Dec. 8, 1953 S. I. LINDELL ET AL 2,662,138

CIRCUIT INTERRUPTER HOUSING

Filed March 30, 1951 3 Sheets-Sheet 1

Fig. 1A.

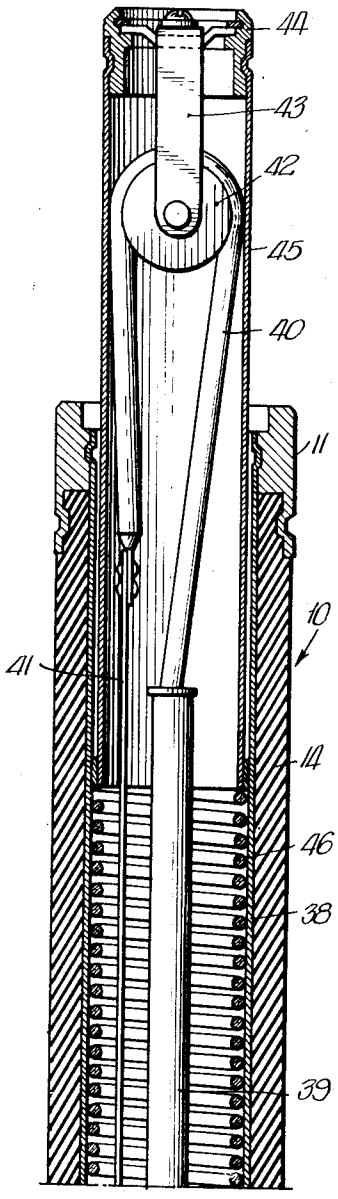


Fig. 1B.

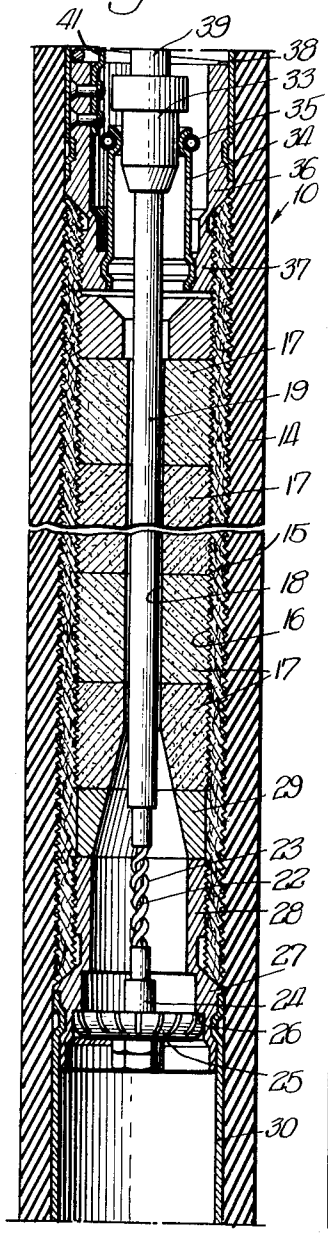
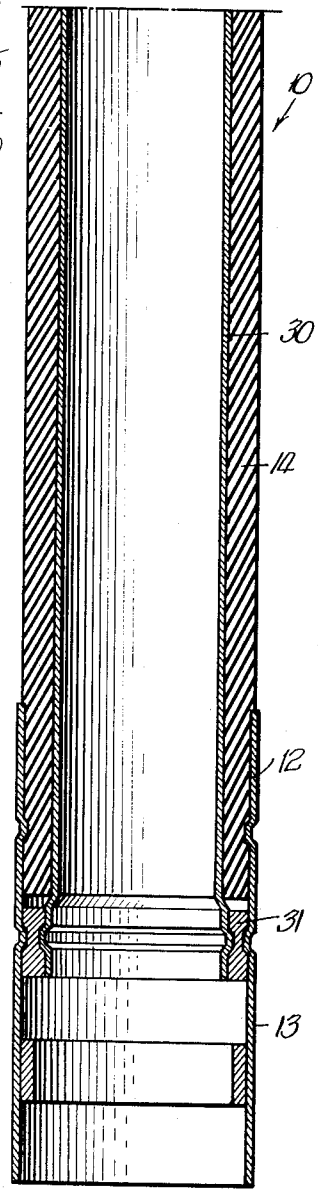


Fig. 1C.



