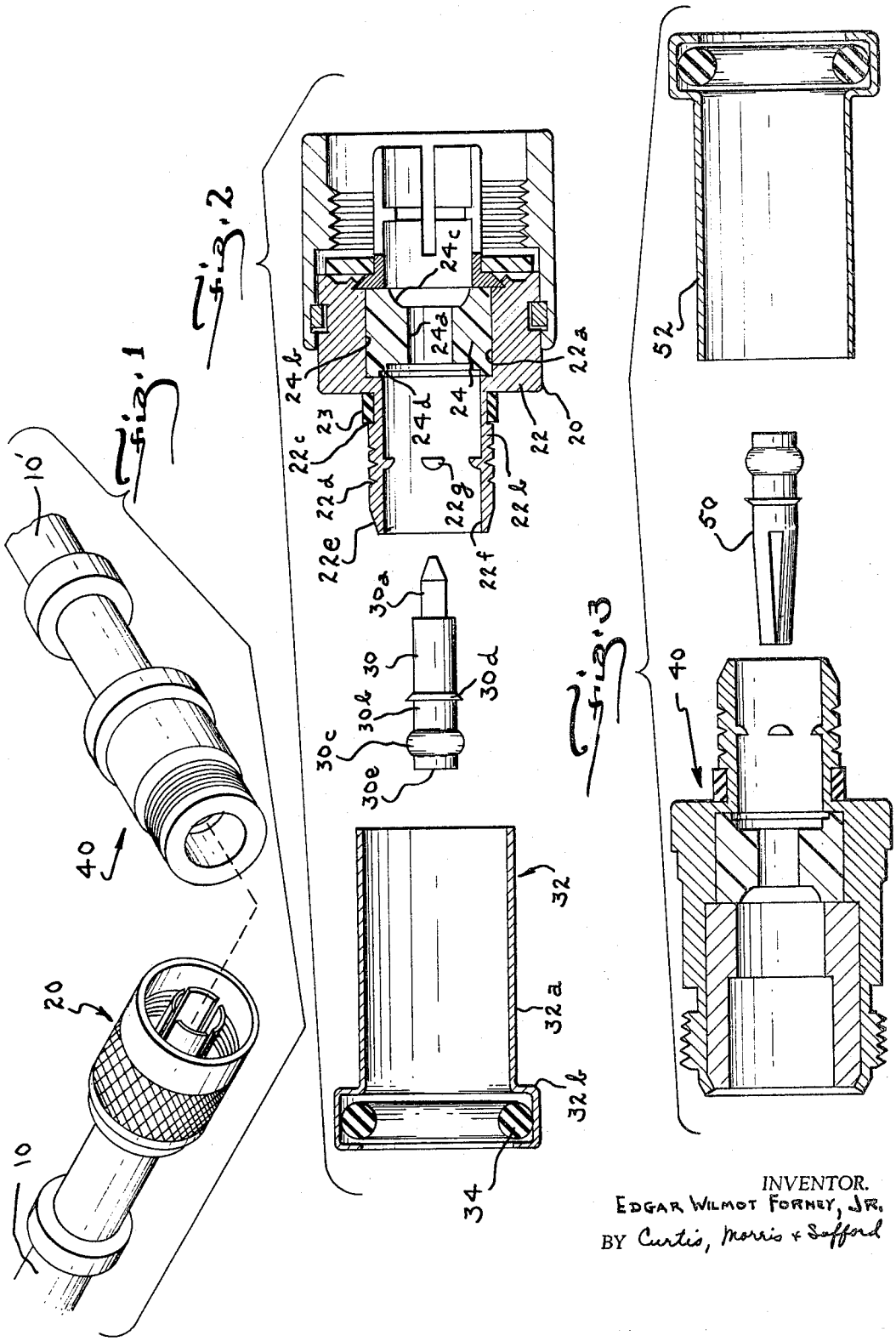
June 25, 1968 E. W. FORNEY, JR. 3,390,374

