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Hayward

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[54] **COAX PUSH-ON TEST CONNECTOR**

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[51] **Int. Cl.**^{3} **H01R 17/18**

[52] **U.S. Cl.** .... **339/177 R**; 339/255 R

[58] **Field of Search** 339/177, 255

[56] **References Cited**

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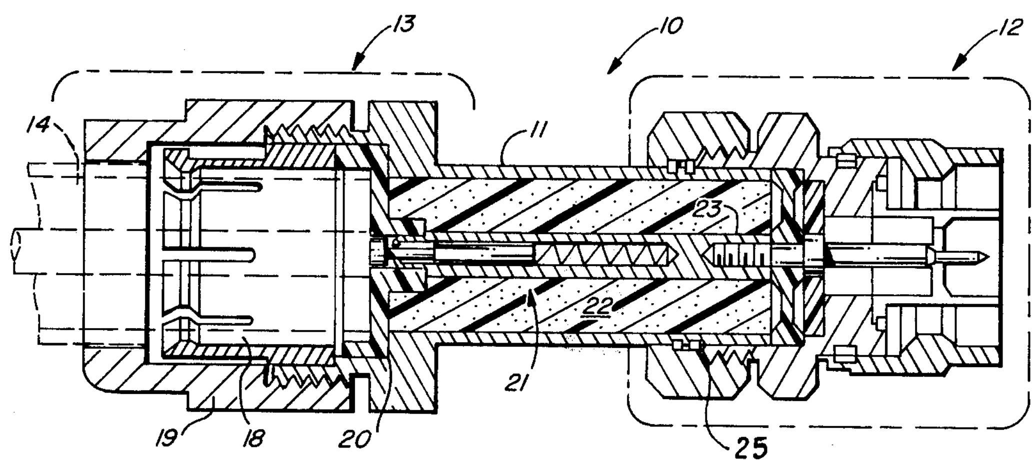
[57] **ABSTRACT**

In a push-on cable connector assembly, the connector is merely pushed onto the coaxial cable and positive pressure devices maintain electrical continuity at points of contact between the outer conductor of the cable undergoing tests and that of the connector assembly and between the inner conductor of said cable and that of the connector assembly. A spring fingered ferrule provides positive contact pressure with the outer conductor of the coaxial cable. Uniquely, a resilient spring contact probe, commonly applied in production testing of printed circuit boards, is adapted as the center conductor of the push-on connector assembly and provides positive contact pressure between the center conductor of the cable undergoing tests and the center conductor of the push-on connector assembly. A standard coaxial connector of the designer's choice is provided as part of the push-on cable connector assembly.

