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3,092,794

COMPENSATED CABLE CONNECTOR

Filed March 6, 1961

FIG. 1

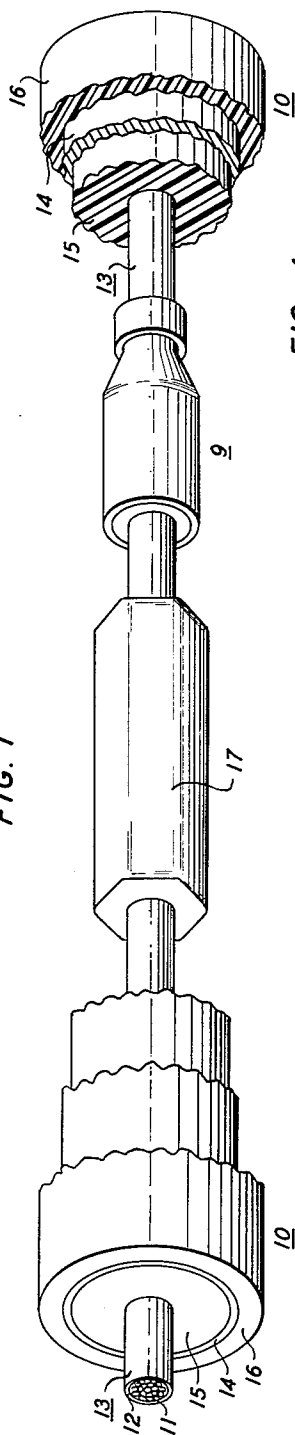


FIG. 4

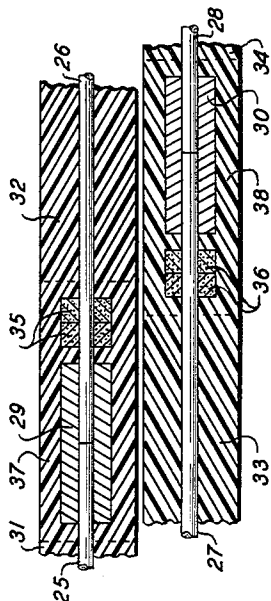


FIG. 2

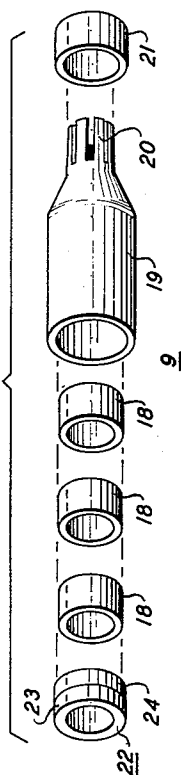
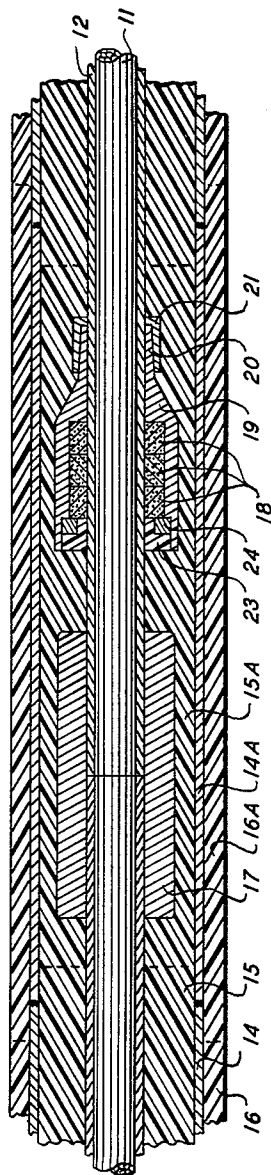


FIG. 3



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3,092,794

COMPENSATED CABLE CONNECTOR

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This invention relates to means for connecting together transmission line conductors.