COAXIAL CONNECTOR WITH CABLE LOCKING MEANS

Filed Sept. 1, 1965 2 Sheets-Sheet 1



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

June 25, 1968 E. W. FORNEY, JR 3,390,374

COAXIAL CONNECTOR WITH CABLE LOCKING MEANS

Filed Sept. 1, 1965 2 Sheets-Sheet 2

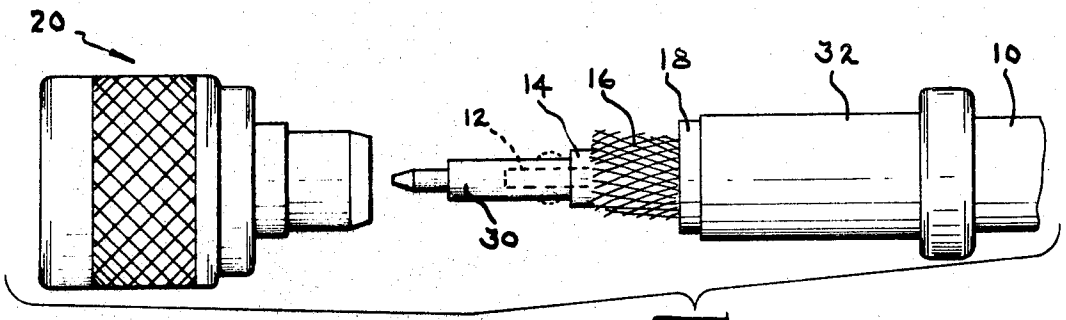


Fig. 4

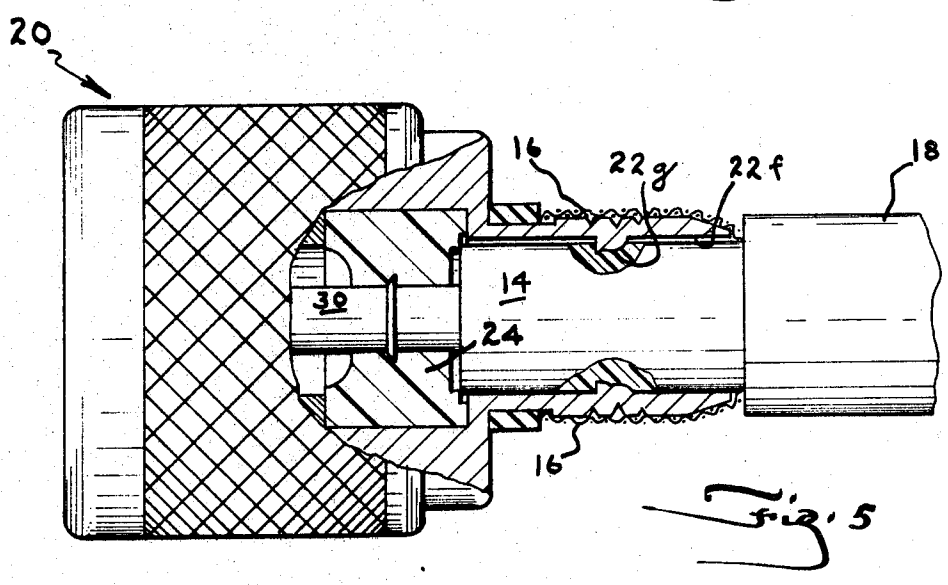


Fig. 5

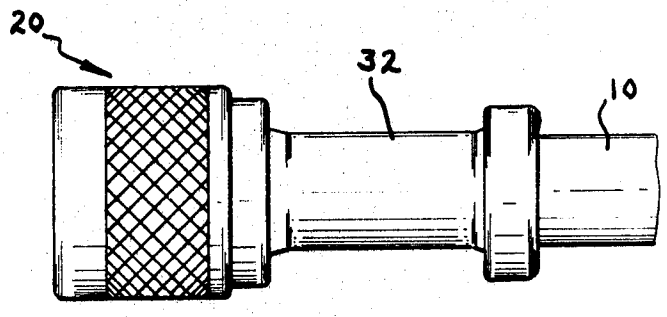


Fig. 6

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

United States Patent Office 3,390,374 Patented June 25, 1968

3,390,374

COAXIAL CONNECTOR WITH CABLE LOCKING MEANS

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

Filed Sept. 1, 1965, Ser. No. 484,286
2 Claims. (Cl. 339—177)

