Oct. 19, 1948. E. C. QUACKENBUSH ET AL 2,451,868

JOINT FOR HIGH-FREQUENCY TRANSMISSION LINES

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Fig. 1.

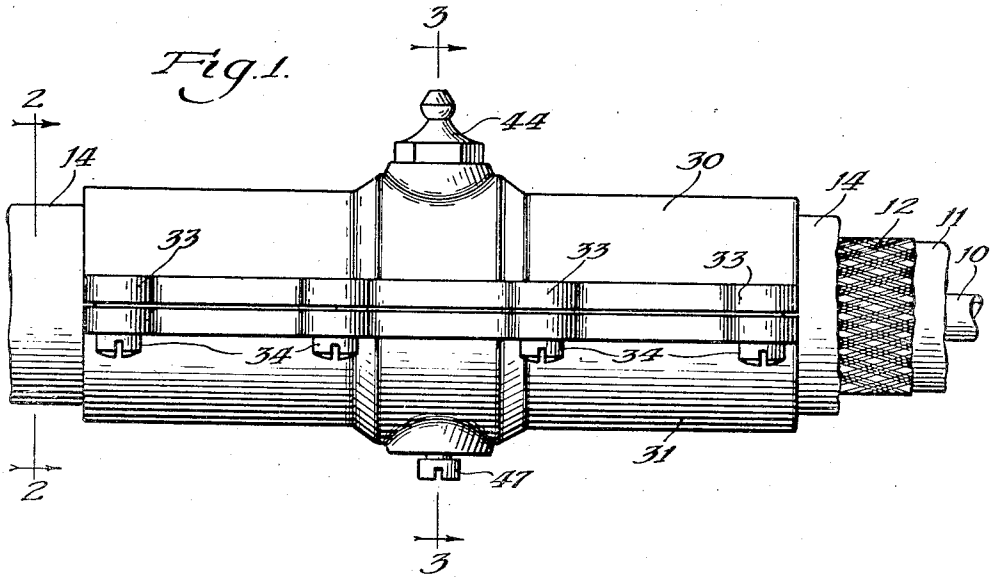


Fig. 2.

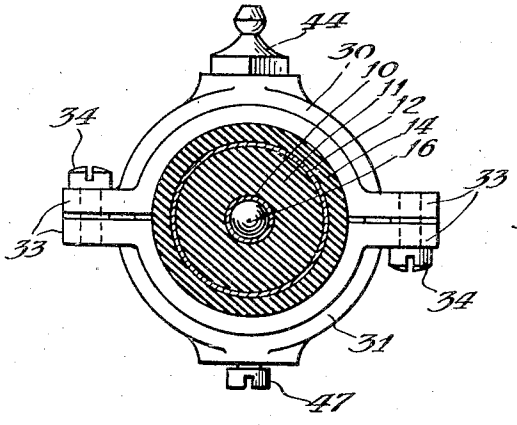
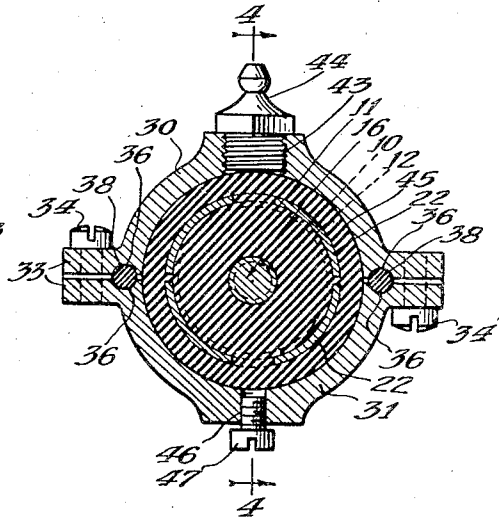


Fig. 3.



Inventors:
Edward Clarke Quackenbush
Harner Selvidge
By: Lee J. Darby
Attorney:

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Fig. 4.

