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INSULATED ELECTRICAL CONDUCTOR TERMINAL STRUCTURE

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Fig. 1.

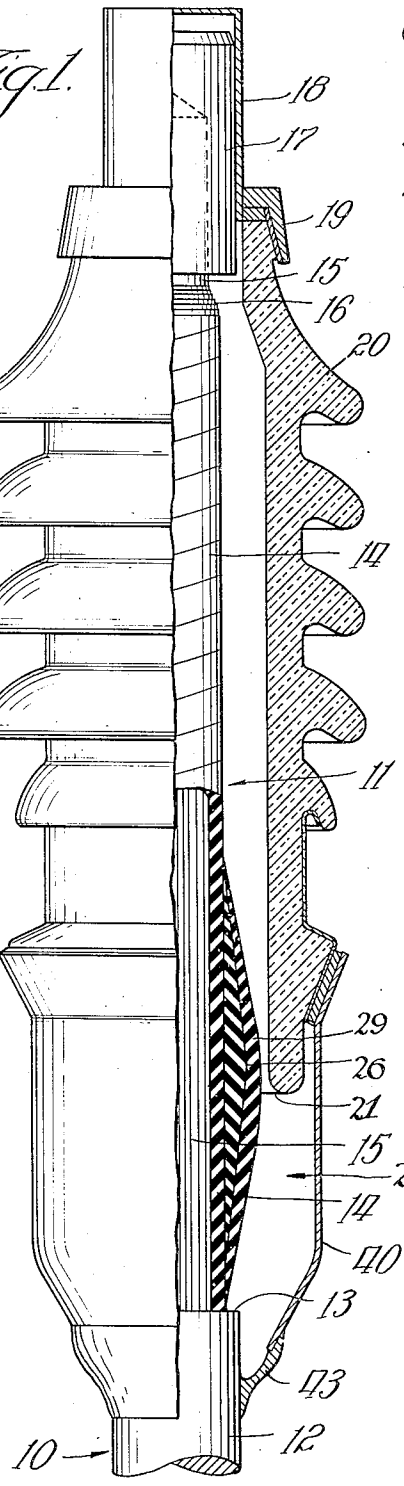
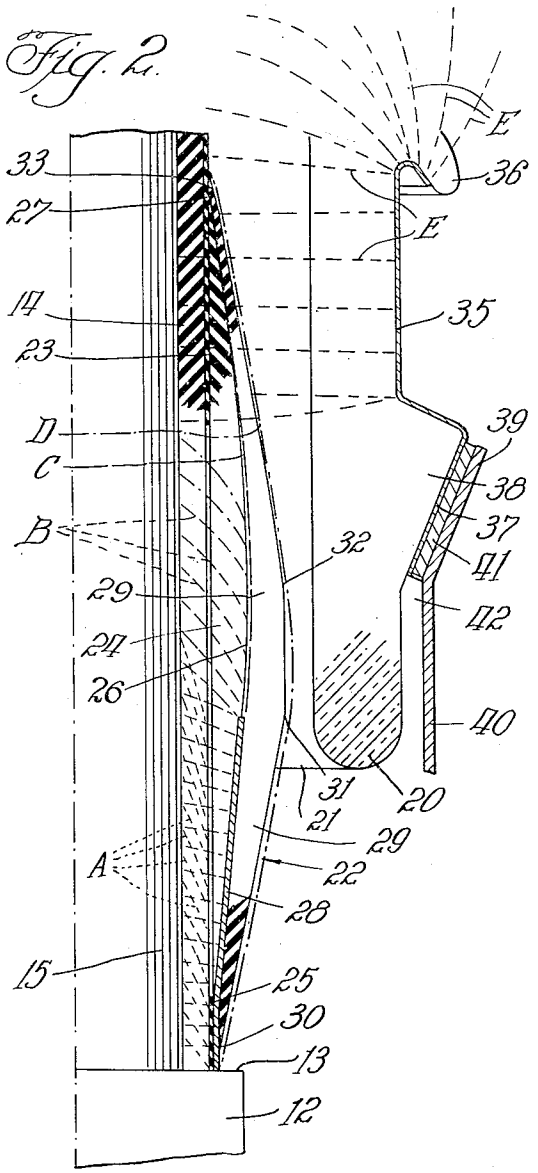


Fig. 2.



Inventor:
James H. Nicholas
By: Stone, Ortman & Bisson
Att'ys.