The use of sleeve type connectors as conductor splicing devices is well known in the cable art. These connectors are usually cylinders of mechanically strong electrically conductive material into which conductor ends are inserted and secured by compressive pressure. The speed and ease with which they can be installed and their degree of reliability as to joint strength and electrical continuity make them highly desirable as conductor splicing means. But these connectors are larger in diameter than the conductors which they connect. It is well known that a localized reduction in insulation thickness between conductor paths will cause an increase in shunt capacitance. This results in a localized mismatch between the impedance in the region of the insulation reduction and the characteristic impedance of the line, and the mismatch will distort and attenuate the signal being transmitted. The obvious means of utilizing the advantages of sleeve type connectors while avoiding the mismatch is by maintaining a uniform inter-conductor insulation thickness. Therefore, the practice heretofore has been to increase the overall diameter of the insulation layer in the connector region so that in that region the spacing between facing conductive surfaces is adjusted consistently with that in the main cable body.

But the corresponding core diameter increase which this engenders is undesirable in certain installations such as submarine installations, and incompatible with certain established manufacturing procedures, such as outer jacket extrusion. Thus the method heretofore used to join conductors in circumstances where such restrictions governed was to weld or braze the conductor ends together and buff the joint to a diameter uniform with that of conductors in the main cable body. This method not only sacrifices the obvious advantages of a sleeve type connector, but also is totally unsuited to the joining of certain types of cable. For example, in the newer designs of coaxial submarine transmission cable wherein the supporting member is a steel strand at the center of the center conductor, brazing not only would be difficult and tedious but also would materially alter the properties of the cable structure components beyond desired limits.

An object of this invention is to permit the use of sleeve type connectors and, at the same time, avoid a localized impedance mismatch. Another object of this invention is to achieve an electrically matched transmission line joint without increasing the cable diameter at the joint location.

This invention achieves this object by compensating for the increased shunt capacitance resulting from the use of the connectors through introduction of series inductance in the circuit by disposing magnetizable material about the conductor in proximity to the connector. By use of this invention, the core diameter and local impedance in the region of the joint can be adjusted so that they will not vary materially from the core diameter of the main cable sections and the characteristic impedance of the line.

This invention can be more readily understood by referring to the accompanying drawings in which:

FIG. 1 is a perspective cutaway view of a compensated coaxial cable connection with portions of the outer jacket, conductor and insulation removed;

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FIG. 2 is an exploded perspective view of the compensator assembly shown in FIG. 1;

FIG. 3 is a cross sectional view of a finished coaxial cable connection; and

FIG. 4 is a cross sectional view of a finished connection in two adjacent conductors of a multiconductor cable.

FIG. 1 illustrates a compensated connection joining the center conductors of cable sections in a coaxial line. In this particular embodiment a joint in a coaxial cable assembly 10 designed for installation beneath the surface of the water is shown. The cable assembly comprises a stranded steel supporting member 11 which is surrounded by a swaged copper tube 12 to form a center cable conductor 13. Between the center conductor and an outer conductor 14 is an insulating material 15. This insulation may be any solid or fluid dielectric material, but for purposes of illustration it will be considered that polyethylene is used in this particular embodiment. Over the outer conductor a protective jacket 16 may be applied of any suitable material, including plastic.

When sections of center conductors are to be connected, the ends of the exposed center conductors are cut so that they will abut each other uniformly. A compensator means such as the assembly 9 is installed on one of the center conductors in proximity to the end of the conductor and the ends of the center conductors are inserted into a sleeve type connector 17. The connector is then compressed radially using an appropriate tool, thereby producing a firm mechanical and electrical connection between the two adjacent center conductors.

The construction of a suitable compensator means 9 is illustrated in exploded perspective in FIG. 2. It should be understood that the compensator means shown here is only one of several possible methods of disposing inductive material about the center conductor and is selected solely because of its particular adaptability for use with the cable type illustrated.

The compensator assembly 9 includes rings of magnetic material 18. I prefer to use ferrite because of its physical and electrical properties, but it is to be understood that other inductive materials in shapes other than rings may also be employed. The rings are adapted to slide over the center cable conductor and into a ring housing 19. This housing is made from strong material so that it will isolate the rings 18 from any external pressures. The housing is advantageously made from a conductive material and may be brass plated to insure a good bond with the polyethylene insulation. When so made and properly designed, as shown in FIG. 2 where leaves 20 on one end form a positive pressure contact with the center conductor, the electrical potential of the housing and the center conductor will be the same, and the possibility of corona about or within the structure is eliminated. In this illustration pressure contact of the leaves is positively maintained and the leafed end of the housing is sealed by means of a ferrule 21 which has a beveled inside surface corresponding to the outside surfaces of the leaves. The ferrule is driven into place over the leaves after the housing is located in its desired position. The opposite end of the housing is sealed by means of an end cap 22 which comprises a backing ring 23 made from a suitable material such as polytetrafluoroethylene which has as its trademark Teflon, having a peripheral seat on one face in which is disposed a metallic gasket 24. The purpose of the end cap is to seal the end of the housing after the inductive material has been installed therein. When the housing is so sealed, materials such as ferrite are protected from significant changes in their electrical properties which might result from collision during handling, or from pressure variations transmitted by the insulation directly or because of the cold flow of plastic insulating materials.

