Nov. 4, 1941. L. W. SPOONER 2,261,633

POTENTIAL DISTRIBUTING INSULATOR TUBE AND METHOD OF MAKING SAME

Filed May 14, 1940

Fig. 1.

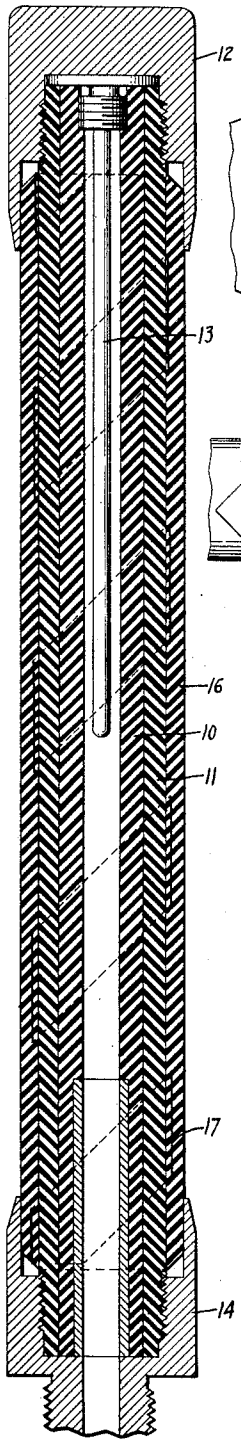


Fig. 2.

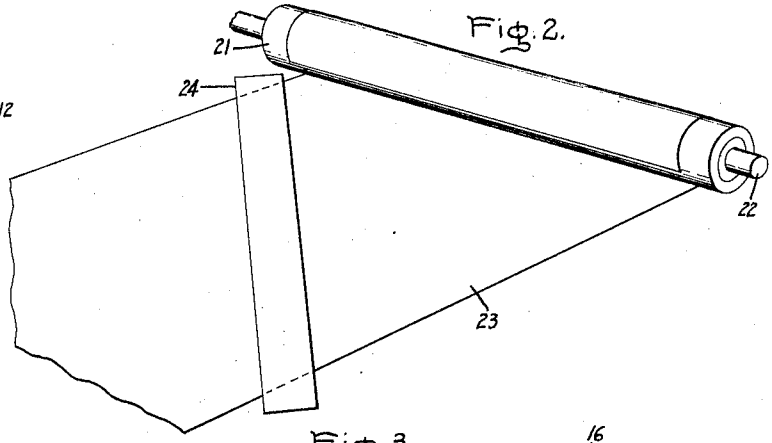


Fig. 3.

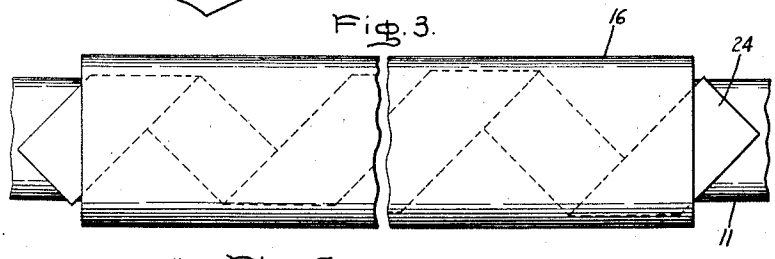


Fig. 5.

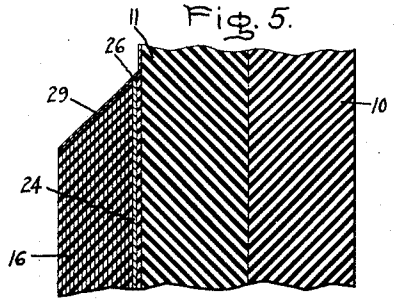


Fig. 4.