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INSULATED ELECTRICAL CONDUCTOR TERMINAL STRUCTURE

James H. Nicholas, Chicago, Ill., assignor to G & W Electric Specialty Company, Chicago, Ill., a corporation of Illinois

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6 Claims. (Cl. 174—73)

This invention has to do with terminal devices for insulated electrical conductors of the type enclosed within a metallic sheath, and relates more particularly to an electrostatic flux controlling structure associated with an end portion of said sheath to direct therefrom, externally of the device, flux lines that would otherwise extend from said sheath end portion interiorly of the device to the conductor.

The general object of the invention is to provide an improved and more effective means for dispersing the flux lines traversing a medium between an end of the conductor sheath and a conductor portion of different electrical potential projecting axially from such sheath, whereby the potential difference between the conductor and its sheath can obtain at higher values without incurring excessive ionization of said medium.

The prevalent practice in the insulation of electrical conductors from their conductor sheaths, as in cables employed in the commercial transmission of high voltage electricity, is to supplement the solid insulation between these conductors and their sheaths with oil, to fill any voids that occur in the solid insulation or between such insulation and the conductor or the sheath and thereby provide an insulation having greater dielectric strength to withstand stresses resulting from line potential surges. Insulated conductors of this type generally require accessory equipment for supplying oil to them under pressure to prevent the development of an oil deficiency at any point. However, the original and maintenance cost of such equipment is sufficient that for installations in the lower part of the voltage range in which the oil-filled insulated conductors or cables have been used heretofore, the practice of using cables filled with compressed gas is finding favor. A cable containing nitrogen, commonly maintained at about fifteen pounds per square inch gauge pressure or higher, has proven satisfactory and has certain advantages not pertinent to the present disclosure.

The terminal devices used with these cables are communicative therewith so that an oil-filled terminal device, such as a pothead, is used with an oil-filled cable, whereas a gas-filled terminal device is used with a gas-filled cable. Hence there arises another general object of this invention, namely, the provision of an electrostatic flux dispersing structure employable in such a manner with a gas-filled terminal device that excessive stress upon the gas portion of the dielectric therein will be avoided without materially increasing the size of the device.

A more specific object is the provision of an electrical conducting shield about an exterior portion of a terminal device insulating tube and connectable with an electrical conducting sheath of an insulated conductor extending into the tube, to create an electrostatic flux pattern between said external shield and the conductor in parallel with the electrostatic flux pattern between the sheath terminus and the conductor interiorly of the tube as an expedient for decreasing the concentration of the latter pattern.

These and other desirable objects inherent to and encompassed by the invention will be better understood from the ensuing description together with the annexed drawing, wherein:

Fig. 1 is a view partly in side elevation and partly in section, illustrating the invention in its application to a pothead device associated with a dressed end portion of a lead sheathed conductor; and

Fig. 2 is an enlarged fragmentary sectional view presenting greater detail of parts shown in Fig. 1, and also illustrating flux patterns and dielectric breakdown paths for certain construction stages.

The invention is illustrated in its application to a pothead terminal for a lead sheathed cable inasmuch as it is particularly adapted for such an installation although conceivably the invention is capable of utility in other types of structures.

Referring now to the drawing, a sheathed insulated conductor of the cable type there indicated at 10 has a dressed end portion 11 which is initially prepared by removing therefrom a portion of a lead sheath 12 from a point beyond an end 13 of this sheath. Removal of this portion of the sheath 12 exposes a length of conductor insulation 14 which is disposed between the stranded conductor proper 15 and said sheath. Adjacently to the end of the conductor 15 the insulation 14 is stripped away, exposing that part of the conductor end portion beyond the terminus 16 of the insulation layer. An electrical conductor ferrule member 17 is connected to this exposed end portion of the conductor 15. In the fully assembled device this ferrule member 17 is telescoped into an electrical conductor cap 18 of which a skirt portion 19 is seal-connected to the upper end of a tubular porcelain insulator 20. The fit between the ferrule 17 and the cap 18 establishes an electrical conductor relation between these parts wherefore said cap is electrically connected with the conductor 15 and is adapted to have connected therewith other electrical conductor connecting devices (not shown)

which are for conducting electric energy to or from the conductor 15.

