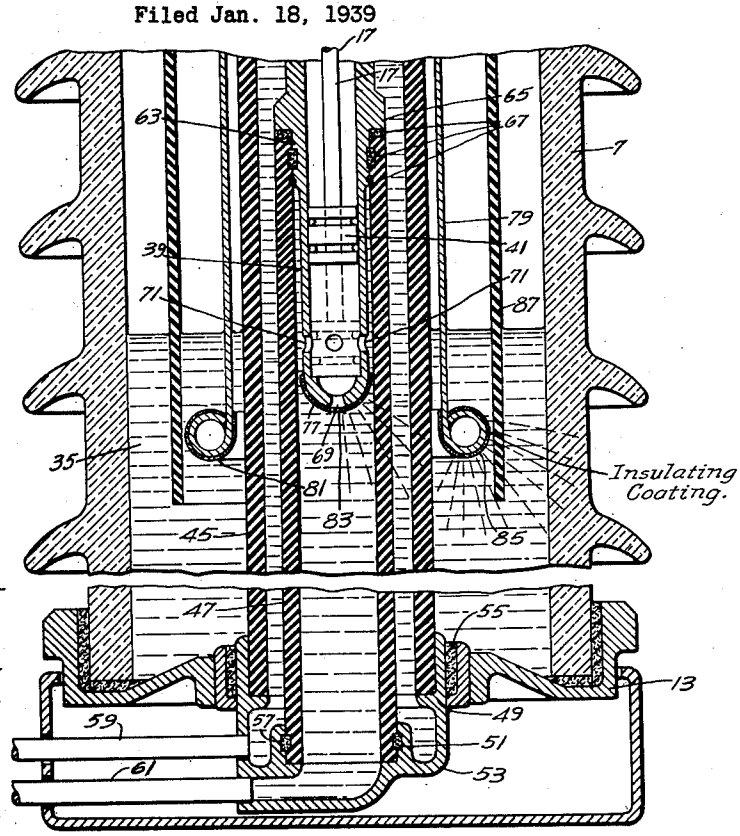
April 23, 1940. H. BARTHELT 2,198,491

CIRCUIT BREAKER

Filed Jan. 18, 1939

Fig. 2.



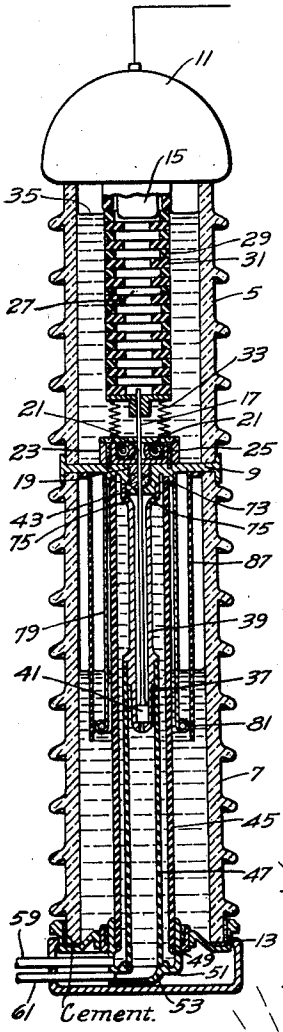


Fig. 1.

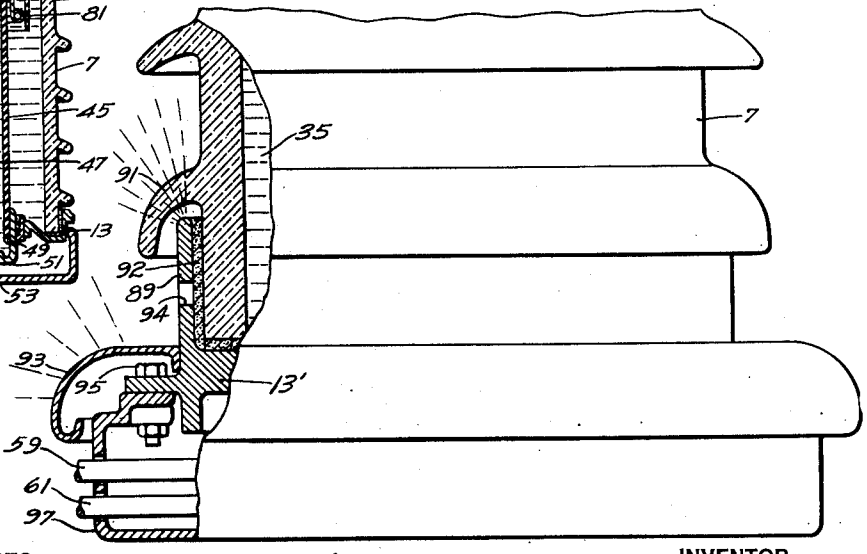


Fig. 3.