10 Claims, 5 Drawing Figures



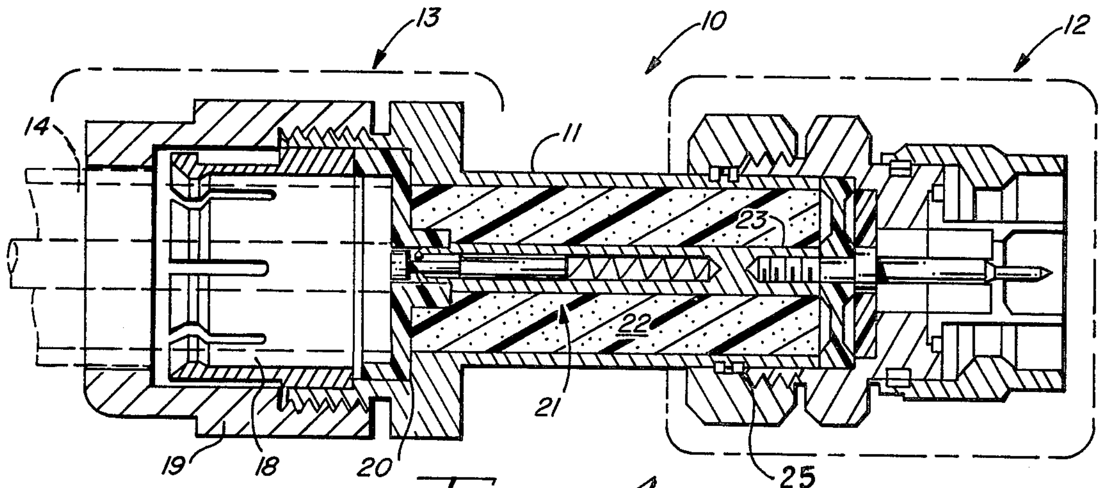


FIG. 1

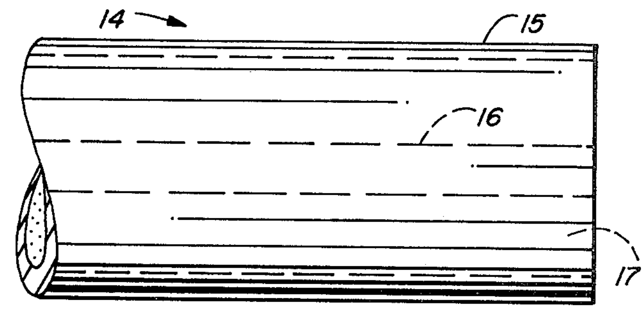


FIG. 2

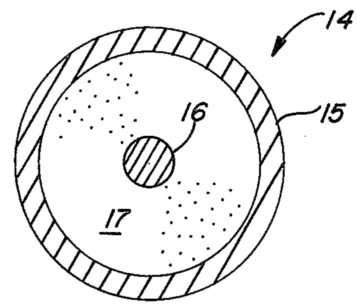


FIG. 3

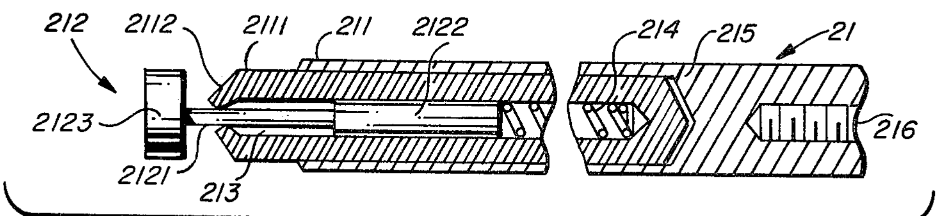


FIG. 4

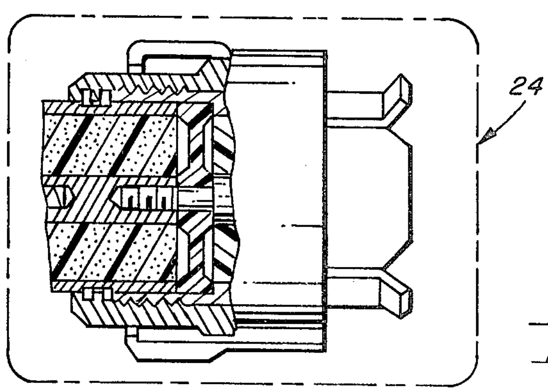


FIG. 5

COAX PUSH-ON TEST CONNECTOR

BACKGROUND

1. Field of the Invention

The invention relates to the field of coaxial cable connectors. In particular, the invention relates to coaxial connectors particularly adapted for use during tests of coaxial cable parameters. More specifically, the invention relates to coaxial test connectors which may be made up to an associated coaxial cable by a simple push-on, slide fit connection.

2. Prior Art

Coaxial cables are precision devices. The characteristic impedance of coax cables is determined not only by the ratio of the diameters of the outer and inner conductors, but also upon the coincidence of the axes of these conductors. An eccentric line results when the inner conductor is displaced from the central axis of the outer conductor and the characteristic impedance of the coaxial cable is modified in accordance with the degree of such eccentricity. A cable inadvertently bent about too small a radius may experience a displacement of its center conductor from its nominal coaxial position. An indentation impressed into the outer conductor will also have adverse affects on the characteristic impedance of the coaxial transmission line.