Prior to inserting the dressed portion of the insulated conductor 15 upwardly into the tubular insulator 20 from its open lower end 21, a flux dispersing structure 22 is first formed upon the exposed conductor insulation 14. In the formation of this structure 22 there is first applied about the cable insulation 14 a layer 23 of varnished cambric. In the illustrated installation this varnished cambric layer consists of a single half-lapped winding of dry varnished cambric, that is, each turn of the winding is lapped halfway over the preceding turn. The layer 23 is coextensive with the cable insulation projecting from the end of the lead sheath 12. There is added onto the layer 23 a shorter layer 24 which begins at a point 25 spaced axially from the end of the sheath 12 and tapers with increasing radius to a point 26 at which the taper is reversed, decreasing in diameter to the end of said layer 24 at a point 27. Insulation layer 24 is also made of varnished cambric together with a suitable dielectric compound interposed between successive layers to prevent the trapping of air in the dielectric mass. A suitable compound, well known in the trade by the notation "G. E. 219 Compound" is obtainable from the General Electric Company at Schenectady, New York. An electrostatic stress relief cone is formed by applying an electrical conducting medium 28 upon the tapered surface of the layer 24 nearest to the insulated conductor sheath 12, this member 28 being in electrical conducting relation with the sheath and in the present instance is formed of a spirally wrapped electrical conductor braid. Solder is preferably applied to the stress relief member 28 to hold the free end from unwrapping and to prevent fraying of any of the filaments forming the braid.

A final dielectric layer 29 is applied over the stress relief cone member 28 and over the remaining surface of the layer 24. Said layer 29 is also formed of spirally wrapped layers of dry varnished cambric between which a dielectric compound as the aforesaid is applied. The layer 29 begins at a point 30 spaced slightly from the end of the sheath 12 and tapers axially of the structure by increasing in diameter until a point 31 is reached. The outer periphery of the dielectric layer 29 is cylindrical between the point 31 and a point 32 at which a reversely tapered portion begins, decreasing in diameter to the end of said layer 29 at a point 33.

The function of this flux dispersing structure 22 is to deconcentrate or disperse the electrostatic flux pattern formed between the end of the conductor sheath 12 and the conductor 15 when a difference in electrical potential exists between these parts. When in use the sheath 12 will usually be grounded whereas the conductor 15 will be potentialized with respect to ground. If no part of this structure 22 were employed the flux lines caused to exist between the conductor and the sheath would form a pattern somewhat of the nature illustrated by the dotted lines A. It will be noted that these lines form a pattern in which the lines reaching farthest from the sheath end approach parallelism with the conductor and this is because the dielectric constant (specific inductive capacitance) of the cable insulation is greater than that of the surrounding medium, so that the flux tends to pass through the cable insulation and follow the surface of such cable in the medium of the lower dielectric constant to the grounded sheath electrode. This surface creepage may be sufficient when increased pursuant to line voltage surges to which the conductor 15 may be subjected, to so increase and concentrate the flux lines within a medium about the cable insulation layer 14 above the sheath end 13 that excessive ionization of the medium will there occur, precipitating its electrical failure and flashover between the sheath end 13 and the end of the conductor exposed above the insulation layer 14. When the insulation layer 24 and the member 28 are assembled with the sheath 12 in the manner shown (assuming the layer 29 not present) the flux pattern will change to one somewhat as illustrated by the short dash lines B. It will be observed that these flux lines are more nearly perpendicular to the insulation wrappings than are the flux lines A. However, when the difference in the potential of the conductor 15 and the sheath 12 is raised sufficiently, the flux lines B will be projected more distantly from the end of said cone than illustrated in the drawing, causing excessive ionization along the cable surface from member 28 and ultimate electrical flashover over the surface of the insulation layer 24 along a path such as that illustrated by the long dash line C. This is due to the relatively large dielectric constant of the insulation whereby flux creepage occurs as explained above. By addition of the solid dielectric layer 29, which has greater dielectric strength (in contrast to dielectric constant or conductivity of electrostatic flux) than a gas at low pressure, ionization at the cone member 28 can be suppressed. When the potential between the conductor and the sheath is increased to a certain value, ionization will occur along the surface of the layer 29 beginning from a zone in radial registry with the terminus of the stress cone member 28. Under these circumstances the flashover will occur at a higher voltage than noted above but between the sheath end 13 and the upper end of the conductor, along a path somewhat as that illustrated by the dot-dash line D.

