Feb. 26, 1957 G. R. McCLOUD 2,783,328

PROTECTIVE BUSHING FOR ELECTRICAL APPARATUS

Filed Oct. 12, 1954 2 Sheets-Sheet 1

Fig. 1

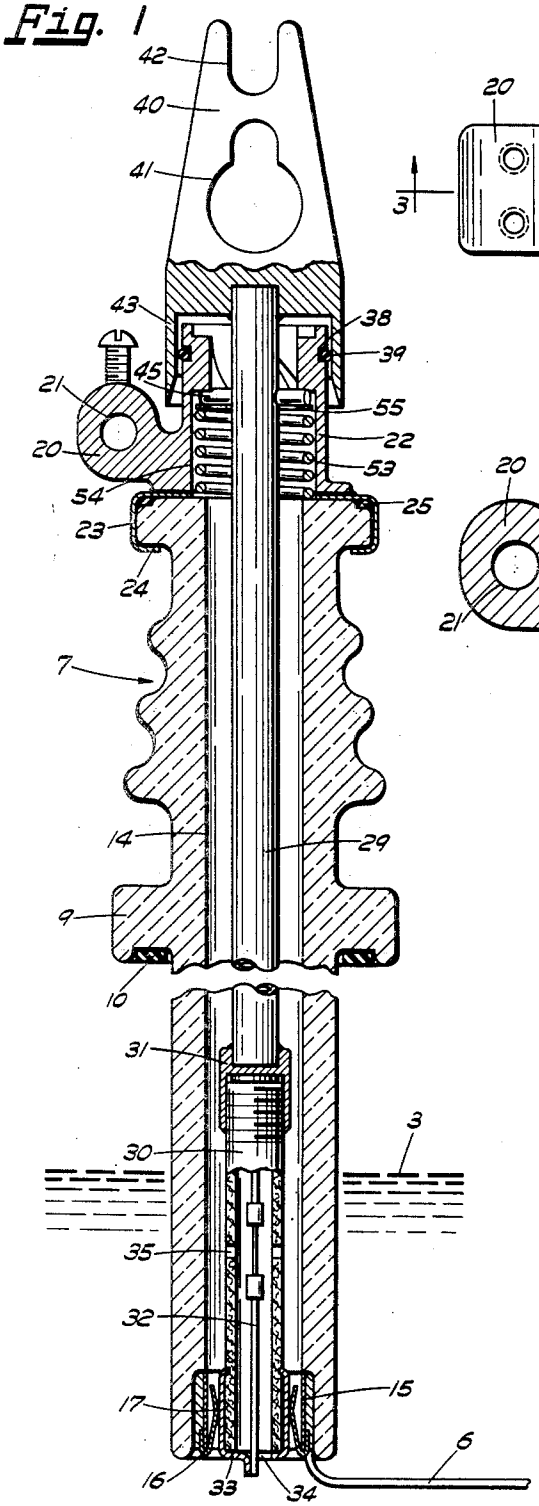


Fig. 2

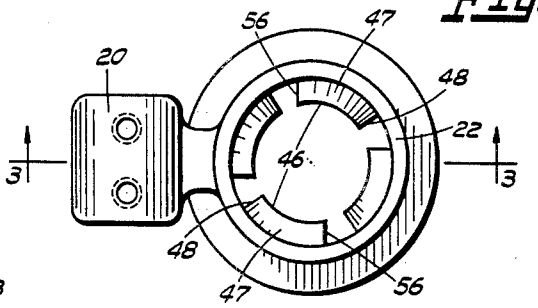


Fig. 3

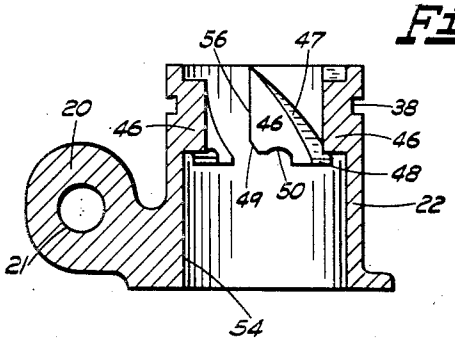
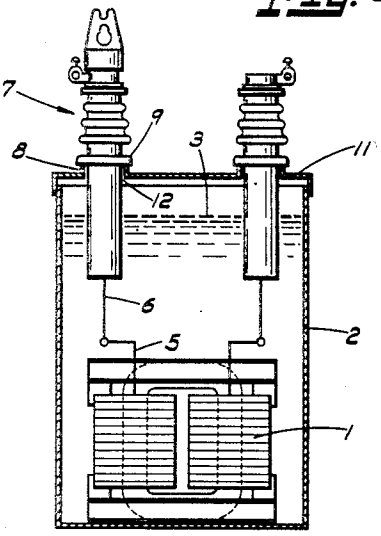