WITNESSES:
C. J. Weller.
Thos. C. Groome

INVENTOR
Hans Barthelt.

BY
Ralph Z. Swingle
ATTORNEY

Patented Apr. 23, 1940 2,198,491

UNITED STATES PATENT OFFICE

2,198,491

CIRCUIT BREAKER

Hans Barthelt, Berlin-Siemensstadt, Germany, assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 18, 1939, Serial No. 251,542
In Germany January 29, 1938

20 Claims. (Cl. 200—150)

The invention relates to high voltage circuit interrupters, in general, and more particularly to high voltage circuit breakers which are operated hydraulically by an oil pressure actuating means.

One type of hydraulically operated circuit breaker comprises an oil pressure operated piston connected directly to the movable contact rod of the breaker, and an actuating cylinder for the piston the opposite ends of which are connected by a pair of oil pressure conductors to a suitable oil pressure control pump. Due to sliding of the piston on the walls of the cylinder, these parts are constructed of metal, and since the piston is connected to the movable contact member, both the piston and the cylinder are at line potential. The oil pressure conducting tubes extend upwardly through the grounded metal frame or base and through the interior of the hollow supporting insulator of the circuit breaker, and since the tubes are subjected to considerable internal pressure stresses, they are constructed of a strong fibrous or laminated artificial insulating material. This insulating material, however, due to its fibres or laminations does not possess as high a resistance to electrical discharge or potential breakdown in the direction of its length or fibres as in a cross direction.

In order to reduce the total height of the circuit breaker, the actuating cylinder is arranged countersunk in the hollow supporting insulator. This arrangement, however, results in a relatively short space between the lower end of the metal cylinder and the grounded metal frame or base. The cylinder being at high potential and forming in effect a projecting electrode, its lower end constitutes an area of highest potential stress or electrical field. This fact coupled with the low resistance to potential breakdown in the direction of its length of the oil pressure tube connected to the lower end of the cylinder, and the short space between the lower end of the cylinder and the grounded base makes it relatively easy for an electrical discharge to take place between the lower end of the cylinder and the grounded base by way of the oil pressure tube.

A circuit breaker of the above-mentioned type is disclosed in the copending application of Paul Duffing, Serial No. 246,410, filed December 17, 1938, and assigned to the assignee of the present invention. This type of circuit breaker is simple, reliable and inexpensive to manufacture, and with the exception of the above-mentioned electrical weakness at high potentials is a very desirable structure and possesses a number of advantages over other prior art devices.

An object of the invention is the provision of a circuit breaker of the general type described with a means for equalizing the electrical field to effectively prevent electrical discharges from the parts at high potential to the grounded metal frame or base.

Another object of the invention is the provision of a high voltage circuit breaker of the type described embodying a construction or means for equally distributing the electrical field between the parts at high potential and the grounded metal base so as to materially reduce the possibility of a potential breakdown therebetween.

Another object of the invention is the provision of a circuit breaker of the class described in which means is provided for equalizing the electrical field to prevent an electrical discharge from taking place between the lower end of the metal cylinder which is countersunk in the hollow supporting insulator, and the flanged metal base of the insulator which is at ground potential.

A further object of the invention is the provision of an improved high voltage hydraulically operated circuit breaker which is simple, compact, and inexpensive to manufacture, and in which the parts at high potential are effectively insulated from the grounded base of the breaker.

In accordance with the above and further objects of the invention, the metal actuating cylinder within the hollow supporting insulator is supported by and countersunk in the upper end of the oil pressure tube which supplies oil to the lower end of the cylinder for closing the breaker. The lower portion of the cylinder is spaced from the inner walls of the tube and its lower end which constitutes the position of highest potential stress is located in the body of oil within the tube and is free of any connections, a suitable opening being provided in the lower end of the cylinder for the entry of oil therein. The cylinder is connected to the top of the tube at a predetermined distance above the lower end of the cylinder and this connection is in the region where the electrical field strength or potential stress is practically zero. Thus the position of highest potential stress, i. e., the lower end of the metal cylinder is free of any connections and is disposed in the body of oil which has a dielectric strength equal or almost equal in all directions. In addition, this position of highest potential stress is displaced in a direction towards the grounded metal base with reference to the connection of the cylinder to the insulat-

ing oil pressure tube so that the connection is in a region where the electrical field strength is substantially zero. Furthermore, the entire length of the oil pressure tube is thus made available for insulating the metal cylinder from the grounded metal base.

