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H. H. FAHNOE

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CIRCUIT INTERRUPTER

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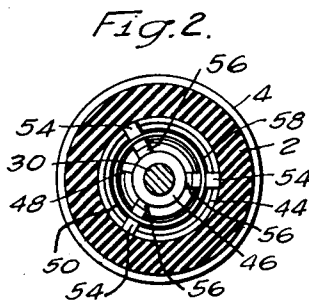
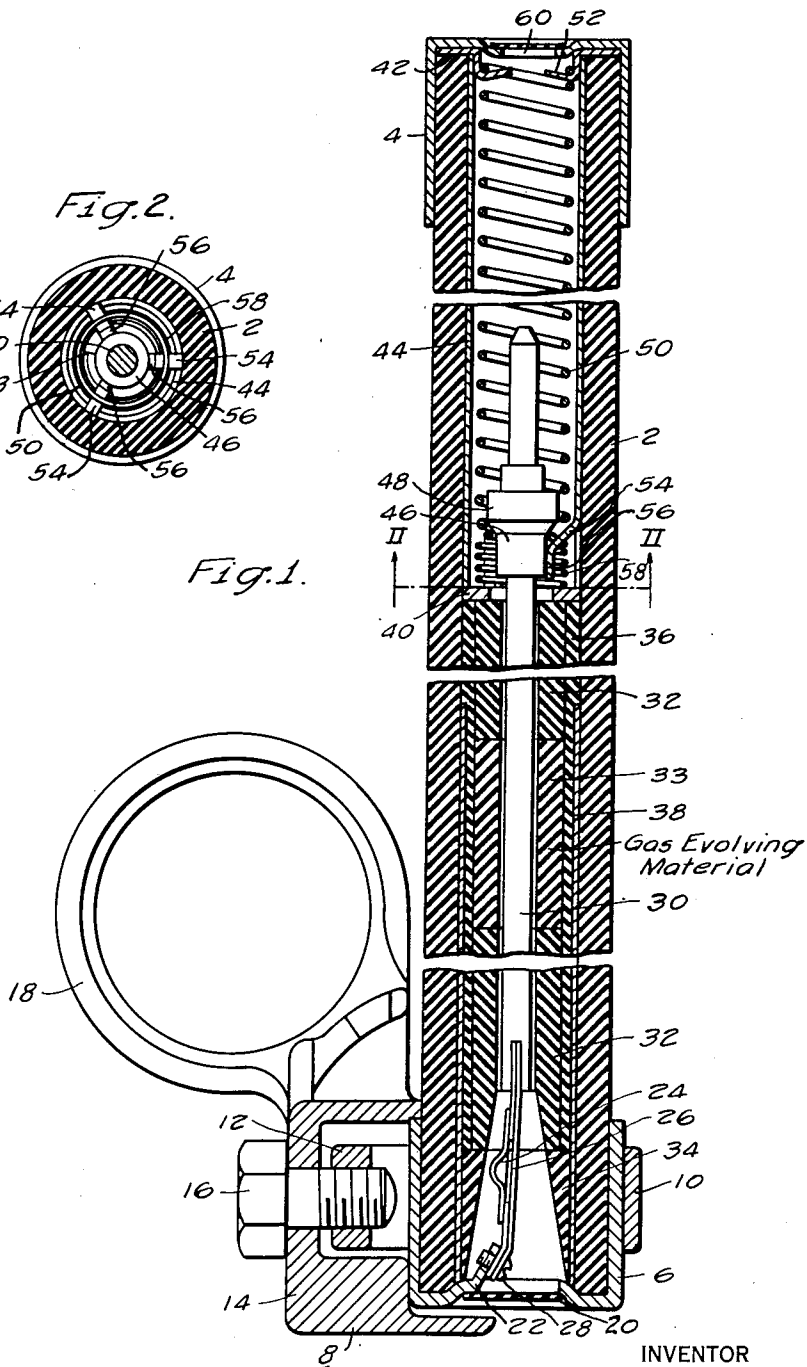


Fig. 1.



WITNESSES:

E. A. M. L. L. L.

Q. T. Stratton

INVENTOR

Harold H. Fahnoe.

BY

F. W. Lyle.

ATTORNEY

UNITED STATES PATENT OFFICE

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CIRCUIT INTERRUPTER

Harold H. Fahnoe, Wilkinsburg, Pa., assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

Continuation of application Serial No. 432,576,
February 27, 1942, now Patent No. 2,403,121, issued
January 29, 1946, Serial No. 654,571

16 Claims. (Cl. 200—120)

1

This invention relates in general to electric circuit interrupters, and more specifically to high voltage fuses.