INVENTORS.
Sigurd I. Lindell,
BY Charles H. Baker,
Robert R. Lockwood
Atty.

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Fig. 2.

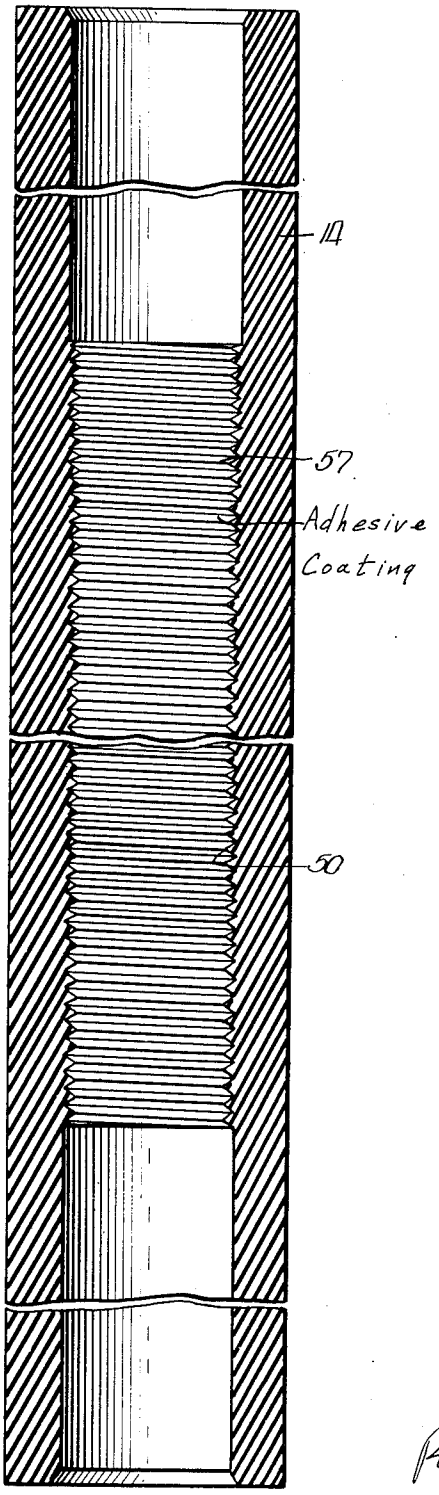
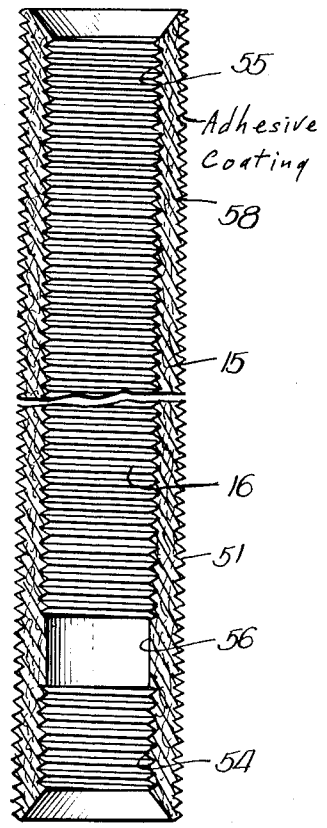


Fig. 3.



INVENTORS.
Sigurd I. Lindell,
BY Charles H. Baker,
Robert R. Lockwood
attys.