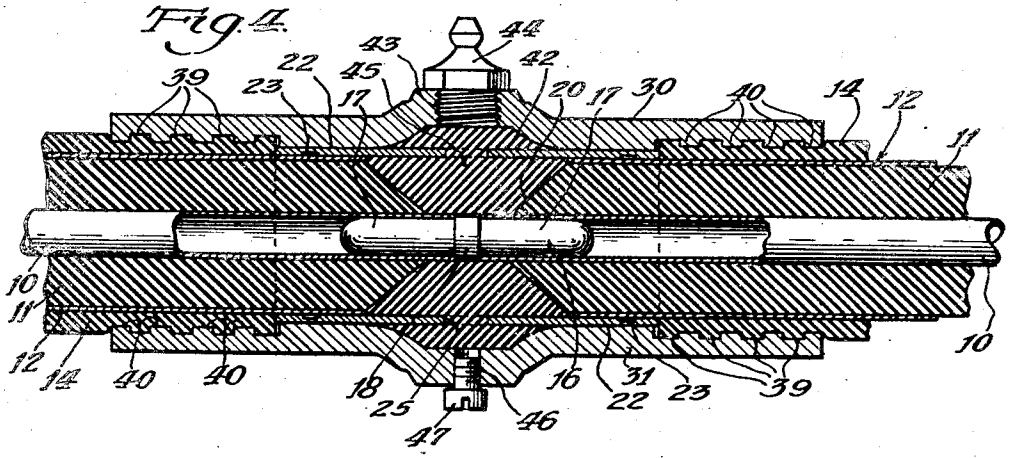


Fig. 5.

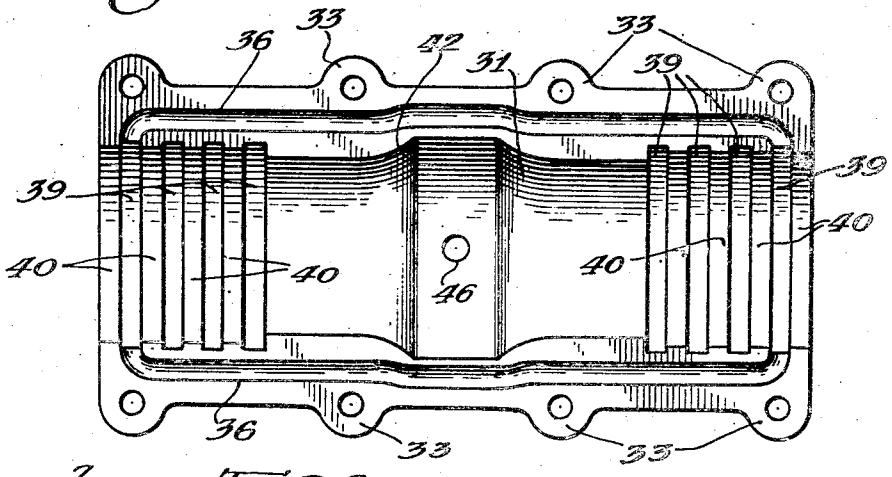


Fig. 6.

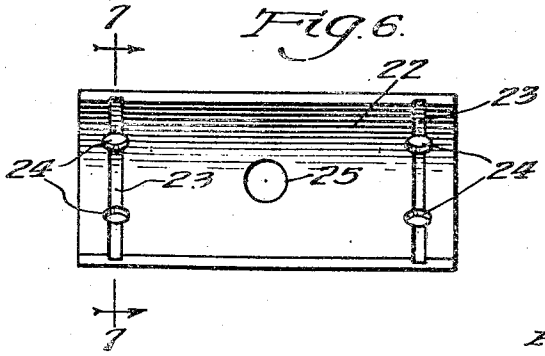
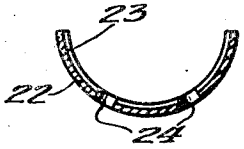


Fig. 7



Inventors
Edward Clarke Quackenbush
Harner Selvidge
By: Lee J. Gary
Attorney:

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JOINT FOR HIGH-FREQUENCY TRANSMISSION LINES

Edward Clarke Quackenbush, Roselle, Ill., and Harner Selvidge, Silver Spring, Md.

Application January 18, 1943, Serial No. 472,708

6 Claims. (Cl. 174—88)

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The present invention relates to electrical cable connectors and more particularly to connectors of the type adapted for connecting the ends of two sections of coaxial cable.