While the embedding of the conical stress relief member 28 in the dielectric layers 24 and 29 results in the disposal of additional dielectric material in the path of the electrostatic flux lines bridging the flared or larger diameter end of said member and the conductor 15, and thus correspondingly increases the difference in potential that may exist between the said conductor and its sheath 12 without causing ionization of the dielectric along the surface of the conductor insulation within the tubular insulator 20 and ultimate flashover, it has been found that the potential difference between the conductor 15 and its sheath 12 can be still greater without resulting in flashover by providing an electrical conductor shield 35 about the outer periphery of said tubular insulator at a portion thereof adjacently to its end that is disposed in proximity to the end of the sheath 12. This shield 35, which is an important feature of the present invention, may be applied to the insulator 20 by firing a conductive coating on the insulator at the surface area desired to be covered. Another method of affixing the layer 35 is to spray molten metal onto the desired surface area and allowing this sprayed metal to solidify in the form of a thin electrical conductor sheet. The shield 35 may consist of a preformed metal body, or, it may be incorporated into the metallic body or mounting brackets of the device. Said shield 35 may completely circumscribe the tubular insu-

lator 20, the upper end thereof reaching to and curving radially outwardly and downwardly a short distance upon the under side of the lower petticoat 36 of the bushing. Preferably the shield 35 is a solderable material such as copper and a portion 37 thereof extends downwardly over the outer periphery of a shoulder 38 extending about the base of the insulator to facilitate the connection of a flared upper edge portion 39 of a wiping sleeve 40 to the insulator through a solder layer 41. Prior to attaching the wiping sleeve 40 to the insulator a ring 42 of heat resisting material as felted asbestos is interposed between the wiping sleeve and the insulator to provide a dam onto which molten solder forming the ring 41 can be poured into the space between the flared portion 39 of the wiping sleeve and that part of the metal shield layer 35 upon the bushing shoulder 38. Thus the wiping sleeve 40 is electrically seal-connected with the shield 35, wherefore such wiping sleeve, together with a wiped solder joint 43 at its lower end, grounds the shield 35 to the grounded sheath 12.

The axial dimensions of the wiping sleeve 40 and of the shield member 35 about the base portion of the tubular insulator are such that this shield member is disposed more distantly from the end of the sheath 12 than the projecting end of the stress relief cone member 28. This places the shield member 35 in radial registry with the upper portion of the dielectric layers 24 and 29. Inasmuch as the shield member 35 is electrically connected with the sheath 12, the potential difference between the shield 35 and the conductor 15 will be the same as that between the sheath and said conductor. It follows that there will be electrostatic flux lines bridging the space between said shield 35 and the conductor 15, these flux lines forming a pattern such as that illustrated by the dotted lines E. Particularly it should be noted that the electrostatic flux lines E traverse the solid insulation or dielectric material to reach that part of the conductor 15 which is also linked with the stress relief member 28 by flux lines. In this manner the shield 35 is operable to supplement the stress relief member 28 as a terminus for flux lines reaching to the projecting portion of the conductor and thus diminish the number of flux lines linked with said member 28 for any given potential existing between the conductor 15 and its sheath 12. In fact with a flux dispersing structure and tubular insulator 20 of the proportions illustrated in the drawing, addition of the shield member 35 so diminishes the flux concentration at the stress relief cone 28 that upon increasing the potential between the conductor 15 and its sheath 12 to the point of excessive ionization, the flashover actually takes place exteriorly of the tubular insulator, between said shield 35 and the electrical conductor parts connected with the conductor 15 at the upper end of the tubular insulator, when air at atmospheric pressure is contained in the tubular insulator about the solid insulation. The insulation layer 29 is instrumental in obtaining this external flashover. If it were omitted from the shown structure the shield 35 would not prevent internal flashover, which would occur along the zone indicated by the line C. Since the layer 29 has greater dielectric strength than air it prevents the formation of conductive corona streamers issuing axially from the end of the stress relief cone member 28 at potentials sufficiently great for the flux pattern at E to attain proportions significantly relieving the flux stress at said cone.

By incorporating the dielectric layer 29 in the flux dispersing structure 22, described above, the potential attainable between the conductor 15 and the sheath 12 before incurring flashover, along the path indicated by the dot-dash line D, is 30% to 40% greater than the potential attainable between said conductor and its sheath when the layer 29 is omitted and when the flashover occurs along a path such as that indicated by the long dash line C. When the layer 29 is present as well as the shield 35 and its connections with the sheath 12, the aforesaid flashover exteriorly of the porcelain tube has been obtained at a potential between the conductor 15 and its sheath as much as 65% greater than that incurring flashover under similar circumstances when the shield 35 is not used, and approximately 130% greater than the potential attainable between said conductor and its shield when the stress relief member 28 is exposed exteriorly of the dielectric layer 24 by the absence of the layer 29 and when the bushing shield 35 is not used. These percentages are based upon experiments employing a tubular insulator approaching the maximum length at which the flashover occurs exteriorly instead of interiorly thereof.