ABSTRACT OF THE DISCLOSURE

A coaxial connector for high frequency use is disclosed which includes inwardly directed projections within the outer conductive shell of the connector of a height and shape to bite into the dielectric sheath of the cable and hold the cable in position during and after assembly of the connector on the cable. The connector includes a center contact pin having an annular rib on a height insignificant when compared to the inner and outer conductor spacing of the connector and positioned to bite into a dielectric insert held within the connector to prevent contact float. In a preferred embodiment the cable sheath is made to abut against the insert with the barb holding the contact pin being on one side of such abutment and with the projections holding the sheath being on the other side thereof.

Background of the invention

The most frequently used coaxial cable is comprised of a center conductor, stranded or solid, surrounded and supported by a sheath of dielectric and insulating and plastic material in turn surrounded by an outer conductor, braided or solid, covered over by a relatively tough insulating protective sheath. The next most frequently used cable differs only in having a non-solid dielectric material made of spaced discs or helically formed strips. Care is taken in construction of cable to maintain a concentric and even spacing of the center conductor relative to the outer conductor to provide a constant characteristic impedance along its length to prevent signal loss or degradation. The typical connector device for use with such cable requires that the cable be carefully stripped and prepared in a stepped fashion exposing the various layers which are individually, mechanically and/or electrically terminated to various portions of the connector device. In certain prior art connector devices the connection of the conductors is accomplished by soldering with the center conductor being inserted in a center contact pin member and soldered thereto through a soldering port and with the outer conductor worked up over an outer shell and soldered thereto around the end thereof. In other devices the outer conductor is entrapped between a number of wedging rings with the center pin being soldered to the center conductor. Still other and more recently developed connector devices utilize crimping techniques for mechanically and/or electrically supporting and terminating the various layers of the cable.

In all of these devices there is a common assembly problem which is well appreciated by those skilled in the art. It is that in assembly of a stripped and prepared cable to a connector device there is considerable opportunity for the various parts to be accidentally displaced relative to each other in an axial sense. For example, in a crimp type connector device after the center pin member has been crimped to the cable center conductor and positioned within the connector there is some chance that the center pin may be erroneously positioned relative to the rear of the connector wherein the termination is made to the outer conductor. This can easily occur after the connector parts have been loosely installed on the cable and while the assembly is being manipulated into the tool of use. Also, crimping forces applied to the cable may tend to squeeze the cable in a manner to cause axial displacement of the center contact pin within the balance of the connector. If the interiors of connector devices were of a constant diameter this axial displacement would have no substantial affect as long as continuity were preserved in final connection. But the standard connector device has numerous changes in diameter, including as a critical one the point wherein the cable center conductor goes into the cable center contact. In high frequency applications even slight differences in placement of parts or displacement of parts can cause discontinuities which appear as high VSWR readings at one or more frequencies over the range of frequencies for which the connector device is designed.

Still another problem affecting all of the foregoing connector designs is one of axial displacement of the connector parts caused by axial strains placed on the cable itself. The typical failure mode occurring by reason of such circumstance is that the center conductor of the cable and/or the dielectric sheath surrounding such center conductor are caused to move outwardly within the cable outer conductor and protective sheath drawing the center contact of the connector along therewith. When this happens to even a slight extent, the performance of the connector in any appreciable frequency range may be expected to deteriorate. It is not uncommon to find axial strains imposed upon the cable resulting in the center contact being displaced axially out of the connector to break continuity and cause a total failure of connection.

