May 23, 1967 E. W. FORNEY, JR 3,321,732

CRIMP TYPE COAXIAL CONNECTOR ASSEMBLY

Filed May 14, 1965 3 Sheets-Sheet 1

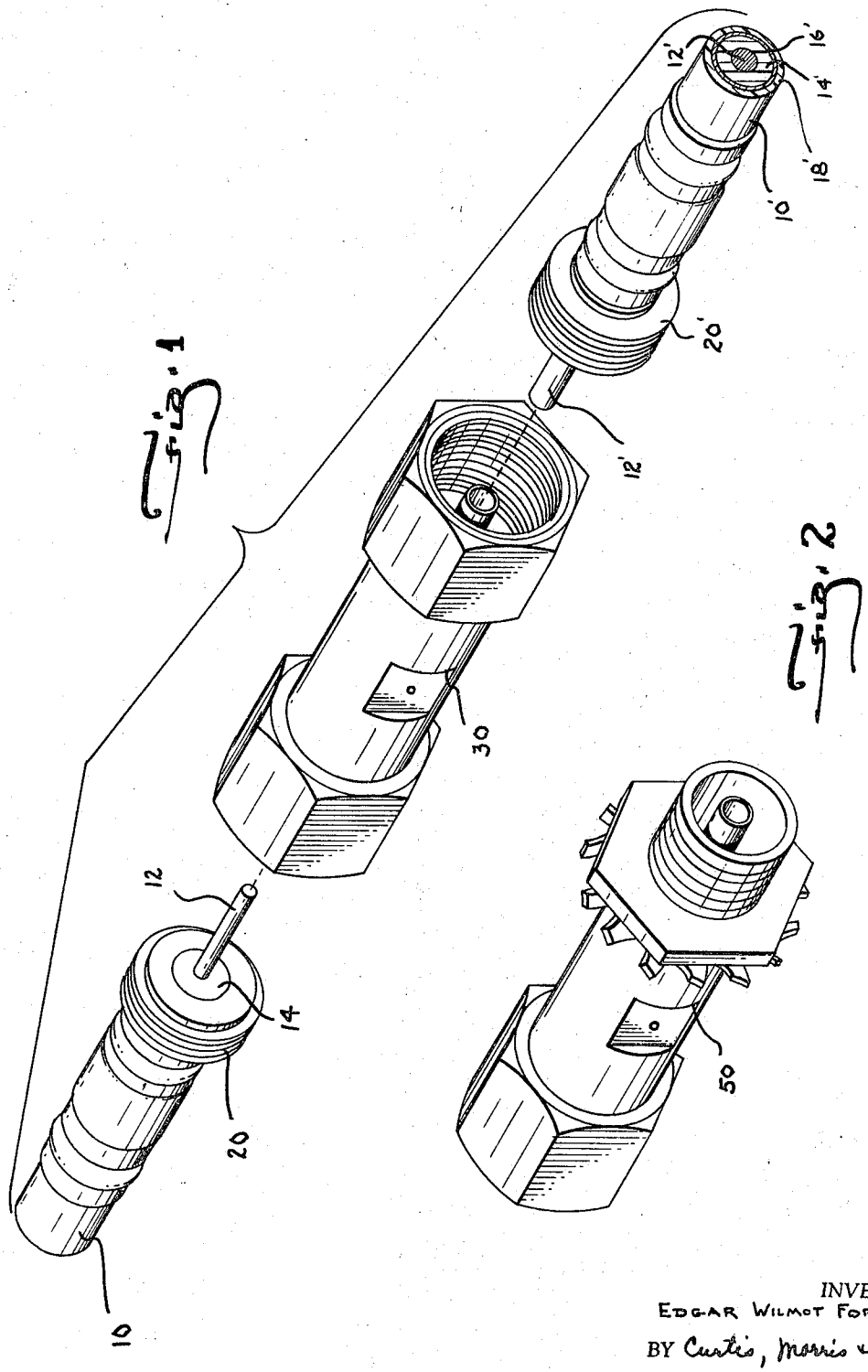


Fig. 1

Fig. 2

INVENTOR.
EDGAR WILMOT FORNEY, JR.
BY Curtis, Morris & Safford

May 23, 1967 E. W. FORNEY, JR 3,321,732

