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A. H. WAITE, JR
COAXIAL CABLE COUPLING

2,615,953

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2 SHEETS—SHEET 1

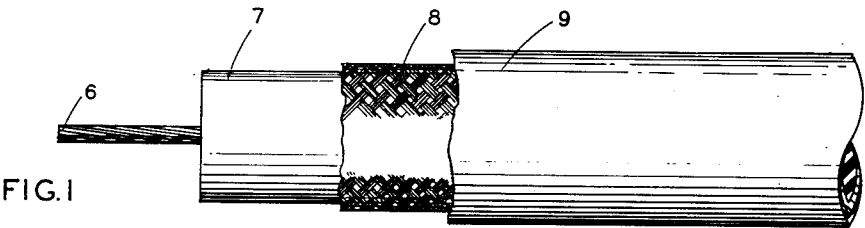


FIG. 1

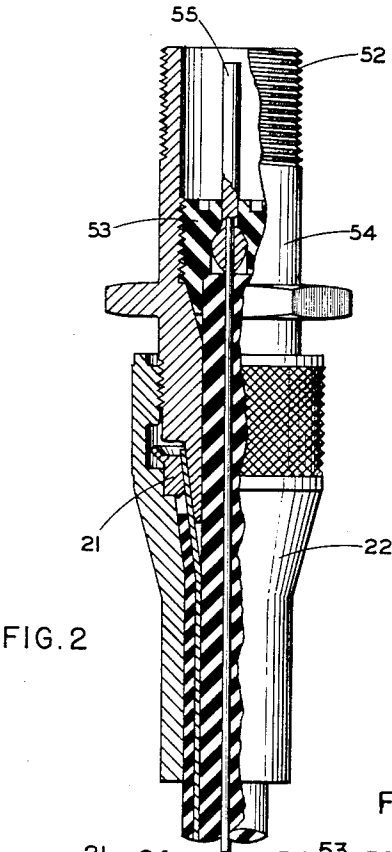


FIG. 2

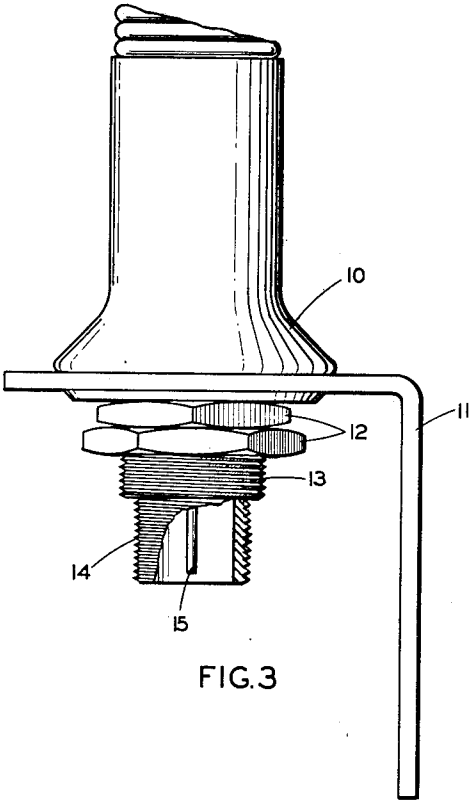


FIG. 3

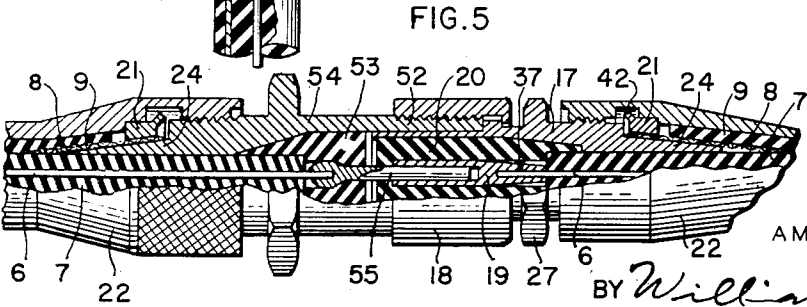


FIG. 5

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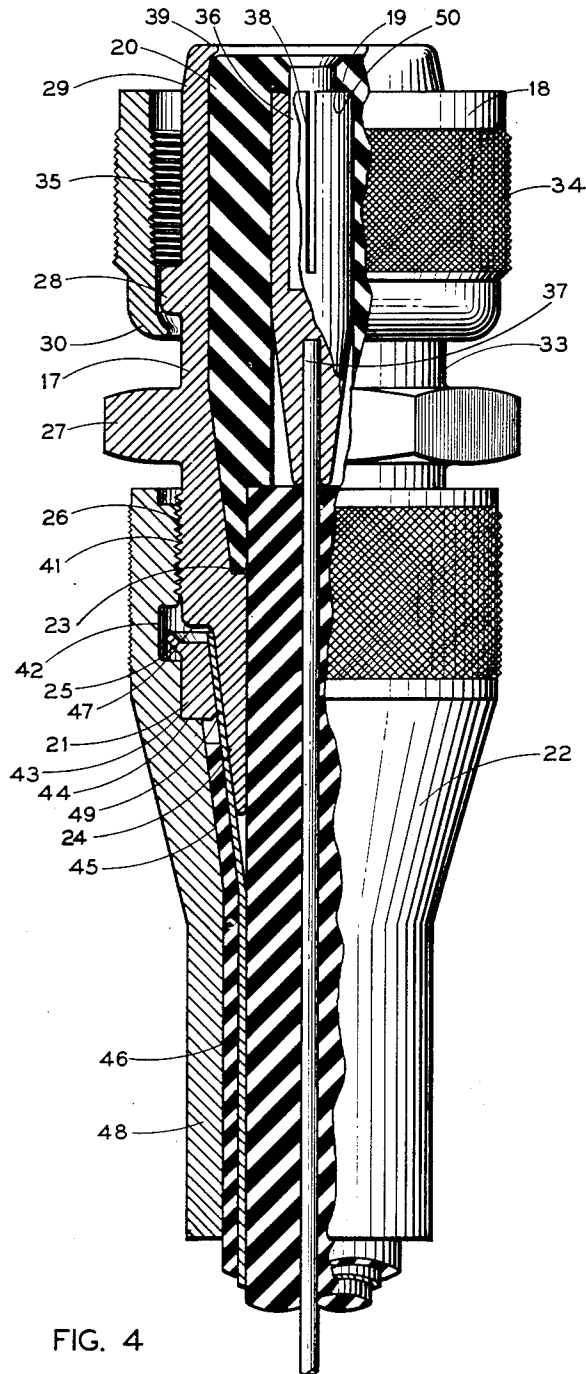
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2 SHEETS—SHEET 2



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COAXIAL CABLE COUPLING

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5 Claims. (Cl. 174—88)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The present invention relates to improvements in electrical connectors, and more particularly to an improved coupling means adapted for use with flexible coaxial cable.

The need for a simple and efficient coupling device for coaxial cable has become more pronounced with the increase in the application of high frequency currents to communications and other fields. For example, in mobile radio apparatus mounted in tanks, trucks, and the like, the antenna mast is made flexible so that it will give and bend readily when meeting obstructions such as low branches of trees, etc. In order to withstand frequent bendings, such antenna masts must be of strong construction, and the parts associated with the antenna masts must also be of strong and secure construction. This is especially true of the plug for connecting, to the antenna mast, a coaxial cable leading to the radio apparatus.

One type of coaxial cable employed for connecting an antenna mast to a radio apparatus comprises a center conducting core of stranded wire surrounded by a thickness of solid, flexible, high insulation material, which in turn is surrounded by a copper braid, the entire structure having an outer cover of vinyl resin insulation material. There have been many types of connectors and plugs designed and made for the purpose of connecting such cable to another plug, line, or similar cable. Heretofore, it has been generally necessary to apply solder to the outer conducting sheath, resulting in a heating and consequent highly undesirable deformation and even melting of the inner dielectric, as well as entailing additional time and trouble in the application of such device. Another property of the earlier connectors which led to the deformation of the inner dielectric was the excess pressure applied thereto in order to properly retain the coaxial cable. Further, there are present, in the earlier connectors, sharp discontinuities in electrical characteristics as well as abrupt corners in the path of the radio frequency currents, both of which cause excessive losses, due to the formation of frequent discharges and breakdown, and excessive heat.