The lower end of the metal cylinder is rounded so that no substantial electrical field concentration is present at this end of the cylinder. In addition, a cylindrical shielding electrode is provided which extends downwardly from the high potential terminal to a position below the lower end of the metal cylinder. The cylindrical electrode surrounds the metal cylinder and the concentric oil pressure conducting tubes and its lower edge is curled back to provide an annular cylindrical surface. This shielding electrode serves to decrease the strength of the electrical field adjacent the lower end of the metal cylinder and to equally distribute the electrical field in the surrounding high tension region to effectively prevent any voltage breakdown from taking place to the grounded metal base.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof will be best understood from the following detailed description of several embodiments thereof when read in connection with the accompanying drawing, in which:

Figure 1 is a vertical sectional view, partly in elevation, of a circuit breaker constructed in accordance with the invention.

Fig. 2 is an enlarged fragmentary sectional view of the lower portion of the circuit breaker shown in Fig. 1, illustrating the features of the invention, and

Fig. 3 is an enlarged fragmentary elevational view, partly in section, of a modified base construction of the circuit breaker.

Referring to Fig. 1 of the drawing, the housing of the circuit breaker comprises an upper tubular casing 5 of vitreous insulating material, such as porcelain, which is mounted on a hollow porcelain supporting insulator 7. Interposed between and connecting the casing 5 and the supporting insulator 7 is a flanged metal terminal member 9 which separates the casing 5 from the supporting insulator 7 and forms the lower terminal of the circuit breaker. A metal connecting head 11 mounted on the upper end of the casing 5 closes this end of the casing and forms the upper terminal of the breaker. The lower end of the hollow supporting insulator 7 is mounted on and closed by a flanged metal base or frame 13 which is disposed at ground potential.

A stationary contact means 15 is mounted within the upper end of the casing 3 and this contact means is electrically connected to the metal connecting head 11. A cooperating movable contact member 17 which may be in the form of a rod or bar of conducting material is disposed centrally within the circuit breaker housing and is mounted for vertical movement therein. The movable contact member 17 extends through a central opening in the terminal member 9 and this opening is made oil-tight by means of a stuffing box 19. The contact member 17 is movable upwardly to closed circuit position in engagement with the stationary contact means 15, and downwardly to open circuit position away from the stationary contact means by an actuating means in the hollow supporting insulator which will be hereinafter described.

For conducting current to the movable contact member 17 from the terminal member 9 there is provided a plurality of spring pressed contact segments 21 which are mounted within a contact holder 23 of conducting material secured to the upper side of the terminal member 9. The contact segments 21 are biased into pressure engagement with the sides of the contact member 17 by means of a circular coil spring 25, and each segment is electrically connected to the contact holder 23 and through the same to the terminal members 9 by means of suitable pigtails or flexible shunt conductors not shown.

An arc extinguishing device indicated generally at 27 is mounted inside of the casing 3 for extinguishing arcs drawn between the movable contact member 17 and the stationary contact means 15 during interruption of the circuit. The arc extinguishing device 27 is preferably of the expansion type and comprises a stack of alternately disposed annular insulating rings 29 and intermediate disc-shaped insulating rings 31 which form an expansible arc extinguishing chamber surrounding the path of movement of the upper end of the contact member 17. The arc extinguishing structure 27 is supported at its lower end on a plurality of coil springs 33 above the terminal member 9. The springs 33 permit the rings 29 and 31 to separate and release the gas pressure generated by the arc in the arc extinguishing chamber when this gas pressure attains a predetermined value.

The tubular insulating casing 5 is filled with an insulating liquid 35 preferably oil up to a level slightly above the lower end of the stationary contact means 15. The supporting insulator 7 is also preferably filled with a body of oil to further insulate the conducting parts which are at high potential from the grounded metal base 13 and to assist in preventing any internal flashover between the live parts and ground.

For actuating the movable contact member 17 to open and to closed circuit position there is provided an oil-pressure actuating means indicated generally at 37. The actuating means 37 is disposed within the hollow supporting insulator 7 and comprises a metal actuating cylinder 39 which is countersunk in the supporting insulator 7 to reduce the total height of the circuit breaker, and an oil pressure operated metal piston 41 movable in the cylinder 39 and connected directly to the lower end of the movable contact member 17. The upper end of the cylinder 39 engages and is closed by a central boss 43 formed on the lower side of the terminal member 9. The movable contact member 17 extends through an opening in the boss 43 and through the stuffing box 19 into the upper casing 5.