CRIMP TYPE COAXIAL CONNECTOR ASSEMBLY

Filed May 14, 1965 3 Sheets-Sheet 2

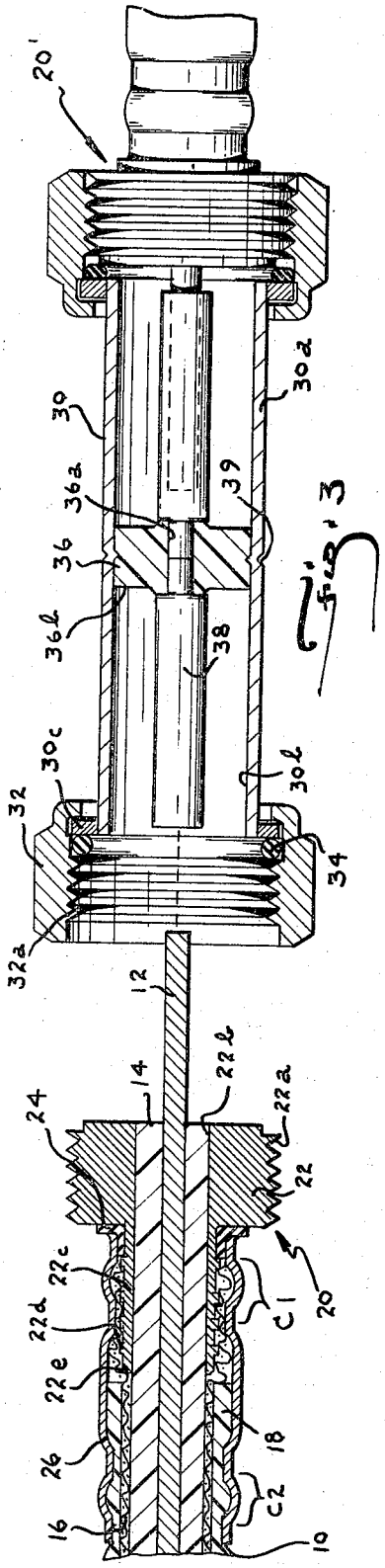


Fig. 3

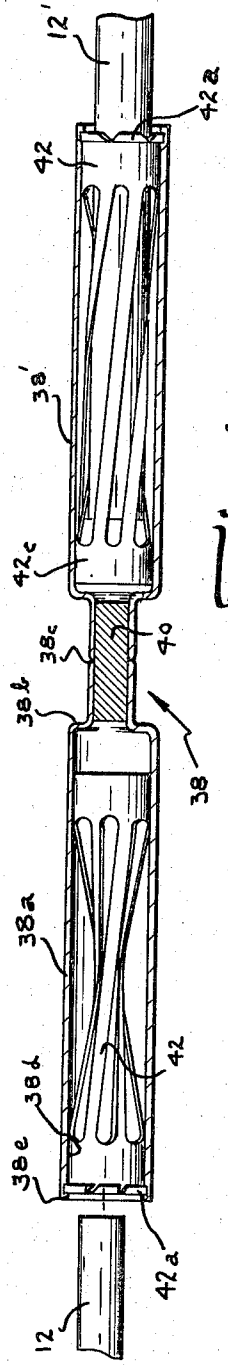


Fig. 4

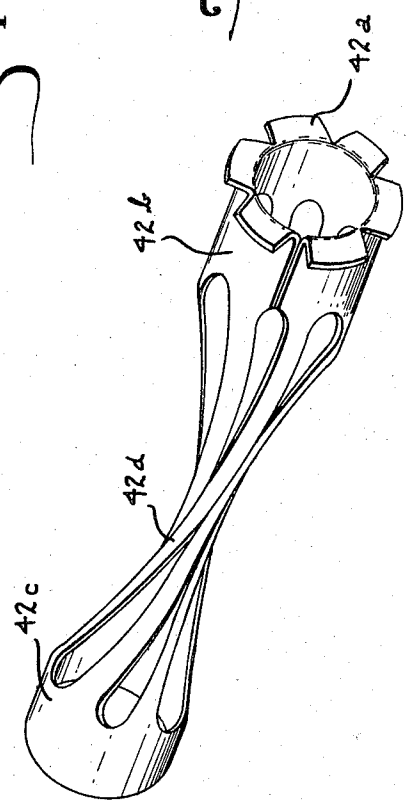


Fig. 5

INVENTOR.
EDGAR WILMOT FORNEY, JR.
BY Curtis, Morris & Safford

