May 19, 1942. A. P. STROM 2,283,656

CIRCUIT INTERRUPTER

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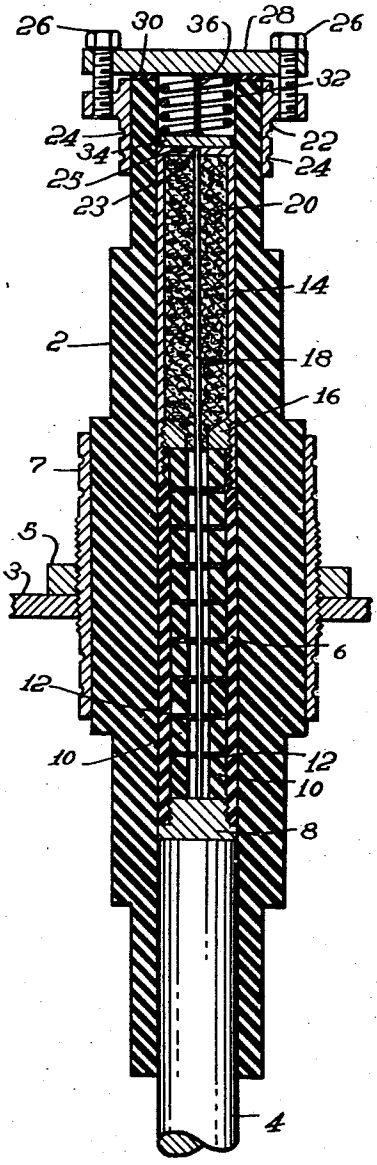


Fig. 1.

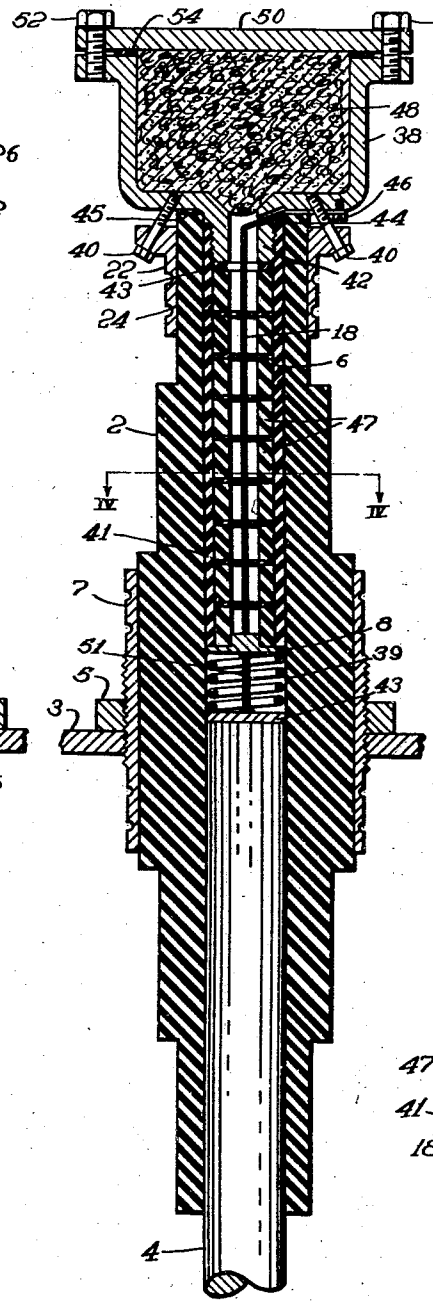


Fig. 2.

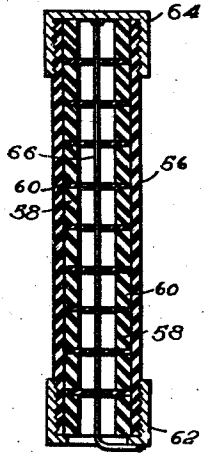


Fig. 3.

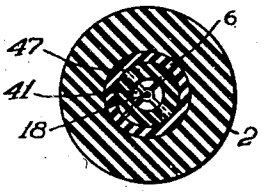


Fig. 4.

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CIRCUIT INTERRUPTER

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18 Claims. (Cl. 200—120)

My invention relates to circuit interrupters in general, and more particularly to circuit interrupters which embody means for automatically interrupting a circuit upon the passage therethrough of currents of a predetermined magnitude.

For the protection of certain types of transformers, capacitors and other enclosed types of electrical equipment, it is highly desirable to provide some means forming a part of the transformer to protect the transformer at least against short circuit conditions. Such a protective device should preferably be totally enclosed to facilitate its ready incorporation as an integral portion of a transformer structure.