A pair of concentrically disposed oil pressure conducting tubes 45 and 47 are mounted vertically within the supporting insulator 7. The upper ends of the tubes communicate with the opposite ends of the cylinder 39, and their lower ends are supported in the flanged portions 49 and 51 of a joint 53 which is secured centrally in the metal base 13. The joints between the flanged portions 49, 51 and the lower ends of the tubes 45 and 47 are sealed tightly by packing rings 55 and 57 to make these joints oil tight. The lower ends of the concentric tubes 45 and 47 communicate with a pair of oil pressure conducting tubes 59 and 61 which extend through

the side of the metal base 13 and connect to a suitable oil pressure control pump (not shown). The control pump is operable to force oil under pressure through the tubes 45 and 47 into either end of the cylinder 39 to cause the piston 41 to open or close the circuit breaker. The entire hydraulic system is filled with oil.

The tubes 45 and 47 are subjected to considerable internal pressure stresses during operation of the breaker and are, therefore, constructed of a strong fibrous or laminated artificial insulating material, for example, from layers of cloth impregnated with a resinous material, molded and compressed under heat to the desired shape. The fibrous insulating material of the tubes 45 and 47, however, does not have as high a dielectric strength or resistance to potential breakdown in the direction of its length as in a transverse direction, due to the fibres or laminations.

Since the metal piston 41 is connected to the movable contact member 17, the piston 41 and the cylinder 39 are at the same high potential as the terminal member 9, and since the cylinder 39 is mounted in the supporting insulator 7 to reduce the height of the breaker, the space between its lower end and the grounded metal base 13 is not very great. The cylinder 39 constitutes, in effect, a downwardly projecting electrode and consequently its lower end forms the position of highest potential stress. The insulating tubes 45 and 47 must be connected to the cylinder 39 in order to communicate with the opposite ends thereof and these tubes do not have as high dielectric strength in the direction of their length as in a transverse direction. From these facts it will be readily understood that an electrical discharge or potential breakdown may occur between the lower end of the cylinder 39 and the grounded metal base 13 unless some means is provided for preventing such discharges.

In accordance with the invention in order to prevent electrical discharges or potential breakdowns from taking place between the parts at high potential and the grounded metal base, the thrust position, i. e., the position of engagement of the oil pressure conducting tube 47 with the cylinder 39, is disposed a predetermined distance above the lower end of the cylinder 39 in a region where the electrical field strength is substantially zero, and the lower end of the cylinder 39 is arranged free of any connections and disposed in the body of oil within the tube 47. Thus the lower end of the cylinder is disposed in a dielectric (the oil) in which the dielectric strength is substantially equal in all directions. For this purpose, the cylinder 39 is provided with an enlarged or thickened shoulder portion 63 at a predetermined distance above its lower end in the region where the electrical field strength is substantially zero, and the upper end of the inner tube 47 which supplies oil to the lower end of the cylinder engages the cylinder only at the shoulder 65 of the shoulder portion 63. The tube 47 serves to support the cylinder 39. The joint between the upper end of the tube 47 and the shoulder portion 63 of the cylinder 39 is made oil tight by a plurality of packing rings 67. The lower portion of the cylinder 39 is of smaller diameter than the inner diameter of the tube 47 so that it is spaced from the inner surface of the tube, and this lower portion of the cylinder is disposed in the body of oil which fills the tube 47. The tube 47 communicates with the lower end of the cylinder through a bottom opening 69 and one or more side openings 71 provided in the lower end of the cylinder 39. Thus the cylinder 39 is countersunk in the insulating tube 47, and the position of engagement of the tube with the cylinder is in the region where the electrical field strength is substantially zero. The lower portion of the cylinder 39 is spaced from the walls of the tube 47 and the lower end of the cylinder which is at the highest potential stress is free of any connections and is located in a dielectric (the oil within the tube 47) in which the dielectric strength is substantially equal in all directions. Furthermore, by this arrangement a greater length of the tube 47 is made available for insulating the cylinder 39 from the grounded metal base 13.

The upper end of the outer tube 45 which supplies oil to the upper end of the cylinder 39 engages the underside of the terminal member 9 also in a region where the electrical field strength is substantially zero, and this end of the tube 45 is tightly sealed in a depending circular flange 73 formed on the terminal member 9. The upper end of the insulating tube 45 communicates with the upper end of the cylinder 39 through an opening 75 (Fig. 1) provided in the side of the cylinder 39 adjacent its upper end.

In order to prevent any substantial concentration of the electrical field at the lower end of the cylinder 39, this end of the cylinder is rounded as indicated at 77 (Fig. 2). The rounded surface 77 serves to equally distribute the electrical field at and adjacent the lower end of the cylinder 39.