The prior art has utilized a variety of techniques to eliminate the foregoing problems. One of these is to provide a radial shoulder or flange on the center contact, which is caused to rest against a forward face of the connector dielectric material or insert. The problem with this is that the offset represents a discontinuity which must be compensated for by alterations in the connector dielectric and inner diameter of the outer conductive portions thereof. Furthermore, the provision of a flange on center contact members represents an additional complexity of part adding to the cost of manufacture and of assembly and thus adding to the applied cost of the connector. Still other approaches utilize a number of rings and wedges which trap and hold the braid of the cable and thus the cable itself. This latter approach does not prevent the cable center conductor and dielectric sheath from moving together within the outer conductor or braid of the cable. Still other approaches grip the cable radially and deform it inwardly to support and prevent pull-out of the cable. Experience has shown however, that no amount of gripping will adequately prevent the center conductor from sliding within the cable dielectric short of forces which actually deform the outer conductor inwardly to a point of constriction thus changing the diameter of spacing between the cable conductors and causing a serious discontinuity.

Summary of the invention

This invention relates to improvements in connector devices and techniques of termination for coaxial cable.

Accordingly, it is one object of the present invention to provide a connector and termination technique which assures a proper placement and axial alignment of connector portions relative to cable conductive and dielectric portions during assembly of a connector device on a coaxial cable. It is another object to provide a coaxial connector having features which preclude relative movement of the connector parts in use due to axial strains imparted to the various portions of the coaxial cable. It is still another object to provide a simple and reliable connector device for high performance use which may

be quickly and easily assembled on coaxial cable utilizing crimping techniques and which includes features operating to lock portions of cable to portions of the connector device and prevent relative movement thereof during use. Another object is to provide a connector assembly featuring a rear loading of the connector contact member after it has been terminated to the cable center conductor.

The foregoing problems are solved and the foregoing objectives are met by the present invention through a construction which operates to lock the connector center contact pin to a dielectric member insert within the connector and/or lock the cable dielectric to the outer shell of the connector device. The end of the cable dielectric and the end of the center contact member are held in abutment to thus prevent axial floating of the center contact by reasons of strains imparted to the cable center conductor or axial floating of the center contact by virtue of floating of the cable dielectric and the center conductor of the cable. The invention connector device and technique is disclosed relative to a specific Type N connector which is adapted to be terminated to the cable by crimping of the outer conductor and center conductor, but it is contemplated that these features may be utilized with other types of terminations such as the types previously mentioned. The crimp version shown is, however, preferred. It is also contemplated that these aspects of the invention may be utilized in a wide variety of coaxial connectors, splices and terminals, as well as in coaxial L's, T's and Y's and in multiple connector blocks.

In the drawings:

FIGURE 1 is a perspective showing the ends of coaxial cable terminated to plug and jack halves of a coaxial connector embodying the features of the invention;

FIGURE 2 is a longitudinal section showing the components of the plug half of the connector of the invention prior to termination to cable;

FIGURE 3 is a longitudinal section showing the parts of the jack half of the connector of the invention prior to termination to cable;

FIGURE 4 is a plan view showing coaxial cable prepared and positioned for insertion within the plug half of the connector of FIGURE 1;

FIGURE 5 is an enlarged partially sectionad view showing the plug half of the connector of FIGURE 1; and in detail the cable inserted and positioned thereon; and

FIGURE 6 is a plan view of the plug half terminated to the cable.

Description of preferred embodiment

Referring now to FIGURE 1 there is shown a coaxial connector embodying the invention including a plug half **20** and a jack half **40**. The plug and jack halves are intermatable to mechanically and electrically interconnect the coaxial cables **10** and **10'**. The construction of this cable is identical in each end to include, as best shown in FIGURE 4, a center conductor **12** surrounded and supported by plastic and dielectric insulating material **14** in turn surrounded by a metallic braid outer conductor **16** covered over by a protective sheath **18**. The forward and mating portions of the plug and jack halves, which are shown in some detail in FIGURES 2 and 3, are standard and their details will be recognized by those skilled in the art as that of the well-known Type N connector. The center and rear portions of the plug and jack halves are identical, as will be apparent from the details in FIGURES 2 and 3, and a description will be given as to these details only as to the plug half **20**.