This invention is particularly concerned with certain improvements in high voltage fuses of the type shown in copending application of H. L. Rawlins and J. J. Mikos, Serial No. 428,710, filed January 29, 1942, now Patent No. 2,403,121, issued July 2, 1946, and assigned to the same assignee as this invention, and is a continuation of my now abandoned application Serial No. 432,576, filed February 27, 1942, for Circuit Interrupters, also assigned to the same assignee of this invention. Fuses of this type when used at very high voltages, for example, 46 kilovolts and higher, are such efficient interrupters of high short circuit currents, that interruption occurs upon a very short travel of the movable arcing terminal. This is especially true when a gas evolving material, such as boric acid, is used for arc-extinguishing purposes. This results in a very high voltage stress between the end of the movable arcing contact and the lower fuse ferrule and its fittings at the moment when interruption occurs and for a short time afterwards. The space within the fuse has a high enough dielectric strength at this time to withstand such high voltage stress because of the presence of un-ionized gases evolved from the arc-extinguishing material. On the other hand, the voltage stress outside of the fuse tube is poorly distributed and the capacitance between the movable arcing terminal and the exterior ferrule and fittings may be high enough so that an appreciable charging current flows. This results in a corona discharge at the ferrule and fittings and at the outer surface of the fuse tube adjacent the movable arcing terminal thereby requiring the dielectric strength of the air about the fuse tube to a point where an external flashover may occur during interruption or directly thereafter.

Accordingly, one object of this invention is to provide a high voltage fuse having means for avoiding exterior corona discharge and consequent impairment of the dielectric strength of the surrounding air.

Another object of this invention is to provide a fuse for very high voltages with means for concentrating the region of high voltage stress during and immediately following a circuit interrupting operation in solid dielectric.

High voltage fuses of the type shown in the above-mentioned copending application of H. L. Rawlins et al. use an electrical connection between one contact of the fuse and the movable

2

arcing contact which is separable upon the occurrence of a circuit interrupting operation. Such separable connections are required to carry normal load currents without unreasonable temperature rise and yet separate readily upon release of the movable arcing terminal. It is also required that these connections be capable of withstanding rough handling, and be capable of easy assembly, and in general, have characteristics which are unchanged by time or variations in size of the fuse elements associated therewith.

Accordingly, another object of this invention is to provide novel separable current carrying connections between one contact of a fuse and the movable arcing contact thereof.

Another object of this invention is to provide novel separable current carrying connections between one contact of a fuse and the movable arcing contact thereof which is efficient in operation, yet simple in form and susceptible of easy assembly.

These and other objects of this invention will become more apparent upon consideration of the following detailed description of preferred embodiments thereof when taken in connection with the attached drawings, in which:

Figure 1 is a longitudinal sectional view of a high voltage fuse embodying this invention;

Fig. 2 is a transverse section taken substantially on the line II—II of Fig. 1;

Fig. 3 is a longitudinal sectional view of the lower end of a slightly modified form of fuse;

Fig. 4 is a partial longitudinal sectional view of a fuse showing a modified contact construction; and

Fig. 5 is a view like Fig. 4 but showing a still further modified contact construction.

As stated above, this invention may be embodied in a fuse of the type shown in the copending application of H. L. Rawlins et al., Serial No. 428,710, which comprises, in general, an insulating tube 2 constituting the holder for the fuse and formed of any desired insulating material, such for example, as fiber, a synthetic resin or the like. The fuse tube 2 is provided with end terminal caps 4 and 6, respectively, and the lower end terminal cap 6 may be provided with a mounting and handling fixture 8. The fixture 8 comprises a collar 10 adapted to fit over terminal cap 6, having an offset portion 12 provided with a threaded aperture for a purpose to be described. The fixture 8 further includes a U-shaped clamping member 14 which is channel shape in section, and is apertured for the reception of a clamping screw 16 adapted to be thread-

ed in the aperture provided in offset portion 12 of collar 10, for clamping the fixture tightly to terminal cap 6. Fixture 8 may also have the clamping member 14 thereof provided with an integral hook eye 18 for the reception of a hook stick or other operating member. Collar portion 10 of the fixture may be provided with trunnions or the like (not shown) for pivotally mounting the fuse. For a more particular disclosure of the above-described parts of the fuse, reference is hereby made to the above-mentioned copending application of H. L. Rawlins et al.