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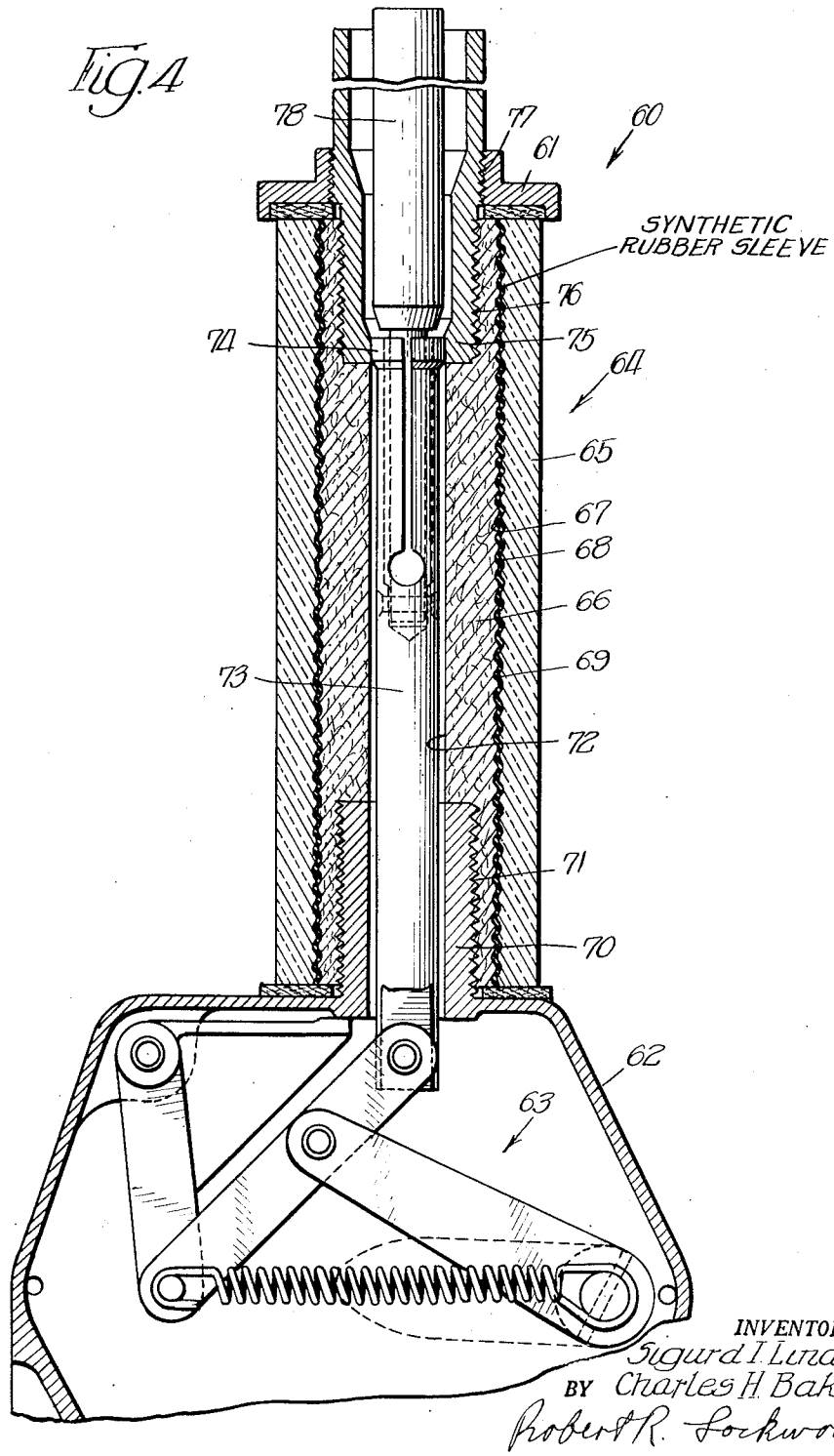
Fig. 4



INVENTORS.
Sigurd I. Lindell,
BY Charles H. Baker,
Robert R. Lockwood
Atty.

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2,662,138

CIRCUIT INTERRUPTER HOUSING

Sigurd I. Lindell, Chicago, and Charles H. Baker, Maywood, Ill., assignors to S & C Electric Company, Chicago, Ill., a corporation of Delaware

Application March 30, 1951, Serial No. 218,448

9 Claims. (Cl. 200—120)

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This invention relates, generally, to circuit interrupters, and it has particular relation to housings for high voltage circuit interrupters. It constitutes an improvement over the circuit interrupter housings disclosed in application Serial No. 273,633, filed February 27, 1952; and in application Serial No. 96,034, filed May 28, 1949, now Patent No. 2,599,187, granted June 3, 1952, all assigned to the assignee of this application.