In FIGURE 2 the plug half may be seen to be comprised of an outer metallic shell **22** which has a forward thickened portion **22***a* containing an enlarged bore which houses a dielectric insert **24**. As an integral part of **22** there is a rear sleeve extension **22***b* of relatively thin wall section. In the outer surface of **22***b* at the point of juncture with the forward portion of **22** there is a slot **22***c* adapted to retain a sealing gasket **23**. Between the slot **22***c* and the end of **22***b* are a series of radially disposed grooves **22***d* which serve to improve the mechanical gripping of the cable braid forced thereagainst and to improve the contact therewith by breaking up metallic oxides on the braid. The outer end of **22***b* is beveled as at **22***e*. The outer diameter of **22***b* is made to be only slightly larger than the inner diameter of the braid of the cable, so that the braid may be easily fitted thereover. The inner bore of **22***b*, shown as **22***f*, is made to be of a diameter approximating the diameter of the dielectric sheath **14** of the cable so as to support the cable dielectric sheath within the connector body. In the center of the sleeve extension are four projections **22***g*, somewhat enlarged here for clarity, which are rounded on the rear surface and flattened on the forward surface. These inward flanges are formed by dimpling indentations in the sleeve material followed by a flattening of the forward edge. The indentations serve the purpose of locking the cable dielectric to the connector in a manner to be described hereinafter. The indentations are held to be as small as possible to still provide an adequate holding of the dielectric of axial displacement. It is contemplated that more or less than four projections may be employed with an adjustment in area to achieve a proper engagement with the dielectric material.

The dielectric insert **24** includes a center bore **24***a* which is of a diameter to receive in a tight sliding fit a center pin member which is shown as **30**. The forward and rearward faces of insert **24** are shaped as at **24***c* and **24***d*, respectively, to provide compensation for the connector. This particular compensation is described in greater detail in U.S. application Ser. No. 395,150 filed September 1964 in the name of John C. Fan. The dielectric material utilized for **24** was in an actual embodiment made of Teflon machined to the configuration shown. The outer diameter **24***b* of the insert is made to equal the inner bore of the forward portion of **22***a* so as to be wedge-fitted therewithin.

The center contact member for plug half **20** is shown in FIGURE 2 to be comprised of a solidly formed metallic member having a reduced and pointed contact end **30***a*, a barrel portion **30***b*. There is a bore therewithin adapted to receive the center conductor of the cable. Toward the rear end of the center contact member, there is a humped portion **30***c* which is adapted to be crimped down to define a smooth outer surface of the pin for the purpose of eliminating discontinuities in the connection. This taught more fully in U.S. application Ser. No. 268,873 filed Mar. 29, 1963 in the name of Frank B. Stark et al. Just forwardly of the hump portion **30***c* there is provided a very slight annular rib (relatively enlarged here for clarity) shown as **30***d*. This rib is made to be almost insignificant in height relative to the diameter of **30** and is shaped so as to have a perpendicular rear surface and a sloping forward surface. The shaping of the rib permits it to be easily slipped into **24***a* and the rear surface serves to bite in and anchor the center contact to the insert. Quite surprisingly the rib has been found to hold against axial pull-out to ten pounds and more. Its evenness about the surface of **30** and its limited height has been found to cause no substantial discontinuity in the connector and a quite satisfactory VSWR has been measured with connectors utilizing the rib without any special adjustment or compensation of the characteristic impedance of the connector in the zone of the rib.