Fig. 4



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PROTECTIVE BUSHING FOR ELECTRICAL APPARATUS

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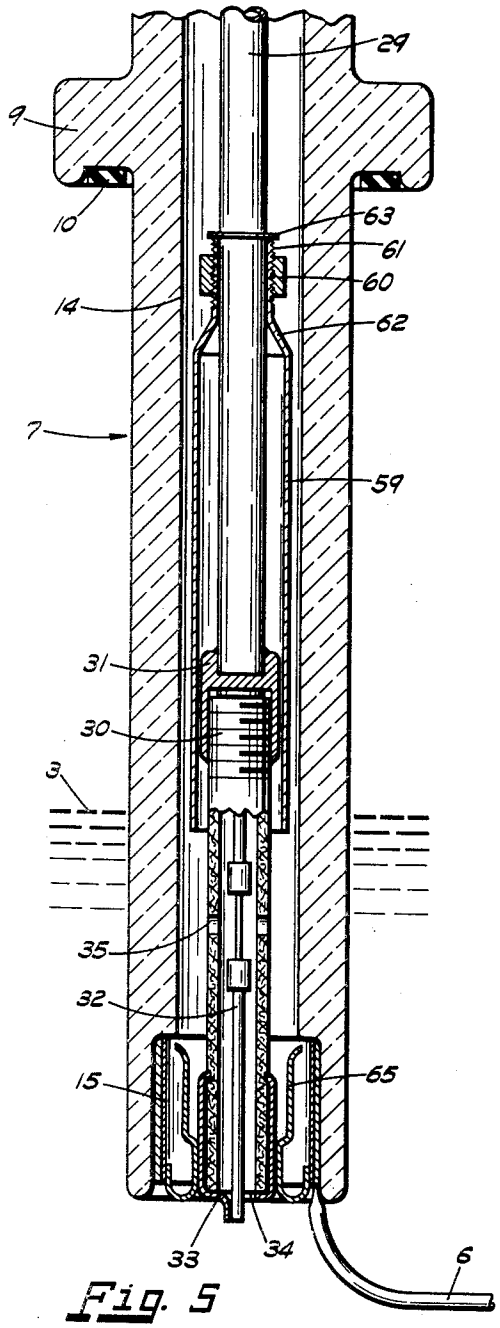