The tubular housings for the circuit interrupters shown in these applications are subjected to relatively high open circuit voltages after an arc has been drawn therein and extinguished. Where the normal frequency voltage impressed across the tubular housing is of the order of several thousand volts, for example 69 kv., and where the normal frequency voltage may be exceeded to a great extent by transient voltages arising from various sources, difficulty has been encountered particularly in high current capacity interrupters employing high strength liners within the insulating housing in making certain that any reignition or restriking of the arc will take place only in the bore where it is originally drawn and extinguished and where it can be subjected to the arc extinguishing action of a gas or water vapor evolving medium such as boric acid or magnesium borate.

In constructing the circuit interrupter housings just mentioned there is employed an outer tube that is weather resisting, has little tendency to permit leakage paths over its external surface, has good dielectric qualities, and is capable of withstanding severe dielectric stresses. However, this outer tube mechanically is relatively weak and unable under all operating conditions to withstand the high internal pressures and other mechanical forces that are incident to the operation of high current circuit interrupters. The materials preferably used for making these outer tubes are rolled laminated paper tubes impregnated with phenolic condensation products, melamine resins, porcelain, etc.

In order to furnish the necessary arc extinguishing characteristics there is provided within such a tube a material which is capable of evolving a large quantity of water vapor or other arc extinguishing gas when subjected to the heat of the arc. Some materials which are satisfactory for this purpose are boric acid and magnesium borate, these being granular in character, and horn fibre or vulcanized fibre either in tubular self-sustaining form or as a stack of rings. These materials are arranged to provide a bore within which the arc is drawn and extinguished. Where

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it is desired to increase the resistance of the outer tube formed of the materials above noted to internal pressure, a liner in the form of a vulcanized fibre tube or other tough material is located within the former and the solid arc extinguishing material, such as boric acid, is positioned therein.

As set forth in application Serial No. 273,633, the granular solid arc extinguishing material is compacted into a grooved inner surface of the tubular housing or into such a surface of the fibre liner. The purpose of this is to increase the creepage and striking distance over the outer surface of the filling of solid arc extinguishing material at the junction between it and the adjacent surface of the housing and to insure that the arc will not restrike here. When a liner of fibre or other material of suitable physical properties is employed to provide the desired resistance to internal pressure, difficulty has been encountered in producing a solid homogeneous outer housing wall and satisfactory bonding between it and the fibre lined to prevent reignition or restriking of the arc along the junction therebetween or through longitudinal voids in the tubular housing itself. This has been particularly true where the wall thickness of the laminated tube formed of rolled paper and phenolic condensation product has a thickness above ⅜ inch, for example ½ inch to ⅝ inch, and where the thickness of the fibre liner is about ¼ inch.

For the reasons pointed out in application Serial No. 273,633, the fibre liner has a length about equal to half that of the tubular housing and is located midway between its ends. For certain voltages a tube length of over four feet is required with an external diameter of three inches. Such tubes were made by rolling paper impregnated with phenolic resin layer on layer onto a fibre liner under pressure and then baking in an oven to cure the resin. For the wall thickness required it was found impractical to follow this procedure. Due to the resiliency of the liner uniform pressure could not be maintained during the manufacturing process. As a result there was a tendency for the tube to delaminate and the junction with the fibre liner was unsatisfactory. Gas or air pockets were present in a high percentage of assemblies which caused the dielectric structure to be non-uniform and provided a path where breakdown could occur under severe overvoltage conditions rather than restriking through the bore where the arc could be extinguished readily. These difficulties necessitated elaborate test procedures in manufacturing accompanied

by a high percentage of rejections in providing the desired composite tubular housing.