One object of my invention, therefore, is to provide a totally enclosed fuse construction.

Another object of my invention is to provide a device for automatically interrupting an electric circuit in response to the passage therethrough of currents of a predetermined value, together with a means for emitting a gas to extinguish the arc formed, which device is of a totally enclosed construction.

Another object of my invention is to provide an automatic protective device, especially constructed and arranged to be supported in an insulating bushing.

Another reason why it is desirable to provide a totally enclosed protective device of this type, is that such a device enables the use of apparatus with which it is associated, in many locations, such as in explosive atmospheres, or other locations where there is a distinct fire hazard present.

To effectively and efficiently extinguish arcs of relatively small current magnitudes, the arc should be confined in a relatively small chamber or passageway, especially where the chamber or passage has at least the inner wall portions thereof, of a material capable of emitting an arc extinguishing gas when in proximity to an electric arc. Likewise for extinguishing large current arcs it is highly desirable to provide a relatively large arc chamber.

Accordingly, another object of my invention is to provide a novel form of arc chamber which is capable of efficiently interrupting arcs of any current magnitude.

Still another object of my invention is to provide an arc extinguishing chamber having walls forming a relatively small arc passage for the interruption of small current arcs, and which is automatically enlarged upon the striking of a large current arc in the passage.

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

Figure 1 is a longitudinal sectional view showing a fuse positioned in an insulating bushing in accordance with one form of my invention.

Fig. 2 is a similar view showing a modified form of fuse condenser and mounting therefor relative to a bushing;

Fig. 3 is a longitudinal cross sectional view of a cartridge type fuse embodying my novel arrangement of arc extinguishing material; and

Fig. 4 is a transverse cross sectional view taken on the line IV—IV of Figure 2.

In general, my invention resides in the application of a fuse to a bushing for a transformer, capacitor or other enclosed electrical apparatus. These bushings are generally made tubular in form with a relatively small bore for accommodating the electrodes or leads leading within the enclosure to the electrical apparatus therein. Because of this, a fuse constructed to fit in such a bushing must necessarily be of a peculiar construction because of the space requirements. I have designed my fuse to fit in the bore of this type of bushing in a manner to be totally enclosed so that the same may be conveniently used in the presence of explosive atmospheres or other fire hazards, with a maximum of safety.

In general, my fuse includes an elongated fuse tube having at least the inner walls thereof of a material which is capable of evolving an arc extinguishing gas when in proximity to an electric arc. As a continuation of the fuse tube, I have provided a condenser casing which is adapted to receive, cool, and condense the gas produced by the fuse lining and the vaporization of the fuse itself, when the fuse blows. I have also incorporated in the fuse proper, a novel arrangement of gas evolving material to enable the efficient extinction of both large and small current arcs. In general, the arrangement of gas evolving material comprises spaced constricted portions along the fuse tube, which constricted portions function to extinguish small current arcs, and upon the formation of large current arcs in the fuse tube the constricted portions are arranged to be frangible or bendable in response to such an arc formation to automatically provide a larger arc passage for an efficient extinction of such large current arcs.

In the embodiment of my invention shown in Fig. 1, I have provided an insulating tubular bushing member 2, made of any suitable in-

