

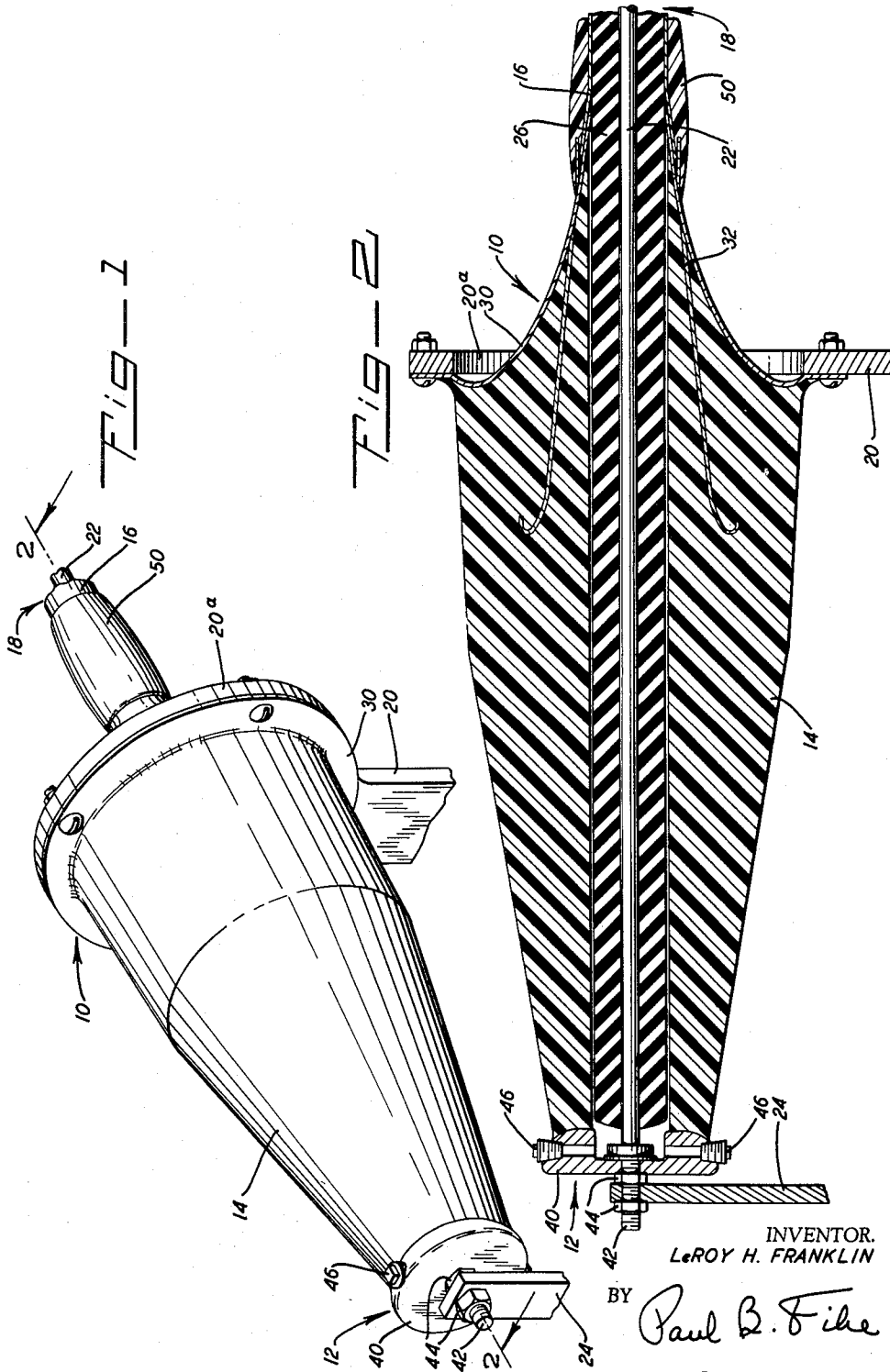
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HIGH VOLTAGE CABLE TERMINAL WITH STRESS CONES

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HIGH VOLTAGE CABLE TERMINAL WITH STRESS CONES

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The present invention relates generally to electrical terminals, and more particularly to terminals for high voltage coaxial cables and the method for producing the same.