May 23, 1967 E. W. FORNEY, JR 3,321,732

CRIMP TYPE COAXIAL CONNECTOR ASSEMBLY

Filed May 14, 1965 3 Sheets-Sheet 3

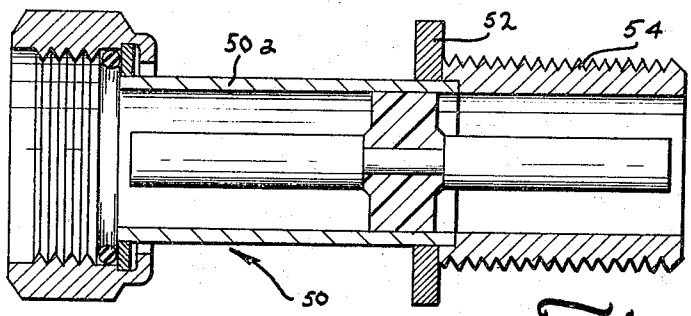
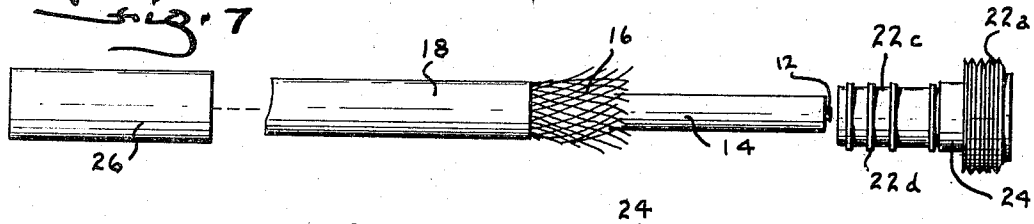


Fig. 6

Fig. 7



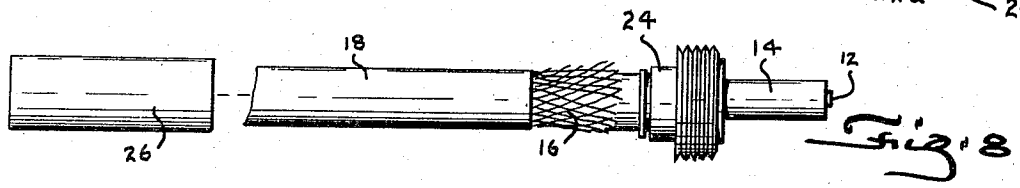
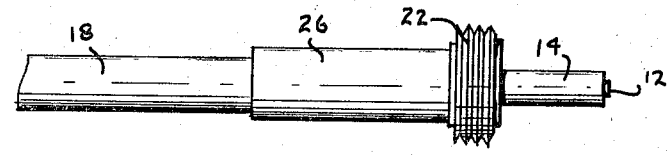