Terminal cap 6 is provided with a central aperture as shown, and a closure disc 20 is adapted to be releasably secured over this aperture, for example, as by being cemented thereto. Terminal cap 6 is provided with an integral tongue 22 to which is secured one end of a fusible element 24 and a strain element 26, for example, as by a screw 28. The other ends of the fusible and strain elements are secured in a slot provided in the lower end of an arcing contact rod 30, and the fusible and strain elements act to normally maintain arcing contact rod 30 in the position shown in Fig. 1.

The arcing contact rod 30 extends upwardly through fuse tube 2, and through a lining provided in the tube of an insulating material which is capable of evolving an arc-extinguishing gas when in proximity to an electric arc, such, for example, as boric acid, a synthetic resin or the like. The lining, shown in Fig. 1, comprises a plurality of blocks 32 of compressed boric acid having central bores therethrough forming an arc passage for receiving arcing contact rod 30. The end boric acid block 32 has the outer end portion of its bore flared outwardly to form a continuation of the outwardly flared bore provided in an insulating spacing washer 34 between this boric acid block and terminal cap 6, to thereby provide an outwardly flared end for the portion of the arc passage in which the fusible and strain elements are located. An insulating spacing tube 36 is preferably provided between the inner surface of tubular holder 2 and the boric acid blocks, and the outer surface of spacer tube 36 is recessed to closely receive a tubular metal shielding member 38 of conducting material, such for example, as copper or the like. Shielding tube 38 is thereby closely confined between insulating tube 2 and insulating spacer tube 36, while being electrically connected with terminal cap 6, all for a purpose to be hereinafter described.

Seated on the upper end of the insulating blocks 32 and spacer tube 36, there is provided a metal washer 40 between which, and a second washer 42 clamped between terminal cap 4 and the adjacent end of tube 2, is located a metal tube 44 of conducting material, such for example, as copper or the like. Adjacent the inner end of arcing contact rod 30 there is provided an integral contact head portion 46 of enlarged cross-section, and an adjacent stop portion 48 still further enlarged in cross-section. A coil tension spring 50 has one coil thereof about the contact rod 30 below stop portion 48 thereof, and the other end thereof seated on integral supporting prongs 52 provided on washer 42, to thereby bias contact rod 30 upwardly as shown in Fig. 1, and maintain fusible element 24 and strain element 26 under tension. The lower end of metal conducting tube 44 is slit longitudinally at a plurality of points so that integral contact arms 54 may be bent inwardly therefrom at an obtuse

angle with respect to the wall of the tube, and these arms terminate in downwardly bent contact portions 56 adapted to engage the contact head 46 provided on contact rod 30. A coil compression spring 58 is seated between washer 40 and the inclined portions of contact arms 54 to exert a force having a component adapted to urge contact portions 56 of contact arms 54 into engagement with contact head 46 on rod 30. Terminal cap 4 is also provided with a central aperture like terminal cap 6, and this aperture is normally adapted to be closed by a disc 60 releasably secured in position, for example, as by cementing or the like.

The circuit through the fuse described above extends from terminal cap 4 through washer 42, conductor tube 44, contact arms 54, contact head 46, arcing contact rod 30, fusible element 24 to terminal cap 6. In the event of the occurrence of overloads in the circuit, fusible element 24 will melt, and element 26 will melt immediately thereafter, whereupon spring 50 is free to move arcing contact rod 30 upwardly away from terminal cap 6. Spring 50 is operable to move the arcing contact rod upwardly until the upper end thereof engages closure disc 60 and displaces this disc to permit the upper end thereof to project through the aperture in terminal cap 4 and until stop head 48 on the rod engages terminal cap 4. This, as more particularly described in the above-mentioned copending application, may provide an indication of the operation of the fuse, or release a latch holding the fuse in circuit. When spring 50 first moves contact rod 30 upwardly, the contact head 46 on the rod slides along contact portions 56 of stationary contact arms 54 and finally disengages these contact arms so that the current will then be carried entirely by spring 50. Since the arcing time is very short, it has been found that spring 50 is operative to carry the current for such short periods without objectionable impairment of the spring.