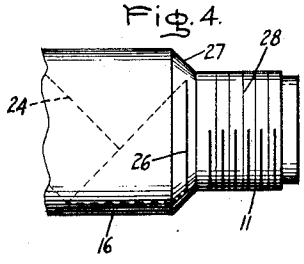
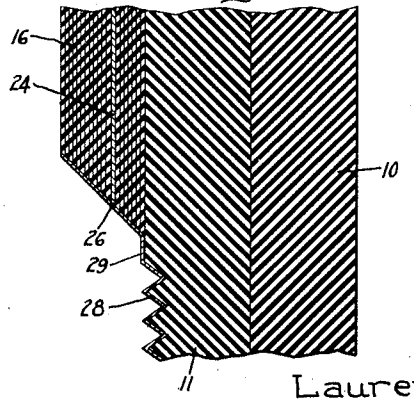


Fig. 6.



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His Attorney.

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2,261,633

UNITED STATES PATENT OFFICE

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POTENTIAL DISTRIBUTING INSULATOR TUBE AND METHOD FOR MAKING SAME

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Application May 14, 1940, Serial No. 335,093

11 Claims. (Cl. 201—63)

This invention relates to insulator tubes and more particularly to such tubes having means for distributing a potential over the tubes between electrodes at the opposite ends thereof, and a method for making the same.

With certain types of insulators it is desirable to distribute the potential difference between the electrodes at the opposite ends thereof over the length of the insulator for various reasons, such as, to minimize high potential gradients at the edges of one or the other of the electrodes or both. In certain forms of insulators such grading of the potential difference may be accomplished by means of an element or coating of semiconductive, high resistance material provided on the outer surface of the insulator and connecting the two electrodes. Frequently, as in the case of the insulator tubes of arc expulsion type lightning arresters, the resistivity of the element must be relatively accurately determined and applied in such a manner that it will be substantially indestructible and weatherproof. The construction of such tubes by prior known methods has been an inaccurate and expensive procedure.

It is an object of the present invention to provide a new and improved insulator having a high resistance potential distributing element embodied therein of a predetermined resistivity connecting the electrodes at the opposite ends thereof.

It is a further object of the invention to provide a new and improved method of making an insulator tube having a resistance potential distributing element connecting the electrodes at the opposite ends thereof which method may be carried out in a simple manner and with a resultant high degree of accuracy in the finished product.

For a better understanding of my invention, attention is directed to the following specification and the claims appended thereto taken in connection with the accompanying drawing in which Fig. 1 is a cross sectional view of a lightning arrester embodying an insulating tube constructed in accordance with my invention; Figs. 2, 3, and 4 illustrate various steps in the manufacture of the insulating tube; and Figs. 5 and 6 are enlarged sectional views of opposite end portions of the insulating tube illustrated in Fig. 1.

The invention will be described as it may be applied to the construction of a lightning arrester of the arc expulsion type though it will be readily understood that the invention is not necessarily so limited. In Fig. 1 is shown a lightning arrester of this type comprising a pair of tightly telescoped insulating tubes 10 and 11 having a line electrode 12 including a depending portion 13 threaded onto the upper end thereof and a ground electrode 14 threaded onto the lower end thereof.

With the lightning arrester as thus far described, the line electrode, or that nearest the protected high voltage conductor tends to assume a potential determined by the capacity between this electrode and the high voltage circuit and the capacity between this electrode and the grounded electrode and any other nearby grounded object. The line electrode is usually much nearer the protected high voltage line than it is to the grounded electrode or any other grounded object so that it tends to assume a voltage very much above the grounded electrode. The distribution of this high voltage along the insulating tube will not be uniform so that high potential gradients and corona occur at the extremities of the line electrode parts. The formation of corona during normal voltage conditions at the surface of the inner electrode part 13 not only results in a deterioration of the tube and a shortening of its useful life but also in considerable radio interference. To minimize these effects it is desirable to distribute the potential substantially uniformly over the length of the tube, which may be accomplished by the provision of a resistance element or coating of a suitable semiconductive material extending the length of the insulating tube and connecting the opposite electrodes. A lightning arrester provided with such a high resistance coating is more fully described and claimed in the copending application Serial No. 290,855 of Elmer J. Wade, filed August 18, 1939, and assigned to the General Electric Company, the assignee of the present application.