This relatively compact flux controlling structure including the tubular insulator shield 35 so increases the opposition to flashover that a gas-filled terminal device equipped therewith need be no larger for use upon a cable of a given potential than an oil-filled device having only a conventional stress relief cone.

While I have herein shown and described but a single preferred embodiment, thought to be fully illustrative of the invention, it should be understood that the invention extends to other forms, arrangements, structures, details and degree of improvement falling within the scope and spirit thereof and not sacrificing all of its material advantages.

I claim:

1. In a terminal structure for an insulated electrical conductor having a portion projecting outwardly from an electrical conductive casing therefor, the combination of a flux-dispersing structure including an electrical conducting member spaced radially from and projecting axially of and about said projecting insulated conductor portion in electrical conducting relation with said casing, a tubular insulater about a projected end portion of said electrical conducting member and, also about the projecting conductor portion and projecting axially thereof a greater distance from said casing than the flux-dispersing structure, an electrical conducting shield about the outer periphery of said tubular insulator within a zone extending toward the end of the projecting conductor portion to an axial limit more distantly from said casing than the portion of said electrical conducting member most distant from said casing, and electrical conducting means extending between said shield and said casing.

2. In a terminal structure for an insulated electrical conductor having a portion projecting from an end of an electrically conductive sheath, a solid dielectric material about a section of the projecting conductor portion adjacently to said sheath end, an electrical conductive member about the projecting conductor portion, said member being embedded in said dielectric material and being internally flared radially and axially away from said sheath end, a dielectric housing about

the dielectric material and also about a projected end portion of said electrical conductive member, an electrical conductive shield disposed exteriorly of the housing with at least a portion thereof a greater axial distance from the sheath end than the flared end of said embedded member, and means for maintaining the shield at substantially the potential of said sheath.

3. In a gas-filled terminal structure for an insulated electrical conductor having a portion projecting from an end of an electrically conductive sheath, a mass of substantially gas-free solid dielectric material about a section of the projecting conductor portion adjacently to said sheath end, an electrical conductive member about the projecting conductor portion, said member being embedded in said dielectric material and being internally flared radially and axially away from said sheath end, a dielectric housing about the dielectric material and also about the flared end of said embedded member, an electrical conductive shield disposed exteriorly of the housing with at least a portion thereof a greater axial distance from the sheath end than the flared end of said embedded member, and means for maintaining the shield at substantially the potential of said sheath.

4. The combination set forth in claim 2, wherein the last named means is an electrical conductor bridge between the shield and sheath and including a sleeve-like electrical conductor member about the insulated conductor.

5. In a terminal structure for an insulated electrical conductor having a portion projecting from an end of an electrical conductive sheath, the combination of a flux-dispersing structure projecting axially from said sheath end about the projecting conductor portion to sustain a pattern of flux lines extending generally axially of the conductor and oppositely from said sheath end into intersecting relation with a section of said projecting conductor portion, a dielectric housing about said projecting conductor portion exteriorly of the flux dispersing structure, and an electrical conductive shield conductively connected to said sheath and having a portion disposed exteriorly of said housing adjacently to the projecting conductor portion at a section spaced from the sheath end as distantly as the section intersected by the lines of the first named pattern, to sustain a pattern of flux lines intersecting such section of the projecting conducting portion.

6. In a terminal structure for an insulated electrical conductor having a portion projecting from an end of an electrical conductive sheath therefor, the combination of a tubular insulator disposed about said projecting conductor portion in radial spaced relation therewith and having an end portion in proximity to said sheath end, a body of solid dielectric material substantially filling the space between said bushing end portion and a part of the conductor substantially radially opposed thereto, a sleeve-like electrical conducting member having an inner periphery of graduated diameter increasing toward an end thereof, said sleeve-like member being disposed about said conductor portion with the larger diameter end thereof embedded in said dielectric material and projecting into said tubular insulator and with the other end thereof conductively connected to said sheath end, an electrical conducting shield about the outer periphery of said tubular insulator within a zone extending axially a limited distance from said insulator end, and a sleeve-like electrical conducting member interconnecting said shield and said sheath.

JAMES H. NICHOLAS.