As arcing contact rod 30 is moved upwardly by spring 50, an arc is struck between the lower end of the rod and terminal cap 6, and this arc is drawn out and elongated in the restricted bore provided in gas evolving material 32 so that the arc is extinguished both by increasing the length thereof and subjecting the same to quantities of un-ionized gases evolved from the material 32. During and at current interruption, a high voltage stress exists between the lower end of arcing contact rod 30 and terminal cap 6, and this stress is distributed across the capacitance between the moving contact rod and tubular shield 38. By this means the voltage stress at this time is provided in solid dielectric material, rather than in the air surrounding the lower part of the fuse, as would be the case in the event shield 38 were not provided. Therefore, the provision of shield 38 for causing the high voltage stress to be located in solid dielectric, positively prevents the occurrence of external flashovers between terminal cap 6, or the fittings secured thereto, and terminal cap 4. As previously pointed out, this is especially likely to occur because of the corona discharge outside of the fuse tube when the shielding member is not used, coupled with the fact that arcing contact rod 30 is moving toward terminal cap 4. The provision of tubular metal shielding member 38 in the region where the arc is drawn and interruption occurs, also operates to strengthen the walls of the fuse enclosure at this critical point. By the provision of the lateral engagement of contact

5

arms 54 with contact head 46 on arcing contact rod 30, spring 50 has only to overcome the sliding friction between these parts due to the component of force exerted by contact biasing spring 58 in a lateral direction, in order to initiate upward movement of arcing contact rod 30.

In Fig. 3 of the drawings, there is illustrated a slightly modified manner of assembling a tubular shielding means with a fuse tube, and since many of the parts illustrated are identical with those shown in Fig. 1, like reference numerals will be used to identify such like parts. The fuse in this embodiment of the invention is identical with that shown in Fig. 1, except that the tubular shield 62 in this instance is provided of a metal foil which may be embedded directly in tubular fuse holder 2 instead of being located between the tube and an insulating spacing tube, as in the previously described embodiment. This construction has the advantage of requiring fewer parts, since the insulating spacer tube may be omitted and the blocks 32 of gas evolving material may be made of a size to entirely fill the interior of fuse tube 2. The operation of this embodiment of the invention is identical with that previously described, because the tubular shielding means 62 is located within a solid dielectric, to thereby prevent exterior corona discharge and consequent flashovers.

Figs. 4 and 5 illustrate modified forms of connections to arcing contact rod 30, and since many of the parts illustrated in these figures are identical with those shown in Fig. 1, like reference numerals will be used to designate such like parts.

Referring to Fig. 4, a plurality of thin flexible strips 64 of a conducting material, such as copper or the like, are secured to the lower end of conducting tube 44 in any desired manner, for example, as by rivets 66. The other ends of these conducting strips are secured to a contact disc 68 having a central aperture larger than arcing contact rod 30 for freely receiving the same, and this disc is adapted to have butt engagement with the lower side of stop head 48 formed on the contact rod. If desired, contact disc 68 may be provided with a plurality of spaced limited area contact portions 70 projecting from the upper surface thereof for engagement with contact head 48, and these projections and/or the confronting surface of contact head 48 may be provided with a coating or plating of silver or other noble metal having a low resistance. A coil compression spring 72 is seated between washer 40 and contact disc 68 to bias the disc upwardly towards stop head 48 to provide a predetermined contact pressure between these parts.

In the operation of this embodiment of the invention, the contact rod 30 may move upwardly as before upon the occurrence of overloads in the circuit, and although contact disc 68 may follow a relatively short distance under the influence of spring 72, its movement is limited by flexible conducting strips 64 so that stop head 48 on the rod will entirely disengage contact disc 68 and the current path will be transferred to spring 50. One advantage of this contact construction is that spring 50 is not called upon to overcome any contact friction to initiate movement of arcing contact rod 30 in a direction to draw out the arc upon blowing of the fuse. As a matter of fact, it will be observed that contact spring 72 actually aids spring 50 in overcoming the inertia of the arcing contact rod and thereby assists at least in the initial movement of contact rod 30. Furthermore, a predetermined contact pressure

6

between disc 68 and stop head 48 is always obtained as in the first embodiment of the invention, by virtue of spring 72 being independent of spring 50. It will be noted that the contact head portion 46 on arcing contact rod 30 provided in the embodiment of the invention shown in Fig. 1, may be omitted with the structure shown in Fig. 4, because actual contact takes place in a plane extending transversely of the path of movement of the arcing contact rod.

The connection shown in Fig. 5 comprises a coil spring 74 having the ends thereof secured together and positioned between contact head 46 on arcing contact rod 30 and tubular conductor 44. The spring 74 should be of a good conducting material, such for example, as copper or a copper alloy, and the coils of the spring are slightly greater in external diameter than the distance between tubular conductor 44 and contact head portion 46, so that each coil of the spring is flattened out and, therefore, stressed to some extent to provide a high contact pressure between each coil of the spring and tubular conductor 44 and contact head 46, respectively.