The characteristic impedance and the electrical line length of a coaxial transmission line is dependent upon the dielectric material contained within the outer conductor and surrounding the inner conductor. The characteristic impedance varies inversely as the square root of the dielectric constant of the dielectric employed. Production anomalies, which may introduce variations in the dielectric constant, can cause significant impedance mismatches to exist along the length of a coaxial transmission line.

In addition to the affects on characteristics impedance of conductor eccentricity and dielectric constant variations, the ability of a given coaxial cable to withstand high voltage breakdown may also be adversely affected by these factors.

Since the physical deformation and production inadequacies which can produce problems in characteristic impedance of the line and its ability to withstand high voltage breakdown are frequently such as to be unobservable in the course of a visual examination of the coaxial cable, electrical testing of the cable is carried out with some frequency between the time at which the cable is fabricated and that at which it is finally emplaced and utilized within an operating system. Even then, there will be occasions to recheck cable parameters after it has been finally installed within a system. However, tests under these circumstances are usually facilitated by the fact that a cable already installed within a system will be provided with coaxial connectors to facilitate terminating the cable runs into various equipments and devices.

Certain coaxial cable tests may be conducted without the need for providing coaxial cable connectors on the cable undergoing test. Examples of such tests are simple DC continuity checks of the inner and outer conductors including simple DC resistance measurements with an ohmmeter, and tests of the coaxial structure to withstand a specified high voltage impressed across inner and outer conductors without breaking down. However, even these tests will often be facilitated by the use of coaxial connectors on the transmission line.

Certain electrical tests cannot be properly performed other than by use of cables equipped with proper coaxial connectors. Such tests include the measurement of the characteristic impedance of the line by means of time domain reflectometry; structure return loss measurements by means of frequency domain reflection bridge equipment; and tests of attentuation utilizing frequency domain volt meter measurements.

The tests noted above are typical of tests which may be performed by the manufacturer of the coaxial cable at the point of fabrication to assure that the cable has been manufactured to specified performance levels and applicable tolerances. Most frequently, the cable will be tested while it is still on the reel. Both ends of the cable are available and each has to be modified in order to accept the coaxial connectors necessary for the performance of the various tests.

The cable is then shipped to the purchaser who will usually perform acceptance tests to assure that the cable meets the purchase specifications. The manufacturer does not ship the cable with coaxial connectors in place at each end. Thus, the purchaser, in order to perform acceptance tests, will have to once more emplace coaxial connectors on the cable ends. This generally means another modification of the cable ends since there is a high likelihood of cable-end damage having been incurred during shipment of the cable from the manufacturing facility.

The handling which a cable receives in the course of its installation, for example, in an elevated run between poles, in interior cable runs and conduit, or in underground trenches dictates the need for additional testing so as to ascertain that the cable installation has been achieved without damage to the cable. Once more, the ends of the cable will have to be prepared to accept a connector since cable ends originally so prepared will in all likelihood have been damaged in the course of installation of the cable.

The reason a cable end is likely to be damaged results from the manner in which it is typically modified to accept a coax connector. Usually, when so modified, the center conductor of the coaxial cable will protrude beyond the extreme ends of the outer conductor by one-half inch or more. This configuration readily lends itself to being damaged as a result of center conductor distortion. Further, it is not unlikely that the extreme ends of the outer conductor will be damaged or distorted by a blow in the course of transporting and handling the cable.

A considerable amount of time must be spent in preparing the cable ends each time a connector is to be emplaced thereon. For example, assume that the particular coaxial cable in question consists an aluminum outer conductor and a solid copper inner conductor with a dielectric medium surrounding and supporting the inner conductor. To prepare the end of the cable to accept a conventional coaxial connector, a length of outer conductor must be removed. This step leaves exposed a length of inner conductor surrounded by a dielectric medium. Next, the dielectric is removed so as to expose the center conductor of the coaxial cable. The center conductor must be cleaned to remove all dielectric material, and its extreme end must be de-burred to assure its facile assembly with the components of the coaxial connector. The coaxial connector is then assembled to the cable and tightened in place.

