

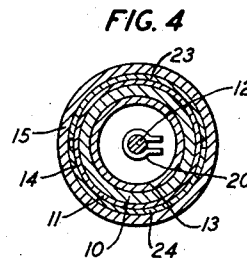
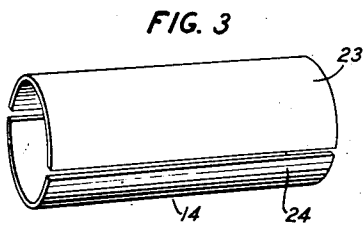
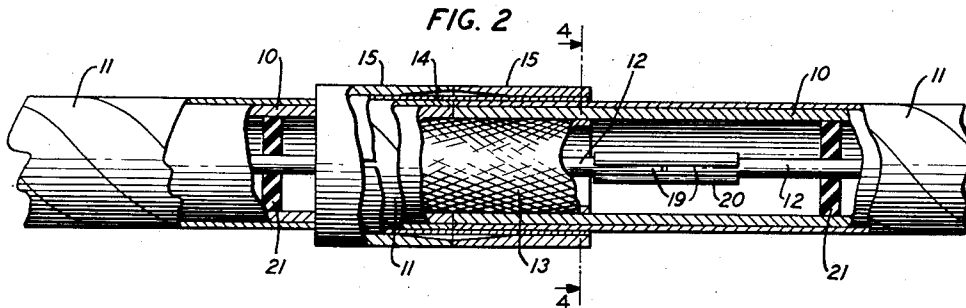
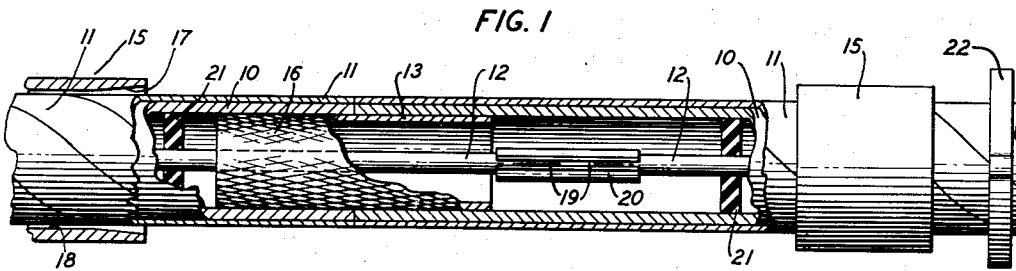
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JOINT FOR COAXIAL CONDUCTORS

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JOINT FOR COAXIAL CONDUCTORS

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This invention relates to a joint or splice for hollow electrical conductors and particularly for conductors of the type commonly referred to as coaxial cable.

An object of this invention is to reduce the length and diameter while increasing the strength of a coaxial conductor splice.

Another object is to improve the electrical characteristics of a solderless joint between coaxial conductor sections.

Another object is to simplify the structure of a coaxial cable joint so that it is adapted for use either in the field or in the shop.

A further object is to construct a splice whose quality can be determined without destructive tests.

Heretofore solderless joints have been employed to join sections of tubular conductor. W. S. Hayford Patent 2,305,473, issued December 15, 1942, discloses such a structure wherein dielectric reinforcing members are inserted in the ends of the tubular conductor sections and a malleable tube is placed over these ends. This joint is secured by compressing the portion of the ends of the tube, coaxial with the reinforcing members, on the outer conductor to form an electrical and mechanical connection between the ends of the conductors through the tube.

A further development of this type of joint adapted for use with coaxial cables having outer metallic armor tapes is shown in a copending application filed by E. L. Alford on December 29, 1945, Serial No. 638,350, now Patent No. 2,538,225. This joint employs short substantially compressible metallic reinforcing sleeves on the tubular conductor ends to be joined and a plurality of malleable sleeves on the exterior of said tubular conductor. One of the outer sleeves extends over the ends of the tubular outer conductors and bridges the gap between them, while the two remaining sleeves embrace the ends of the metallic armor tapes adjacent the ends of said first sleeve. In order to provide a mechanically secure, gas-tight joint having low resistance the whole assembly is subjected to a compressing action which forces the first-mentioned outer sleeve into intimate contact with the outer surfaces of the outer conductors and the other outer sleeves into intimate contact with the metallic tapes.