In the operation of this embodiment of the invention, the contact rod 30 may be moved upwardly by spring 50 as before, and this will cause a rolling action of the spring coils until the spring is rolled off the lower end of contact head portion 46. This also provides very little resistance to spring 50 in starting movement of arcing contact rod 30 away from terminal cap 6 to draw out the arc. The reason for this is that there is substantially no sliding movement between spring 74, contact head 46 and tubular conductor 44, when arcing contact rod 30 is moved by spring 50, because the relative movement between these parts consists substantially entirely of a rolling action of each coil of spring 74 on tubular conductor 44 and contact head 46, respectively.

From the foregoing, it is apparent that this invention provides a means of constructing fuses for very high voltages which will prevent external flashovers, and this means is particularly adapted for use in fuses of the type shown in the previously mentioned copending application of H. L. Rawlins et al., wherein the arc is extinguished by attenuation thereof in a narrow arc passage by a spring moved arcing contact normally connected in the circuit by contacts which are separable from, and entirely disengage the arcing contact upon arc-drawing movement thereof. There is also provided herein novel forms of separable connections especially adapted for use in fuses of this type, which connections are particularly designed with a view to obtaining a predetermined contact pressure to get a good electrical connection to the movable arcing contact, and to provide a minimum of opposition to the arcing contact moving means when the fuse blows and it becomes necessary to rapidly move the arcing contact to give efficient and quick arc extinction.

Having described preferred embodiments of the invention in accordance with the patent statutes, it is desired that the invention be not limited to the specific constructions herein specifically disclosed, because it will be obvious, particularly to persons skilled in the art, that many changes and modifications may be made in these particular constructions, without departing from the broad spirit and scope of this invention. Therefore, it is desired that this invention be interpreted as broadly as possible, and that the

following claims be limited only as required by the prior art.

I claim as my invention:

1. In a circuit interrupter, a tubular casing of insulating material having terminals adjacent opposite ends thereof, respectively, tubular conducting means connected to each of said terminals and extending from each terminal toward the other, said conducting means being located within said casing, means of insulating material in said casing for covering one of said conducting means, and the other of said conducting means being exposed to the interior of said casing, and circuit interrupting means concentric with said conducting means and connected between said other conducting means at a point adjacent the inner end thereof and the terminal associated with said one conducting means.

2. In a circuit interrupter, a tubular casing of insulating material having terminals adjacent opposite ends thereof, respectively, conducting means connected to each of said terminals and extending from each terminal toward the other, said conducting means being located within said casing, with one of said conducting means embedded in insulating material, and the other of said conducting means being exposed to the interior of said casing, circuit interrupting means connected between said other conducting means at a point adjacent the inner end thereof and the terminal associated with said one conducting means, said interrupting means having a movable rod-like terminal in said casing to draw an arc toward said other conducting means, a low resistance electrical connection between said rod-like terminal and the inner end of said other conducting means, said connection being separable in response to movement of said rod-like terminal to interrupt the circuit, a flexible connection between said rod-like terminal and casing terminal with which said other conducting means is associated, said flexible connection having a higher resistance than said separable connection but being capable of carrying the arcing current.

3. In a circuit interrupter, a tubular casing of insulating material having terminals adjacent opposite ends thereof, respectively, tubular conducting means connected to each of said terminals and extending from each terminal toward the other, said conducting means being located within said casing, with one of said conducting means embedded in the material of said casing, and the other of said conducting means being exposed to the interior of said casing, and circuit interrupting means concentric with said conducting means and connected between said other conducting means at a point adjacent the inner end thereof and the terminal associated with said one conducting means.

4. In a circuit interrupter, a tubular casing of insulating material having terminals adjacent opposite ends thereof, respectively, tubular conducting means connected to each of said terminals and extending from each terminal toward the other, said conducting means being located within said casing, with one of said conducting means located between the inner wall of said casing and a second tube of insulating material telescoped within said casing, and the other of said conducting means being exposed to the interior of said casing, and circuit interrupting means concentric with said conducting means and connected between said other conducting means at a point adjacent the inner end thereof

and the terminal associated with said one conducting means.