Fig. 5

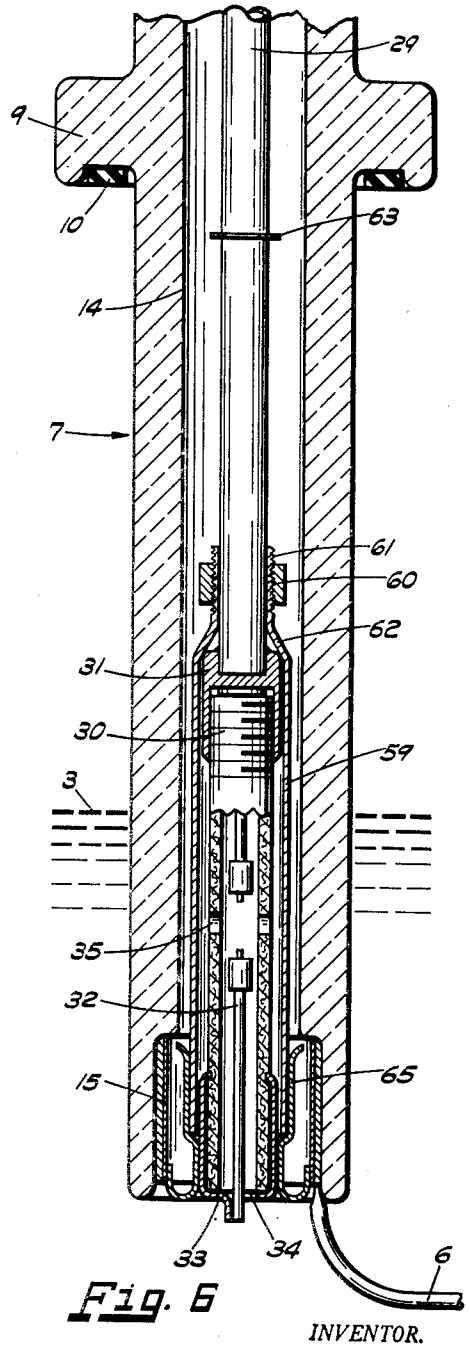


Fig. 6

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PROTECTIVE BUSHING FOR ELECTRICAL APPARATUS

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Application October 12, 1954, Serial No. 461,780

8 Claims. (Cl. 200—114)

This invention relates to a protective device for electrical apparatus such as transformers and has particular application in a protective bushing in the form of an elongated tubular insulating member having a bore for receiving a manually removable current carrying member for connecting a line terminal located exteriorly of a liquid filled apparatus enclosure to an apparatus load terminal located within the enclosure.

It is an object of this invention to provide a bushing mounted circuit closer with a simplified mechanism for positively securing the closer in the bushing during normal current carrying operation but which may be easily withdrawn by means of a hook stick when opening of the circuit, or replacement of a fusible section carried thereby, is desired.

Another object is to provide a locking mechanism which will maintain the closer in the bushing in opposition to severe forces of expulsion usually accompanying abnormally heavy current flow to the protected apparatus.

A further object is to provide a fused circuit closer which may be easily restored to closed circuit condition, by manual means, subsequent to rupture of its protective fuse.

A further object is to provide a closer which may be easily maintained and economically manufactured.

Other objects will appear explicitly or by implication from time to time throughout the following specification.

Referring to the drawing:

Fig. 1 is a sectional view taken on the longitudinal axis of an embodiment of the invention;

Fig. 2 is a top view of the line terminal component, removed from the assembly illustrated in Fig. 1;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is a view in elevation, partly in section, showing the invention incorporated in a transformer which is illustrated more or less symbolically;

Fig. 5 is a sectional fragmentary view of a manually restorable circuit closer adaptable to the embodiment shown in Fig. 1; and

Fig. 6 is similar to Fig. 5 except that the parts are shown in a different position.

Like parts are designated by the same reference characters throughout the several views.

Fig. 4 illustrates a typical use of the invention in conjunction with a transformer 1 enclosed within a tank 2 which is filled with a dielectric liquid to the level indicated by the reference numeral 3. Transformer 1 receives electrical energy through a primary lead 5 which connects through a flexible leader 6 extending from the bushing 7. It will be seen that the primary bushing 7 is mounted on tank cover 11 and extends into tank 2 through a hole 12 surrounded by an annular flange 8. The lower end of the bushing 7 is immersed in the dielectric fluid 3. For illustrative purposes, a single circuit closer is shown embodied within bushing 7 for protecting, in this case, the primary circuit of the transformer 1.

The novel circuit closer and locking mechanism therefor are most clearly illustrated in Fig. 1 where the closer assembly is seen to comprise an insulating bushing 7 having an integral shoulder portion 9 which bears on annular flange 8 formed integral with cover 11 of transformer tank 1. Any well known bushing clamp may be used in conjunction with bushing 7 to urge shoulder 9 into tight compressive relation with flange 8 for the purpose of obtaining a moisture proof and oil tight joint.

The novel circuit closer is made in convenient form for inserting and withdrawing from bushing 7, the latter being provided with a concentric bore 14 substantially coextensive with its length for that purpose. A fixed load terminal, to which the enclosed electrical apparatus is to be connected, indicated by the reference numeral 15, is affixed to the interior of bore 14 at the lower end of bushing 7 by any suitable bonding means such as metallizing the interior of the bushing and flowing soft solder between the bushing and terminal. This technique permits facile connection of the flexible leader 6 by inserting it between terminal 15 and the bushing bore and retaining it by the same solder which holds terminal 15. Terminal 15 also has soldered thereto circumferentially spaced resilient contact clips 16 having current transfer contact points 17 projecting radially inward toward the axis of bushing bore 14 for the purpose of electrically engaging one end of the circuit closer as will be more fully explained hereinafter.