sulating material such, for example, as porcelain, a phenolic condensation resin, or the like, the central portion of which is adapted to pass through a wall portion 3 of a transformer or other enclosed electrical apparatus, and be secured thereto with an electrode 4 positioned in the lower end of the bushing 2. The central portion of the bushing 2 has a metallic sleeve 7 rolled thereon which has a threaded portion for cooperation with a threaded aperture in wall 3, and a lock nut 5. The electrode 4 and the lower end of the bushing will normally be positioned within the casing of the particular electrical apparatus with which this device is assembled. The electrode 4 may be secured in the position shown at Fig. 1 in the bushing 2 by any desired means. Thus, the electrode may be anchored within the apparatus or it may be frictionally secured in the bore of the bushing 2. The electrode 4 is formed of any suitable conducting material such for example as copper or the like. Positioned above the electrode 4 in the bushing 2 I have provided an insulating fuse tube 6 made of any desired insulating material such for example as fiber or the like. Threadedly engaged in the lower end of the fuse tube 6 is a terminal plug 8 for closing the lower end of the fuse tube. The terminal plug 8 is made of any desired suitable conducting material. Within the fuse tube 6, I have provided a stack of alternate, thick and thin washers 10 and 12, respectively, which are of a material which is capable of evolving an arc extinguishing gas when in proximity to an electric arc, such for example, as boric acid, horn fiber, or the like. The thicker washers 10 have relatively large central apertures, whereas the thin washers 12 have relatively small central apertures, all for a purpose to be hereinafter described. Threadedly mounted on the upper end of the fuse tube 6 and forming a continuation thereof, is an elongated tubular metallic casing 14 having a closed upper end. The casing serves to maintain an apertured plug element 16 which is threadedly engaged within the lower end of the casing in a position at the upper open end of the fuse tube, to maintain the stack of washers 10 and 12 in position in the fuse tube. A fuse wire 18 is connected at one end to the fuse terminal plug 8 in any desired manner, for example, as by soldering, and the other end of the fuse wire is soldered in an aperture 23 in the closed upper end of the condenser casing 14. The condenser casing 14 is filled with a fine metallic material in the form of strands, such for example, as metal shavings or a metallic wool, such as copper wool. An anchoring sleeve 22 is secured about the upper end of the insulating bushing 2 in any desired manner, such, for example, as by the indentations 24 interlocking with corresponding grooves in insulator 2. The anchoring sleeve serves to support a bushing terminal cover plate 28, which is secured to the anchor plate by the machine screws 26, to clamp the same against the upper open end of the bushing 2, with packing material 30 interposed between the bushing and the terminal cover plate 28. A coil compression spring 32 is compressed between the terminal cover plate 28 and a contact plate 34 which in turn is thus held in contact with the upper end of the condenser casing 14. The terminal cover plate and the contact plate 34 are electrically connected by a flexible shunt 36 made of any suitable flexible conducting material such, for example, as stranded copper wire. It can thus be seen that the coiled spring 32 maintains the fuse terminal plug 8 in general engagement with the electrode 4.

The circuit through the device extends from the electrode 4, to the fuse terminal plug 8, fuse wire 18, condenser casing 14, contact plate 34, flexible shunt 36, and terminal cover plate 28. Suitable connections may be made to the terminal cover plate 28 for connecting the device to an electric circuit. In assembling the parts of this device, it is obvious that the bushing 2 may be inserted or provided on a transformer or other electrical apparatus in the manner shown. My novel fuse may then be dropped into the open upper end of the bushing, and the cover plate 28 together with the spring 32, contact plate 34, and shunt 36 may then be secured in position by the screws 26 and the device will then be ready for service. A small threaded depression 25 is provided in the upper end of the condenser casing 14 for the reception of a threaded handling implement to remove the fuse from the bushing.

In the operation of this form of my invention, it is obvious that upon the occurrence of currents of a predetermined value, such, for example as short circuit currents, the fuse wire 18 will vaporize and an arc will be formed adjacent the gas evolving material 10 and 12. Quantities of arc extinguishing gas will be liberated and escape into the condenser 14 where they will be cooled down and condensed. The action of the gas flowing from the lower part of the fuse into the upper part, caused in part by the condenser action, will create strong currents of unionized gas flowing through the arc to effectively extinguish the same. In the event that the arc formed is of a low current value, it can be readily seen that the thin washers 12 of gas evolving material, having relatively small apertures therein, present portions thereof, close enough to the fuse wire and hence to the arc formed, to effectively extinguish such low current arcs. Upon the interruption of relatively high current values, such, for example as short circuit currents, the gas pressure produced by the vaporization of the fuse wire and by the evolution of relatively large quantities of the gas from the gas evolving materials 10 and 12 will cause the relatively weak washers 12 of gas evolving material, to be either bent against the casing wall, or broken off and blown out of the casing substantially instantaneously, or they may be entirely disintegrated. Obviously, this presents an unobstructed relatively large arc passage for the extinction of such large current arcs. The device shown in Fig. 1 is primarily a single shot device. In other words, it is intended that when the fuse has blown that it will be necessary to replace the same by an entirely new fuse. However, it is obvious that the fuse shown in Fig. 1 could be fused, for example, by removing plug 8, securing a new fuse wire thereto and threading it through the fuse and aperture 23, whereupon the plug 8 can be screwed in place and the fuse wire pulled through and soldered adjacent aperture 23.