Those skilled in the art will recognize that there are a variety of commercially available coaxial connectors available for use with coaxial cable.

It is an object of the present invention to provide a coaxial connector which may be connected to a coaxial cable with minimal modification of the end of said cable.

It is a further objective of the invention to provide a coaxial cable connector which may be readily assembled to a coaxial cable which has had its end square/-flush cut.

It is a specific objective of the invention to provide a coaxial connector which may be simply pushed-on to the square cut end of a coaxial cable in order to make the necessary connection to said cable to permit tests to be performed on said cable.

SUMMARY OF THE INVENTION

The invention is a coaxial connector which provides push-on connection to the end of a coaxial cable. The push-on connector comprises slidable pressure contact means for slidably positioning said connector on the outer conductor of a coaxial cable. When the connector has been so positioned, the slidable pressure contact means maintains contact with the outer conductor so as to provide electrical continuity between itself and said outer conductor. The push-on connector includes a resilient in-line pressure contact means for resiliently maintaining in-line contact with the center conductor of the coaxial cable when the slidable pressure contact means has been slidably positioned onto the outer conductor. The resilient in-line pressure contact means provides electrical contact between itself and the center conductor of the coaxial cable. In a preferred embodiment of the invention disclosed herein, the slidable pressure contact means comprises annular, spring finger means for enveloping the outer conductor of the coaxial cable and maintaining electrical contact therewith. The resilient pressure contact means at the center conductor comprises a spring loaded, extensible center conductor within the push-on connector. In the presently preferred embodiment of the invention, a coaxial transition couples both the slidable and the resilient in-line pressure contact means to a standard coaxial connector. This coaxial transition comprises an outer conductor coupled to the slidable pressure contact means and an inner conductor coupled to the resilient in-line pressure contact means. The inner conductor of the transition comprises the spring-loaded extensible shaft. This extensible shaft is coupled to an in-line pressure contact which maintains contact with the center conductor of the coaxial cable. The opposite end of this transition center conductor is adapted to be coupled to the center conductor of a standard coaxial connector. In the presently preferred embodiment to be disclosed herein, the inner conductor of the transition section of the push-on connector comprises a resilient spring contact probe such as is generally employed in production testing of bare and loaded printed circuit boards, wire wrapped back planes and in other applications where circuit access requires a compliant contact system.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of the push-on coaxial connector showing the manner in which a square cut coaxial cable may be readily coupled to the connector without the need for further modification.

FIGS. **2** and **3** are side and end views, respectively, of a coaxial cable illustrating the configuration thereof and identifying the cable elements.

FIG. **4** is a detailed cross-sectional illustration of the center conductor of the push-on connector detailing the resiliently extensible in-line contact.

FIG. **5** illustrates a standard coaxial connector different from that utilized with the push-on cable connector of FIG. **1** to show the broad adaptable range of standard connectors which may be employed with the invention.

DETAILED DESCRIPTION OF THE INVENTION

Since the connector of the invention may be readily pushed-on or pulled off of a coaxial cable, the push-on connector, the subject of this disclosure, is intended primarily for test purposes rather than for permanent installation although, those skilled in the art will readily conceive of cable gripping devices well known in the prior art for anchoring the push-on connector permanently in position on a coaxial cable.

The push-on cable connector assembly **10** is illustrated in cross-section in FIG. **1**. The connector assembly **10** is comprised of a coaxial transition section **11** which couples a standard coaxial connector **12** (here illustrated, but not limited to, a type N coaxial connector) to a push-on cable connector **13**.

FIGS. **2** and **3** illustrate the coaxial cable section in side and end view, respectively. The coaxial cable **14** is comprised of an outer conductor **15** and inner conductor **16**. The axis of inner conductor **16** is coaxial with the axis of outer conductor **15**. A dielectric **17** supports inner conductor **16** within outer conductor **15** and determines certain of the electrical characteristics of the cable.