In order to provide for the proper operation of the lightning arrester, it is desirable that the resistance element connecting the line and ground electrodes have a predetermined resistivity which, for example, may be of the order of about one-quarter to one megohm per inch. According to one method used heretofore the resistance element consists of a coating of a semiconductive paint sprayed onto the outer surface of the insulating tube which had been previously suitably prepared. The coated tube is then baked to harden the coating. Because of the fragility of this coating it must be further protected against injury due to handling and weathering by an additional covering. First a

layer of a suitable phenolic resin varnish is applied over the coating followed by a baking step and then a few layers of phenolic resin varnish impregnated paper are wrapped around the tube followed by additional baking. It will be readily appreciated that the resistivity of the coating is influenced by each subsequent operation so that it is difficult to arrive at a predetermined resistance value in the finished product since minor variations in the different steps produce relatively wide fluctuations in resistance of the coating from one unit to the next. The spraying of the resistance paint onto the tube surface is a very difficult step to control with a high degree of accuracy because of the many variable factors entering into this operation coupled with the fact that few close checks can be made until each tube is fully completed and the final resistance of the coating measured. With this procedure spoilage due to faulty resistance values is excessively high resulting in a high cost for those found acceptable.

In accordance with this invention I provide a plurality of wound layers 16 of insulating material around the outer tube 11 having a longitudinal strip 17 of semi-conductive high resistance material wound up therewith extending spirally or helically around the tube with the opposite ends thereof conductively connected to the electrodes at the opposite end of the tube. As illustrated in Fig. 2 a cylinder 21, which in this instance may comprise the telescoped fiber tubes 10 and 11 for a lightning arrester, is supported upon a mandrel 22 adapted to be mounted within a lathe or other suitable winding machine (not shown). One end of a web 23 of suitable insulating material such as paper or cloth impregnated with a phenolic resin varnish may be attached to the cylinder 21 and be wrapped thereon by rotation of the mandrel 22. A resistance element 24 which has been previously treated and measured to have a predetermined end to end resistance is placed upon the web 23 angularly with respect to the opposite edges thereof so that only predetermined end portions of the resistance element extend beyond the edges of the web. As the web is wound on the cylinder 21 the resistance element 24 will assume a spiral configuration around the tube between consecutive layers of the web material.

After the element 24 has been completely wound into the tube and with a desired number of additional layers of wrapping applied, the tube may be baked and then removed from the mandrel. Following this, the ends of the tube may be suitably machined and threaded, as indicated in Fig. 4, for cooperatively receiving the electrode parts 12 and 14. It will be noted that the opposite ends of the resistance element 24 are left exposed by the machining operation as indicated at 26 and to insure a good conductive connection between this edge and the electrodes, I prefer to paint the beveled portions 27 as well as the threaded portions 28 with a continuous layer 29 of conductive paint as indicated in Figs. 5 and 6.

While the resistance elements or strips 24 may comprise any suitable flat material having a predetermined resistivity, I prefer to use a cloth tape treated with a semiconductive mixture of unplasticized cellulose acetate, colloidal carbon and solvatone such as is fully described in my copending application Serial No. 305,933 filed November 24, 1939, and assigned to the General Electric Company, the assignee of the present application. Such a tape can be readily manufactured with uniformity in long lengths and measured portions can be cut off having a desired predetermined end to end resistance value. Defective portions of the tape can thus be readily detected and discarded before they are wound into the insulator tube. Furthermore, minor variations of the resistivity of the tape portions can be compensated for by varying the effective lengths of the strips by simply altering the angle at which they are laid across the web 23 before they are wound into the tubes. While I prefer to wind the element into the tube with the strip placed upon the web substantially at a 45-degree angle in order to minimize the formation of voids at the edges of the tape, it will be readily appreciated that this angle is not at all critical.

While the resistivity of the elements may be varied somewhat by the wrapping and subsequent baking of the wrapped tube, this is usually a relatively constant variation and may be readily compensated for in the measurement of the resistance element prior to its being wound into the tube.

It is obvious that insulator tubes having high resistance elements embodied therein connecting the electrodes at the opposite ends thereof can be manufactured in accordance with this invention with a high degree of accuracy, in an expedient manner, and at a relatively low cost.

Having described an insulator tube and the method for manufacturing it as adapted for one specific application, it is obvious that the invention is not so limited and that it may be carried out in other embodiments.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A potential distributing insulating tube having electrodes at the opposite ends thereof, said tube comprising a plurality of wound layers of insulating material, a semiconductive strip having a predetermined resistance being wound into said tube between consecutive layers, the opposite ends of said strip being conductively connected to said electrodes.