Connectors of this general class are preferably constructed so as to be conveniently used in the "field," and hence, necessitates the embodiment of a construction which permits quick and easy assembly to and disassembly from the cooperating ends of the conductors of two sections of coaxial cable. Connectors of this type, heretofore available, have not been made adequately water resistant, and/or sufficiently strong in both mechanical and electrical connections for reliable service.

One of the primary objects of our invention is to provide an improved coaxial cable connector of the character indicated which is constructed in a novel manner so as to provide a reliable waterproof joint.

Another object is to provide an improved coaxial cable connector which may be quickly and easily applied in the field and which is capable of being economically manufactured.

A further object is to provide an improved coaxial cable connector which is constructed and arranged so as to maintain proper spaced-apart relationship between the inner and outer conductor members of the cable so as to maintain uniformity of impedance in the cable.

Still another object is to provide a novel and improved coaxial cable connector which is constructed and arranged to provide a strong mechanical connection between the adjacent ends of the two sections of cable, while also providing a strong, reliable electrical joint connection between the conductors of the two sections of coaxial cable.

A still further object is to provide an improved coaxial cable connector which permits making a joint possessing as high a voltage breakdown characteristic as the cable itself.

Other objects and advantages of this invention will be apparent from the following description, taken in connection with the accompanying drawings in which:

Fig. 1 is a view in side elevation of the novel cable connector embodying our present invention, shown applied to two sections of coaxial cable for connecting them together.

Fig. 2 is a transverse section, taken at line 2—2 of Fig. 1, showing the connector in end elevation.

Fig. 3 is a transverse section through the connector and the joint between the two sections of

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cable, taken substantially as indicated at lines 3—3 of Fig. 1.

Fig. 4 is a longitudinal axial section through the connector and the connecting ends of the two sections of cable, taken substantially as indicated at line 4—4 on Fig. 3.

Fig. 5 is an inside plan view of one of the housing members of the conductor.

Fig. 6 is an inside plan view of one of the curved sleeve members utilized in the connector.

Fig. 7 is a sectional view of the sleeve member taken on the line 7—7 of Fig. 6.

As is well known, the term "coaxial cables" defines electrical cables of the type wherein two or more conductor elements are disposed in spaced apart concentric, insulated relationship to each other. When the cables are of relatively large diameter the inner conductor is usually in the form of a tube, or other somewhat flexible form, and the outer conductors are in the form of a woven or braided shield of circular cross section.

In the drawings we have shown our novel cable connector joining two sections of coaxial cable together, and wherein the coaxial cables each include a central, inner conductor in the form of a tube indicated at 10, which is surrounded by a body of suitable insulating material 11, around which is disposed a braided or woven shield or outer conductor member 12 of circular cross section, disposed concentrically with respect to the inner conductor 10. The conductors are formed of suitable electrically conducting material. The shield or outer conductor member 12, is encased in an insulating jacket 14, formed of suitable material, such as of the vinyl type. The insulating material interposed between the two coaxial conductors 10 and 12 is preferably of a solid extrudable nature, preferably one which possesses the desirable characteristics of a favorable power factor and dielectric constant for use in high frequency applications.

The two cooperating ends of the respective sections of cable to be joined preferably have the insulation 11, intermediate the two conductors, cut back a short distance from the ends of the respective tubular inner conductors 10, as seen in Fig. 4 of the drawings, and preferably the outer conductors or shields 12 are likewise cut back a substantial distance from the ends of the inner conductors 10, and a substantial portion of the outer insulation 14 of each cable is cut away as seen in Fig. 4 of the drawings, to expose annular sections of the outer conductor.

In the connector constituting the present invention, the tubes 10, which constitute the inner

conductors of the two sections of cable to be joined together, are preferably spaced apart a short predetermined distance, so that it may be convenient to calculate the approximate distance that the outer conductor or shield 12 shall be stripped of its external insulation 14. For this purpose there is employed a coupling member 16, which is formed and dimensioned so as to insure the making of a reliable electrical connection between the tubes 10 of the two sections of coaxial cable. The coupling member 16 includes a pair of oppositely extending cylindrical projections 17 joined at their inner ends to a centrally disposed, enlarged circular body 18. The external diameter of the connecting body 18 preferably corresponds to the external diameter of the tubes 10 of the respective sections of cable. The projections 17 are preferably dimensioned so as to be telescoped into the ends of the respective tubes 10 of the two sections of cable, in the process of joining the sections of cable together.