In order to further assist in perventing a voltage breakdown from the parts at high potential to the grounded metal base 13, means is provided for equalizing the electrical field within the supporting insulator 7 in the region surrounding the lower end of the cylinder 39. This means comprises a cylindrical electrode 79 secured at its upper end to the terminal member 9 so as to be at substantially the same high potential as the cylinder 39. The cylindrical electrode 79 extends downwardly around the outside of the outer insulating tube 45, in spaced relation thereto, to a point slightly below the lower end of the metal cylinder 39. The lower edge of the electrode 79 is curled back to provide an annular rounded surface 81. The cylindrical electrode 79 surrounds the lower end of the cylinder 39 and the insulating tubes 45 and 47 in a ring-like fashion and serves to partially electrically unload the lower end of the cylinder 39 and to equally distribute the electrical field in the region surrounding the lower end of the cylinder 39. The course of the electric lines of force from the lower end of the cylinder 39 and from the annular rounded end of the electrode 79 are indicated by the dotted lines in Fig. 2.

It is known that impurities present in the oil are drawn as electrical conductors to the positions of the highest field density and there built up as growths in the form of needles which vary the surface of the parts at high potential in an undesired manner. In the construction of the present invention this rise of needle effect and with it a variation of the surface of the metal parts at high potential is prevented by the motion of the oil in the oil pressure conducting tubes 45 and 47 during operation of the breaker. The oil flow, particularly along the surface of the lower portion of the cylinder 39 and the

rounded lower end thereof, plays on these surfaces and thereby cleans the same of any needle growth. Since, however, the operation of the breaker occurs relatively infrequently, auxiliary means may be provided for protecting the surfaces from the rise of needle effect. This auxiliary means comprises a coating of insulating material indicated at 83 and 85 applied to the external surfaces of the lower rounded end of the cylinder 39 and to the lower end and rounded portion of the electrode 79. The coating of insulating material may consist of a webbed, knitted or woven material which is afterwards saturated with shellac or lacquer.

For the purpose of further increasing the dielectric strength an additional insulating cylinder 87 is provided which surrounds the cylindrical electrode 79 and is interposed between the electrode 79 and the inner surface of the supporting insulator 7 at a predetermined distance from the inner surface of the supporting insulator.

In order to obtain a more equal distribution of the electrical field in the region of the metal base 13 at the lower end of the supporting insulator 7, the metal base 13 is preferably constructed in the manner shown in Fig. 3. The metal base 13', as shown in Fig. 3, is provided with an upwardly projecting cylindrical flange 89 which extends a sufficient distance above the remaining portions of the base so that it forms a thrust-out electrode and thus serves to electrically unload the remaining portions of the base 13 and to more equally distribute the electrical field in the neighborhood of the metal base. The upper edge of the cylindrical flange 89 is rounded and the distribution of the electrical lines of force extending therefrom are indicated by the dotted lines in Fig. 3.

In order to still further improve the dielectric strength, the supporting insulator 7 is provided with a lower porcelain screen or petticoat 91 which extends downwardly for a predetermined distance around the sides of the upper portion of the cylindrical flange 89 so that the screen 91 acts as an ion barrier. By reason of the projection of the cylindrical flange 89 into the screen 91 it is difficult to insert a cement layer 92 between the flange 89 and the lower end of the supporting insulator 7 for securing the insulator 7 to the metal base 13'. This difficulty is overcome by providing the cylindrical flange 89 with a plurality of lateral openings 94 through which the cement may be forced into the space between the flange 89 and the lower end of the insulator 7.

An annular metallic shield 93 formed to provide a rounded surface has its inner edge secured to the metal base 13' at the lower end of the flange 89 and this shield serves to cover the projecting metal portions and bolts 95 which secure the base 13' to the metal frame 97. The shield 93 due to its rounded surface serves to equally distribute the lines of electrical force as indicated by the dotted lines in Fig. 3, and thus prevents any concentration of lines of force on the sharp edges or projections of the metal base and frame.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details thereof may be made without departing from the spirit of the invention. It is desired, therefore, that the appended claims be given the broadest reasonable interpretation permissible in view of the prior art.

I claim as my invention:

1. A high voltage circuit breaker having a movable contact member and a hollow supporting insulator in which is mounted a fluid pressure operated metal piston connected to the contact member, a metal cylinder for the piston, and at least one fluid pressure conducting tube of insulating material communicating with the cylinder, and in which supporting insulator, means are also provided for equalizing the electrical field, characterized by the fact that the position of highest potential stress is disposed in a dielectric having substantially equal dielectric strength in all directions, and the connection of the insulating tube to the metal parts at high potential, as for example the metal cylinder, is disposed in a region in which the electrical field strength is substantially zero.