When a coaxial cable adapted to carry high voltages (e.g., 100 kilovolts) terminates and connection is made to the inner and outer conductors of such coaxial cable, arcing and corona loss must be avoided. If connection from the end of the cable is to be made to conductors which are supported in air or oil, the terminal must not only be designed so as to eliminate any sharp projecting edges which might provide a concentrated electrical field, but the terminal must also provide for the appropriate spacing between the two conductors to accommodate the change in the dielectric constant of the medium between the conductors. In short, the terminal connecting the inner and outer conductors of a coaxial cable and the two conductors to which such cable is to be connected must be made so that an appropriate electrical stress distribution will be maintained throughout the transition. The problem would, of course, be simplified if no limitations on spacing between the conductors had to be met, but for many installations, space requirements limit the practical distance that can be maintained between conductors. Substantially commensurate with the space or size limitation placed upon a practical high voltage electrical terminal, is the economic limitation. The minimum spacing is obviously also meaningful in retaining the material and labor costs involved in producing a terminal at an economically reasonable level.

Accordingly, it is a general object of the present invention to provide a terminal structure for a high voltage coaxial cable and a method for producing the same which conjointly function to minimize the space and cost requirements thereof.

More particularly, it is a feature of the invention to provide a high voltage terminal which incorporates metallic stress cones for connection to the outer conductor of the coaxial cable which can be fashioned simply by a metal spinning operation into the desired shape to insure the required even electrical stress distribution within the terminal itself.

Another feature relates to the method of assembly of the terminal which involves the molding or casting of an insulator for disposition between the two conductors of the terminal.

Another feature relates to the carrying out of this casting process in a manner such that the casting is supported between the metallic conductors and moreover lends physical support to those conductors in addition to precluding arcing or corona loss therebetween.

An additional feature relates to the manner of carrying out this process under vacuum conditions so that voids within the cast insulator are eliminated and a homogeneous insulating structure is thus provided.

These and other objects and features of the invention will become more apparent from a perusal of the following description of an exemplary terminal structure and the method for producing the same when taken in conjunction with the accompanying drawing wherein:

FIG. 1 is a fragmentary perspective view of a preferred form of terminal structure embodying the present

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invention and shown in connecting relationship between a coaxial cable and two conductors disposed in air, and

FIG. 2 is a fragmentary sectional view taken substantially through the longitudinal center line of FIG. 1 as indicated thereon by the line 2-2.

With reference to the drawing, the terminal embodying the present invention includes a pair of conductors, generally indicated at 10 and 12, that are held in electrically and physically separated relationship by an insulator 14. The first conductor 10 is adapted to connect the outer conductor 16 of a coaxial cable generally designated at 18 to a first metallic strap 20 while the central or inner conductor 22 of the cable 28 is in turn connected by the second terminal conductor 12 to a second metallic strap 24. As conventionally employed, the outer conductor 16 of the cable 18 is maintained at ground potential while the inner conductor 22 is maintained at a high voltage, which may be 100 kilovolts or more depending upon the particular installation. An annular insulator 26 separates the outer and inner cable conductors 16 and 22.

More particularly, as can best be visualized by reference to FIG. 2, the first terminal conductor 10 includes a metal plate that is spun into a hollow, outwardly flaring, substantially conical configuration, such part being generally referred to as a stress cone and designated by the numeral 30. The smaller end of the stress cone 30 is soldered or otherwise connected to the outer conductor or shield 16 of the cable 20 and the outwardly flaring end of the stress cone is provided with small apertures so that it may be bolted to the ring-like end 20a of the metal strap 20, previously referred to. A second stress cone 32 which flares somewhat less than the first stress cone 30 is soldered at its smaller end to the inner surface of the first stress cone and extends therefrom a predetermined distance. The configuration and dimensions of both stress cones 30, 32 are predetermined to provide for the proper electrical stress distribution between this first conductor 10 formed by the two stress cones 30, 32 and the second conductor 12 of the terminal. In some cases, only one stress cone need be employed, while in other instances, additional stress cones may be employed to provide the desired stress distribution.