Accordingly, among the objects of this invention are: To provide for manufacturing a composite insulating tube for use in high voltage circuit interrupter applications where the junction between dissimilar insulating materials will have a dielectric strength substantially greater than that of the straight air path along the boundary surfaces between these materials or equal to or greater than the break down strength between the ends of the tube; to construct the tubular housing by rolling paper impregnated with phenolic resin to the desired thickness and curing the same without creating voids therein or having it delaminate; to prefabricate a liner and a housing therefor separately in a new and improved manner so that when assembled into a unitary structure, each can have desired characteristics different from those of the other without impairment of any of them; and to prefabricate a tubular liner which is relatively tough and mechanically strong and has arc extinguishing properties and to prefabricate separately a tubular housing therefor which has relatively good weather resisting qualities and relatively high dielectric strength and to assemble this liner and housing into a unitary structure in such manner that these characteristics are unimpaired with configuration of the juxtaposed surfaces being such that the boundary zone between the liner and housing has a substantially greater dielectric strength than the straight air path along adjacent portions of the liner and housing.

Other objects of this invention will, in part, be obvious and in part appear hereinafter.

This invention is disclosed in the embodiments thereof shown in the accompanying drawings and it comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the constructions hereinafter set forth and the scope of the application of which will be indicated in the appended claims.

For a more complete understanding of the nature and scope of this invention, reference may be had to the following detailed description, taken together with the accompanying drawings, in which:

Figures 1A, 1B and 1C, taken together in the order named and placed one above the other, show a longitudinal cross sectional view of a fuse type of circuit interrupter in which this invention is embodied;

Figure 2 is a longitudinal sectional view at an enlarged scale of the tubular insulating housing shown in the preceding figures;

Figure 3 is a longitudinal sectional view of the fibre liner for the tubular insulating housing shown in Figure 2; and

Figure 4 is a longitudinal sectional view of a circuit interrupter of the separable contact type in which the present invention is embodied.

Referring now particularly to Figures 1A, 1B and 1C of the drawings, it will be observed that the reference character 10 designates, generally, a circuit interrupter for use on high voltage electric power transmission lines. For example, the circuit interrupter 10 can be employed on circuits the voltage of which is of the order of 69 kv. to 110 kv. However, its application is not limited to these particular voltages.

The circuit interrupter 10 has an upper terminal 11 and a lower terminal 12 which are arranged to be connected suitably to stationary line terminals. The lower terminal 12 has an extension 13 for facilitating mounting of a removable fitting thereon.

The terminals 11 and 12 are located at the ends of a tubular insulating housing 14 which may be formed of rolled paper impregnated with melamine resin or of a phenolic condensation product, the latter being preferred. Such a housing has the characteristics referred to hereinbefore but, as indicated, is relatively weak mechanically insofar as concerns its ability to resist the bursting stress incident to the operation of the circuit interrupter under heavy or short circuit current interrupting conditions. In order to withstand the bursting stress incident to such operation there is provided a liner 15 which is formed of horn fibre or vulcanized fibre. As illustrated, the liner 15 is located midway between the ends of the tubular insulating housing 14 and its length is about equal to one-half the length thereof.

For the reasons outlined in application Serial No. 273,638, the fibre liner 15 is threaded internally as indicated at 16 for the purpose of receiving a filling 17 in the form of cakes of boric acid. This granular arc extinguishing material, which evolves a large quantity of water vapor when subjected to the heat of the arc, is compacted into the grooved surface provided by the threads 16 so as to be held mechanically thereby and to provide a junction with the fibre liner 15 so that no breakdown therealong takes place when the circuit interrupter 10 is subjected to severe overvoltage conditions. The filling 17 of arc extinguishing material is arranged to have a bore 18 extending longitudinally therethrough in which a rod-like terminal or arcing rod 19 is arranged to move.

The terminal 19 is restrained against movement upwardly through the bore 18 by a strain wire 22 which is paralleled by a fusible element 23. They are connected at their lower ends to a terminal 24 which is carried by a spider 25. The spider 25 bears against a shoulder 26 of a tubular terminal 27 the upper end 28 of which is threaded into the lower end of the fibre liner 15 and bears against an exhaust ring 29 formed of suitable insulation such as fibre. Under severe operating conditions when the fusible element 23 and strain wire 22 are blown, the spider 25 may be blown out of the lower end of the insulating housing 14. Extending downwardly from the tubular terminal 27 is a metallic tube or stress distribution shield 30 the function of which is set forth in application Serial No. 273,638. At its lower end the metallic tube 30 is secured to a retaining member 31 which in turn is secured, as shown in Figure 1C, to the lower terminal 12.