An object of this invention is to provide an easily applicable coupling member for flexible coaxial cable wherein said coupling member presents a minimum of electrical discontinuity and points of breakdown.

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A further object of the present invention is to provide a coupling for splicing flexible coaxial cable wherein the inner dielectric of the cable will not be deformed, and a good electrical and mechanical connection will be secured between both the corresponding outer conductors and inner conductors of the spliced cables, as well as between the cable and connector.

Another object of this invention is to provide a coupling device for flexible coaxial cable, which device is sturdy, simple and efficient, and which may be properly applied with maximum ease.

Broadly, the invention comprises a pair of telescoping tubular members having confronting surfaces, at least one of said surfaces being tapered, whereby a flexible conducting sheath or an insulating cover or both may be securely engaged between the mentioned surfaces and whereby the aforesaid surfaces may have the perpendicular distance between them changed by relative longitudinal movement of the tubular members.

More specifically, the improved connector consists of a body member or sleeve having a smooth inner face and a frusto-conically shaped end, a clamp ring with a tapered inner surface, and a locking collar preferably having part of its inner wall tapered, and having a recess for receiving the ring and means for engaging the sleeve. The clamp ring is essentially a shoulder on the locking collar, but is made separate in order that it need not rotate against a clamped conductor when the locking collar is screwed home on the body sleeve. Additional members are provided for engaging and spacing the inner conductors of the cable or line and for properly securing the connector to a desired plug or the like. The connector is applied by cutting the various layers of the coaxial line to properly predetermined offset positions, placing the inner conductor and dielectric into the sleeve, inserting the conical end of the sleeve between the sheath and inner dielectric, and employing the clamp ring and the collar member for securing the conducting sheath and outer insulating cover to the inner sleeve member. By positioning an apertured rod on the inner conductor, the combination is in condition for being conveniently applied to a properly prepared plug or the like.

The various features of the invention will be understood more fully from the following detailed description and the illustrative embodiments shown in the accompanying drawings.

Figure 1 is a side view of a flexible coaxial cable of well known type, showing the various layers forming the cable.

Figure 2 is a side view, partially in section, of

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an embodiment of the improved connector shown applied to a coaxial cable.

Figure 3 is a side view of an antenna mast base with the coaxial socket shown partially broken away.

Figure 4 is a side view partially in section of the preferred embodiment of the invention.

Figure 5 is a longitudinal section of a connection between two cable ends.

Referring to the drawings, and more particularly to Figure 1, there is illustrated a flexible coaxial cable formed of an inner conducting core of stranded wire 6, a surrounding dielectric 7, an outer sheath 8 of braided conducting material and an insulating pliable cover 9. It is often necessary to join a coaxial cable to a concentric type of socket so that the inner conductor 6 is in electrical contact with an inner conductor of the socket and the sheath 8 is in contact with an outer portion of said socket.

In Figure 3, a mast base 10 is shown secured to a bracket 11 by means of nuts 12 and threaded extension 13, said bracket 11 being positioned on a tank, or other vehicle. Depending from extension 13 is socket member 14 having concentric therewith a rigid conducting member 15. The lower outer surface of said socket member 14 is threaded for the purpose of engaging a connector plug or the like.

The present invention is utilized for electrically and mechanically securing a coaxial cable to a socket similar to that heretofore shown.

