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ELECTRICAL CABLE COUPLER

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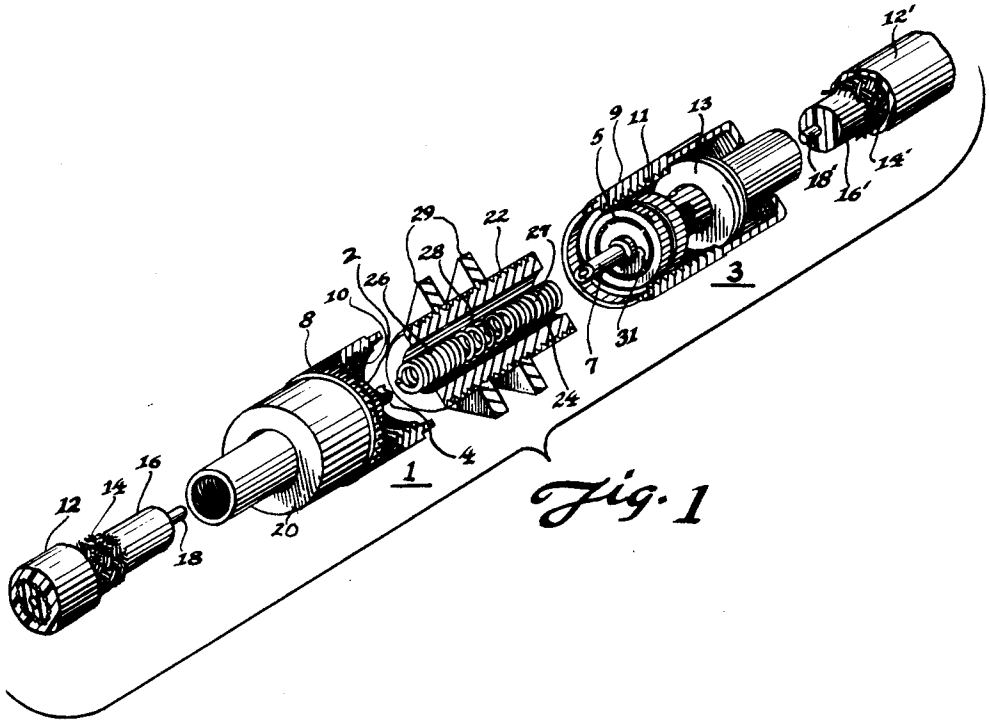


Fig. 1

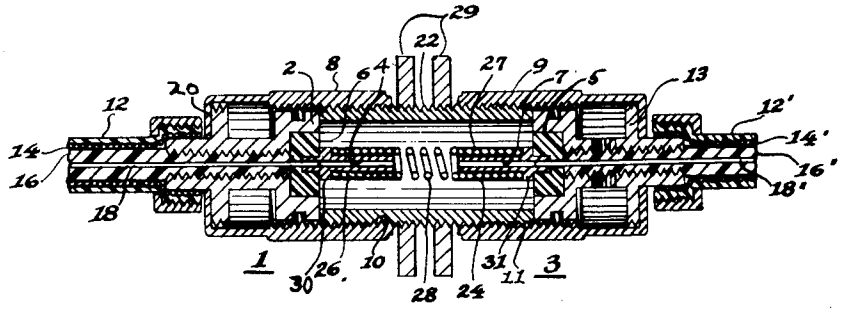


Fig. 2

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ELECTRICAL CABLE COUPLER

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The present invention relates to electrical cable couplers and, more particularly, to radio-frequency coaxial transmission-line couplers.

Standard types of male connectors have been established in the art for use with coaxial transmission lines such as, for example, the conventional 75-ohm coaxial cable widely utilized in television and other radio-frequency systems. Frequently, it is required that two sections of cable, each having such a male connector, be electrically and mechanically joined together. Couplers or splicer-junctions have been proposed for accomplishing this purpose, but, unfortunately, such couplers have been found to introduce impedance discontinuities at the junction of the coaxial-line sections. As an illustration, many of such coaxial-cable couplers have impedances that are only of the order of about 25 ohms. When these couplers are utilized to join two sections of, for example, the before-mentioned 75-ohm coaxial cable, a serious impedance mismatch or discontinuity is produced, resulting in the production of deleterious standing waves. This is not too serious a problem, however, in the event that the junction of the coaxial cables is to be effected at or in the electrical equipment associated with the cables. This is because compensation for such impedance discontinuities can be introduced in the circuits of that equipment. When, however, it is necessary to splice coaxial cables at a point remote from the equipment, or to pass the cables through a metal or other wall, with the requirement that the shield or outer conductor of the cable be grounded at the point of connection, this impedance discontinuity problem becomes of considerable significance. Serious impedance mis-matches and standing-wave phenomena result that do not lend themselves to easy compensation.