At its upper end the rod-like terminal 19 has a cylindrical contact section 33 which is engaged about its periphery by contact fingers 34 that are urged into contact engagement by a surrounding garter spring 35. The contact fingers 34 extend upwardly from a tubular terminal 36 the lower end 37 of which is threaded into the upper end of the fibre liner 15. Secured to and extending upwardly from the tubular terminal 36 is a metallic tube or stress distribution shield 38 whose function is similar to that of the metallic tube or stress distribution shield 30 at the lower end of the tubular insulating housing 14. At its upper end the metallic tube 38 is connected, as shown in Figure 1A, to the upper terminal 11.

The rod-like terminal 19 is provided with an

extension 39 above the cylindrical contact section 33 to the upper end of which one end of a flexible conductor 40 is connected. The other end of the flexible conductor 40 is connected by a conducting strap 41 to the tubular terminal 36 as shown at the top of Figure 1B. The purpose of the flexible conductor 40 and conducting strap 41 is to provide a metallic conducting path between the extension 39 of the rod-like terminal 19 and the tubular terminal 36 after the cylindrical contact section 33 moves out of engagement with the contact fingers 34. The flexible conductor 40 is trained over a pulley 42 which is carried by a yoke 43 that is supported by an end ring 44 carried by the upper end of a compression tube 45. The compression tube 45 is slidably mounted in the upper end of the metallic tube 38 and is urged upwardly by a coil compression spring 46 for the purpose of retracting the rod-like terminal 19 through the bore 18 in the filling 17 of solid arc extinguishing material when the strain wire 22 and the fusible element 23 have been melted as a result of the flow therethrough of overload or short circuit current.

As pointed out hereinbefore, difficulty has been encountered in fabricating the tubular insulating housing 14 with the fibre liner 15 therein. An imperfect bond at the junction therebetween was obtained in a high percentage of the manufactured assemblies and there was a tendency for delamination of the layers of impregnated paper when rolled under pressure to make up the tubular insulating housing 14 due to the resiliency of the liner onto which the laminated tube was rolled. As a result there were numerous instances of voltage breakdown in manufacturing tests between the fibre liner 15 and the tubular insulating housing 14 at the junction therebetween or along adjacent layers of the impregnated paper making up the housing 14.

In accordance with the present invention as illustrated in Figure 2, these difficulties are overcome by fabricating separately the tubular insulating housing 14 of a phenolic condensation product. This makes it possible to provide the desired wall thickness by winding the layers of impregnated paper onto a rigid steel mandrel which extends throughout the entire length of the finished housing 14. Thereafter it is cured to polymerize the resin and to fix the insulating and other desirable characteristics as may be desired. The housing 14 then is provided with an internally annularly or circumferentially grooved surface as indicated at 50 preferably by cutting a thread therein. For example, in the particular embodiment illustrated where the outside diameter of the housing 14 is two and $\frac{13}{16}$ inches the thread is a one and ¾ inches-8 Class 1 thread.

As illustrated more clearly in Figure 3 the liner 15 is provided with an externally annularly or circumferentially grooved surface 51 which is formed by cutting a like thread on its outer surface. Also prior to assembly of the fibre liner 15 in the housing 14 the internal threads 16 are cut. The end sections 54 and 55 of the threads 16 may be cut to a slightly greater pitch diameter for receiving the tubular terminals 27 and 37. Further there is provided an unthreaded section 56 for receiving the exhaust ring 29.

While the fibre liner 15 constructed as shown in Figure 3 can be threaded into the grooved surface 50 of the housing 14 without applying anything to the grooved surfaces, it is preferable

to apply thereto an adhesive coating. For this purpose the grooved surface 50 has an adhesive coating, as indicated at 57, applied thereto and likewise an adhesive coating as indicated at 58 is applied to the grooved surface 51 of the fibre liner 15. This adhesive is formed preferably of water soluble urea resin which polymerizes without substantial change in volume. Immediately after the application of the adhesive coatings 57 and 58 to the grooved surfaces 50 and 51, the fibre liner 15 is threaded into the insulating housing 14 so as to provide the composite tubular construction illustrated in Figure 1B. Thereafter the composite housing is baked to hasten polymerization of the adhesive.