The present invention relates to a solderless splice for coaxial cable and particularly to an improved structure for joining the hollow outer conductor which will have lower resistance, greater strength and smaller size than the joints of the prior art. This splice comprises any

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of the means currently used to join the inner conductors of a coaxial cable in combination with an outer conductor joint composed of a rigid tubular insert electrically and mechanically bridging the joint between the butted ends of the outer conductor sections and a sleeve secured in compression over said insert. The compressive force exerted on this sleeve is supplied by a pair of contractor rings which are slid axially over the sleeve thereby reducing its diameter by the camming action of their tapered inner diameters.

The invention will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings, in which:

Fig. 1 is a partially sectioned view in elevation of the joint disclosing the relationship of the elements prior to placing the outer sleeve over the metallic tapes;

Fig. 2 is a partially sectioned view in elevation of the completed joint;

Fig. 3 shows the outer sleeve in perspective; and

Fig. 4 is a cross section of the joint taken along the line 4—4 of Fig. 2.

As shown in the drawing, the coaxial cable splice of this invention comprises two mechanically independent joints, one joining the outer conductor sections 10 and their protective sheath of armor tape 11, and the other joining the inner conductor sections 12.

The outer joint as shown in Fig. 2 comprises a rigid tubular insert 13 located partially within the abutting ends of both outer conductor sections 10, a longitudinally split sleeve 14 positioned around the insert and embracing the outer conductor 10 and the armor tapes 11, and a pair of rings or caps 15 which reduce the diameter of the sleeve and compresses it into intimate contact with the tapes which in turn compress the outer conductor on the rigid insert. In order to increase the friction between the inner surface of the ends of the outer conductor sections 10 and the insert 13, its outer surface 16 is roughened as by knurling or threading and the rings 15 are constructed to develop a pressure on the sleeve 14 of such magnitude that softer material of the inner wall of the outer conductor sections 10 is forced into the contours of the roughened surface.

The pressure necessary to produce such intimate contact is attained by employing rings of one of the higher tensile strength materials, such as steel, formed so they will transpose to

a radial pressure the axial force applied to them in sliding them from the position adjacent the ends of the sleeve to a position over the sleeve. The structure which has been found to most satisfactorily give this result is a ring having a portion of its inner periphery which is positioned adjacent the sleeve 14 chamfered to form a gradually tapering camming surface 17 on its inner diameter. This camming surface 17 tapers from a diameter greater than the outer diameter of the sleeve 14 to a diameter sufficiently less than the outer diameter of the sleeve to contract the sleeve and thereby exert the necessary pressure on the splice.

In operation, when the ring is moved axially along the cable towards the joint it first contracts the sleeve 14 by the camming action of its taper and as it is advanced it applies an increasing pressure until the end of the taper is reached at which point further advancement merely increases the pressure further along the sleeve, the portion of the ring having a uniform inner diameter 18 merely serving to maintain the maximum pressure developed by the taper.

The inner conductor sections 12, in the embodiment illustrated, are joined at their ends 19 by a split sleeve 20 secured by some suitable method, for example by crimping it on the ends 19. No support maintaining the spacing between the sleeve 20 and the insert 13 is necessary in this splice since the completed structure is short enough so that the ordinary evenly spaced inner conductor supports, shown as dielectric washers 21 in this embodiment of the splice, are sufficient.