Fig. 8

Fig. 9



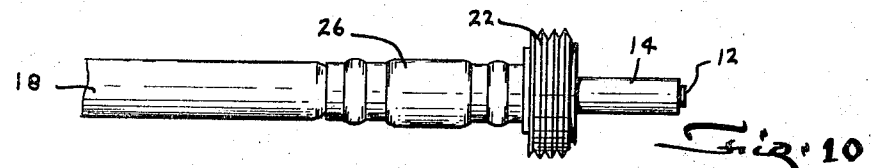


Fig. 10

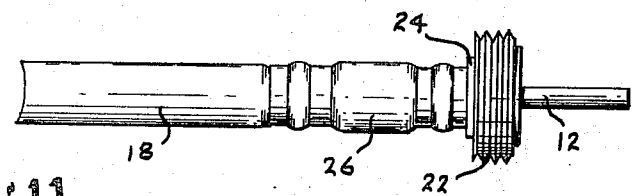


Fig. 11

INVENTOR.
EDGAR WILMOT FORNEY, JR.
BY Curtis, Morris + Safford

United States Patent Office 3,321,732 Patented May 23, 1967

3,321,732

CRIMP TYPE COAXIAL CONNECTOR ASSEMBLY

Edgar Wilmot Forney, Jr., Harrisburg, Pa., assignor to AMP Incorporated, Harrisburg, Pa.

Filed May 14, 1965, Ser. No. 455,819
4 Claims. (Cl. 339—89)

This invention relates to crimp type coaxial connector assemblies of the type adapted to serve cable utilized to transmit television signal frequencies and the like.

The Community Antenna Television (CATV) Industry has developed a variety of equipment adapted to supply consumers with improved television signal reception. In practive a CATV service company constructs a rather elaborate antenna tower in a location which is optimum for signal reception with respect to various television station complexes, usually large cities. From this central tower antenna the company installs a network of transmission lines routed into the various communities nearby. For a fee and service charge the company then provides tap-offs or drop lines from the transmission line network to individual consumers. In this way an individual consumer may receive a variety of high quality channels from a high quality antenna and network far beyond his means as an individual to support.

The most expensive part of a CATV system is the network of lines and cables connecting a central antenna to the various consumers with a good part of the expense going to cable connectors and installation labor. One reason for this is that the cable utilized must be high quality coaxial cable capable of, in certain instances, transmitting television signals without signal degradation over substantial distances to several hundred or thousand consumers. For what might be termed trunk transmission the cable employed takes the form of a "semi-rigid" construction employing a solid or tubular copper center conductor supported by a dielectric material within a relatively heavy aluminum outer sheathing which forms the cable outer conductor. For branch lines a smaller flexible cable is frequently employed which has a solid copper center conductor surrounded by foam dielectric material and a corrugated shield surrounded by a relatively heavy, tough, protective outer sheathing of flexible and insulating material. The usual consumer drop line cable consists of a solid copper inner conductor surrounded by foamed dielectric material and a heavy copper braid surrounded by a tough and flexible insulating outer sheath. For reasons of economy, the cable network is worked out to the individual consumer with these various cables being reduced in diameter in accordance with power requirements, and it has been the practice to manufacture connectors in various sizes to accommodate the different sizes of cable. One of the problems has been that connectors designed in accordance with the prior art are of a configuration wherein few, if any, of the same parts of a connector for one size cable may be employed with a connector for a different size cable. For example, in one of the most frequently used connector designs of the prior art the mechanical connection to the cable is accomplished through a split wedge ring axially driven by threaded nut having surfaces therein to engage the ring and compress such to clamp the cable and including a forward connector portion mating with a nut. The ring, nut and forward portion of the connector are generally suitable for only one size of cable. This same problem is also encountered in the connector devices used to terminate cable, such as for inputs and outputs for various amplifiers, couplers and taps distributed along the transmission line network.

Still another problem affecting the connection and termination of CATV type cables is one of labor. While television signals are only on the order of 215 megacycles, the frequency involved is still sufficiently high to make it necessary to maintain the conductive portions of the connector device employed in careful alignment to prevent discontinuities and large losses in the transmitted signal. This means that skilled labor must be employed with great care being taken in the assembly of the connector to the cable. The relative complexity and large number of parts of connectors and terminals utilized with CATV installations adds to this problem and to the amount of time necessary for each connection or termination.

