common to all forms of the in-

vention illustrated in the drawings, as will be observed, is the small size of the arc-inclosing chamber, which affords several distinct advantages in rupturing the circuit. The small capacity permits a rapid increase of pressure when the arc is sprung, which reacts upon the arc stream and crowds the vapor of which it is composed into a compass of smaller cross-section, thereby increasing its resistance and permitting it to be more quickly extinguished. Where oil is employed, it requires also a much smaller quantity of oil, thereby reducing the fire hazard in the use of the apparatus and for storage of the oil, also reducing the expense of maintenance of the switch.

I have herein referred to oil as a typical insulating liquid. Other substances, however, may be employed which have great dielectric strength when in a liquid state, whether of an oily nature or not, among which may be mentioned glycerin and turpentine.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. Means for rupturing a high-potential current, comprising contacts, an inclosure around the points of contact adapted to store high pressure upon the separation of said contacts, a body of insulating liquid submerging the contacts, and quick-acting means for separating the contacts with a quick break and a long motion whereby the arc products are squeezed into small cross-section and the arc is stretched until ruptured.

2. Means for rupturing a high-potential current, comprising contacts, an inclosure around the points of contact adapted to store high pressure upon the separation of said contacts, a body of insulating liquid submerging the contacts, and quick-acting means for separating the contacts with a quick break and withdrawing one of them out of said liquid whereby the arc products are squeezed into small cross-section and the arc is stretched until ruptured.

3. Means for rupturing a high-potential current, comprising contacts, a metallic inclosure around the points of contact adapted to store high pressure upon the separation of said contacts, a body of insulating liquid submerging the contacts, a lining of insulating material for the inclosure extending above the level of the liquid to prevent jumping of an arc, and quick-acting means for quickly separating said contacts and withdrawing one of them from the liquid whereby the arc products are squeezed into small cross-section and the arc is stretched until ruptured.

4. Means for rupturing a high-potential current, comprising separable contacts, a small inclosure for the break-points of the contacts for confining the pressure produced by the arc so as to compress the arc into small cross-section as the contacts separate, an insulating liquid within said inclosure submerging said contacts, and means for separating said contacts with a quick break.

5. Means for rupturing a high-potential current, comprising contacts, a small vessel adapted to withstand great pressure containing an inelastic fluid insulator submerging the contacts, means for cushioning the pressure, and means for separating the contacts rapidly by a long movement whereby the arc is squeezed into a small cross-section of high resistance when the contacts are rapidly separated.

6. Means for rupturing a high-potential current, comprising contacts, a small oil vessel, a bath therein submerging said contacts when the circuit is closed, and power-driven means for rapidly separating the contacts with a long range of movement whereby the increase of pressure and wide quick separation of the contacts extinguish the arc.

7. A circuit-breaker or switch for opening circuits of high potential and large amperage comprising contacts, an oil-bath submerging the contacts, a small vessel containing said bath adapted to store high pressure, and an air-pocket in said vessel, small relatively to the volume of oil, whereby a sudden rise of pressure under heat of the arc compresses the arc into small cross-section and thereby admits of its easy extinguishment.

8. Means for rupturing a high-potential current, comprising separable contacts, an inclosure around the points of contact, a body of insulating liquid in said inclosure filling the greater portion thereof and leaving an air-space small relative to the volume of oil, and means for separating the contacts in oil and drawing one of them into the air within said inclosure.

9. Means for rupturing a high-potential current, comprising an inclosure, a body of insulating liquid contained therein, an apertured insulator for supporting said inclosure, a terminal extending through the aperture in said insulator into said inclosure, a contact in circuit therewith, a coöperating movable contact arranged to break therewith under the insulating liquid, and a support for said insulator embracing the exterior of the same.

10. An electric switch comprising two fixed contacts, two mechanically and electrically connected movable contacts adapted to be moved into and out of engagement with said fixed contacts, a separate inclosure for each break-point, a cover for each inclosure for rendering the same capable of withstanding high pressure and an insulating liquid in each of said inclosures submerging said break-points.