In the embodiment of my invention shown in Fig. 2, the fuse per se and bushing are substantially identical with that already described in connection with Fig. 1 of the drawing, and hence, like numerals will be used to indicate like parts. This embodiment of my invention differs from that shown in Fig. 1 in that a dif-

ferent form of condenser structure is employed, and the condenser is maintained outside of the bushing 2. As shown in Fig. 2, the electrode 4 is extended further up into the bushing 2 than is the case with the structure shown in Fig. 1, so that the fuse proper is positioned substantially at the upper end of the bushing 2. A coil spring 39, shunt 51, and contact disc 43 are provided between the fuse and electrode 4, these parts being similar to the spring and shunt structure at the top of the fuse in Fig. 1. In this embodiment of my invention, I have provided a generally cup shaped condenser 38 which is secured to the anchoring sleeve 22 on the upper end of the anchoring sleeve 22, for example, by the machine screws 40. The condenser housing 38 has a depending, reduced tubular portion 42, threadedly engaged within the fuse tube 14. The fuse wire 18 in this instance, where it emerges from the upper end of the fuse tube is bent angularly to extend through an aperture in the reduced portion 42 of the condenser casing, and extends between the casing and bushing 2 to be secured to the outer side of the condenser 38, as for example, by the machine screw 46. Packing material 45 is provided between the condenser casing and the upper end of the bushing to seal the upper end of the bushing and to prevent damage to the relatively fragile bushing. The condenser 38 is filled with metallic material 48, which may be the same as the material 20 described in connection with the embodiment shown in Fig. 1. A condenser terminal cover plate 50 is secured over the open end of the condenser 38, as by the machine screws 52 which clamp the terminal plate 50 to the open end of the condenser 38 with packing material 54 interposed between the plate 50 and the condenser. The fuse tube in this embodiment is provided with washers 41 and 47 of gas evolving material as in the previous embodiment. If desired, and as shown in Fig. 4, the small washer elements 41 may be slotted or formed of a plurality of segmental portions to weaken the same in order to make these washers readily bendable or breakable, so that they may be bent or substantially instantaneously blown out of the fuse casing to form an enlarged arc passage. Whether the washers 41 are merely bent, or entirely broken off, will depend on the magnitude of the current interrupted. As shown in Fig. 4, the thin washers 41 are quartered. This structure is particularly desirable if horn fiber or other relatively strong material is used as the gas evolving substance. It should be obvious, however, that the thin washers 41 may be made in any desired number of sections if it is not desired to quarter them, as shown in Fig. 4. Also, they may be split radially for only a portion of their extent, if desired.

The operation of this embodiment of my invention is much the same as the embodiment shown in Fig. 1 and hence to prevent repetition, it will not be again described in detail. It should be noted, however, that the fuse in this embodiment of my invention may be refused by removing the terminal plug 8 and attaching a new fuse wire thereto, extending the fuse wire through the fuse 2 and through the aperture 44 in the condenser 38, then securing the fuse plug 8 in position, and finally securing the other end of the fuse wire to the condenser casing by means of the screw 46. Although in this form of my invention the condenser portion of the fuse is exposed outside of the bushing 2, it has the advantage of presenting cooler surfaces and greater volume, and hence, providing a more efficient condensing action than may be obtained with the embodiment shown in Fig. 1.

In Fig. 3, I have shown a conventional cartridge type fuse which includes an insulating fuse tube 56 similar to the fuse tube 6 previously described and being interiorly provided with a stack of alternate large and small washers or spacer elements 58 and 60, respectively. These elements are preferably of a gas evolving material the same as the elements 10, 12, 41 and 47 described in connection with the previous embodiments. A terminal cap 64 is threadedly engaged over one end of the fuse tube 56, and an apertured terminal cap is likewise threadedly engaged with the other end of the fuse tube, with the washers 58 and 60 maintained in assembled position by engagement of the washers with portions of the terminal caps 62 and 64, respectively. A fuse wire 66 extends through the fuse tube and is anchored at its ends to the terminal caps 62 and 64, respectively.

The operation of this embodiment of my invention is the same as the operation of the fuse per se of the two previously described embodiments. This fuse, however, is designed to be used outside in the open or in other places where there is substantially no fire hazard.

It is believed obvious from the foregoing that I have provided a novel totally enclosed fuse structure, which is particularly adapted for mounting in the terminal bushings of transformers, capacitors, or other types of enclosed electrical apparatus, which fuse is provided with a condenser to take care of the gas evolved when the fuse blows, and which condenser may be mounted either within or without the bushing proper. It should also be evident that I have provided for use, not only in the particular type of fuse mentioned above, but also in the fuse art generally, and in the electric arc extinguishing art generally, a novel form of arcing chamber, which embodies spaced restricted portions along the arc chamber or arc passage which may be of a gas evolving material to efficiently interrupt both large and small current arcs.