Accordingly, it is one object of the present invention to provide a coaxial connector and terminal assembly adapted to accommodate a range of cable sizes and constructions with the same structure. It is another object to provide a connector and terminal assembly for coaxial cable having few parts and requiring little skill in assembly. It is a further object of the invention to provide a connector and terminal assembly for use with coaxial cable which itself becomes a part of the assembly tooling and to provide a method of connection and termination for coaxial cable utilizing the connector parts as tooling. It is a general object of the invention to provide a universal connector and terminal assembly for coaxial cables of a design and construction reducing the average cost per installation on coaxial cable.

The foregoing objectives are obtained in the present invention through the use of a receptacle adapted to receive the center conductor of a range of coaxial cable sizes which may be simply inserted therein. To mechanically and electrically connect to the cable and its outer conductor, a mating plug member is provided which is crimped to the cable outer conductor and which supports the center conductor and dielectric core in a manner continuous with the cable. The receptacle of the invention includes a double-ended contact sleeve carrying a spring capable of receiving a range of conductor diameters with the sleeve being coaxially mounted in the receptacle in a manner matching the receptacle impedance to that of the line. The plug of the invention is arranged so that it may be used in conjunction with the stripping preparation of the cable through a method adapted to facilitate cable termination. In the practice of this method the cable is partially stripped, inserted into the plug member of the invention, crimped and then further stripped to the final form for use in the receptacle of the invention.

In the drawings:

FIGURE 1 is a perspective view showing the connector receptacle of the invention and two plug members positioned for insertion therein to terminate different sizes of cable;

FIGURE 2 is a perspective of the receptacle of the invention in a terminal embodiment;

FIGURE 3 is a longitudinal section of the receptacle of the invention having one plug member carrying one cable size fitted therein and another plug member termi-

nated to a cable shown in section, positioned for insertion within the receptacle;

FIGURE 4 is an enlarged longitudinal section view of the center conductor sleeve of the receptacle of FIGURE 3;

FIGURE 5 is an enlarged perspective of one of the contact springs utilized in the sleeve assembly of FIGURE 4 and the connector receptacle of FIGURE 3;

FIGURE 6 is a longitudinal section of the terminal receptacle of the invention shown in FIGURE 2; and

FIGURES 7–11 are views showing the assembly procedure and method of the invention utilizing the plug member to facilitate a termination of the cable.

Referring now to FIGURE 1 there is shown a connector assembly **30** adapted to interconnect cables **10** and **10'** of different power capacities and geometrics. These cables have essentially the same construction with differently sized inner and outer conductors to adjust the cable impedance to some standard impedance such as seventy-five ohms. Viewing the two cables **10** and **10'**, the center conductors **12–12'** are of solid copper rod coaxially supported and surrounded by a dielectric filling **14–14'**, typically of foamed dielectric material; an outer conductor shown with respect to cable **10'** as **16'**, typically a braid of flat copper strips and an outer protective and insulating sheathing **18'**. The cable **10'** may be considered as a secondary trunk or distribution cable and the cable **10** may be considered as a drop line to a single consumer of CATV service. As can be seen the center conductor **12'** is substantially larger than the center conductor **12**. The outer conductors and spacing between the conductors of the cables are also different. It is this difference which represents a problem in termination and which has caused prior art devices to turn to assemblies which can only be employed to terminate one set or pair of differently sized cables.

The invention assembly for performing a connection of the cables **10** and **10'** is, as shown in FIGURE 1, comprised of a receptacle **30** adapted to receive and mechanically and electrically connect to plug members **20** and **20'** individually terminated to the respective cables. To accomplish a termination of one of the cables to equipment such as to an amplifier or to the consumer receiver or to accomplish a connection through a bulkhead, the receptacle assembly may take the form shown in FIGURE 2, as assembly **50**, which is similar to **30** with the addition of structure to accommodate a bulkhead or box fitting. The assembly **50** thus includes a receptacle on one end and a plug and receptacle structure on the other end. A plug like that of **20** is utilized with **50** with the addition of a threaded nut fitted over the end thereof generally in the manner to be described with respect to the nut structure of the assembly **30**.

