Sept. 16, 1958 D. C. PRINCE 2,852,596

HIGH VOLTAGE CABLE CONNECTOR

Filed May 20, 1952

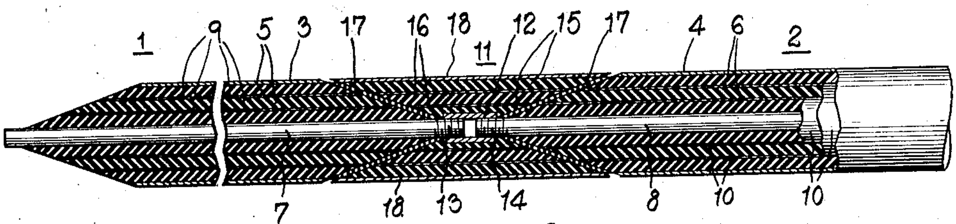

Fig. 1.

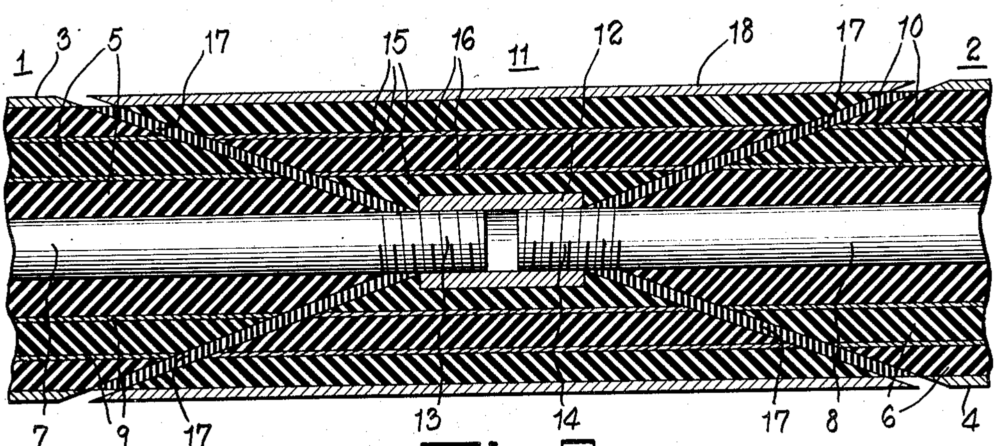

Fig. 2.

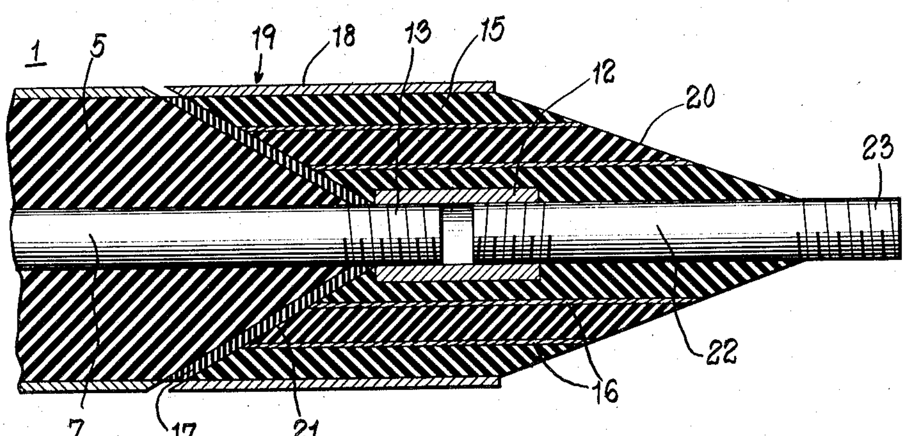

Fig. 3.

INVENTOR
DAVID C. PRINCE
BY Davis, Hoxie & Faithfull
ATTORNEYS

United States Patent Office

2,852,596

Patented Sept. 16, 1958

2,852,596

HIGH VOLTAGE CABLE CONNECTOR

David C. Prince, Schenectady, N. Y.

Application May 20, 1952, Serial No. 288,795

3 Claims. (Cl. 174—73)

This invention relates to improvements in high voltage cables.