Referring to Figure 4, the improved connector consists specifically of an inner body or sleeve member 17, a coupling collar 18, an inner sleeve-like conductor connector 19, an insulating separator 20, a clamp ring or annulus 21 and a locking collar 22. The inner surface of the sleeve 17 is of circular cross section, being of uniform diameter for a substantial part of the length of said sleeve, thence tapering inwardly at an angle of approximately $7\frac{1}{2}^\circ$ to the axis of the connector. It has been found that this angle results in a minimum of reflection and consequent losses. This taper extends to the inwardly projecting shoulder 23 and a bore surface thence extends uniformly to the inner end of the sleeve 17. The outer surface of member 17 has the inner end thereof tapered to form the frusto-conical portion 24, which has its extremity tapered to very thin material, but having a rounded terminal edge, the base of the conical portion extending radially outwardly to form an annular shoulder 25. The sleeve thence continues rearwardly and has formed on its outer surface, in the following order: A threaded portion 26, hex-nut 27, annular projection 28 (a resulting channel 33 being thus formed between the projection 28 and hex-nut 27), and the uniform extension 29 which has its extremity 39 inwardly swaged.

Rotatably and slidably secured to the sleeve member 17 is the coupling collar 18 having an inwardly projecting retaining flange 30 extending into the channel 33, a knurled outer surface 34 and an inner threaded portion 35.

The inner conductor connector 19 is a rod-shaped member having its rearward end tapered at the same angle before mentioned and having bores 36 and 37 axially formed therein. As one result of the taper the wall of the bore 37 at the rearward end is very thin, and its extremity is also rounded, as illustrated. The bore 36 has a diametrically positioned slot 38 extending the length of said bore, whereby the surrounding walls may be resiliently sprung. Slidably en-

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gaging connector 19 is the insulating separator 20 which is secured within the sleeve 17 by means of swaged outer end 39 and internal shoulder 23 formed on said sleeve. The outer surface of separator 20 is of the same contour as the inner surface of the sleeve 17 between the shoulder 23 and swaged end 39. The separator 20 is provided with a longitudinal bore having a recess of enlarged diameter at the tapered end thereof and a reduced diameter, so as to form the shoulder 50, at the opposite end. The separator 20 is made of a low-loss dielectric, such as polystyrene or the like.

The locking collar 22 has formed, on the forward portion of its inner face, an internal thread 41 which is adapted to engage the external thread 26 of sleeve 17. Extending rearwardly of thread 41 are the annular internal groove 42, ledge 43, seat shoulder 44 and the tapered and uniform portions 45 and 46 respectively. The taper 45 is of the same slope as the taper of the frusto-conical portion 24 of sleeve 17 and the inner surface 46 of the tubular extension 48 has a diameter equal to the outer diameter of the insulation of the coaxial cable with which the connector is to be employed.

The forward outer portion of the collar 22 is knurled and the remainder of the said outer surface may take any convenient shape, and in the present device follows the general contour of the inner surface.

Positioned within collar 22, beyond the threaded portion 41 thereof, is the clamp ring or annulus 21 which is seated on shoulder 44 and has a flaring flange 47 extending into the groove 42 of collar 22, the clamp ring thus being retained within the collar when the coupling parts are disengaged. The inner surface 49 of the clamp ring 21 is tapered at the same slope as the frusto-conical surface at 24 of the sleeve 17.

In applying the improved connector to a coaxial cable, the various components of the cable are cut to the offset positions substantially as shown in Figure 1. The connector 19 is held so that the bore 37 faces upwardly and molten solder is poured therein. The core 6 of the coaxial cable is then inserted into bore 37 and it is thus apparent that a minimum of heat will reach the inner dielectric 7.