Referring now to FIGURE 3, a more detailed description of the assembly of the invention will now be given. The plug member shown as **20** as terminated to the cable **10** is comprised of but three parts; a metallic plug body **22** having an integral extension to fit beneath the cable outer conductor **16**, a gasket **24** and an outer ferrule **26** adapted to be crimped in two spaced regions as shown by the numerals C–1 and C–2 from a generally cylindrical configuration as shown in FIGURE 7. The plug body **22** has a forward relatively heavy portion having a series of threads **22***a* along the outer surface thereof and having a bore of constant diameter **22***b* extending therethrough. The bore **22***b* also extends through an integral sleeve extension **22***c* and is of a diameter adapted to receive and support the dielectric sheath **14** of the cable. The outer surface of the extension **22***c* includes annular projecting rings shown as **22***d* which serve to lock the surface to the outer conductor of the cable upon crimping and to break up oxides further improving the connection of the outer conductor to the body of the plug. The outer end of the extension **22***c* is terminated in a beveled end portion **22***e* which serves to facilitate insertion of the extension within braid or outer conductor of the cable. The extension **22***c* is made sufficiently rigid and deformation resistant to permit the crimping operation to be described hereinafter without constriction of bore **22***b*. The gasket **24** is positioned overlying extension **22***c* at the point of junction with the body of **22**. This gasket is made sufficiently resilient to be compressed by the forward portion of crimp C–1 during the crimping operation to seal the connection at this point. The ferrule of **26** is of relatively thin malleable material slightly larger in its undeformed shape than the outer sheathing of the cable so as to fit thereover and to be crimped inwardly by the deformations C–1 and C–2 to mechanically and electrically join the cable to the plug. The spaced crimps of C–1 thus seal and join the cable outer conductor to the sleeve extension **22***c* and the crimps of C–2 grip and mechanically support the cable through compression of the outer sheath at a point displaced from the end of the extension. The deformations represented by C–1 and C–2 are preferably O shaped in cross section to grip the cable fully around its circumference and the deformation of C–2 is limited radially so as not to displace the outer conductor **16** to present a discontinuity in the cable at this point. It has been found useful to make the crimps as shown with a space between the points of deformation in each crimp to permit the bulging that is apparent from FIGURE 3. This reduces the force necessary to complete the crimp and at the same time permits some axial flow of materials within the budged portion to both serve as a seal and preclude undue inward deformation.

The opposing plug **20'** is substantially identical to the plug **20** with the exception of dimensions increased to accommodate the large cable **10'**. These changes in dimension do not include the forward outer diameter of the plug body and the outer threading of the plug which are the same in all plugs to fit within the same receptacle **30**. The dielectric of the cable is caused to extend fully through the bore of the plug to a point flush with the front face of the plug and the center conductor of the cable **12'** is permitted to extend outwardly from this forward face as shown in FIGURE 3. The assembly and installation of cable in a plug member will be described in greater detail hereinafter relative to FIGURES 7–11.

Again, referring to FIGURE 3, the connector receptacle of the invention is shown to be comprised of an outer sleeve **30***a* having a constant diameter bore **30***b*. The wall thickness of **30***a* is made sufficiently rigid to avoid bending in use and is typically made of a conductive material such as brass tubing. On each end of the sleeve **30***a* is a ring **30***c* welded, braized or otherwise affixed, which serves to secure a nut **32** having internal threading **32***a* adapted to cooperate with threading **22***a* of a plug. The nut assembly is the same on each end of the connector receptacle **30** as shown. Carried within each nut **32** is an O ring **34** of resilient material adapted to be driven in compression upon full insertion of a plug within the connector receptacle.

In the center of the receptacle sleeve **30***a* is a dielectric insert and support structure **36** which includes an internal bore **36***a* adapted to receive and hold coaxially of the sleeve bore a further sleeve carrying contact springs for engagement with the center conductors of cable. The insert **36** is preferably made in two halves or split so as to be fitted over the relieved center portion of **38** to captivate **38** upon being positioned within the sleeve **30***a*. After fitting, the insert is staked as indicated at **39** to trap the assembly and hold it against axial displacement. The insert is made sufficiently long to provide an adequate bearing area for holding the sleeve **30***a* and is made of a material sufficiently strong to prevent movement of **38** due to plastic flow. The insert **36** is further made of a dielectric material having dielectric constant and shape to match the portion in the center of **38** to the characteristic impedance of the lines; e.g., to seventy-five ohms.