The coupling member 16 is formed of a suitable electrical conducting material such as copper or brass and is soldered in place with respect to the tubes 10 of the respective sections of the cable in such a manner that the external diameter of the inner conductor members or tubes 10 are not altered or increased, or varied in relation to the outer conductors, so that the impedance of the cable is not changed by reason of the connection of the two sections.

When the tubes, constituting the inner conductors of the two sections of cable, are thus connected together by the coupling member 16, there is provided, immediately surrounding the terminal portions of the tubes 10, an annular groove or cavity indicated at 20, formed by the cutaway portions of the insulation 11, outer conductors 12, and the external insulation 14.

The braided shields or outer conductors 12, of the respective sections of cable are firmly connected together, to insure a proper and efficient electrical joint, by means of a pair of substantially semi-circular sleeve elements 22 which are adapted to be placed in surrounding relation to the joint of the two sections of cable, in direct contact with the exposed portions of the outer conductors or shields 12 of the respective sections of cable. The sleeve elements are formed of suitable electrically conductive metal, such as copper, brass, bronze, etc. When the two sleeve members are placed in such position their longitudinal edges are disposed in substantially abutting engagement with each other as seen in Fig. 3 of the drawings. The opposite ends of each of the respective sleeve elements 22 are formed with internal channels or grooves 23 which, when the two sleeves are disposed in cooperating relation form a substantially continuous annular groove, surrounding the outer conductors or shields 12 of the respective sections of cable to be joined, as clearly seen in Fig. 4 of the drawings.

Suitable apertures 24 are formed in each of the sleeve elements, in registration with the channels 23, and each of the sleeve sections is provided with a centrally located relatively large opening 25. After the two sleeve members 22 are placed in position surrounding the exposed parts of the outer conductors or shields 12, solder is poured into the openings 24, and because of channels 23 the solder is caused to flow around the outer conductors 12, so as to form substantially complete annular rings of solder around said corresponding outer conductor members, and thus serve to rigidly connect the sleeve elements in place, and

also provide a substantial and relatively permanent electrical connection between the outer conductors of the respective sections of cable. This connection further precludes creepage of moisture and condensation to accumulate in the interior of the joint of the two sections of cable.

The joint between the two sections of cable is then encased within a housing composed of two substantially similar, generally semi-circular in cross section, case metal sections 30 and 31. The housing sections include correspondingly aligned, laterally extending lugs or ears 33 which are adapted to be clamped together by means of screws 34. The internal dimensions of the housing sections 30 and 31, when clamped together, provide a snug contact with the two semi-circular sleeve elements 22 as seen in Fig. 4 of the drawings.

The abutting flanges of the two housing sections are each formed with correspondingly disposed grooves or channels 36, of semi-circular cross section, which extend longitudinally of the flanges of the respective housing sections for substantially their entire length. The respective ends of said grooves 36, terminate inwardly and open into the interior of the housing section adjacent the ends thereof, as seen in Fig. 5 of the drawings. Disposed in each set of cooperating channels 36, of the respective housing sections, are gaskets 38, preferably of soft flexible material such as rubber, which when the two housing sections are clamped together by the screws 34, serve to provide a substantial waterproof joint to preclude the passage of moisture between the two housing sections.

The outer ends of each of the housing sections 30 and 31 are provided with a series of aligned, axially spaced apart grooves 39 which form a series of spaced apart annular beads 40. When the two housing sections are placed in position, and clamped together, they firmly embrace the outer insulation 14 of the respective sections of cable, and the beads 40 press into the insulation deforming the same in a manner so as to cause it to flow into the grooves 39, and this serves to lock the insulation, and thereby the sections of cable, firmly in place with respect to the two housing sections, in such clamped together relation.