The simplified construction of this joint is adapted for either shop or field use. One method of assembly being as follows: The loose armor tapes 11 on the ends of the cable sections are rewound and are secured by placing several turns of adhesive tape around them. A tape securing ring 22 is slipped over each of the section ends and crimped on the cable armor far enough from the point where the splice is to be made to give the splicer enough length of cable, when the outer tapes are opened, to make the splice. Next rings 15 are slipped over the section ends with their chamfered ends toward the joint and are slid along the armor tape to the rings 22. Then the tapes are released at their ends by removing the turns of adhesive tape and are unwrapped from around the outer conductor. The outer conductor 10 of one section, hereafter referred to as the first section and shown as the left-hand section in Figs. 1 and 2 of the drawing, is cut back so that the end of the inner conductor 12 projects therefrom a distance greater than one-half the length of the insert 13. As a corresponding step, the outer conductor of the mating section, hereafter referred to as the second section and shown in Figs. 1 and 2 of the drawing as the right-hand portion, is split open longitudinally and the inner conductor is cut so that it is an equal distance back from the end of its outer conductor. Next, a sleeve is secured on the end of the first inner conductor and the insert is secured in its outer conductor by first splitting the outer conductor open, then placing the insert half-way in it and reforming the conductor over it. Then the two sections are brought together, the sleeve is crimped on the end of the second inner conductor, and the outer conductor is reformed over the projecting portion of the insert so that it butts with the first-mentioned outer conductor. The tapes of both sections are then reformed around the outer conductors and are cut flush at

the butted ends of the sections so that they are not in overlapping relationship with each other. The joint now appears as shown in Fig. 1. With the tape temporarily clamped in position near the joint the sections 23 and 24 of the split sleeve 14 are placed over the assembly and centered over the insert. The splice is then completed by sliding the rings 15 toward the joint and onto the sleeve. As previously described, the advancement of the tapered surface 17 causes the sleeve to be wedged down on the previously unheld ends of the tape which in turn reform around the coaxial and transmit the pressure thus applied to the outer conductor to make the proper electrical and mechanical contact with the insert. As a final step the securing rings 22 may be removed from the cable armor by cutting them.

This type of splice offers a unique manner of gauging the quality of a completed splice without the need of a destructive test. Major dimensional changes which occur during assembly are confined by design to the outside rings. As pressure is developed by the rings, they increase in diameter in proportion to the total radial pressure developed since the structure under the rings is substantially unyielding after the parts are forced into intimate contact. Consequently a micrometer, caliper or other means can be used to gauge the increase in diameter of the rings or cap which occurs during pressing.

The increase in diameter of the rings measures strain as the result of stress in the ring material. The value of the stress in p. s. i. may be established from knowledge of the stress-strain properties of the material of the ring or cap. The coefficient of friction μ , between the insert and the outer conductor and the sleeve and the tapes, may be determined experimentally. The tensile strength of the splice is then

$$T. S. = \left(\frac{2t S_t}{D} \right) \mu$$

and the total strength of the splice is

$$S = \left(2t \times \frac{S_t}{D} \right) \mu A$$

where t is the ring wall thickness, S_t is the stress in the rings produced by the measured strain, μ is the coefficient of friction between the insert and the outer conductor of the coaxial and between the split sleeve and the tapes D is the diameter of the ring and A is the area under one ring. It is to be noted that the quantity in the brackets represents the radial unit pressure developed by the ring.

It has been found that this method of securing the elements of the splice together achieves and maintains a higher pressure and thus a more intimate electrical and stronger mechanical connection than the currently used methods of joining conductors by the use of sleeves. This structure provides a simple compact splice having a diameter small enough to be housed in a sheath with a plurality of other coaxial cables without necessitating any enlargement of the sheath. It further provides a splice having a tensile strength which exceeds that of the coaxial cable to which it is applied, said splice being practicable for use in the factory as well as in the field and requiring no complex tools or jigs in its construction.

Several modifications of this splice have been developed. One of these makes the connection between the conductor sections with the armor tapes spliced at a point spaced from the joint between the outer conductors thereby permit-

ting the sleeve and ring to be positioned over continuous sections of the armor tape. In another arrangement the sleeve 14 has been applied directly to the coaxial outer conductor and the armor tapes have been continued over the completed splice and spliced apart from it. In a further embodiment the outside diameter of the insert 13 has been made larger than the inside diameter of the outer conductor so that when it is reformed over the insert its diameter is enlarged in the region of the insert. The rings are then forced over the enlarged section omitting the sleeves entirely and the tapes are spliced over the rings.