The shaping shown at 36*b* is for the purpose of reducing or minimizing effective losses due to the change in conductor spacing at this point and is in accordance with the compensation technique disclosed in U.S. application S.N. 395,150 by John Fan, filed Sept. 9, 1964.

Sleeve **38** is duplicated on the opposite side of the connector receptacle by sleeve **38'** and the two sleeves are joined together in the center. Each sleeve includes as shown with respect to **38** an outer conductive sleeve portion **38***a* of considerable length, open at one end and reduced at the other end as at **38***b* to a smaller diameter portion welded as at **38***c* to the opposing sleeve. A copper plug **40** substantially filling the smaller sleeve portions and extending into each sleeve is provided to add rigidity to the joint of the sleeves and to increase the conductive material at the point of juncture of the sleeves. The reduction in diameter of the sleeves and the resulting faces **38***b* define surfaces permitting the insert to lock the sleeves against axial displacement. The inner bore of **38** as shown **38***d* is terminated at the end opposite to the joint of the sleeves by a recessed portion with end **38***e* of the sleeve turned inwardly to entrap portions of a spring member carried within the sleeve. This spring member is shown at **42** to include at one end outwardly displaced tabs **42***a*, a barrel portion **42***b* and spaced therefrom a barrel portion **42***c* with the barrel portions being joined by integral spring arms **42***d*, which are relatively flat in cross sectional configuration, but are bowed and twisted along the lengths thereof. The type of spring represented in FIGURE 5 is disclosed in greater detail in U.S. application, S.N. 286,725, filed in the name of Glenwood A. Fuller on June 10, 1963, now Patent No. 3,286,671. As mounted with the sleeve, the spring **42** is capable of being expanded radially in the center portions and axially at one end; namely, the free end or the barrel **42***c*. This expansion is depicted on the right side of FIGURE 4 where the conductor **12'** is shown as inserted within the sleeve and spring member. The basket type of spring is preferred since it permits a connection to be made with different diameter conductors inserted therein. In an actual embodiment having a configuration generally depicted in FIGURES 4 and 5, the spring member and sleeve quite adequately accommodated conductors ranging from No. 9 AWG through No. 14 AWG, or six sizes of center conductors. If it is desired to extend utility of the spring to even smaller sizes a conductive pin may be secured to the conductor **12** or **12'** having a forward diameter to fit within the basket spring. For most uses, however, it is preferred to utilize the structure shown in the drawings with an incidental saving in parts and in assembly time.

As an important point the amount of material utilized for the sleeve **38** and **38'** and their conductivity should be made such as to carry the currents involved in CATV systems. Additionally, the contact spring employed should provide an adequate contact area with the conductor outer surface to avoid excessive heat being developed through losses under the higher loads found in CATV transmission. The helical spring **42** maximizes this contact area and for that reason is preferred.

FIGURE 6 shows a terminal bushing **50** which is substantially like the connector receptacle **30** with the addition of a flange **52** and threaded portion at one end **54**, which replaces the nut utilized in the assembly **30**. It is contemplated that a sleeve structure may be employed on one end with other terminal configurations on the other end.