For use with the push-on connector **10**, coaxial cable **14** is prepared by making a clean, square, flush cut across the cable as illustrated in FIG. **2**. Connector **10** is then simply positioned on cable **14** by sliding the connector **10** down over the square cut end of cable **14** and along the exposed outer conductor **15**. This joining of cable **14** to connector **10** is shown in FIG. **1** where cable **14** is illustrated in phantom outline.

Push-on connector **10** is provided with an annular, spring finger ferrule **18** which slidingly maintains a pressure contact with the outer conductor **15** of cable **14**. This pressure contact between the spring fingers of ferrule **18** and the outer conductor **15** provides electrical continuity between the cable outer conductor and the ferrule. Ferrule **18** may be a press fit into transition outer conductor **11** to provide electrical continuity therewith. Guide **19** provides means for guiding cable **14** into contact with ferrule **18**. Guide **19** also provides protection for the spring fingers of ferrule **18** and aids in maintaining ferrule **18** in contact with transition outer conductor **11**.

With cable **14** in place within push-on connector **10** as illustrated in FIG. **1**, coax cable center conductor **16** will bear against transition center conductor **21** to provide electrical continuity between the cable center conductor **16** and transition center conductor **21**.

One end of transition center conductor **21** is supported and captivated by dielectric bead **20**. This bead **20** is sized and configured as required to provide an impedance-matched junction between cable center conductor **16** and transition center conductor **21**. The manner by which the size and shape of dielectric bead **20** is determined is well known to those in the prior art.

At the right-hand side of push-on connector **10**, as illustrated in FIG. **1**, is coupled a standard type N coaxial connector **12**. Standard connector **12** is maintained in position on transition outer conductor **11** by compression rings **25** in a manner well known to those skilled in the art. Transition center conductor **21** is coupled to center contact **23** of standard connector **12** which provides support and further captivation of transition center conductor **21**.

The dielectric medium **22** within the transition section between push-on connector **13** and standard connector **12**, as well as the ratio of the inside diameter of transition outer conductor **11** to the diameter of transition inner conductor **21** are chosen to provide the proper impedance structure to match the push-on connector impedance to that of the standard connector impedance.

As suggested by the illustration of FIG. **5** showing a GR type connector coupled to transition outer conductor **11** and transition center conductor **21**, push-on connector assembly **10** will accommodate various types of standard coaxial connectors as may be required to provide a push-on cable test connector to satisfy the connector type requirements of the associated test equipment.

For good electrical performance, it is necessary that a low loss consistent electrical contact be maintained between coaxial cable **14** and push-on connector **13** of connector assembly **10**. The positive pressure applied by the spring fingers of ferrule **18** provide and maintain good electrical continuity between outer conductor **15** of cable **14** and cable assembly **10**. To provide a consistent low loss electrical continuity connection between inner conductor **16** of cable **14** and transition inner conductor **21** of connector assembly **10** requires that some positive pressure be maintained at the junction of these two center conductors just as the spring fingers of ferrule **18** maintain a positive pressure on the outer conductor **15** of cable **14**. To this end, transition center conductor **21** is provided with a resiliently extensible contact **2123** (FIG. **4**) to maintain positive contact with inner conductor **16** of coaxial cable **14**.

FIG. 4 illustrates transition center conductor **21** in greater detail than is provided in FIG. **1**. Transition inner conductor **21** is comprised of a cylindrical body **211** and extensible section **212** which is supported within a central bore **213** under the resilient pressure provided by spring **214**. Body **211** is provided with an exposed shoulder section **2111** which slidingly mates with dielectric bead support **20**.

Resiliently extensible contact **212** is provided with a reduced diameter shaft **2121** which is guided by the close proximity provided by the rolled shoulders **2112** of body **211**. An enlarged diameter shaft section **2122** is restricted in passage by shoulders **2112** and thus is captivated within bore **213** of body **211**. Extensible length **212** is provided with an enlarged diameter section **2123** maintained external of bore **213** which provides the actual contact with the center conductor **16** of coaxial cable **14**. The contact pressure between cable center conductor **16** and extensible contact **2123** is maintained at a positive pressure level by the resilient urging of spring **214** against the end of shaft section **2122**.