By employing the interfitting annularly grooved surfaces 50 and 51 the creepage and striking distance over the fibre liner 15 is substantially increased. For example, it may be increased as much as 50% to 100% over the original creepage or striking distance. The adhesive coatings 57 and 58 fill any voids which might otherwise exist along the boundary between the grooved surfaces and bonds the two members into an integral structure. After being baked tests have shown that the boundary between the grooved surfaces 50 and 51 has a dielectric strength equal to air of twice the linear distance along the boundary of the adjacent materials between their ends. As indicated the threads forming the grooved surfaces 50 and 51 for the housing 14 and fibre liner 15 are formed by matching threads. These threads can be modified so that they have an interference fit and thus mechanically provide for filling the spaces between adjacent threads when the fibre liner 15 is threaded into position under the required pressure.

In Figure 4 of the drawings there is illustrated, generally at 60, a circuit interrupter of the separable contact type. The circuit interrupter 60 includes an upper line terminal 61 and a lower line terminal 62 in the form of a housing which is employed for enclosing an operating mechanism that is indicated, generally, at 63. Between the line terminals 61 and 62 there is provided an insulating housing, shown generally at 64, which comprises a suitable ceramic material such as a tubular porcelain insulating housing 65 having therewithin and coextensive therewith a liner 66 formed of vulcanized fibre or horn fiber. The porcelain housing 65 is provided with a grooved inner surface 67 which is formed by cutting a thread therein prior to the curing of the housing 65. Likewise the outer surface of the fibre liner 66 is grooved as indicated at 68 by a suitable cutting tool.

Prior to threading the fibre liner 66 into the porcelain housing 65, the former is enclosed in a sleeve 69 that is formed preferably of synthetic rubber and has sufficient body to fill the spaces between the threads in the grooved surfaces 67 and 68 when the fibre liner 66 is threaded into the porcelain housing 65. In order to facilitate the entry of the fibre liner 66 with the synthetic rubber sleeve 69 thereover, the outer surface of the latter can be provided with a suitable lubricant such as talc or the like.

At its lower end the fibre liner 66 is arranged to receive an extension 70 from the line terminal housing 62 and the same is provided with threads 71 to fix the same in position. The fibre liner 66 has a bore 72 extending therethrough in which the arc is drawn and extinguished and through which a rod-like terminal 73 is movable by the operating mechanism 63.

At its upper end the rod-like terminal 73 has contact fingers 74 which engage a contact sleeve 75 that is threaded at 76 into the upper end of the fibre liner 66. The contact sleeve 75 is threaded intermedate its ends at 77 for threaded engagement with the line terminal 61 at the end of the insulating housing 64. An insulating trailer 78 is movable with the rod-like terminal 63 into the bore 72 of the fibre liner 66 for the purpose of confining the arc between its outer surface and this bore when it is drawn between the contact fingers 74 and the contact sleeve 75.

Since certain further changes can be made in the foregoing constructions and different embodiments of the invention can be made without departing from the spirit and scope thereof, it is intended that all matter shown in the accompanying drawings and described hereinbefore shall be interpreted as illustrative and not in a limiting sense.

What is claimed as new is:

1. In a high voltage circuit interrupter, in combination, an insulating tube having a length several times its diameter and having a threaded inner surface over a length several times its diameter, line terminals at the ends of said tube, a one-piece tubular self-sustaining liner having a length several times its diameter and having a threaded outer surface threaded into said tube, the space occupied by said liner and said tube coextensive therewith being free from voids and no path being provided therebetween along which current can flow or an arc is likely to be struck, stationary conducting means extending from each line terminal into said tube for a substantial distance with the inner end of each conducting means projecting into the corresponding end of said liner, and means interconnecting said conducting means for drawing an arc within said tube and liner on operation of the interrupter, the break distance between the terminals of said arc drawing means in the circuit open position being less than the length of the juxtaposed threaded surfaces of said tube and liner.