As part of the invention, the plug structure **20** heretofore described is utilized to aid in preparing the cable for its final termination in a connector or terminal structure. This is depicted in FIGURES 7–11. The assembly procedure begins with a first preparation of the cable which includes a removal of the portion of the outer sheath **18** for a length as generally shown in FIGURE 7 to expose a section of the outer conductor or braid **16** approximately as long as the extension **22***c* and a portion of the dielectric sheath **14** and center conductor **12** considerably longer than the assembly **20**. With the cable so prepared the ferrule **26** is slipped back on to the cable over sheath **18** and the plug is inserted as indicated in FIGURE 8, with the braid being pulled up over **22***c* to a point where its end is near the gasket **24**. This leaves the portion of the dielectric **14** and center conductor **12** protruding continuously through the plug body as indicated in FIGURE 9. With the cable and plug structure so arranged the crimp heretofore described is accomplished as indicated in FIGURE 10. After this the cable and plug structure will be tightly locked together against any relative displacement; principally through the two spaced deformations C–1 and C–2 and the dielectric can be removed to a point flush with the outer face of **22**, as indicated in FIGURE 11. The plug then becomes a tool for holding the cable during the final preparation for use. If a center pin member need be added to the center conductor it may then be positioned on a portion thereof and crimped or soldered thereto. In the present invention the principal use of the assembly is contemplated to be without center pin members and the cable will be terminated in its finished form after the step depicted by FIGURE 11. This method has substantial advantages over and above merely serving as a holding means to permit the final stripping of the cable. First of all, any accidental or forced displacement of the dielectric sheathing or center conductor arising during the crimping operation can be accommodated in the final cable preparation step. Secondly, since the cable is tightly gripped during the final preparation step so no further relative movement can take place. As can be appreciated, in high frequency devices small discrepancies in conductor spacing are significant. The invention method minimizes these discrepancies.

While the present invention has been described particularly relative to CATV cable and application, it is fully contemplated that the advantages attendant thereto may be utilized in other fields for other purposes wherein there is a need to connect or terminate coaxial cable.

Having described the invention in terms of its preferred mode of practice, the invention is now defined by the appended claims.

What is claimed is:

1. In an assembly for connecting coaxial cables of the type having an inner conductor surrounded by dielectric material and an outer conductor, the combination comprising a conductive receptacle including a first tubular sleeve having a bore of substantially constant diameter extending therethrough with means at either end of said first sleeve to electrically and mechanically connect to plug members terminated to coaxial cable for insertion at either end of said receptacle, a dielectric bead adapted to be fitted within said first sleeve toward the center thereof, said bead having an axial length small in comparison to the axial length of said sleeve and having a central bore extending therethrough, a second condctive sleeve having a center section of reduced diameter to define spaced shoulders adapted to engage the outside end surfaces of said bead, said bead being split along its length so as to be fitted over the center section of said second sleeve with said second sleeve in the said bore of said bead and axially aligned within said first sleeve whereby to be closed against the said center section of said second sleeve to position and axially lock said second sleeve within said first sleeve, said second conductive sleeve being of a diameter substantially less than the interior diameter of said first sleeve and being held by said bead to extend coaxially along portions of said first sleeve, said second sleeve carrying therein spring contact members having a plurality of spirally formed fingers extending along the second sleeve length with a substantial spring action transverse to the length of said second sleeve whereby to be capable of substantial radial deflection to accommodate differently sized center conductors of coaxial cable inserted therewithin.

2. The assembly of claim 1 wherein said second conductive sleeve has an exterior surface configuration which is smooth whereby to maintain the spacing between the outer surface of the second sleeve and the inner surface of the first sleeve substantially constant along said assembly except in said center section whereby to maintain the characteristic impedance of said asesmbly substantially constant, notwithstanding the insertion of differently sized center conductors inserted therewithin.

3. The assembly of claim 1 wherein said spring contact members are affixed at the outside ends of said second sleeve and free for axial displacement at the inside ends of the spring members within said second sleeve.

4. The assembly of claim 1 wherein said second sleeve is comprised of a pair of conductive sleeve members secured together at the inner ends thereof.

References Cited by the Examiner

UNITED STATES PATENTS

3,040,288	6/1962	Edlen et al.	339—177 X
3,120,418	2/1964	Deakin	399—221 X

FOREIGN PATENTS

695,439	8/1953	Great Britain.
993,316	5/1965	Great Britain.
183,270	4/1963	Sweden.
154,312	8/1932	Switzerland.

MARVIN A. CHAMPION, *Primary Examiner.*

W. DONALD MILLER, *Examiner.*