5. In a circuit interrupter, a tubular casing of insulating material having terminals adjacent opposite ends thereof, respectively, hardware associated with one of said terminals and extending toward the other terminal on the outside of said casing, tubular conducting means connected to each of said terminals and extending from each terminal toward the other, said conducting means being located within said casing, the said conducting means associated with said one terminal being embedded in insulating material and extending toward the other of said casing a distance greater than said hardware, and the other of said conducting means being exposed to the interior of said casing, and circuit interrupting means concentric with said conducting means and connected between said other conducting means at a point adjacent the inner end thereof and the terminal associated with said one conducting means.

6. In a circuit interrupter, a tubular casing of insulating material having terminals adjacent opposite ends thereof, respectively, tubular conducting means connected to each of said terminals and extending from each terminal toward the other, said conducting means being located within said casing, with at least one of said conducting means embedded in insulating material, and circuit interrupting means concentric with said conducting means and connected between said other conducting means at a point adjacent the inner end thereof and the terminal associated with said one conducting means.

7. In a high voltage circuit interrupter, a tubular housing of insulating material, terminals at opposite ends of said housing, a restricted arc passage in said housing comprising a longitudinally extending bore of relatively small cross section which is open at one end adjacent one end of the housing at least for the expulsion of gases formed during a circuit interrupting operation, an arc-drawing rod movable through said arc passage and electrically connected with the terminal adjacent the other end of said housing, means biasing said rod for movement toward said other end of the housing, means automatically responsive to currents above a predetermined value for normally electrically connecting said rod to the terminal at said one end of the housing and for normally holding said rod at a position wherein one end thereof is adjacent said one end of the housing, whereby upon an automatic circuit interrupting operation said rod is released and moved through said bore by said biasing means to extinguish the arc, said one end of the rod after release constituting a point of high voltage stress concentration, means providing a dielectric strength in said arc passage at least when the arc is drawn therein which is higher than the dielectric strength of the medium outside of said housing whereby all of the space confined within the outer surface of said housing between said one end of the rod and said one end of the arc passage has a dielectric strength greater than the medium outside of said housing, and tubular means of electrical conducting material extending inwardly from said one end of the housing within the outer confines of said housing to a point at least adjacent to said space and substantially coaxial therewith for confining said high voltage stress to said space to thereby prevent external flashover.

8. In a high voltage circuit interrupter, a tubu-

lar housing of insulating material, terminals at opposite ends of said housing, a restricted arc passage in said housing comprising a longitudinally extending bore of relatively small cross section which is open at one end adjacent one end of the housing at least for the expulsion of gases formed during a circuit interrupting operation, hardware mounted on the outside of said housing and electrically connected with the terminal at said one end of the housing, said hardware extending toward the terminal at the other end of said housing and terminating in at least one portion of relatively small area to provide a portion of high voltage stress concentration outside of said housing, an arc-drawing rod movable through said arc passage and electrically connected with the terminal adjacent the other end of said housing, means biasing said rod for movement toward said other end of the housing, means automatically responsive to currents above a predetermined value for normally electrically connecting said rod to the terminal at said one end of the housing and for normally holding said rod at a position wherein one end thereof is adjacent said one end of the housing, whereby upon an automatic circuit interrupting operation said rod is released and moved through said arc passage and past said hardware portion by said biasing means to extinguish the arc, said one end of the rod after release constituting a point of high voltage stress concentration inside said housing, means providing a dielectric strength in said arc passage at least when the arc is drawn therein which is higher than the dielectric strength of the medium outside of said housing whereby all of the space confined within the outer surface of said housing between said one end of the rod and said one end of the arc passage has a dielectric strength greater than the medium outside of said housing, and tubular means of conducting material electrically associated with the terminal at said one end of the housing and extending therefrom at least beyond said hardware portion for confining said high voltage stress to said space at least until said one end of the rod has moved past said hardware portion far enough to prevent break-down and external flashover between said points of high voltage stress concentration.

9. In a high voltage circuit interrupter, a tubular housing of insulating material, terminals at opposite ends of said housing, a restricted arc passage in said housing comprising a longitudinally extending bore of relatively small cross section which is open at one end adjacent one end of the housing at least for the expulsion of gases formed during a circuit interrupting operation, an arc-drawing rod movable through said arc passage and electrically connected with the terminal adjacent the other end of said housing, means biasing said rod for movement toward said other end of the housing, means automatically responsive to currents above a predetermined value for normally electrically connecting said rod to the terminal at said one end of the housing and for normally holding said rod at a position wherein one end thereof is adjacent said one end of the arc passage, whereby upon an automatic circuit interrupting operation said rod is released and moved through said arc passage by said biasing means to extinguish the arc, said one end of the rod after release constituting a point of high voltage stress concentration, means forming inner wall portions of said arc passage of an insulating material which