An object of the present invention, therefore, is to provide a new and improved electrical-cable coupler that shall not be subject to the before-mentioned difficulties and that, on the contrary, is particularly suited for the joining together of electrical cables at points remote from their associated electrical equipment.

Another object is to provide a new and improved radio-frequency coaxial-line-cable coupler.

Other and further objects will be explained hereinafter and will be more particularly pointed out in the appended claims.

The invention will now be described in connection with the accompanying drawings, Fig. 1 of which is a perspective view illustrating the invention in preferred form, with the parts being shown dis-assembled and partly broken away, in order to illustrate the details of construction; and

Fig. 2 is a side elevation, partly in section, illustrating the parts, as assembled.

Conventional present-day coaxial-line male connectors are shown at 1 and 3 provided with respective outer cylindrical conductors 2 and 5 and inner-conductor plugs 4 and 7. The plugs 4 and 7 are usually mounted in insulating separators, such as the insulation disc 6 associated with the connector 1, coaxially disposed within the outer conductors. Conductive collars or sleeves 8 and 9 are

disposed about the respective outer conductors 2 and 5 and are free to move thereon within predetermined limits. The interior surfaces of the collars 8 and 9 are threaded, as shown at 10 and 11, for cooperating with the threads of a female-type coaxial connector, not shown, with which they are usually employed. The threaded collars 8 and 9 are limited in their movement coaxially over the respective outer conductors 2 and 5 of the coaxial-line connectors 1 and 3 by flanges 20 and 13 upon the respective outer conductors 2 and 5.

The connectors 1 and 3 are shown associated with respective coaxial-line sections 12 and 12' which are to be joined together electrically and mechanically. Referring to the coaxial-line section 12, for example, its insulation-covered outer sheath conductor 14 is separated by insulation 16 from the inner conductor 18. The outer sheath conductor 14 makes electrical contact with the outer connector conductor 2 and the inner conductor 18 makes electrical contact with the connector plug 4, as is well known. In similar fashion, the outer conductor 14' of the coaxial-line section 12' is connected to the outer conductor 5 of the connector 3 and the inner conductor 18' is connected to the inner plug conductor 7.

In accordance with the present invention, the two male connectors 1 and 3 are coupled together by an externally threaded conductive tube 22. The external diameter of the tube 22 and the threads thereupon are such that the collars or sleeves 8 and 9 of the respective connectors 1 and 3 may be threaded upon opposite ends of the tube. In this manner, the collars 8 and 9 of the respective connectors 1 and 3 may be joined together electrically and mechanically. When threaded to a sufficient degree upon the conductive tube 22, moreover, the collars 8 and 9 will respectively contact the before-mentioned flanges 20 and 13 of the outer conductors 2 and 5 of the respective coaxial-line conductors 1 and 3, thereby to establish electrical connection between the outer conductors 14 and 14' of the respective coaxial-line sections 12 and 12'. The degree of threading may be limited by adjustable stop washers 29, permitting the use of the invention with connectors of different lengths, and permitting easy attachment to the before-mentioned metal or other walls.

Electrical connection between the inner conductors 18 and 18' of the coaxial-line sections 12 and 12' is established through the medium of a preferably helical spring member 24 of cross dimension or diameter somewhat larger than the cross-dimension or diameter of the inner-conductor plugs 4 and 7. The spring 24 receives the plugs 4 and 7 at opposite ends. The terminal portions of the helical spring are preferably soldered together to provide continuous conductive terminal-portion sheaths 26 and 27 for reasons later explained. The length of the terminal portions 26 and 27 is substantially equal to and preferably somewhat greater than the length of the inner conductor plugs 4 and 7, and the overall length of the helical spring member 24 is somewhat greater than the overall length of the tubular member 22. Interconnecting the terminal portions 26 and 27 of the helical spring member 24 is an intermediate portion constituted of several spaced resilient turns of the spring, as shown at 28.

When the collars 8 and 9 of the male connectors 1 and 3 are threaded upon the tube 22 to the appropriate degree, as before stated, thus providing electrical contact between the outer conductors 14 and 14' of the respective coaxial-line sections 12 and 12', the spring member 24 is compressed between the conductive collars 30 and 31 at the inner ends of the respective plugs 4 and 7. No further support for the spring member 24 is needed, since this is furnished by the plugs 4 and 7 of the male connectors 1 and 3.