Thereafter the coaxial cable is inserted into the collar member 22, and connector 19 is forced into the bore of separator 20 until the forward end of said connector abuts the projecting shoulder 50. The cable has been so cut that the inner dielectric 7 will abut the shoulder at the inner end of the enlarged recess of the separator 20 and will snugly fit within the recess of the separator. During the aforesaid positioning of the coaxial cable, the frusto-conical portion 24 of the sleeve 17 is inserted between the inner dielectric 7 and the conducting sheath 8. It should be noted that the tapered portion 24 of the sleeve 17 is surrounded at its wider part only by the outer conducting sheath 8, and at its terminal portion by both the outer conductor sheath and the insulating cover 9 of the coaxial cable. Collar member 22 is then screwed onto the sleeve 17, shoulder 44 of said collar member forcing the clamp ring 21 toward the wider end of the frusto-conical portion 24, resulting in a secure engagement of the conducting sheath 8 between the outer surface of the conical portion 24 and the inner surface of the clamp ring 21. The outer insulating cover 9 of the cable, as well as the conducting sheath 8, is firmly engaged between the surface of the nar-

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lower end of the tapered portion 24 and the inner sloped face 45 of the collar 22. The tubular extension 48 prevents excessive bending of the cable in the vicinity of the joined portions. In coupling the connector of Figure 4 to a socket similar to that shown in Figure 3, a pin 15, having a diameter which will permit a snug fit into the bore 36 of conductor connector 19, is secured to the inner conductor of said socket. This may be done by providing the pin 15 with an axial aperture, and, by means of solder, securing said pin to the inner conductor of the socket. The connector is then brought into engagement with the socket so that the pin 15 will pass through the opening in the separator 20 and into frictional fit with conductor connector 19. The coupling collar 18 engages the outer threaded portion of the socket and retains the connector properly secured.

As it is often necessary to join or splice the ends of two lengths of flexible coaxial cable, a slight modification as shown in Figure 2 will permit such utilization of the connector. In this embodiment the collar 22 and clamp ring 21 are similar to the collar and ring of the above described connector, whereas the inner sleeve member 54 differs from the sleeve 17 of Figure 4 only in that the outer surface of the forward portion (corresponding to socket 14 of Fig. 3) has a thread 52 formed therein and is not supplied with a coupling collar 18 nor the corresponding engaging groove 33. A dielectric separator 53 is screw engaged into an enlarged bore formed in the sleeve 54. The separator 53 has a longitudinal opening therethrough, one end of which is of such size as to snugly engage the outer surface of the inner dielectric 7 of a flexible cable, the other end being so formed as to frictionally engage a connector pin 55 (corresponding to the one 15). Connector pin 55 has an enlarged head at the inner end thereof, which head has no abrupt change in surface and is provided with an axial bore which is adapted to engage the core 6 of the coaxial cable. The other end of the pin 55 extends substantially to the end of the sleeve member 54. The connector just described is applied to a coaxial cable in a manner similar to that utilized in the earlier described embodiment.

It is apparent that the front end of the afore-said connector (at the top in Fig. 2) is of the same general structure as the socket (14 in Fig. 3) of the antenna mast to which the connector (Figure 4) earlier described was attachable and, as such, said connector of Fig. 2 may be coupled to such latter connector of Fig. 4, as shown in Fig. 5.

There have been shown preferred embodiments of the present invention but it is obvious that numerous changes and omission may be made without departing from the spirit thereof.

I claim:

1. A connector for coaxial cable, comprising a sleeve member having the outer surface of one end thereof tapered and being externally threaded inwardly of the tapered part, means positioned at its other end to couple the sleeve to an outer conductor of an inserted coaxial line, a longitudinally bored dielectric spacer within said sleeve, concentric means within the spacer to connect with the inner conductor of an inserted coaxial line, an internally threaded locking collar adapted to receive the tapered end of said sleeve member free therewithin and to engage the thread on said sleeve member, said locking collar having a concentric annular groove

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formed on its inner surface positioned so as to surround the tapered end of the sleeve member, and a clamp ring rotatably fitted within said locking collar and having an extended flange projecting into and loosely disposed in said annular groove, said inner surface of the locking collar at both sides of the groove being of less diameter than the outer diameter of said flange, said clamp ring having an inner surface confronting the tapered surface of the sleeve member and said two surfaces named being arranged and adapted to clamp therebetween the outer conductor of a coaxial cable end inserted in the locking collar at a locking position of the locking collar on said sleeve member.