Attention is now directed to the upper end of the bushing where a line terminal 20 is provided for fastening a wire in hole 21, by any well known means, such as a screw. The line terminal 20 may be formed integral with a die cast conductive cylindrical member 22 which is carried on the bushing 7 concentrically with the latter's bore 14. The line terminal cylinder 22 is rigidly fastened to the fuse bushing 7 through the medium of a thin metallic sleeve 23 having its margin 24 rolled tightly against bushing 7. A gasket 25, made of a resilient material, such as rubber, is interposed between sleeve 23 and bushing 7 for the purpose of providing a barrier against entry of moisture into the bushing.

Electrical connection between the line terminal 20 at the upper end of bushing 7, and load terminal 15 at the lower end of bushing 7, is made through a conductive assembly including a metallic tube 29 and intermediate members which are described in greater detail, subsequently. Tube 29 is provided at its lower end with a protective fuse assembly comprising an insulating tube 30 coupled to conductive tube 29 by means of a threaded conductive ferrule 31 which is permanently affixed to tube 29 by soldering, brazing, or other suitable means. Electrical continuity between ferrule 31 and fixed terminal 15 is accomplished by means of a series circuit including a fuse link 32 interposed between ferrule 31 within a fiber tube 30 and a cap 33 which holds the lower end of fuse link 32 and which electrically contacts clip 16 of terminal 15.

When inserted in bushing 7, fuse tube 30 projects beneath oil level 3 within tank 2 housing the electrical transformer 1. An aperture 34 is provided in cap 33 for permitting oil to rise within fuse tube 30 to the level indicated in Fig. 1. When excessive current causes rupture of the fusible section 32, tube 30 evolves gases, in a well known manner, which gases may be vented through aperture 34 and auxiliary vent holes 35 through the walls of fuse tube 30.

For inserting and removing conductive tube 29 from bore 14 of bushing 7, which amounts to making and breaking the electrical circuit through the bushing, the tube is provided with a pyramid shaped cap member 40 which is in turn provided with an eye 41 for convenient engagement by a hook stick (not shown). A U-shaped

groove 42 at the upper end of cap 40 facilitates pushing the tube 29 into bushing 7. In order to prevent entry of water and other foreign matter into the bushing 7, cap 40 is equipped with an annular depending apron portion 43 overhanging the cylindrical portion 22 of terminal 20 when the circuit closer is in the bushing 7. A resilient cord ring 39 disposed between apron 43 and cylinder 22 in an annular groove 38 in cylinder 22, further prevents entry of foreign matter into the bushing and effects a snug, well aligned fit between apron and cylinder.

The novel locking mechanism for retaining the conductive assembly in closed circuit position within bushing 7 includes a locking pin 45 projecting from each side of tube 29 normal to the longitudinal axis of the latter. For cooperating with pin 45 to cause locking engagement between the circuit closer and bushing, it will be seen by referring to Figs. 2 and 3 that the cylindrical portion 22 has within its interior a plurality of circumferentially spaced arcuately triangular segments 46 which are adapted for selective engagement or disengagement by locking pin 45. Each segment 46 has an edge 47 inclined or tapered spirally in the direction of the longitudinal axis of bushing 7 upon which surface a free end of pin 45 bears when the pin is being advanced crosswise into cylinder 22 by applying a downward thrust on cap 40. Of course, the respective ends of pin 45 bear upon diametrically opposite inclined surfaces 47 during this operation so that alignment of the closer assembly and bushing 7 will be maintained. Hence, as the closer assembly is caused to advance inwardly, locking pin 45, tube 29, and fuse cap 33 are caused to rotate and advance simultaneously in much the same manner as if the pin 45 were being turned into a screw thread. When locking pin 45 has been advanced inwardly sufficiently to pass the lower apex 48 of triangular segment 46, the pin comes into bearing relation against the spring urged washer 55. Upon this event the closer is given a clockwise turn through the medium of cap member 40 causing pin 45 to rotate past chamfered edge 49 and into the recess or locking groove 50. Aside from locking the closer into the bushing, the rotational movement of the closer causes a wiping action to occur between cap 33 and clips 16, thus enhancing electrical contact with lower terminal 15.