The second conductor 12 of the terminal includes an annular lug 40 which can be either a machined casting or an entirely machined part. Such lug 40 is disposed in axial alignment with the stress cones 30, 32 at a predetermined distance therefrom and is connected to the end of the central conductor 22 of the coaxial cable 18 which is arranged to extend through the hollow stress cones 30, 32 and the interior of the terminal insulator 14, which is of hollow substantially cylindrical form. The cable insulator 26 which separates the outer conductor 16 of the cable 18 from the central conductor 22 thereof also extends substantially the entire distance between the two conductors 10, 12 of the terminal, actually terminating just short of the point of connection of the central conductor 22 to the lug 40. A stud 42 is secured within the central opening of the annular lug 40 to project outwardly therefrom, and extend through an aperture in the aforementioned second metallic strap 24. The strap 24 is held physically and electrically connected to the stud 42 by suitable nuts 44 that engage opposite faces of the strap in clamping relationship therewith. For a purpose to become apparent hereinafter, small radial holes are provided in the annular lug 40 and at their outer ends are threaded to receive metallic threaded plugs 46 in sealing relationship.

The previously mentioned insulator 14 is a casting of plastic material, that is bounded at its one end by the first stress cone 30 while the second stress cone 32 is embedded within the cast material. The casting, as mentioned, is generally cylindrical in form with inner dimen-

sions sufficient to accommodate the central conductor 22 and insulator 26 of the coaxial cable 18 while the outer portion of the casting is preferably tapered from the stress cone 30 inwardly toward the terminal lug 40. The apertured portion of the stress cone 30 extends beyond the cast insulator 14 to enable the aforementioned bolted connection to the strap ring 20a. While various plastic materials can be employed to fabricate the described casting, it is preferred to use a material with a high dielectric strength and also one which during the casting process is substantially homogeneous and free from voids. With such an insulating material and the appropriate configuration of the stress cones 30, 32, an even electrical stress distribution can be maintained between the grounded portion of the terminal and the high voltage portion thereof. By way of example, an epoxy resin casting has been found particularly suitable for an insulating material at the voltages with which the present invention is particularly concerned. Additionally, this material adheres well to metallic surfaces so that sealing relationship may be had therewith.

After the terminal has been attached to the cable 20, as described and shown in the drawing, a small plastic casting 50, also preferably of epoxy resin material is applied over the juncture between the stress cone 30 and the cable shield 16 to provide a protective cover for such connection and also establish sealing relationship between the stress cone 30 and the cable 18. After the assembly is thus complete, one plug 46 in the radial opening in the lug 40 can be removed and a quantity of insulating oil can be poured therethrough to completely fill all of the annular openings between the insulator 14 and the portions of the cable 18 disposed therewithin. All air voids within the structure are thus effectively eliminated.

The terminal, as shown and described hereinabove, not only provides for particularly efficacious utilization, but its design is such that in accordance with one aspect of the present invention, the structure lends itself to production by a particularly effective yet inexpensive process. Broadly considered, this process entails first forming the stress cones 30, 32 and thereafter holding them on a mandrel or core in sealing relation therewith. An exterior tapered mold is then placed in endwise sealing relationship with the first stress cone 30 and the plastic insulating material may then be poured to fill the annular space between the central mandrel and the exterior mold.

Preferably, the two stress cones 30, 32 are formed by spinning each of two annular plates into the desired flaring configuration, as shown in the drawings.

Also preferably, connection is made to a vacuum pump so that the entire interior space within the mold can be evacuated during the casting process. This evacuation substantially eliminates the possibility of the formation of air occlusions or voids, within the finished insulator 14.

It will be noted that the stress cone 30 functions as a portion of the mold within which the insulator 14 is cast, and while the central mandrel and the exterior mold are treated so that their easy removal from contact with the insulator 14 can be achieved, the plastic material adheres quite tenaciously to each of the stress cones 30, 32. Moreover, the stress cone 30 not only forms one boundary of the insulator 14, but in turn, the insulator provides support for the stress cones 30, 32 themselves. In view of the fact that metal spinning can be performed most successfully with relatively thin metallic material, it is definitely advantageous that the insulator 14 abuts or surrounds the stress cones 30, 32 to provide additional physical support therefor.