FIG. 3 illustrates a cross section of the embodiment of

my invention shown in FIG. 1. This figure illustrates a finished joint between two sections of completely manufactured coaxial cable. To make such a joint, an insulation patch 15A is formed in the connector region so that its surface is essentially contiguous with that of the insulation in the body of the cable sections, and an outer conductor splice 14A is installed and a jacket patch 16A made contiguous with that of the cable outer conductor 14 and jacket 16 respectively. The outer conductor splice may be bonded to the cable outer conductor by soldering, brazing, overlaying or other methods which are well known in the art. In the case of a connector assembly made to connect core sections during manufacture of long continuous lengths, the outer conductor splice 14A and jacket patch 16A shown in FIG. 3 could be eliminated and the cable outer conductor 14 and jacket 16 formed in the regular manner over the connector region as over the main cable body.

FIG. 4 illustrates another embodiment of this invention, wherein is shown a cross sectional view of two adjacent conductor paths in a multiconductor cable. The conductors in such a cable might be parallel to each other, or in twisted groupings. In this embodiment, conductors 25 and 26 are joined as are conductors 27, 28 by means of connecting sleeves 29 and 30 respectively, after the conductor insulation 31, 32, 33, 34 has been cut away to expose the conductor ends, and ferrite rings 35, 36 have been disposed about the conductors. Thereafter, insulation patches 37, 38 are made so that their surfaces are essentially contiguous with the conductor insulation. Obviously, my invention could be used employing ring housings over the inductive material in such grouped cables as has been disclosed for use with coaxial cables, and could extend to groupings of coaxial cables as well.

Thus the present invention teaches a means by which transmission line conductor sections may be joined using sleeve type connectors, whereby variations in shunt capacitance introduced by such connectors can be compensated for so that there is no mismatch, and by which the core and outer cable diameter in the connector region can be maintained uniform with that of the main cable body.

The embodiments of the invention herein disclosed are only illustrative of the principles of the present invention and numerous other embodiments may be made by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a signal transmission line comprising sections of coaxial cable having a center conductor and an outer conductor, a joint assembly at each junction of said sec-

tions, said assembly comprising means for connecting said center conductors, said means tending to introduce unwanted shunt capacitance between said inner and outer conductors in the vicinity of said junction, and means to compensate for said capacitance including magnetizable material disposed within a protective housing about one of said center conductors, said housing being made of electrically conductive material and in electrical contact with said center conductor.

2. The device described in claim 1 wherein the outside diameter of said connector means is larger than the outside diameter of said inner conductor.

3. In a multiconductor signal transmission line, a joint assembly comprising means for connecting abutting conductors to each other to form a continuous connected conductor path, said means tending to introduce unwanted shunt capacitance between said means and an adjacent conducting path, and means to compensate for said capacitance including magnetizable material disposed within a protective housing in proximity to said first mentioned means about said conductor path, said housing being supported at its ends so as to maintain its relative position to said latter path.

4. The assembly described in claim 3 wherein the housing is cylindrical and is concentric with said connected conductive path.

5. The assembly described in claim 4 wherein the housing is made of electrically conductive material and is electrically connected to said connected conductor path.

6. In a signal transmission line comprising sections of coaxial cable having a center conductor and an outer conductor, a joint assembly at each junction of said sections, said joint assembly comprising means for connecting said center conductors, said means tending to introduce unwanted shunt capacitance between said inner and said outer conductors in the vicinity of said junction, and means to compensate for said capacitance including a plurality of cores contiguous to each other disposed within a protective housing and about one of said center conductors, said housing being in electrical contact with said conductor.

7. The apparatus described in claim 6 wherein said cores are made of ferrite material.

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