is capable of evolving an un-ionized gas when in proximity to an electric arc to provide a dielectric strength in said arc passage at least when the arc is drawn therein which is higher than the dielectric strength of the medium outside of said housing whereby all of the space confined within the outer surface of said housing between said one end of the rod and said one end of the passage has a dielectric strength greater than the medium outside of said housing, and tubular means of electrical conducting material extending inwardly from said one end of the housing within the outer confines of said housing to a point at least adjacent to said space and substantially coaxial therewith for confining said high voltage stress to said space to thereby prevent external flashovers.

10. In a high voltage circuit interrupter, a tubular housing of insulating material, terminals at opposite ends of said housing, a restricted arc passage in said housing comprising a longitudinally extending bore of relatively small cross section which is open at one end adjacent one end of the housing at least for the expulsion of gases formed during a circuit interrupting operation, an arc-drawing rod movable through said arc passage and electrically connected with the terminal adjacent the other end of said housing, means biasing said rod for movement toward said other end of the housing, means automatically responsive to currents above a predetermined value for normally electrically connecting said rod to the terminal at said one end of the housing and for normally holding said rod at a position wherein one end thereof is adjacent said one end of the housing, whereby upon an automatic circuit interrupting operation said rod is released and moved through said bore by said biasing means to extinguish the arc, said one end of the rod after release constituting a point of high voltage stress concentration, means providing a dielectric strength in said bore at least when the arc is drawn therein which is higher than the dielectric strength of the medium outside of said housing whereby all of the space confined within the outer surface of said housing between said one end of the rod and said one end of the arc passage has a dielectric strength greater than the medium outside of said housing, and means confining said high voltage stress to said space to thereby prevent external flashovers, comprising relatively stationary tubular means of conducting material having a relatively large bore and extending substantially coaxially with said arc passage from the terminal adjacent said one end of the housing toward the other end a predetermined distance.

11. In a high voltage circuit interrupter, a tubular housing of insulating material, terminals at opposite ends of said housing, a restricted arc passage in said housing comprising a longitudinally extending bore of relatively small cross section which opens at one end adjacent one end of the housing at least for the expulsion of gases formed during a circuit interrupting operation, hardware mounted on the outside of said housing and electrically connected with the terminal at said one end of the housing, said hardware extending toward the terminal at the other end of said housing and terminating in at least one portion of relatively small area to provide a portion of high voltage stress concentration outside of said housing, an arc-drawing rod movable through said arc passage and electrically connected with the terminal adjacent the other end

11

of said housing, means biasing said rod for movement toward said other end of the housing, means automatically responsive to currents above a predetermined value for normally electrically connecting said rod to the terminal at said one end of the housing and for normally holding said rod at a position wherein one end thereof is adjacent said one end of the housing, whereby upon an automatic circuit interrupting operation said rod is released and moved through said arc passage by said biasing means to extinguish the arc, said one end of the rod after release constituting a point of high voltage stress concentration inside said housing, means providing a dielectric strength in said arc passage at least when the arc is drawn therein which is higher than the dielectric strength of the medium outside of said housing whereby all of the space confined within the outer surface of said housing between said one end of the rod and said one end of the arc passage has a dielectric strength greater than the medium outside of said housing, and means confining said high voltage stress to said space to prevent breakdown and external flashover between said points of high voltage stress concentration during and after circuit interruption, comprising relatively stationary tubular means of conducting material having a relatively large bore and being substantially coaxial with said arc passage and extending from the terminal adjacent said one end of the housing toward the other end a distance at least greater than the extent of said one hardware portion.

12. In a high voltage circuit interrupter, a tubular housing of insulating material, terminals at opposite ends of said housing, a restricted arc passage in said housing comprising a longitudinally extending bore of relatively small cross section which opens at one end adjacent one end of the housing at least for the expulsion of gases formed during a circuit interrupting operation, an arc-drawing rod movable through said arc passage and electrically connected with the terminal adjacent the other end of said housing, means biasing said rod for movement toward said other end of the housing, means automatically responsive to currents above a predetermined value for normally electrically connecting said rod to the terminal at said one end of the housing and for normally holding said rod at a position wherein one end thereof is adjacent said one end of the housing, whereby upon an automatic circuit interrupting operation said rod is released and moved through said arc passage by said biasing means to extinguish the arc, said one end of the rod after release constituting a point of high voltage stress concentration, means providing a dielectric strength in said arc passage at least when the arc is drawn therein which is higher than the dielectric strength of the medium outside of said housing whereby all of the space confined within the outer surface of said housing between said one end of the rod and said one end of the arc passage has a dielectric strength greater than the medium outside of said housing, and annular means of electrical conducting material in said space and telescopically receiving at least the lower portion of said arc passage for confining said high voltage stress to said space to thereby prevent external flashovers.