In practice, cylindrical body **211** of transition center conductor **21** may be a resilient spring contact probe such as manufactured and sold by Assembly and Test Equipment Corporation of Pomona, California. Such probes are commonly applied in production testing of bare and loaded printed circuit boards, wire wrapped back planes and other applications where circuit access or function requires a complaint contact system. Cylindrical body/spring contact probe **211** is disclosed here as being housed in a receptical **215**. This permits ease of replacement of spring contact probe **211** to eliminate the effect of wear and tear brought on by repetitious use of connection **10**. Indeed all parts are readily replaceable so that the performance effectiveness of the connector may be maintained over long-life usage.

The end of receptical **215** opposite resilient spring contact **2123** is provided with a bore **216** which may be thread-coupled or solder fastened to the center contact **23** of a standard coaxial connector such as **12** or **24**.

What has been disclosed is the means and method for providing a push-on cable connector assembly wherein the connector is merely pushed onto the coaxial cable and positive pressure devices maintain electrical continuity at points of contact between the outer conductor of the cable undergoing tests and that of the connector assembly and between the inner conductor of said cable and that of the connector assembly. A spring fingered ferrule provides positive contact pressure with the outer conductor of the coaxial cable. Uniquely, a resilient spring contact probe, commonly applied in production testing of printed circuit boards, is adapted as the center conductor of the push-on connector assembly and provides positive contact pressure between the center conductor of the cable undergoing tests and the center conductor of the push-on connector assembly. A standard coaxial connector of the designer's choice is provided as part of the push-on cable connector assembly.

A preferred embodiment of the invention has been disclosed. Those skilled in the art will conceive of other embodiments satisfying the same function and which will fall within the spirit and scope of the invention herein disclosed. It is intended that all such embodiments shall fall within the ambit of protection provided by the claims attached hereto.

Having described my invention in the foregoing specification and drawings in such a clear and concise manner that those skilled in the art may readily understand and simply practice the invention, that which I claim is:

1. Coaxial connector means providing push-on connection to the end of a coaxial cable comprising

slidable pressure contact means for slidably positioning said connector on the outer conductor of a coaxial cable and for maintaining contact therewith when so positioned so as to provide electrical continuity between itself and said outer conductor; and

resilient in-line pressure contact means for resiliently maintaining in-line contact with the center conductor of a coaxial cable on whose outer conductor said slidable pressure contact means has been slidably positioned so as to provide electrical contact between itself and said center conductor.

2. The coaxial connector means of claim **1** wherein said slidable pressure contact means comprises annular spring finger means for enveloping said outer conductor of a coaxial cable and maintaining electrical contact therewith.

3. The coaxial connector means of claim **1** wherein said resilient pressure contact means comprises a spring loaded extensible center conductor of said coaxial connector means.

4. The coaxial connector means of claim **1** further comprising coaxial transition means coupled to both said slidable and said resilient in-line pressure contact means for providing impedance matched electrical continuity to standard coaxial connector means.

5. The coaxial connector means of claim 4 further comprising coupling means for coupling a standard coaxial connector to said transition means.

6. The coaxial connector means of claim 5 wherein said coaxial transition means comprises:

outer conductor means coupled to said slidable pressure contact means; and

inner conductor means coupled to said resilient in-line pressure contact means.

7. The coaxial connector means of claim 6 wherein said inner conductor means comprises a spring loaded extensible shaft.

8. The coaxial connector means of claim 7 wherein said resilient in-line pressure contact means comprises an in-line pressure contact coupled to said spring loaded extensible shaft.

9. The coaxial connector means of claim 8 wherein said inner conductor means further comprises coupling means for coupling said inner conductor means to the center conductor of standard coaxial connector means.

10. The coaxial connector means of claim 5 wherein said inner conductor means comprise a resilient spring contact probe as is generally employed in production testing of bare and loaded printed circuit boards, wire wrapped back planes and in other applications where circuit access requires a compliant contact system.

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