11. An electric switch comprising two fixed contacts, two mechanically and electrically connected movable contacts adapted to be moved into and out of engagement with said

contacts, a separate inclosure for each break-point, a cover for each inclosure for rendering the same capable of withstanding high pressure, an insulating fluid in each of said inclosures submerging said break-points, and means for separating said contacts with a quick break.

12. Means for rupturing a high-potential current, comprising separable contacts, an inclosure about said contacts containing a liquid insulator, means for separating the contacts in said inclosure, means for contracting the arc in cross-section after a definite range of movement and means for preventing the expulsion of the liquid from the inclosure.

13. Means for rupturing a high-potential current comprising separable contacts, an inclosure about said separable contacts, a tube communicating with the chamber, and means for separating the contacts in said chamber and drawing one of them into said tube.

14. Means for rupturing a high-potential current comprising separable contacts, an oil-chamber about said separable contacts, a tube communicating with the chamber, and means for separating the contacts under oil and withdrawing one of them into said tube.

15. Means for rupturing a high-potential current, comprising separable contacts, an oil-chamber about said separable contacts, a tube communicating with the chamber, and means for withdrawing a contact from the oil into the tube when the circuit is opened.

16. Means for rupturing a high-potential current, comprising separable contacts, an oil-chamber about said separable contacts, a tubular extension closely embracing the movable terminal, and means for withdrawing said terminal from the oil into the extension when the circuit is opened.

17. Means for rupturing a high-potential current, comprising a chamber containing an insulating liquid, separable contacts submerged in said liquid when the circuit is closed, a tubular extension in which the movable contact is mounted above the liquid-line, and means for withdrawing the movable contact from the liquid.

18. Means for rupturing a high-potential current, comprising a metallic closed chamber about a single pair of separable contacts, an insulating-lining for said chamber, a movable contact, a narrow tubular connection into which the movable contact may recede, and means for producing a long movement of said contact in said tubular connection to rupture the circuit.

19. Means for rupturing a high-potential current, comprising a closed chamber about a single pair of separable contacts, an insulating-lining for the chamber, a movable contact, a tubular extension of the chamber of insulating material closely fitting the movable contact, and means for withdrawing the contact from the chamber into the tube.

20. Means for rupturing a high-potential current, comprising an inclosure about the separable contacts, a tubular extension communicating with said inclosure and closely fitting the movable contact adjacent to its connection with the inclosure, and means for separating the contacts in said chamber and drawing one of them into said tube.

21. A switch or circuit-breaker for high-potential currents, comprising multipolar separable contacts, independent substantially air-tight inclosures having solid insulating-walls for the several contacts, and quick-acting means for separating all poles simultaneously with a quick break.

22. A switch or circuit-breaker for high-potential currents, comprising multipolar separable contacts, an independent oil-chamber about each pair of contacts, said oil-chambers being so arranged as to prevent the arc from holding over between the different sets of multipolar contacts, and quick-acting means for separating all poles simultaneously with a quick break.

23. A switch or circuit-breaker for high-potential currents, comprising multipolar separable contacts, an independent closed oil-chamber around each pair of contacts, and quick-acting means for separating all poles simultaneously with a quick break.

24. A high-potential switch or circuit-breaker comprising circuit-terminals, a plurality of closed oil-pots containing an oil-bath for the circuit-terminals, and quick-acting means for moving a plurality of the circuit-terminals simultaneously to form a plurality of quick breaks under the oil.

25. A multiphase electric switch comprising a plurality of pairs of separable contacts, an independent inclosure for each pair, insulating liquid in each inclosure, and quick-acting means for simultaneously separating all the contacts with a quick break.

26. A multiphase electric switch comprising a plurality of pairs of separable contacts, an independent inclosure for each pair, insulating liquid in each inclosure, and insulating-partitions for separating the inclosures of the different phases.

27. A multiphase electric switch comprising a plurality of pairs of separable contacts, an independent inclosure for each pair, insulating liquid in each inclosure, and insulating-walls for completely inclosing the inclosure of each phase.

28. A high-potential switch comprising an insulating-support, polyphase terminals mounted in a plurality of separate insulated closed cells, one for each phase, an operating-motor, and a control-circuit governing the motor leading a distance from the switch.