The end of **30** is shown as **30***e* and it defines a transverse of perpendicular surface relative to the dielectric material of the cable. In practice it is butted up against the dielectric sheath of the cable in the manner shown in FIGURE 5. There is additionally provided a ferrule **32** which is comprised of thin wall malleable material such as annealed copper. The ferrule is of constant diameter in its forward portion and adapted to be crimped inwardly

to terminate the cable outer braid to the outer surface of **22***b*. At the rear there is an outwardly formed portion **32***b* which contains a gasket **34**. In use this portion operates to seal and grip the cable and support the cable against bending movements being transmitted to the interior of the connection. Care should be taken to prevent the gasket **34** from deforming the cable outer conductor to constrict the cable and cause a discontinuity. The crimping of ferrule of the type of **32** is more completely described in application Ser. No. 413,569 filed Nov. 20, 1964, in the name of Frank B. Stark et al.

The foregoing features will be apparent in the jack half of the connector shown in FIGURE 3 as **40** which includes a center pin member **50** and a ferrule **52**. The forward end of **50** is adapted to cooperate with and receive **30***a* of the plug half just described.

As can be seen in FIGURE 4, the cable is stripped exposing the various layers thereof in lengths generally as shown. The ferrule is fitted back up over the cable and the center contact member **30** is positioned on the cable center conductor and abutted against the front face of the dielectric sheath **14**. The center contact pin member is then crimped to the cable center conductor and the assembly as in FIGURE 4 is positioned for axial insertion within the rear of **20**. Next, the cable assembly as stripped with the center contact crimped and the ferrule as shown in FIGURE 4 is grasped and moved forwardly within plug half **20** and forced up to the position shown in FIGURE 5 wherein the cable dielectric sheath **14** butts against the rear face of the dielectric insert **24** of the connector half. At this point the center pin member will have been forced through the bore **24***a* to the position shown in FIGURE 5 with the rib **30***d* worked into the center of the insert material in a position to resist pull-out. At this point the indentations **22***g* will have also engaged the cable dielectric sheath **14** as shown to resist pull-out and axial displacement of the cable and member **30**. Thereafter the ferrule **32** is worked up over the braid which is disposed around **22***b* and crimped inwardly as heretofore described and as shown in FIGURE 6.

As positioned within **20** the cable is locked thereto by virtue of the ferrule **32** deformed inwardly against the cable braid or outer conductor and deformed inwardly against the cable outer sheath **18**. The cable is also locked to the connector by virtue of the dielectric material being locked through indentations **22***g* against pull-out to the right in FIGURE 5, and against movement to the left by engagement with the rear face of insert **24**. The center pin **30** is locked in use against leftward axial displacement by its engagement with the opposing and complementary pin half in jack half **40** and against displacement to the right by virtue of the rib **30***d* embedded in the dielectric material **24** as well as its engagement with the forward face of the dielectric material **16**. Strains imparted to the cable dielectric will be resisted by the indentations **22***g*. Strains imparted to the cable center conductor will be resisted by both the rib **30***d* and the end of the center contact **30***e* in its abutment with the dielectric material which is in turn held by **22***g*.

As thus far presented the connector of the invention has been related to our inclusion of two locking features; viz. the projections **22***g* which bite into the cable dielectric **14** and the rib **30***d* which bites into the connector insert **24**. Either feature will work to accomplish this end and it is contemplated that one or the other may in production be used exclusively in the certain types of cable or both may be used together to provide a connector which is adapted for either solid dielectric cable or non-solid cable. For example, in cable where the dielectric is comprised of air and spaced discs of material the rib alone will operate since there is no solid material to accommodate projections such as **22***g*. In cable like that actually depicted the projections **22***g* will ordinarily suffice to provide an adequate holding for assembly and in use.

As an important point and part of the invention, the structure of locking the cable to the connector is very useful during assembly. After the cable is prepared, as shown in FIGURE 4, the center contact may be crimped in an exact position with its end abutted against the forward face of the dielectric material. The assembly may be then inserted within the rear of the connector until the abutment with the dielectric insert occurs, which is obviously a simple operation. In this position the indentations **22***g* become operative to prevent any axial displacement of the cable and center contact in the connector and thus serve as a holding means while the ferrule is positioned up over the outer conductor. Frequently, with small cable and particularly fine braid, it is necessary to comb the braid and to position it evenly about the circumference over the extension **22***b*. It is during this type of operation that slight displacement of the cable center contact could occur to cause the problems previously mentioned. With the invention connector this cannot occur and the entire assembly is positively secured against displacement during the final crimping operation. This would also be the case if the outer conductor were being attached by some other means as by a variety of ring and wedge members threaded onto the rear end of the connector or even by soldering.