2. A high voltage circuit breaker having a movable contact member, and a hollow supporting insulator mounted on a grounded metal base and in which is mounted an oil pressure operated metal piston connected to the contact member, and a metal cylinder for the piston, and a pair of oil filled oil pressure conducting tubes of insulating material communicating with the opposite ends of the cylinder, and in which is also provided means for equalizing the electrical field, characterized by the fact that the position of highest potential stress, for example the lower end of the cylinder, is free of any connections and disposed in the body of oil in one of said tubes, and also is displaced towards the grounded metal base with reference to the connections of the insulating tubes to the parts at high potential.

3. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker, actuating means comprising a fluid pressure operated metal piston connected to the movable contact member and a metal cylinder for the piston countersunk in said supporting insulator, a pair of fluid pressure conducting tubes of insulating material within said supporting insulator and communicating with the opposite ends of said cylinder, said structure being characterized by the fact that the lower end of said cylinder which is the position of the highest potential stress is free of any connections and is disposed in a dielectric in which the dielectric strength is substantially equal in all directions, and the position of engagement of the tube which communicates with the lower end of said cylinder is disposed in a region in which the electrical field strength is substantially zero.

4. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a metal frame, actuating means including an oil pressure operated metal piston connected to the contact member and a metal cylinder for the piston extending into the supporting insulator, and at least one oil pressure conducting tube of insulating material within said supporting insulator communicating with the inside of said cylinder, the end of said cylinder nearest said metal frame which end is at the highest potential stress being free of any connections and disposed in a body of oil, and the position of engagement of said insulating tube with said metal cylinder being disposed in a region in which the electrical field strength is substantially zero.

5. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a metal frame, actuating means including a fluid pressure operated metal piston connected to the contact member and a metal cylinder for the piston disposed in the supporting insulator, and at least one fluid pressure conducting tube of fibrous insulating material within said supporting insulator communicating with the inside of said cylinder, the end of said cylinder nearest said metal frame which end is at the highest potential stress being free of any connections and disposed in a dielectric, which has substantially equal dielectric strength in all directions, and the position of engagement of said insulating tube with said metal cylinder being disposed in a region in which the electrical field strength is substantially zero, and means for equalizing the electrical field in the region surrounding the end of said cylinder nearest said metal frame.

6. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a metal frame, actuating means comprising an oil pressure operated metal piston connected to the contact member and a metal cylinder for the piston disposed in the supporting insulator, and a pair of oil filled oil pressure conducting tubes of fibrous insulating material extending within said supporting insulator from said metal frame and communicating with the opposite ends of said cylinder, the end of said cylinder nearest said metal frame and having the highest potential stress being free of any connections and disposed in the oil in one of said tubes which supplies oil to said end of the cylinder, and the position of engagement of said tube with said cylinder being disposed in a region in which the electrical field strength is substantially zero.

7. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a metal frame, actuating means comprising an oil pressure operated metal piston connected to the contact member and a metal cylinder for the piston disposed in the supporting insulator, and a pair of oil filled oil pressure conducting tubes of fibrous insulating material extending within said supporting insulator from said metal frame and communicating with the opposite ends of said cylinder, the end of said cylinder nearest said metal frame and having the highest potential stress being free of any connections and disposed in the oil in one of said tubes which supplies oil to said end of the cylinder, the position of engagement of said tube with said cylinder being disposed in a region in which the electrical field strength is substantially zero, and means for equally distributing the electrical field in the region surrounding the end of said cylinder nearest said metal frame.

8. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising a fluid pressure operated metal piston connected to said contact member and a metal cylinder for the piston extending into said supporting insulator, at least one fluid pressure conducting tube of insulating material extending upwardly within said supporting insulator from said metal base and communicating with said cylinder, the position of engagement of said tube with said cylinder being disposed in a region in which the electrical field strength is substantially zero, and the lower end of said cylinder which has the highest potential stress being free of any connections and disposed in a dielectric, and means for equalizing the electrical field comprising an electrode substantially at the high potential of said cylinder projecting into said supporting insulator and surrounding in ring fashion the lower end of the metal cylinder.

9. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising an oil pressure operated metal piston connected to said contact member and a metal cylinder for the piston disposed in said supporting insulator, a pair of oil filled oil pressure conducting tubes of insulating material extending upwardly within said supporting insulator from said metal base and communicating with the opposite ends of said cylinder, said cylinder having an opening in its lower end and being mounted in the upper end of one of said tubes and engaged and supported by said tube in the region in which the electrical field strength is substantially zero, the lower portion of said cylinder projecting downwardly within said tube in spaced relation to the tube with its lower end which has the highest potential stress disposed in the body of oil within said tube, and means for equalizing the electrical field comprising a cylindrical electrode at substantially the same high potential as said cylinder spaced from and surrounding in ring manner the lower end of said cylinder and said insulating tubes.

10. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising a fluid pressure operated metal piston connected to said contact member and a metal cylinder for the piston disposed in said supporting insulator, a pair of fluid pressure conducting tubes of insulating material extending upwardly within said supporting insulator from said metal base and communicating with the opposite ends of said cylinder, said cylinder having an opening in its lower end and being mounted in the upper end of one of said tubes and engaged and supported by said tube in the region in which the electrical field strength is substantially zero, the lower portion of said cylinder projecting downwardly within said tube in spaced relation to the tube with its lower end which has the highest potential stress disposed in a dielectric, and means for equalizing the electrical field comprising a tubular electrode at substantially the same high potential as said cylinder extending downwardly and surrounding said cylinder and said insulating tubes with its lower end at a predetermined distance from said grounded metal base.

11. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising an oil pressure operated metal piston connected to said contact member and a metal cylinder for the piston disposed in said supporting insulator, a pair of oil filled oil pressure conducting tubes of insulating material extending upwardly within said supporting insulator from said metal base and communicating with the opposite ends of said cylinder, said cylinder having an opening in its lower end and being mounted in the upper end of one of said tubes and engaged and sup-

ported by said tube in the region in which the electrical field strength is substantially zero, the lower portion of said cylinder projecting downwardly within said tube in spaced relation to the tube with its lower end which has the highest potential stress disposed in the body of oil within said tube, means for equalizing the electrical field comprising a cylindrical electrode at substantially the same potential as said cylinder spaced from and surrounding said cylinder and said insulating tubes in ring fashion, and an insulating cylinder surrounding said electrode and disposed between said electrode and the inner wall of said supporting insulator.

12. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising a fluid pressure operated metal piston connected to said contact member and a metal cylinder for the piston mounted in said supporting insulator, at least one fluid pressure conducting tube of insulating material extending upwardly within said supporting insulator from said metal base and communicating with said cylinder, the position of engagement of said tube with said cylinder being disposed in a region in which the electrical field strength is substantially zero, the lower end of said cylinder being free of any connections and disposed in a dielectric and being rounded to distribute the electrical field at said end.

13. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising an oil pressure operated metal piston connected to said contact member and a metal cylinder for the piston mounted in said supporting insulator, a pair of oil filled oil pressure conducting tubes of insulating material extending upwardly within said supporting insulator from said metal base and communicating with the opposite ends of said cylinder, said cylinder having an opening in its lower end and being mounted in the upper end of one of said tubes and engaged and supported by said tube in the region in which the electrical field strength is substantially zero, the lower portion of said cylinder projecting downwardly within said tube in spaced relation to the tube with its lower end which has the highest potential stress disposed in the body of oil within said tube, the lower end of said cylinder being rounded to distribute the electrical field at said end, a body of oil in said supporting insulator, and means for equalizing the electrical field comprising a cylindrical electrode substantially at the potential of said cylinder projecting into said body of oil spaced from and surrounding in ring fashion said cylinder and said insulating tubes.

14. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising an oil pressure operated metal piston connected to said contact member and a metal cylinder for the piston disposed in said supporting insulator, a pair of oil filled oil pressure conducting tubes of insulating material extending upwardly within said supporting insulator from said metal base and communicating with the opposite ends of said cylinder, said cylinder having an opening in its lower end and being mounted with its upper portion only engaged by one of said tubes in the region in which the electrical field strength is substantially zero, the lower portion of said cylinder projecting downwardly within said tube in spaced relation to the tube with its lower end which has the highest potential stress disposed in the body of oil within said tube, the lower end of said cylinder being rounded to distribute the electrical field at said end, and the motion of the oil in said tube supporting said cylinder during operation of the breaker acting to prevent variation of the rounded surface of the lower end of said cylinder.

15. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising an oil pressure operated metal piston connected to said contact member and a metal cylinder for the piston in said supporting insulator, at least one oil pressure conducting tube of insulating material extending upwardly within said supporting insulator from said metal base and communicating with said cylinder, the position of engagement of said tube with said cylinder being disposed in a region in which the electrical field strength is substantially zero, the lower portion of said cylinder being free of any connections and disposed in a body of oil, the lower end of said cylinder being rounded to distribute the electrical field at said end, a body of oil in said supporting insulator, means for equalizing the electrical field comprising a cylindrical electrode substantially at the potential of said cylinder projecting into said body of oil and surrounding in ring fashion said cylinder, the outer surface of at least the lower portion of said cylinder and the surfaces of at least the lower portion of said electrode being coated with an insulating material to suppress the rise of needle effect.

16. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising a fluid pressure operated metal piston connected to said contact member and a metal cylinder for the piston extending into said supporting insulator, at least one fluid pressure conducting tube of insulating material extending upwardly within said supporting insulator from said metal base and communicating with said cylinder, the position of engagement of said tube with said cylinder being in a region in which the electrical field strength is substantially zero, the lower portion of said cylinder being free of any connections and disposed in a dielectric, and means for equalizing the electrical field comprising an electrode substantially at the high potential of said cylinder projecting into said supporting insulator and surrounding in ring fashion the lower end of the metal cylinder, said metal base having an upwardly projecting cylindrical metal flange forming an upwardly projecting electrode for electrically unloading the remaining portions of the base and equalizing the electrical field in the region above said base.

17. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising a fluid pressure operated metal piston connected to said contact member and a metal cylinder for the piston extending into said supporting insulator, at least one fluid pressure conducting tube of insulating material extending upwardly within said supporting insulator from said metal base and communicating with said cylinder, the position of engagement of said tube with said cylinder

being in a region in which the electrical field strength is substantially zero, the lower portion of said cylinder being free of any connections and disposed in a dielectric, and means for equalizing the electrical field comprising an electrode substantially at the high potential of said cylinder projecting into a body of oil in said supporting insulator and surrounding in ring fashion the lower end of the metal cylinder and the insulating tube, said metal base having an upwardly projecting cylindrical metal flange encircling the lower end of the supporting insulator and forming an upwardly projecting electrode for electrically unloading the remaining portions of the base and equalizing the electrical field, said flange having at least one lateral opening to permit the insertion of a cement filling between said flange and said supporting insulator.

18. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising an oil pressure operated metal piston connected to said contact member and a metal cylinder for the piston extending into said supporting insulator, at least one oil pressure conducting tube of insulating material extending upwardly within said supporting insulator from said metal base and communicating with said cylinder, the position of engagement of said tube with said cylinder being in a region in which the electrical field strength is substantially zero, the lower portion of said cylinder being free of any connections and disposed in a body of oil in said supporting insulator, and means for equalizing the electrical field comprising an electrode substantially at the high potential of said cylinder projecting into said body of oil in said supporting insulator and surrounding in ring fashion the lower end of said cylinder and said insulating tube, said metal base having an upwardly projecting cylindrical metal flange forming an upwardly projecting electrode for electrically unloading the remaining portions of the base and equalizing the electrical field in the region above the base, said supporting insulator having a petticoat formed therein immediately above said flange which projects downwardly around said flange and acts as an ion barrier.

19. A high voltage circuit breaker having a movable contact member, a hollow supporting insulator for the breaker mounted on a grounded metal base, actuating means comprising a fluid pressure operated metal piston connected to said contact member and a metal cylinder for the piston disposed in said supporting insulator, a pair of fluid pressure conducting tubes of insulating material extending upwardly within said supporting insulator from said metal base and communicating with the opposite ends of said cylinder, said cylinder having an opening in its lower end and being mounted with its upper portion only engaged by one of said tubes in the region in which the electrical field strength is substantially zero, the lower portion of said cylinder projecting downwardly within said tube in spaced relation to the tube with its lower end which has the highest potential stress disposed in a dielectric, a body of oil in said supporting insulator, means for equalizing the electrical field comprising an electrode substantially at the high potential of said cylinder projecting into the body of oil in said supporting insulator and surrounding in ring fashion the lower end of the metal cylinder and the insulating tubes, and an annular metal shield on said metal base having a rounded surface which covers all projections on said base.

20. In a circuit breaker having a movable contact member, a hollow supporting insulator for said breaker, actuating means comprising a metal piston connected to said movable contact member and a metal cylinder for said piston disposed within said supporting insulator, a pair of fluid pressure conducting tubes of insulating material extending upwardly within said supporting insulator and communicating with the opposite ends of said cylinder, said cylinder having an opening in its lower end and being mounted in the upper end of one of said tubes and engaged by said tube only in the region where the electrical field strength is substantially zero, the lower portion of said cylinder projecting downwardly within said tube in spaced relation thereto with its lower end which has the highest potential stress disposed in the fluid in said tube.

HANS BARTHELT.