Having described preferred embodiments of my invention in accordance with the patent statutes, I desire it to be understood that I do not wish to be limited to the particular embodiments disclosed herein, inasmuch as it will be obvious, particularly to persons skilled in the art, that many changes and many modifications may be made in the particular structures disclosed without departing from the broad spirit and scope of my invention. Therefore, I desire that my invention be interpreted as broadly as possible and that it be limited only by what is expressly set forth in the following claims.

I claim as my invention:

1. In a circuit interrupting device, a closed arcing chamber, means for striking an arc therein, at least the inner walls of said chamber being of a material capable of evolving an arc extinguishing gas when in proximity to an electric arc, to extinguish said arc, said inner walls including spaced, constricted portions along the arc passage which are frangible in response to the striking of high current arcs, and said chamber communicating with a closed condenser for said gas.

2. In a circuit interrupting device, an arc passage including spaced restricted portions along

the passage for interrupting small current arcs, which portions are displaceable from inner walls of said passage in response to the striking of large current arcs to automatically enlarge said arc passage by removal of said restricted portions.

3. In a circuit interrupting device, an arc passage including spaced restricted portions along the passage for interrupting small current arcs, which portions are displaceable from inner walls of said passage in response to the striking of large current arcs to automatically enlarge said arc passage by removal of said restricted portions, and at least inner wall portions of said passage being formed of a material capable of emitting quantities of arc extinguishing gas when in proximity to an electric arc.

4. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, some of said members having portions which are frangible in response to the striking of large current arcs therein to thereby automatically enlarge said passage to accommodate said large current arcs.

5. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, some of said members having portions which are relatively displaceable in response to the striking of a large current arc in said passage, and having smaller apertures therethrough than the others.

6. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members of a material capable of evolving an arc extingishing gas when in proximity to an electric arc, some of said members having portions which are frangible in response to the striking of large current arcs therein to thereby automatically enlarge said passage to accommodate said large current arcs.

7. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, some of said members being weakened so as to present portions relatively movable in response to the striking of a large current arc in said passage, and having smaller apertures therethrough than the others.

8. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, some of said members being radially slit so as to present portions which are displaceable in response to the striking of a large current arc in said passage, and having smaller apertures therethrough than the others.

9. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, alternate members having smaller apertures than the others, and having portions which are movable in response to the striking of large current arcs in said passage to enlarge the arc passage.

10. In a circuit interrupting device, an arc passage including spaced restricted portions along the passage for interrupting small current arcs, which portions are weakened so as to be displaceable in response to the striking of large current arcs to automatically enlarge the arc chamber.

11. In a circuit interrupter, means for automatically interrupting a circuit in response to the passage therethrough of currents of a predetermined magnitude, means of a material capable of emitting an arc extinguishing gas when in proximity to an electric arc for extinguishing the arc formed by operation of said interrupting means to interrupt a circuit, said means being entirely enclosed by fixed wall means, said enclosure including condensing and cooling means for said gas, a tubular insulating bushing having a bore of a size to receive said enclosure, a conductor extending into said bore from one end thereof for closing said one end of the bore and adapted to form a support for one end of said enclosure, and means associated with the other end of said bushing and engaging the other end of said enclosure to maintain it in engagement with said conductor and close the other end of said bore.

12. In a circuit interrupter, a tubular insulating bushing, conducting means extending into and closing off one end of said bushing, interrupting means having a terminal seated on said conducting means in said bushing, and means associated with the other end of said bushing and the other terminal of said interrupter for maintaining said interrupter in operative position in said bushing and closing off the other end of said bushing.

13. In a circuit interrupter, a tubular insulating bushing, conducting means extending into and closing off one end of said bushing, interrupting means having a terminal seated on said conducting means in said bushing, means associated with the other end of said bushing and the other terminal of said interrupter for maintaining said interrupter in said bushing and closing off the other end of said bushing, and resilient means cooperating with one terminal of said interrupting means to maintain at least the other of said terminals in firm engagement with its associated means.

14. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, some of said members being weakened so as to present portions relatively movable in response to the striking of a large current arc in said passage.

15. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, some of said members being slit so as to present portions which are displaceable in response to the striking of a large current arc in said passage.

16. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, some of said members having portions which are displaceable relative thereto in response to the striking of large current arcs therein to thereby automatically enlarge said passage to accommodate said large current arcs.

17. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, some of said members being partially severed so as to present portions which are displaceable in response to the striking of a large current arc in said passage.

18. In a circuit interrupting device, an arc passage comprising a stack of apertured washer-like members, alternate members having smaller apertures than the others, and having portions which are movable relative thereto in response to the striking of large current arcs in said passage to enlarge the arc passage, said members having larger apertures also being thicker than said members having smaller apertures.

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