The usual high voltage cable comprises a conducting core of stranded wire upon which is wound a plurality of layers of paper insulating tape, the whole being enclosed in a lead or other protective sheath. The laying of such cable involves considerable expense, a substantial portion of which is consumed in making joints between the ends of adjacent pieces of cable, and between the final end and the particular apparatus to which it is attached, such as a transformer, pot head, etc.

In order to prevent electrical breakdown of cable insulation, it is common practice to cut the sheath back so as to provide a sufficient creepage distance from the sheath over the surface of the paper tape to the conductor. The problem then becomes one of securing a low enough potential gradient along the exposed paper to prevent a surface creepage breakdown. Since the creepage length is rather considerable, it is necessary to take steps to insure a fairly uniform distribution of potential along this path. Heretofore, it has been attempted to obtain this potential uniformity by hand-winding additional tape on the cable, so as to obtain the desired potential distribution. This hand-winding operation is laborious and becomes even more burdensome when it must be done in confined quarters, as in a manhole. Obviously, a large number of man hours is required to complete these manual operations, so that the cost of cable joints becomes a substantial fraction of the entire expense of installation. These high labor costs are further increased when the designer makes an effort to achieve the ideal of short cable runs between pieces of apparatus. In this case, the cost of the cable ends is so high that this method of construction has been virtually abandoned.

In accordance with my invention these prior difficulties are completely eliminated, so that high voltage cables may be joined together simply and efficiently, with resultant savings in labor costs. The new cable comprises the usual conductor and outer sheathing separated by insulating tape. However, this insulation is divided into insulating layers separated by concentric conducting layers. The sheathing and insulation of the cables to be joined are cut back on a bias such that proper potential distribution along the surfaces is obtained. A coupling structure is provided for completing the joint. The coupling is of substantially the same construction as the cables to be joined, but it also includes a bushing member internally threaded for engagement with complementary threads on the respective conductor cores. Upon rotation of the coupling, electrical continuity of the cables is accomplished. The joint is then completed in the usual manner by drying and filling any air pockets with an insulating compound.

A better understanding of the invention may be had from the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of two high voltage cables made and joined in accordance with my invention;

Fig. 2 is an enlarged longitudinal sectional view of the coupling structure shown in Fig. 1, and

Fig. 3 is a view similar to Fig. 2 but showing another embodiment of the invention.

Referring now to Figs. 1 and 2, two high voltage cables to be joined are indicated generally at **1** and **2**. The cables **1** and **2** comprise, respectively, lead sheaths **3** and **4**, insulation **5** and **6** of varnished cambric oiled paper, styrenated paper, or the like, and conductors **7** and **8**. In these cables **1** and **2** are a plurality of conducting tape layers indicated at **9** and **10**, respectively. These tape layers, which may be thin metal foil, subdivide the insulation layers **5** and **6**. The conducting layers **9** and **10** are concentric with the insulating layers **5** and **6** and with the central conducting cores. As will be explained later in greater detail, the conducting layers **9** and **10** assume electrical potentials determined by their respective capacitances, so that by cutting the cable ends on a suitable bias, a uniform distribution of potential may be obtained along the terminal surface formed by the cut.

In preparing the joint, the cable conductors **7** and **8** are bared and the cable ends are cut on a bias, as previously explained so that they are conical or tapered. As part of the actual joint, a coupling structure indicated generally at **11** is used. This coupling is made in the factory, so that the time required in the field for making the joint is greatly reduced.

As best seen in Fig. 2, coupling structure **11** comprises a bushing member **12** mounted within a sleeve. The sleeve comprises insulation tape layers **15** alternating with conducting layers **16**, the whole being enclosed by a lead sheath **18**. The sleeve ends are internally tapered so that they are complementary to the adjacent tapered ends of the cables. The bushing **12** is internally threaded at its ends for right and left hand threads, respectively. Similarly, the ends of the conductors **7** and **8** have cooperating threads at **13** and **14** for engaging the threaded portions of bushing **12**. The cables are thus united by rotating the coupling **11**. Electrical continuity for the cables is maintained through the bushing member **12**. When the mechanical joint is completed, the lead sheaths are spliced together. The joint is dried and filled with an insulating compound **17** in the usual manner.