The structure as thus far described provides an excellent electrical and mechanical coupling between the coaxial-line sections 12 and 12'. It is necessary, however, also to solve the problem of avoiding the deleterious effects, before mentioned, of impedance discontinuities resulting from an impedance mismatch between the connectors 1 and 3 and the coupler 22, 24. The connectors 1 and 3 inherently have a higher capacity between their inner and outer conductors than exists along the coaxial transmission line iteself. This must be compensated for at the coupling between the connectors if impedance discontinuities are to be avoided. In accordance with the present invention, such substantial impedance discontinuities are avoided through proper dimensioning of the coupling member 24 in order to provided an increased series inductance in the center conductor formed by the coupled plugs 4 and 7 that shall compensate for the higher capacity of the connectors 1 and 3. As before indicated, sufficient turns are present in the intermediate portion 28 of the spring member 24 to provide adequate resiliency for mechanical and electrical connection between the inner-conductor plugs 4 and 7. One of the reasons for providing continuous terminal portions 26 and 27, indeed, resides in the fact that the resiliency is then limited to the region between the plugs 4 and 7, thus insuring a more satisfactory spring action than if the complete member 24 were resilient. By simultaneously selecting the appropriate diameter of the turns 28 and the appropriate number of turns, however, a predetermined amount of series inductance may be introduced in the series connection between the inner plug conductors 4 and 7. This series inductance may be made of the necessary value to compensate for the before-mentioned high capacity of the connectors 1 and 3, thus to match the impedance of the coupled connectors 1 and 3 to that of the lines 12 and 12'. Since the inductance contributed by the spring member 24 is the sum of the inductances of the terminal portions 26 and 27 and the inductance of the intermediate turns 28, it is important to reduce the inductance contribution at the terminal portions 26 and 27 in view of the fact that inductance is already contributed at the regions occupied by the terminal portions 26 and 27 by the plugs 4 and 7. This is another reason for rendering the terminal portions 26 and 27 continuous, so that they present a small inductance compared with that provided by the intermediate turns 28. It is then easy to effect the insertion of the necessary compensating series inductance merely through the design of the intermediate turns 28.

As a typical illustration, where conventional 75-ohm coaxial line connectors 1 and 3 are utilized having inner conductor plugs 4 and 7 about an eighth of an inch in diameter extending about three-eighths of an inch coaxially within the collars 8 and 9 from the insulating supports 6 and 5, the interiorly threaded collars 8 and 9 are customarily about $1\frac{1}{16}$ of an inch in diameter. An appropriate conductive tube 22 having the same thread pitch and number of threads per inch as the threads 10 and 11 of the collars 8 and 9 may have an outer diameter of substantially $\frac{5}{8}$ of an inch, an inner diameter of about $\frac{3}{8}$ of an inch and a length of about $1\frac{5}{32}$ inches. The helical spring 24 may have an inner diameter of about 0.175 inch and the terminal portions 26 and 27 may each be about $\frac{31}{64}$ of an inch in length. In order to provide not only sufficient resiliency but, also, the correct amount of series inductance to compensate for the high capacitance of the coaxial-line connectors 1 and 3, thereby to avoid substantial impedance discontinuity between the connectors 1 and 3, it has been found that substantially three complete turns of 0.032 inch wire, spaced apart over a distance of substantially $\frac{5}{16}$ of an inch, should be provided in the intermediate region 28. It is convenient to form the spring member 24 into the illustrated shape and then to dip the whole spring member into solder. The close-together turns at the terminal portions 26 and 27 become thus soldered together into low-inductance continuous conducting sheaths, whereas the intermediate turns 28 retain their spacing, serving as a relatively high inductance coil of the required predetermined value.

While the invention has been described in connection with 75-ohm connectors, it is clear that the same underlying principles may be applied equally to cable connectors of other impedance values and of other configurations. If all of the features of the present invention are not desired, other types of spring members may also be employed.

Further modifications will occur to those skilled in the art and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. A coaxial-line coupler for connecting together two male coaxial-line connectors each having an outer conductor and an inner-conductor plug insulated therefrom and extending coaxially within the same, the coupler comprising means for mechanically and electrically joining the outer conductors of the connectors, and a spring member of cross dimension larger than the cross-dimension of the plugs but smaller than the cross-dimension of the outer conductors, the spring member having two terminal portions providing a continuous conductive sheath for receiving the plugs of the connectors and an intermediate portion having turns spaced apart to provide resilience for the spring member, the turns of the intermediate portion being adjusted to permit the spring member to become compressed within the outer conductors between the plugs of the connectors when the connectors are joined together and simultaneously to present a predetermined value of series inductance in the connection between the plugs sufficient to compensate for the capacity of the connectors in order to prevent a substantial impedance discontinuity between the connectors.