In brief summary then, the invention connector works to permit the cable to receive the center contact in an exact position of use. The center contact, when positioned, is exposed for crimping or other attaching methods. The assembly is then simply inserted within the connector and upon such insertion locked against axial displacement; the locking means being the rib on the center contact and/or the indentations in the sleeve extension of the connector. Thereafter, the cable may be manipulated for final connection of the outer conductor or other purposes without fear of displacement of the conductive parts. In use, after the termination of the outer conductor to the rear portion of the cable, these locking features also serve to prevent axial strains from causing displacement of the center contact or other portions of the connector with the resulting deterioration or failure of the performance of the connector.

In an actual embodiment for RG213 solid dielectric cable, the bore **22***f* was approximately 0.293 inch in diameter with the indentations being made of a depth approximately equal to 0.010 inch. The center contact pin member for such cable was 0.120 inch in diameter with the rib being 0.004 inch in height. The rib was made to have a forward face sloping at an angle of approximately 30°.

Having now described the invention in a mode intended to serve as a prefered mode of practice, I now define it through the appended claims.

What is claimed is:

1. In a connector for coaxial cable of the type having a center conductor surrounded by a dielectric and insulating sheath and an outer conductor, a connector body including an outer metallic shell member having a forward end including means to mate with further connector means and a rearward end having a bore of an inner diameter to receive in a sliding fit the sheath of a cable inserted therein and having an outer diameter to receive the cable outer conductor fitted thereover, a ferrule member dimensioned to fit over the cable outer conductor as positioned over the outer diameter of the rear portion of said shell member and being of a malleable material to be crimped inwardly to mechanically and electrically join the cable outer conductor to the said rear portion of the shell member and thereby to the connector, the said shell member including affixed therewithin a dielectric insert having a center bore coaxial to the shell member, a center contact member having an outer diameter to slidingly fit within the bore of the insert member, the said center contact member including a forward end to mate with center contact structure of the said further

connector means and a rearward portion including a bore to receive the center conductor of a cable inserted therewithin and being of a malleable material to permit crimping of the center contact member to mechanically and electrically join the center contact member to the center conductor of the cable, the said rear portion bore including a plurality of interiorly disposed projections extending therewithin, said projections each having sloped rearward surfaces and transverse forward surfaces to define a sharp biting edge permitting the cable sheath having the cable center conductor therein with the center contact member crimped to a portion to the end thereof to be slidingly and axially inserted within the said shell member to butt against the insert with the said projections permitting inward movement of the sheath, but resisting rearward movement of the sheath and thereby preventing rearward displacement of said cable by biting into the said sheath whereby to hold the cable relative to the shell member dielectric insert and center contact member in a proper position during crimping of the ferrule member to permanently effect a connection between the cable and the connector.

2. The connector of claim 1 wherein the center contact member includes on the outer surface thereof a flange having a beveled forward surface and a transverse rearward surface defining a sharp edge permitting the center contact member to be slidingly and axially inserted through the bore of the insert but operating to bite into the dielectric material of the insert member to hold the center contact member against displacement rearwardly relative to said connector.

References Cited

UNITED STATES PATENTS

2,839,595	6/1958	Felts et al.	174—75.2 X
2,927,497	3/1960	Rapata	85—21 X
3,047,828	7/1962	Gregson et al.	339—177 X
3,110,756	11/1963	Genung et al.	339—177 X
3,221,290	11/1965	Stark et al.	174—75.2 X

FOREIGN PATENTS

24,968	3/1963	Germany.

MARVIN A. CHAMPION, *Primary Examiner.*

J. R. MOSES, *Assistant Examiner.*