When locking pin 45 is nested within groove 50, the pin is positively retained in electrical contact therewith by means of coil spring 53 acting compressively on intermediate washer 55 surrounding tube 29 within bore 54 of cylinder 22. Washer 55 is interposed between spring 53 and pin 45 to present a smooth bearing surface to the pin and to limit the expansive movement of spring 53 by abutting segments 46 within cylinder 22 when locking pin 45 is withdrawn from the cylinder.

Aside from the reasons for employing segments 46 which may be inferred from the foregoing paragraphs, there are other reasons for their use. For example, the particular triangular configuration adopted results in development between surfaces 47 and 56 of each segment 46 an acute angle whose apex is pointed toward the upper margin of cylinder 22. The practical effect of this is that the closer may be inserted in the bushing 7 more easily where four segments are used because there are only four points or apices which interfere with direct advancement of locking pin 45 into cylinder 22. Thus, where the closer is being handled by a hot-stick (not shown) the operator need not feel out engagement of the pin 45; rather, the closer may be released so that locking pin 45 falls freely on inclined surfaces 47 and rotates downward until the pin comes to rest in line with chamfered edge 49 of segment 46. Consequently, the operator is always working from the most advantageous position since it is only necessary to turn his hot-stick through a very small angle to force locking pin 45 into notch 50.

Removal of the closer to effect circuit opening of the electrical apparatus is accomplished in a very simple manner by pressing downwardly on cap 40 by means of a hook stick and imparting thereto a slight counterclockwise rotational movement. This causes locking pin 45 to be depressed against washer 55 until the former clears the margin of groove 50 and to pass the lower tip 48 of segment 46 and into the free space between adjacent segments. The locking pin 45 may then be lifted upwardly on inclined surfaces 47 for complete removal from bushing 47 by means of lifting on cap 40 with a hook stick engaged in eye 41.

Refer now to Figs. 5 and 6 where the closer is shown in a modified form which greatly enhances its versatility and gives increased effect to the purpose behind bushing mounted circuit closers. The cited figures illustrate novel structure for emergency restoration of the electric circuit through bushing 7 after an overload has ruptured fuse link 32. The lower part of bushing 7 illustrated in Figs. 5 and 6 is broken somewhat above flange 9 of the same bushing 7 represented in Fig. 1 and the structure disposed within the fragment is useable in the same situs, the remaining parts of the closer not being shown for the sake of brevity.

The invention is shown in Figs. 5 and 6 modified to facilitate bridging the gap created between ferrule 31 and cap 33 of the fuse tube after fusible link 32 has ruptured. This operation is often desirable where a dual characteristic fuse is used to protect a transformer from damage caused by sustained moderately excessive currents of considerable duration. It is well known that electrical apparatus such as a transformer may be subjected to relatively large overloads for a short period of time and conversely, to relatively small overloads for a greater period of time. Hence, a fuse link responsive to short duration surges is combined with one responsive to moderate thermal excesses of long duration and the latter is calibrated to rupture upon attaining a predetermined temperature. It may be, however, that the safe loading limit of the apparatus has not been reached even though the thermal element has ruptured so that reclosing the circuit, at least during an emergency period, would be highly advantageous. For an illustration of one means of accomplishing this result and for an example of several forms of dual characteristic fuses, refer to U. S. Patent 2,663,825 to Roald H. Amundson, issued December 22, 1953, and assigned to the assignee of this invention.

For simplicity, a single characteristic fuse 32 is employed in Fig. 5 for conveniently illustrating a novel means for reclosing an electric circuit after rupture of the fuse link. This is accomplished by means of a tubular bridging sleeve 59 arranged for sliding longitudinally along conductive tube 29 to bridge the gap between fuse tube ferrule 31 and fuse tube cap 33. In normal operation, when fuse link 32 is unbroken, sleeve 59 is held in a first position on tube 29 out of electrical circuit by means of an internally threaded knurled collar 60 tightened on a tapered thread 61 on a diametrically constricted portion 62 of sleeve 59 (see Fig. 5). As collar 60 is advanced on tapered thread 61 toward fuse ferrule 31 a radially inward pressure is developed which frictionally secures sleeve 59 on tube 29. The combination of collar 60 and its mating thread 61 constitutes a preferred form of clamping means for holding sleeve 59 in a first position out of electrical contact with fuse tube ferrules 31 and 33. Pin means such as 63 may be provided for limiting longitudinal displacement of sleeve 59 in one direction.