After the insulating material has set sufficiently within the mold, the central mandrel and the outer cylindrical mold portion are removed and the end of the cast insulator is machined preparatory to reception of the lug 40 which is cemented in position by the application of a thin layer of the epoxy resin.

The terminal is now complete and ready for installation. Such installation obviously entails the initial step of cutting

the outer conductor or shield 16 of the cable 18 at a point a predetermined distance from the end thereof and also removing a portion of the annular insulator 26 immediately adjacent the termination of the central conductor 22. Such cutting of the cable shield 16 and removal of a portion of the annular cable insulator 26 are, of course, performed in accordance with the particular dimensions of the terminal structure to be used therewith. After the cable 18 is thus prepared, it is inserted into the terminal until the central conductor 22 abuts the lug 40 and the cable shield 16 comes into position over the small end of the stress cone 30. The soldered connections are made at both points, and preferably a small plastic casting 50 is made above the juncture of the stress cone 30 and the cable shield 16, as previously mentioned and as shown in the drawing. One of the plugs 46 is removed from the lug 40 and insulating oil is poured therein to fill the annular space between the terminal and the cut-away cable 18 and the entire structure is then ready for attachment to the metal straps 20, 24 by the bolted connection as shown in the drawing.

Various modifications both in the structure of the terminal and in the described method of its production can be made without departing from the spirit of the invention. Accordingly, the foregoing description of the structure and its method of production are to be considered purely as exemplary and not in a limiting sense. The scope of the invention is to be indicated by the appended claims.

What is claimed is:

1. A terminal for a high voltage coaxial cable which comprises a lug adapted for removable connection to the inner conductor of the cable, a stress cone adapted for removable connection to the outer cable conductor, an insulator of solid, void-free material disposed between said lug and said stress cone in direct sealing contact therewith so as to support said lug and said stress cone rigidly in predetermined, spaced relation, said insulator being of hollow, generally cylindrical form to enable telescopic insertion of the end of a cable therein, and a second metal stress cone connected to the first stress cone and having a predetermined configuration such that it is embedded within the insulator material, and means sealingly connecting the outer cable conductor to said stress cone.

2. A terminal for a high voltage coaxial cable which comprises a lug adapted for removable connection to the inner conductor of the cable, a stress cone adapted for removable connection to the outer conductor of the cable in sealing relationship therewith and at a distance spaced from said lug, an insulator of generally cylindrical form consisting of solid, void-free material disposed between said lug and said stress cone in direct sealing contact therewith so as to support said lug and said stress cone rigidly in predetermined, spaced relation and accommodate portions of the cable within its interior, said lug having a radial opening therethrough to establish communication between the atmosphere and the space surrounding a cable positioned within the terminal, and a plug for removable insertion into said radial opening to seal the space within the terminal from the atmosphere.

3. A prefabricated terminal for a high voltage coaxial cable which comprises an insulator composed of solid, void-free material and having a hollow generally cylindrical form to enable telescopic insertion of the end of a cable therein, conductive means including a lug secured in direct sealing contact with one end of said insulator to enclose the hollow end thereof and adapted for removable connection to the inner conductor of the inserted cable, an annular conductor in direct sealing contact with the other end of said insulator and means sealingly connecting said annular conductor to the outer conductor of the cable.

4. A prefabricated terminal for a high voltage coaxial cable which comprises an insulator composed of solid, void-free material and having a hollow generally cylindrical

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drical form to enable telescopic insertion of the end of a cable thereinto, conductive means including a lug secured in direct sealing contact with one end of said insulator to enclose the hollow end thereof and adapted for removable connection to the inner conductor of the inserted cable, a stress cone secured in direct sealing contact with the other end of said insulator and means sealingly connecting said stress cone to the outer conductor of the cable, said stress cone being extended at its outer periphery beyond the insulator to provide an annular flange having apertures therein to enable connection thereto.

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