2. A lightning arrester including an insulating tube having an electrode at each end thereof, said tube comprising a plurality of wound layers of insulating material, a high resistance element wound spirally around said tube between consecutive layers of said insulating material, the opposite ends of said element conductively connected to said end electrodes.

3. In a lightning arrester including an insulating tube, an electrode at each end of said tube, the outer surface of said tube being wrapped with a plurality of layers of insulating material, a relatively narrow longitudinal semi-conductive strip having a predetermined resistance being wound spirally around said tube between said layers, the opposite ends of said strip being conductively connected to said end electrodes.

4. A lightning arrester comprising an insulating tube, an electrode at each end of said tube, the outer surface of said tube being wrapped with a plurality of layers of insulating material, a semi-conductive strip of material having a predetermined end to end resistance being wound in between said layers of insulating material and conductively connected to said two electrodes.

5. A potential distributing insulating tube having electrodes at the opposite ends thereof, said tube comprising a plurality of wound layers of insulating material, a flat longitudinal strip of fibrous material treated with a semiconductive

mixture and having a predetermined resistance between spaced points thereof, said strip being wound into said tube between consecutive layers of said insulating material with said spaced points at the opposite ends of said tube, said spaced points being conductively connected to adjacent electrodes.

6. A potential distributing insulating tube having electrodes at the opposite ends thereof, said tube comprising a plurality of wound layers of insulating material, a flat longitudinal strip of fibrous material treated with a semiconductive mixture and having a predetermined resistivity, said strip being wound into said tube between consecutive layers of said insulating material, said strip being exposed at the opposite ends of said tube and means conductively connecting the opposite ends of said strip to adjacent electrodes on said tube.

7. A potential distributing insulating tube having electrodes at the opposite ends thereof, said tube comprising a plurality of wound layers of insulating material, a flat longitudinal strip of fibrous material of such dimensions and treated with such a semi-conductive mixture as to produce a desired and predetermined resistivity, said strip being wound into said tube between layers of said insulating material, said strip being exposed at the opposite ends of said tube and means conductively connecting the opposite ends of said strip to adjacent electrodes on said tube.

8. In a high voltage arc expulsion lightning arrester having a pair of spaced electrodes, a potential distributing insulating tube for supporting one of said pair of electrodes in each end thereof, said insulating tube comprising an inner portion and an outer portion, said outer portion having a semi-conductive high resistance means embedded therein and connecting said pair of electrodes, said means comprising a plurality of turns around said tube, each turn being insulated from the other of said turns.

9. A method of manufacturing a potential distributing insulating tube from a web of insulating material and having a resistance element imbedded therein for connecting electrodes at the opposite ends thereof, said method including the steps of placing a strip having a predetermined end to end resistance angularly across said web with the opposite ends of said length positioned at the opposite edges of said web, winding said web into a tube with the opposite ends of said strip exposed at the corresponding ends of said tube for connection to adjacent electrodes.

10. A method of manufacturing a potential distributing insulating tube from a web of insulating material and having a resistance element imbedded therein for connecting electrodes at the opposite ends thereof for distributing a voltage over said tube between said electrodes, said method including the steps of measuring a strip of semi-conductive material having a predetermined end to end resistance, placing said strip angularly across said web with the opposite ends of said strip projecting slightly from the opposite edges of said web, winding said web into a tube, coating the ends of said tube including the ends of said strip with a conducting material connecting the ends of said strip to adjacent electrodes.

11. A method of manufacturing a potential distributing insulating tube from a web of insulating material and having a resistance element imbedded therein for connecting electrodes at the opposite ends thereof, said method including the steps of measuring a fibrous strip coated with a semi-conductive material and having a predetermined end to end resistance, placing said strip angularly across said web with the opposite ends thereof positioned adjacent the opposite edges of said web, winding said web into a tube, machining the opposite ends of said tube so as to expose the opposite ends of said strip, coating the opposite ends of said tube with a conductive material for conductively connecting the ends of said strip to adjacent electrodes.

LAURENCE W. SPOONER.