The spring clips 65 at the end of bushing 7 are modified by offsetting them to permit reception of sleeve 59 between the clips 65 and tube cap 33. Aside from this modification, clips 65 function and are affixed similarly to those designated by 16 in Fig. 1 so this information will not be reiterated.

To transfer the bridging recloser sleeve 59 into by-pass relation across fuse terminal ferrules 31 and 33, conductor 29 is withdrawn from bushing 7 by releasing locking pin 45 from segments 46 in a manner described hereinbefore so that collar 60 becomes accessible for manually turning

it. Knurled collar **60** is then loosened by rotation on tapered thread **61** until sleeve **59** may be slid freely to a second bridging position across members **31** and **33** (see Fig. 6). This establishes a low resistance path in parallel with the gap created by rupture of fuse link **32**. Bridging sleeve **59** may be re-clamped or re-secured on tube **29**, before replacing the closer assembly in bushing **7**, by turning collar **60** tightly on tapered thread **61**.

Fig. 6 shows the closer replaced in the bushing subsequent to the operation described in the preceding paragraph. Note that although fuse link **32** is shown ruptured, the current path is continuous from member **29** through sleeve **59** to pigtail **6** by reason of sleeve **59** being in direct contact with offset spring clips **65**. Hence, it is seen that bridging sleeve **59** facilitates prompt manual restoration of electric service at least during an emergency period.

In actual use, the closer may be converted from a fuse to an ordinary switch by substituting, for the fiber tube shown in Fig. 1, a solid or tubular cylindrical member of conductive metal.

From the foregoing description, it will be seen that a novel mechanism has been described for easily and positively locking a circuit closer into a bushing mounted on the tank of an electrical apparatus and which assures that the closer will not be inadvertently withdrawn or expelled from the bushing. Moreover, despite being positively locked under normal conditions, the closer may be conveniently withdrawn by means of a hook stick when it is desired to replace a fuse link, connect it to a switch, or to open the circuit supplying the electrical apparatus which the closer is protecting.

Although the novel closer and locking mechanism therefor has been described with respect to a primary transformer bushing, those skilled in the art will readily perceive how to apply the teaching of this invention to other forms of bushings. Accordingly, the scope of the invention is not limited to the preferred embodiment, but only by interpretation of the following claims.

It is claimed:

1. A circuit maker and breaker for an electrical apparatus comprising a tubular insulating bushing having a load terminal at one end and a line terminal at the other end, a circuit closer insertable in said bushing, said circuit closer including an elongated conductive member electrically connecting said load terminal and said line terminal, a locking pin projecting radially from said conductive member within said line terminal, said line terminal including a cylindrical portion having a plurality of circumferentially spaced substantially right triangular locking segments disposed about its interior with an acute angle of each segment adjacent the opening of said cylindrical portion, said acute angle being formed between an axial edge and an inclined edge of each segment, whereupon said locking pin may be freely placed on said inclined edges and spirally advanced therealong to a position axially adjacent said segments, resilient means longitudinally adjacent said segments, whereby said conductive member may be held in electrical engagement with said segments through the medium of said resilient means.

2. A circuit maker and breaker for an enclosed electrical apparatus comprising, an insulating tubular bushing communicating from the exterior to the interior of the enclosure, a load terminal having an entrance opening at one end of said bushing and a line terminal at the other end of said bushing, a circuit closer wholly removable from and insertable within the bushing for electrically connecting said terminals, said closer including an elongated conductive member having pin means at one end normal to the axis of said member, said line terminal including a plurality of arcuately triangular circumferentially spaced segments having apices adjacent said entrance and each disposed interiorly thereof in the rotational path of said pin means, each segment having a notch at its lower margin for receiving said pin means when said closer is inserted within the bushing, a compression spring within

said line terminal in bearing relation with said pin means for releasably urging said pin means into electrical engagement with said segments.