2. A coaxial-line coupler for connecting together two male coaxial-line connectors each having an interiorly threaded collar adapted to contact the outer conductor of the connector and an inner-conductor plug insulated therefrom and extending coaxially within the collar, the coupler comprising an externally threaded conductive tube upon which the collars of the connectors may be threaded for mechanically and electrically joining the outer conductors of the connectors, and a helical spring member of cross dimension larger than the cross-dimension of the plugs but smaller than the cross-dimension of the conductive tube and of length greater than the length of the tube, the spring member having two terminal portions the turns of which are joined together to provide a continuous conductive sheath for receiving the plugs of the connectors and an intermediate portion the turns of which are spaced apart to provide resilience for the spring member, the turns of the intermediate portion being adjusted to permit the spring member to become compressed within the conductive tube between the plugs of the connectors when the connectors are threaded upon the tube and simultaneously to present a predetermined value of series inductance in the connection between the plugs sufficient to compensate for the capacity of the connectors in order to prevent a substantial impedance discontinuity between the connectors.

3. A coaxial-line coupler for connecting together two male coaxial-line connectors each having an interiorly threaded collar adapted to contact the outer conductor of the connector and an inner-conductor plug insulated therefrom and extending coaxially within the collar, the coupler comprising an externally threaded conductive tube upon which the collars of the connectors may be threaded for mechanically and electrically joining the outer conductors of the connectors, stops secured to the tube to limit the position of the collars thereupon, and a helical spring member of cross-dimension larger than the cross-dimension of the plugs but smaller than the cross-dimen-

sion of the conductive tube and of length greater than the length of the tube, the spring member having two terminal portions the turns of which are soldered together to provide a continuous conductive sheath for receiving the plugs of the connectors and an intermediate portion the turns of which are spaced apart to provide resilience for the spring member, the turns of the intermediate portion being adjusted to permit the spring member to become compressed within the conductive tube between the plugs of the connectors when the connectors are threaded upon the tube and simultaneously to present a predetermined value of series inductance in the connection between the plugs sufficient to compensate for the capacity of the connectors in order to prevent a substantial impedance discontinuity between the connectors.

4. A 75-ohm coaxial-line coupler for connecting together two male 75-ohm coaxial-line connectors each having an interiorly threaded collar substantially $11/16$ of an inch in diameter adapted to contact the outer conductor of the connector and an inner-conductor plug about $1/8$ of an inch in diameter insulated therefrom and extending about $3/8$ of an inch coaxially within the collar, the coupler comprising an externally threaded conductive tube substantially $5/8$ of an inch outer diameter, $3/8$ of an inch inner diameter, and $1 5/32$ inches in length, upon which the collars of the connectors may be threaded for mechanically and electrically joining the outer conductors of the connectors, and a helical spring member substantially 0.175 inch inner diameter, the spring member having two terminal portions each substantially $31/64$ of an inch long providing a continuous conductive sheath for receiving the plugs of the connectors and an intermediate portion having substantially three turns of substantially .032 inch wire spaced apart over a distance of substantially $5/16$ of an inch to provide series inductance in the connection between the plugs sufficient to compensate for the capacity of the connectors in order to prevent a substantial impedance discontinuity between the connectors.

5. A coaxial-line coupler for connecting together two male coaxial-line connectors each having an outer conductor and an inner-conductor plug insulated therefrom and extending coaxially within the same, the coupler comprising means for mechanically and electrically joining the outer conductors of the connectors, and a spring member of cross dimension larger than the cross dimension of the plugs but smaller than the cross dimension of the outer conductors, the spring member having two terminal portions for receiving the plugs of the connectors and an intermediate portion having turns spaced apart to provide resilience for the spring member, the turns of the intermediate portion being adjusted to permit the spring member to become compressed within the outer conductors between the plugs of the connectors when the connectors are joined together and simultaneously to present a predetermined value of series inductance in the connection between the plugs sufficient to compensate for the capacity of the connectors in order to prevent a substantial impedance discontinuity between the connectors.

6. Apparatus of the character described comprising two male coaxial-line connectors each having an outer conductor and an inner-conductor plug insulated therefrom and extending coaxially within the same providing a predetermined capacity, means for mechanically and electrically joining the outer conductors of the connectors, and a spring member of cross dimension larger than the cross dimension of the plugs but smaller than the cross dimension of the outer conductors, the spring member having two terminal portions providing continuous electrically conducting sheaths for receiving the plugs of the connectors and an intermediate portion having turns spaced apart to provide resilience for the spring member, the turns of the intermediate portion being adjusted to permit the spring member to become compressed within the outer conductors between the plugs of the connectors when the connectors are joined together and simultaneously to present a predetermined value of series inductance in the connection between the plugs sufficient to compensate for the said predetermined capacity of the connectors in order to prevent a substantial impedance discontinuity between the connectors.

References Cited in the file of this patent

UNITED STATES PATENTS

1,852,190	Roe	Apr. 5, 1932
2,425,834	Salisbury	Aug. 19, 1947
2,449,983	Devol	Sept. 28, 1948
2,451,413	Robinson	Oct. 12, 1948
2,716,202	Little	Aug. 23, 1955
2,732,534	Giel	Jan. 24, 1956

FOREIGN PATENTS

1,047,285	France	Dec. 14, 1953