29. A high-potential switch comprising multipolar break-points housed in oil-baths in separate insulated closed cells, an operating connection on the outside, a motor con-

nected therewith, and a control-circuit governed from a distant point for operating the motor.

30. A switch or circuit-breaker for high-potential currents, comprising separable contacts, a highly-insulated inclosure around the rupture-points of said contacts, a motive device for moving said contacts, and means operated at a distance for controlling said motive device.

31. A switch or circuit-breaker for high-potential currents, comprising a plurality of sets of separable contacts, a highly-insulated inclosure around the rupture-points of each of said sets of contacts, a motive device for moving said contacts, and an independent control-circuit for controlling said motive device.

32. A switch or circuit-breaker for high-potential currents, comprising a highly-insulated oil-receptacle for the separable contacts in which the circuit is made and broken under oil, a motive device for establishing and breaking the contact, and an independent low-voltage control-circuit operated at a distance from the switch for controlling the motor to close or open the contacts.

33. A switch or circuit-breaker for high-potential currents, comprising separable contacts, a highly-insulated oil-receptacle therefor, electrically-operated means for closing or separating the contacts, and a control-circuit including a circuit-controller at a distance from the switch for effecting the closure and separation.

34. A switch or circuit-breaker for high-potential currents comprising multipolar separable contacts, substantially air-tight inclosures for the several contacts, and means controlled from a distant point for separating all poles simultaneously.

35. A switch or circuit-breaker for high-potential currents, comprising a plurality of pairs of separable contacts, an inclosure for each pair of contacts, and remotely-controlled means for separating all poles simultaneously.

36. A switch or circuit-breaker for high-potential currents, comprising separable contacts, an inclosure therefor, a body of insulating liquid submerging the contacts, means for giving a long range of motion to the contacts, a motor device for establishing and separating the contacts, an independent low-voltage control-circuit for operating the motor device including a hand-operated circuit-controller located at a distance from the switch, a circuit-changing device at or near the switch for automatically cutting in or out of service the motor after it has acted, and connections for setting the control-circuit for the subsequent switch operation.

37. A high-potential switch or circuit-breaker, having a plurality of independent closed chambers containing oil, multiple contacts within the several chambers submerged in oil, a motor geared to the movable contacts, a spring between the motor and the movable contacts to effect quick separation, and a controlling device distant from the switch for operating the motor.

38. A high-potential switch or circuit-breaker comprising contact-terminals, a small closed chamber inclosing said terminals, and insulating refractory walls housing said chamber on all sides.

39. A high-potential switch or circuit-breaker comprising multiple separable terminals, each pair of terminals being independently inclosed in a small chamber housed within an insulating fireproof inclosure on all sides.

40. A high-potential switch or circuit-breaker, having its contacts submerged in oil, an oil-chamber therefor, and a fireproof insulating-cell around the oil-chamber, the walls of the cell and the oil-chamber being separated by an air-space.

41. A contact for a switch or circuit-breaker, comprising a plurality of segmental rings each composed of a plurality of independent separate parts held together by an annular helical spring.

42. An electric switch or circuit-breaker having a plug-contact and an annular contact to embrace the plug, comprising a plurality of yieldingly-expansible rings independently connected with a circuit-terminal.

43. An electric switch or circuit-breaker having a plug-contact and an annular contact to receive the plug composed of laterally-sliding elastically-yielding independent segments.

44. A contact for a switch comprising a segmental ring composed of a plurality of independent laterally-sliding segments and means for forcing said segments together.

45. An electric switch or circuit-breaker, comprising a fixed terminal, a socket therein, a cup-contact loosely seated in the socket, a movable terminal, and means for guiding them in alinement.

46. An electric switch or circuit-breaker, comprising a fixed terminal, a socket therein, a loosely-fitting cup-contact in the socket, means for locking the cup removably in the socket, and a movable terminal adapted to enter the cup.

In witness whereof I have hereunto set my hand this 29th day of December, 1899.

EDWIN W. RICE, JR.

Witnesses:
BENJAMIN B. HULL,
MABEL E. JACOBSON.