3. A circuit maker and breaker for an electrical apparatus including, in combination with said apparatus; a tubular insulating bushing having a load terminal at one end and a line terminal at the other end, a circuit closer comprising an elongated conductive member insertable within said bushing for electrically connecting said terminals, said line terminal including a cylindrical body portion having a bore coaxial with said bushing, a plurality of curvate circumferentially spaced substantially triangular segments arranged within said bore, each of said segments having an edge inclined in the direction of the longitudinal axis of said bore, a straight edge substantially parallel with said bore and a bottom edge having a locking pin means receiving notch therein, a compressive spring interposed between said bushing and said segments within said bore, locking pin means rigidly affixed to said elongated conductive member projecting into bearing relation with the inclined edge of said segments when said circuit closer is inserted within said bushing, whereby said closer may be spirally advanced within said bushing until said locking pin means nests within the notch in said segment under the influence of said compression spring.

4. A circuit maker and breaker comprising a tubular insulating bushing having a load terminal at one end and a line terminal at its other end, a circuit closer insertable into said bushing, said line terminal including locking means engageable with said closer for limiting its advancement toward said load terminal, said closer including a conductive member extending from said line terminal in spaced relation with said load terminal, a fusible element normally connecting said conductive member and load terminal, said connection being maintained by said locking means, bridging means carried by said conductive member adjacent said fusible element and normally out of electrical contact with said load terminal, said bridging means having normally inaccessible clamping means normally securing said bridging means out of contact with said load terminal and releasable upon removal of said closer from said bushing for positioning said bridging means coextensive with said load terminal when said closer is placed in said bushing.

5. A circuit maker and breaker for electrical apparatus comprising, an insulating tubular bushing, a load terminal at one end of said bushing and a line terminal at the other end thereof, a circuit closer insertable in said bushing for electrically connecting said terminals, releasable locking means normally restraining said closer within said bushing, said closer including a conductive member extending from said line terminal in spaced relation with said load terminal, a fusible element normally interposed between said load terminal and said conductive member, bridging means carried by said conductive member in a first position spaced from said load terminal and manually advanceable to a second position coextensive with said fusible element for contact with said load terminal upon removal of said closer from said bushing.

6. A circuit maker and breaker for electrical apparatus comprising an insulating tubular bushing, a load terminal at one end of said bushing and a line terminal at the other end thereof, a circuit closer insertable in said bushing for electrically connecting said terminals, releasable locking means normally restraining said closer within said bushing, said closer including a conductive member extending from said line terminal in spaced relation with said load terminal, a fusible element normally connected between said load terminal and said conductive member, bridging means operable to connect said conductive member and said load terminal, said bridging means comprising a sleeve clampingly secured to said conductive member in a first position spaced from said load terminal and movable upon removal of said closer from said bushing

to a second position in contact with said load terminal in parallel relation with the gap created by rupture of said fusible element.

7. A circuit maker and breaker for electrical apparatus comprising an insulating tubular bushing, a load terminal at one end of said bushing and a line terminal at the other end thereof, a circuit closer insertable in said bushing for electrically connecting said terminals, releasable locking means normally restraining said closer within said bushing, said closer including a conductive member extending from said line terminal in spaced relation with said load terminal, a fusible element normally connected between said load terminal and said conductive member, bridging means operable to connect said conductive member and said load terminal, said bridging means comprising a cylindrical sleeve surrounding said conductive member and having a threaded portion at one end, collar means threadingly engaged with said threaded portion for frictionally holding said sleeve in a first position on said conductive member in spaced relation with said load terminal when said fusible element is intact, said sleeve being releasable through the medium of said collar to a second position in conductive relation with said load terminal bridging the gap created by rupture of said fusible element.

8. A circuit maker and breaker comprising a tubular insulating bushing having a load terminal at one end and a line terminal at the other end, said load terminal having a bore therethrough coaxial with said bushing, a circuit closer wholly removable from and insertable through said bore into bridging relation with said terminals, pin means projecting laterally of said closer toward the wall defining said load terminal bore, pin engaging means disposed about the interior periphery of said bore, said last named means including a plurality of circumferentially spaced substantially triangular grooves opening divergently at one end toward the entrance of said bore and converging in a circumferentially displaced notch at the other end thereof for receiving said pin means, whereupon placement of said pin means against the margins of said grooves will permit advancement of the pin means into locking relation with said notches.

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