As evidenced in the preceding paragraph this invention as set forth may be subject to modification, therefore, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A splice joining sections of hollow electrical conductor comprising a rigid tubular member inserted partially within and bridging two adjacent ends of said hollow electrical conductor sections, a pair of metallic strips positioned over and bridging the adjacent ends of said hollow electrical conductor and means to maintain a compressive force on the portions of said strips lying over said rigid tubular member.

2. A splice joining sections of hollow electrical conductor comprising a rigid tubular member inserted partially within and bridging two adjacent ends of said hollow electrical conductor sections, a split sleeve positioned over and bridging the two adjacent ends of said hollow electrical conductor sections, and means to maintain a compressive force on said sleeve thereby compressing the ends of said sections on said tubular member.

3. A splice joining sections of hollow electrical conductor comprising a rigid tubular member inserted partially within and bridging two adjacent ends of said hollow electrical conductor sections, a sleeve positioned over and bridging the two adjacent ends of said hollow electrical conductor sections and a ring positioned over and compressing said sleeve, said ring having an inner diameter less than the outer diameter of said sleeve and chamfered at one end to a diameter greater than the outer diameter of the uncompressed sleeve whereby compressive force is applied to said sleeve by the axial movement of said ring from around said hollow conductor onto said sleeve.

4. A splice for an electrical transmission line of the type having a plurality of sections, each having an inner conductor and an outer conductor coaxial therewith, said splice comprising means joining the adjacent ends of said inner conductors, a tubular insert spaced from said means and bridging the ends of said outer conductors, a split sleeve surrounding the portions of said outer conductors embracing said tubular insert, and means maintaining a compressive force on said sleeve sufficient to reduce the inner diameter thereof.

5. A splice for an electrical transmission line of the type having a plurality of sections, each having an inner conductor and an outer conductor coaxial therewith, said splice comprising means joining the adjacent ends of said inner conductors, a tubular insert spaced from said means and bridging the ends of said outer

conductors, a sleeve surrounding the portions of said outer conductors embracing said tubular insert, and a ring positioned over and compressing said sleeve, said ring having an inner diameter less than the outer diameter of said sleeve and chamfered at one end to a diameter greater than the outer diameter of said sleeve whereby said sleeve is compressed by the axial movement of said ring from around said hollow conductor onto said sleeve.

6. A splice for coaxial cable of the type having a plurality of sections each having an inner conductor, an outer conductor coaxial therewith, and an armor tape sheath, said splice comprising means joining the adjacent ends of said inner conductors, a tubular insert spaced from said means and bridging the ends of said outer conductors, said armor tape sheath extending across the ends of said outer conductors, a pair of strips positioned over the portion of the said outer conductors and said armor tape sheath surrounding said tubular insert, and means to maintain a compressive force on the portion of said strips lying over said insert.

7. A splice for coaxial cable of the type having a plurality of sections each having an inner conductor, an outer conductor coaxial therewith, and an armor tape sheath, said splice comprising means joining the adjacent ends of said inner conductors, a rigid insert mechanically bridging the abutting ends of said outer conductors, said armor tape sheath extending across the ends of said outer conductors, a split sleeve positioned over the portion of said armor tape sheath extending over said insert, and means to maintain a compressive force on said sleeve positioned to reduce the inner diameter thereof.

8. A splice for electrical transmission line of the type having a plurality of sections, each having an inner conductor, an outer conductor coaxial therewith, and an armor tape sheath, said splice comprising means joining the adjacent ends of said inner conductors, a rigid insert spaced from said means and electrically and mechanically bridging the abutting ends of said outer conductors, a split sleeve surrounding said sheath and centered over said rigid insert, and a contracting ring arranged to be moved axially on said armor tape sheath to engage, contract and maintain a compressive force on said split sleeve.

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