In high voltage cables, the radial potential gradient is very high, so that if the cable were cut off at the end in a plane perpendicular to the longitudinal axis of the cable, an electrical breakdown would occur because of the short distance between the sheath and the conductor. As previously mentioned, it has been proposed heretofore to increase the creepage distance between sheath and core by cutting the cable ends on a bias. It is then necessary to hand-wind additional insulating tape on the exposed cut so as to obtain a satisfactory potential distribution along that surface.

The insertion of concentric conducting layers or tapes, between the insulation layers of the high voltage cable, divides the cable into a plurality of concentric condensers positioned between the sheath and the core. These conducting layers assume potentials determined by the capacitances between the cable sheath, the metallic layers and the conductor. By cutting the cable end on a suitable bias, a uniform distribution of potential between the sheath and the core may be obtained without any necessity for applying additional insulating tape along the surface of the cut.

When the cable is to terminate in a pot head, the porcelain bushing of the pot head is merely slipped over the cable end, and the usual oil-tight joints made between the insulator and conductor, and between the insulator and sheath. In the case of a transformer or circuit breaker, ordinary bushings are not required. The cable conductor is merely attached to the inner end of what would otherwise have been the entrance bushing. Since the bushings represent a rather large part of the cost of both circuit breakers and transformers, this construction will materially reduce such cost and lead to a type of sub-station design very much less costly than prior designs.

The quality of the cable joint made in accordance with my invention is superior to present designs. Since the coupling structure is prepared in the factory, few manual operations are required of the workman in the field. The opportunity for human error is thus substantially reduced, so that the cable joints are of uniform high quality throughout the installation.

The ease with which the cable union may be accomplished in the field reduces the time within which the cable insulation is exposed to the moisture in the atmosphere. The time required by the drying process will therefore be considerably reduced. The final results of these measures make for both lower costs and higher quality cable joints.

When the cable joint unites cables having the conducting layers **9** and **10**, the conducting layers **16** may be omitted from the coupling structure **11**. Conversely, a coupling structure **11** having the conducting layers **16** can be used with cables not having the conducting layers **9** and **10**, and the full benefits obtained.

In Fig. 3, I have shown a further embodiment of the invention in which the coupling structure **19** is a central conducting bushing **12** surrounded by insulating layers **15** alternating with conducting layers **16**, and an outer sheathing **18**. One end of the sleeve **15—16—18** is externally tapered to form a male portion **20** while the other end is internally tapered to form a female portion **21**. The cable **1** in this case does not include the conducting layers **9**. The cable conductor **7**, where it protrudes at the end of the cable, is threaded into the bushing **12** at the female end of the coupling structure **19**. A short central conductor **22** is threaded or otherwise secured in the opposite end of bushing **12** and protrudes somewhat from the end of the male portion **20**. The male part **20** can be inserted in a coupling structure similar to the structure **11** shown in Figs. 1 and 2, and the effect is just as though the entire cable **1** were made with the conducting layers **9** of Figs. 1 and 2. In this case, the proper bias of the tapered portions will be slightly

different in order to produce the same result as in the embodiment of Figs. 1 and 2.

I claim:

1. For connecting with the end of a high voltage cable having insulation which tapers conically from a central conductor to an outer sheath, a coupling comprising a central conducting member for electrically connecting with the central conductor of the cable, an outer sheath of substantially the same diameter as the sheath of the cable, a plurality of layers of a high voltage tape wound about said conducting member to act as insulation in the space between said conducting member and said sheath, the exposed ends of tape being tapered from the conducting member to form an extended and continuous creepage path between said conducting member and said sheath, said taper being of the opposite conforming taper to that of the cable, concentric layers of a metallic conducting material of low electrical resistivity interposed between selected layers of the tape with the ends thereof exposed by the continuous taper of the insulation to obtain a potential gradient along the tapers which is substantially uniform, and an insulating compound interposed between the taper of the coupling and the taper of the connected cable.

2. A coupling according to claim 1 wherein is provided a female taper to mate with a corresponding male taper upon the cable.

3. A coupling according to claim 1 wherein the central conducting member is a bushing having threads for engaging corresponding threads upon the end of the central conductor of the cable.

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