The two housing sections 30 and 31, substantially at the center of the length thereof, are formed so as to provide an internal annular chamber 42, surrounding the two sleeve elements 22. The upper housing member 30 is provided with a threaded aperture 43 into which is mounted a conventional check valve 44, through which material of a fluid nature may be forcibly discharged therethrough under pressure such as by means of a pump.

To complete the joint constituting the connection between the two sections of coaxial cable, a suitable insulating material, 45, which is initially in fluid or mastic form, such as polyisobutylene, is forced through the check valve into the annular chamber 42 surrounding the sleeve elements 22, and through the apertures 25 of the respective sleeve elements so as to fill the annular space 20 within the sleeve elements, adjacent the cut-back portions of the insulation 11 of the sections of cable, to insure that the fluid material completely fills all the voids or space within the housing sections when in clamped together relation. A vent provided in the lower housing section 31 in the form of a threaded aperture 46 is adapted to be closed by a screw 47. When the fluid 45 is introduced through the

check valve the screw 47 is temporarily removed to permit escape of the entrapped air and after the chamber 42, as well as the space 20 inside of the sleeve elements 22, is completely filled with the fluid insulating material, the screw 47 is again replaced. It is desired that the insulating fluid 45 be of a material having high insulating properties, and of course any other suitable materials, than polyisobutylene may be employed, such as a soft insulated tape or mastic material. The material used, however, is preferably of such nature that it may be initially introduced in fluid or mastic form. Depending upon the characteristics of the material used, it may or may not become set after a period of time.

By virtue of the construction herein disclosed it will be apparent that our improved connector provides a substantial mechanical connection for two sections of coaxial cable, which insures the provision of an electrical joint of great strength and which possesses the desirable characteristic of being waterproof to preclude the entrance of water or moisture into the joint proper, constituting the connection between the two sections of cable.

It will be apparent that by reason of the construction herein disclosed that proper and exact spacing of the central tubular conductors to the outer conductor or shields, 12 is maintained, and the impedance of the cable will not have been altered in any way as a result of the making of the connection, providing the insulating fluid has the same dielectric constant as the original core insulating material. One of the main advantages of our improved connector resides in the provision of a joint having as high a voltage breakdown characteristic as the cable sections connected. This favorable breakdown characteristic is achieved by first filling the voids of the joint with a liquid or mastic insulating material whose characteristics are equally as good as that used in the cable itself, and second, by tapering of the cable insulation at the ends of the cables to be connected. The tapering of the insulating material of the cable ends insures a longer leakage path along its surface which may be subject to breakdown because of getting dirty or by foreign matter in the process of cutting the ends of the cables. Furthermore, the new and improved method of splicing the cables is attained with a minimum of time and effort. The maintenance of the exact dimensional relationship of the inner conductor to the outer conductor is of great importance particularly in applications in which high frequency current is involved, because it is well known that any substantial change in such dimensional relationship of the conductors will often present serious difficulties.

Although we have shown and described a preferred embodiment of our invention, manifestly it is capable of modification and re-arrangement of parts without departing from the spirit and scope thereof. We do not, therefore, wish to be understood as limiting this invention to the precise form herein disclosed, except as we may be so limited by the appended claims.

We claim as our invention:

1. In a joint for a high frequency transmission line having inner and outer coaxial conductors maintained in spaced relation by a continuous solid dielectric, individual coupling means of conducting material joining the adjacent ends of the coaxial conductors together, said coupling means substantially following the diameters of their corresponding conductors for maintaining the characteristic impedance of the transmission line uniform throughout the joint, the adjacent ends of the solid dielectric of the coaxial line being spaced apart at said joint to provide a recess between said coupling means for dielectric material, and a separate dielectric material completely filling said recess, said separate dielectric material having substantially the same dielectric constant and as high a voltage breakdown characteristic as the dielectric provided in the transmission line.

2. In a joint for a high frequency transmission line having inner and outer coaxial conductors maintained in spaced relation by a continuous solid dielectric, individual coupling means of conducting material joining the adjacent ends of the coaxial conductors together, said coupling means being coaxially spaced and substantially following the diameters of their corresponding conductors for maintaining the characteristic impedance of the transmission line uniform throughout the joint, the adjacent ends of the solid dielectric of the coaxial line being spaced apart at said joint to provide a recess between said coupling means for dielectric material, and a separate molded dielectric material completely filling said recess, said separate dielectric material having substantially the same dielectric constant and as high a voltage breakdown characteristic as the dielectric provided in the transmission line.