13. In a high voltage circuit interrupter, a tubular housing of insulating material, terminals at opposite ends of said housing, a restricted arc

12

passage in said housing comprising a longitudinally extending bore of relatively small cross section which opens at one end adjacent one end of the housing, an arc-drawing rod movable through said arc passage and electrically connected with the terminal adjacent the other end of said housing, means biasing said rod for movement toward said other end of the housing, means automatically responsive to currents above a predetermined value for normally electrically connecting said rod and the terminal at said one end of the housing and for normally holding said rod at a position wherein one end thereof is adjacent said one end of the housing, whereby upon an automatic circuit interrupting operation said rod is released and moved through said arc passage by said biasing means to extinguish the arc, said one end of the rod after release constituting a point of high voltage stress concentration, means providing a dielectric strength in said arc passage at least when the arc is drawn therein which is higher than the dielectric strength of the medium outside of said housing whereby all of the space confined within the outer surface of said housing between said one end of the rod and said one end of the arc passage has a dielectric strength greater than the medium outside of said housing, and conducting means electrically connected with the terminal at said one end of the housing and extending in said space toward the terminal at the other end of said housing for confining said high voltage stress to said space to thereby prevent external flashovers.

14. In a high voltage circuit interrupter, a tubular housing of insulating material, terminals at opposite ends of said housing, a restricted arc passage in said housing comprising a longitudinally extending bore of relatively small cross section which opens at one end adjacent one end of the housing, an arc-drawing rod movable through said arc passage and electrically connected with the terminal adjacent the other end of said housing, means biasing said rod for movement toward said other end of the housing, means automatically responsive to currents above a predetermined value for normally electrically connecting said rod to the terminal at said one end of the housing and for normally holding said rod at a position wherein one end thereof is adjacent said one end of the housing, whereby upon an automatic circuit interrupting operation said rod is released and moved through said arc passage by said biasing means to extinguish the arc, said one end of the rod after release constituting a point of high voltage stress concentration, means providing a dielectric strength in said arc passage at least when the arc is drawn therein which is higher than the dielectric strength of the medium outside of said housing whereby all of the space confined within the outer surface of said housing between said one end of the rod and said one end of the arc passage has a dielectric strength greater than the medium outside of said housing, annular means of conducting material electrically connected with the terminal at said one end of the housing for confining said high voltage stress to said space, to thereby prevent external flashovers, and annular means of conducting material within the outside confines of said housing electrically connected with the terminal at said other end of the housing and having the inner end thereof located adjacent the point occupied by the inner end of said rod at the end of move-

13

ment of the rod by said biasing means, but spaced from the first-mentioned annular means.

15. In a circuit interrupter, a tubular casing of insulating material having terminals adjacent opposite ends thereof, respectively, conducting means connected to each of said terminals and extending from each terminal toward the other, said conducting means being located within said casing, with one of said conducting means embedded in insulating material, and the other of said conducting means being exposed to the interior of said casing, circuit interrupting means connected between said other conducting means at a point adjacent the inner end thereof and the terminal associated with said one conducting means, said interrupting means having a movable rod-like terminal in said casing to draw an arc toward said other conducting means, means biasing said rod-like terminal for arc-drawing movement, separable contact portions connecting said rod-like terminal and the inner end of said other conducting means, and biasing means independent of said rod-like terminal biasing means for urging said separable contact portions into engagement.

16. In a circuit interrupter, a tubular casing of insulating material having terminals adjacent

14

opposite ends thereof, respectively, hardware associated with one of said terminals and extending toward the other terminal on the outside of said casing, tubular conducting means connected to each of said terminals and extending from each terminal toward the other, said conducting means being located within said casing, the said conducting means associated with said one terminal extending toward the other end of said casing a distance greater than said hardware, circuit interrupting means concentric with said conducting means and connected between said other conducting means at a point adjacent the inner end thereof, and a stationary conducting part electrically connected with the terminal associated with said one conducting means.

HAROLD H. FAHNOE.

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