2. A connector as claimed in claim 1, wherein the locking collar has a portion of its inner surface tapered to the contour of and located over a part of said tapered end of the sleeve member beyond said groove, and is positioned for wedging on an interposed end of cable insulation.

3. A connector of the character described comprising a sleeve member having a taper formed at one end thereof and an adjacent external thread thereon, an internally threaded coupling collar rotatably connected to the other end of the sleeve, a tapered locking collar engaged slidably and revolvably around the tapered end of the sleeve engageable with the first named threads of the latter and having an internal concentric groove longitudinally outwardly of said threads and over the larger diameter tapered part of the sleeve, a clamp ring having an outwardly projecting flange permanently engaged in said groove for limited longitudinal lost motion within the locking collar and adapted to engage and clamp the outer conductor of a coaxial cable end against the larger tapered part of the sleeve, a longitudinally bored dielectric spacer positioned within the sleeve at the end opposite the tapered part, and a rod-shaped inner conductor slidably fitted within the dielectric spacer and withdrawable therefrom in the direction of said tapered part, said inner conductor having a cavity formed in at least the end adjacent said tapered part of the sleeve adapted to permanently engage with the axial conductor of a coaxial cable end, the other end of said inner conductor being bored to slidably and separably engage around an axial conductor terminal of an opposed coaxial connector.

4. The structure of claim 3, constituting a first connector; and a second connector comprising a sleeve as in claim 3, a locking collar, clamp ring, and dielectric spacer fixed in the sleeve as in claim 3, said sleeve of the second connector being extended beyond the said dielectric spacer at the end distant from the tapered part with an internal diameter to receive the corresponding end of the sleeve of the first connector slidably therein and being exteriorly threaded on said extension to engage the internal threads of said coupling collar of the first connector, an inner conductor slidable in said spacer of the second connector having a recess therein adjacent the taper of said sleeve to receive permanently the end of the inner conductor of a coaxial cable line end opposed to one engaged in the first connector, the last named inner conductor of the second connector having its medial and end portion opposite the recessed end shaped as a plug member slidable in the spacer and withdrawable therefrom in the direction of the tapered part of the sleeve of the second connector, said plug member being slidably and snugly insertable in

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the said bored end of the inner conductor of the first connector when said first and second connectors are presented end-to-end with coaxial cable ends coengaged therewith as described.

5. A connector for coaxial cable made up of an axial inner conductor, a dielectric surrounding said conductor, a coaxial conductor and an outer compressible rubber-like insulation surrounding the coaxial conductor, comprising a sleeve member having an internal diameter approximately the same as the inner diameter of the outer conductor of the said cable and having a taper termination at one end for penetrating insertion in an end of said coaxial cable line under the outer conductor of the line and including a body part with threads intermediate the ends of the sleeve, a tapped locking collar surrounding said tapered end and interiorly threaded at its inner end to engage the intermediate threads of said sleeve member, said locking collar having an internal concentric groove arranged to lie about the larger tapered part of said sleeve, a clamp ring within the collar and about the larger tapered part of the sleeve and having a circumscribing outwardly projecting flange permanently loosely engaged in and longitudinally movable within the groove, said locking collar having an annular seat shoulder of reduced diameter positioned to engage directly against the side of said ring opposite the body of the sleeve when the threads of the locking collar and said sleeve are coengaged, so as to press the ring into clamping relation to an end portion of the outer conductor of a coaxial cable when laid over and around the said larger tapered part, said locking collar hav-

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ing a tapered internal surface longitudinally beyond said groove over and around the smaller portion of said tapered part of the sleeve so as to compress a coaxial cable outer insulation against said outer conductor when laid over and around said smaller portion of the tapered part longitudinally beyond said ring when the latter is under compression between said seat shoulder and said outer conductor of a cable end, a longitudinally bored dielectric spacer fixed concentrically within said sleeve and stopping short of said tapered part, and an axial conductor member slidably engaged in the bore of the spacer withdrawable therefrom in the direction of the tapered part of the sleeve and adapted to permanently receive the end of the inner conductor of a coaxial cable line end inserted in the connector.

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