2. In a high voltage circuit interrupter, in combination, an insulating tube having a length several times its diameter and having a threaded inner surface over a length several times its diameter, line terminals at the ends of said tube, a one-piece tubular self-sustaining liner having a length several times its diameter and having a threaded outer surface threaded into said tube, the space occupied by said liner and said tube coextensive therewith being free from voids and no path being provided therebetween along which current can flow or an arc is likely to be struck, stationary conducting means extending from each line terminal into said tube for a substantial distance with the inner end of each conducting means projecting into the corresponding end of said liner, said liner having an annularly grooved inner surface, a filling of arc extinguishing material compacted into said grooved inner surface and having a bore from the surface of which an arc extinguishing medium can be evolved due to the heat of the arc, and means interconnecting said conducting means for drawing an arc within said bore on operation of the interrupter, the break distance between the terminals of said arc drawing means in the circuit open position being less than the length of the juxtaposed threaded surfaces of said tube and liner, said conducting means acting to distribute voltage stress applied to said line terminals to prevent arcing therebetween externally of said tube and applying the voltage stress to the ends of said juxtaposed threaded surfaces and the ends of the juxtaposed surfaces of said liner and said filling of arc extinguishing material whereby any arc struck between said conducting means is formed and extinguished in said bore.

3. The invention, as set forth in claim 1, wherein the insulating tube is a phenolic condensation product and the liner is formed of fibre.

4. The invention, as set forth in claim 1, wherein the insulating tube is formed of porcelain and the liner is formed of fibre.

5. The invention, as set forth in claim 1, wherein a layer of insulating polymerized adhesive material whose volume remains substantially constant after polymerization is interposed between the juxtaposed threaded surfaces of the tube and liner.

6. The invention, as set forth in claim 1, wherein a layer of water soluble urea resin is interposed between the juxtaposed threaded surfaces of the tube and liner.

7. The invention, as set forth in claim 1, wherein a layer of synthetic rubber is interposed between the juxtaposed threaded surfaces of the tube and liner.

8. In a high voltage circuit interrupter, in combination, an insulating tube having a length several times its diameter and having its inner surface midway its ends threaded over a length equal to half the length of the tube, line terminals at the ends of said tube, a one-piece tubular self-sustaining liner equal in length to half the length of said tube and having a threaded outer surface threaded into the threaded portion of said tube, the space occupied by said liner and said tube coextensive therewith being free from voids and no path being provided therebetween along which current can flow or an arc is likely to be struck, a stationary tubular conductor extending from each line terminal into said tube and into the corresponding end of said liner, and means interconnecting said tubular conductors for drawing an arc within said tube and liner on operation of the interrupter, the break distance between the terminals of said arc drawing means in the circuit open position being less than the length of said liner.

9. In a high voltage circuit interrupter, in combination, an insulating tube having a length several times its diameter and having its inner surface midway its ends threaded over a length equal to half the length of the tube, line terminals at the ends of said tube, a one-piece tubular self-sustaining liner equal in length to half the length of said tube and having a threaded outer surface threaded into the threaded portion of said tube, the space occupied by said liner and said tube coextensive therewith being free from voids and no path being provided therebetween along which current can flow or an arc is likely to be struck, a stationary tubular conductor extending from each line terminal into said tube and into the corresponding end of said liner, said liner having an annularly grooved inner surface, a filling of arc extinguishing material compacted into said grooved inner surface and having a bore from the surface of which an arc extinguishing medium can be evolved due to the heat of the arc, and means interconnecting said tubular conductors for drawing an arc within said bore, said tubular conductors acting to distribute voltage stress applied to said line terminals to prevent arcing therebetween externally of said tube and applying the voltage stress to the ends of said juxta-

posed threaded surfaces and the ends of the juxtaposed surfaces of said liner and said filling of arc extinguishing material whereby any arc struck between said conducting means is drawn and extinguished in said bore.

SIGURD I. LINDELL.
CHARLES H. BAKER.

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