3. In a joint for a high frequency transmission line having inner and outer coaxial conductors maintained in spaced relation by a continuous solid dielectric, an inner coupling member of conducting material connecting the adjacent ends of the inner conductors, an outer coupling member of conducting material connecting the adjacent ends of the outer conductors, said coupling members substantially following the diameters of their corresponding conductors for maintaining the characteristic impedance of the transmission line uniform throughout the joint, the adjacent ends of the solid dielectric of the coaxial line being spaced apart at said joint to provide a recess between said coupling members for dielectric material, a separate dielectric material completely filling said recess, said separate dielectric material having substantially the same dielectric constant and as high a voltage breakdown characteristic as the dielectric provided in the transmission line, and a housing for enclosing and connecting the adjacent ends of the transmission line and said separate dielectric material.

4. In a joint for a high frequency transmission line having inner and outer coaxial conductors maintained in spaced relation by a continuous solid dielectric, an inner coupling member of conducting material providing oppositely extending portions having telescopic engagement with the adjacent ends of the inner conductors, an outer coupling member comprising a split sleeve of conducting material embracing the adjacent ends of the outer conductors, said coupling members substantially following the diameters of their corresponding conductors for maintaining the characteristic impedance of the transmission line substantially uniform throughout the joint, a split housing enclosing and engaging the adjacent ends of the transmission line and said outer coupling member, the adjacent ends of the solid dielectric of the coaxial line being tapered and being spaced apart at said joint to provide a recess between said coupling members for dielectric material, and a separate dielectric material completely filling said recess, said dielectric ma-

terial being molded against the tapered ends of the transmission line dielectric to form a continous dielectric having a substantially uniform voltage breakdown characteristic and substantially uniform dielectric constant.

5. In a joint for a high frequency transmission line having inner and outer coaxial conductors maintained in spaced relation by a continuous solid dielectric, an inner coupling member of conducting material providing oppositely extending portions having telescopic engagement with the adjacent ends of the inner conductors, an outer coupling member comprising a split sleeve of conducting material embracing the adjacent ends of the outer conductors, said coupling members substantially following the diameters of their corresponding conductors for maintaining the characteristic impedance of the transmission line substantially uniform throughout the joint, the adjacent ends of the solid dielectric of the coaxial line being tapered and being spaced apart at said joint to provide a recess between said coupling means for dielectric materials, a split housing enclosing and engaging the adjacent ends of the transmission line and said outer coupling member, valved coupling means provided on said housing to provide for injecting dielectric material, and a separate dielectric material completely filling said recess, said separate dielectric material being molded against the tapered ends of the transmission line dielectric to form a continuous dielectric having a substantially uniform voltage breakdown characteristic and substantially uniform dielectric constant.

6. In a joint for a high frequency transmission line having inner and outer coaxial conductors maintained in spaced relation by a continuous solid dielectric, an inner coupling member of conducting material providing oppositely extending portions having telescopic engagement with the adjacent ends of the inner conductors, an outer coupling member comprising a split sleeve embracing the adjacent ends of the outer conductors, said coupling members substantially following the diameters of their corresponding conductors for maintaining the characteristic impedance of a transmission line substantially uniform throughout the joint, said outer coupling member being internally grooved for soldering engagement with said outer conductors, the adjacent ends of the solid dielectric of the coaxial line being tapered and spaced apart at said joint to provide a recess between said coupling members for dielectric material, a split housing enclosing and engaging the adjacent ends of the transmission line and said outer coupling member, valved coupling means provided on said housing to provide for injecting dielectric material, and a separate dielectric material completely filling said recess, said separate dielectric material being molded against the tapered ends of the transmission line dielectric to form a continuous dielectric having a substantially uniform voltage breakdown characteristic and substantially uniform dielectric constant.

EDWARD CLARKE QUACKENBUSH.
HARNER SELVIDGE.

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