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(56) Documents Cited

GB 2306802 A GB 2257574 A EP 0188041 A
US 5281167 A US 3732526 A US 3720906 A

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(54) Abstract Title

Coaxial connector for high power radio frequency systems

(57) A coaxial connector (2), particularly for high gain systems, comprises a solder connection between an outer conductor (22) of a cable (18) and connection portion (38) of the connector for good electrical performance. A ferrule (44) of the connector (2) is crimped to a portion (49) of the cable at a certain distance (50) from the solder connection. The latter prevents stresses on the solder connection which may adversely affect the electrical response. Generation of cracks in the solder connection, may produce non-linear signal responses (intermodulation products) that may affect the performance of systems with high gain, such as wireless telecommunications base stations.

FIG. 1

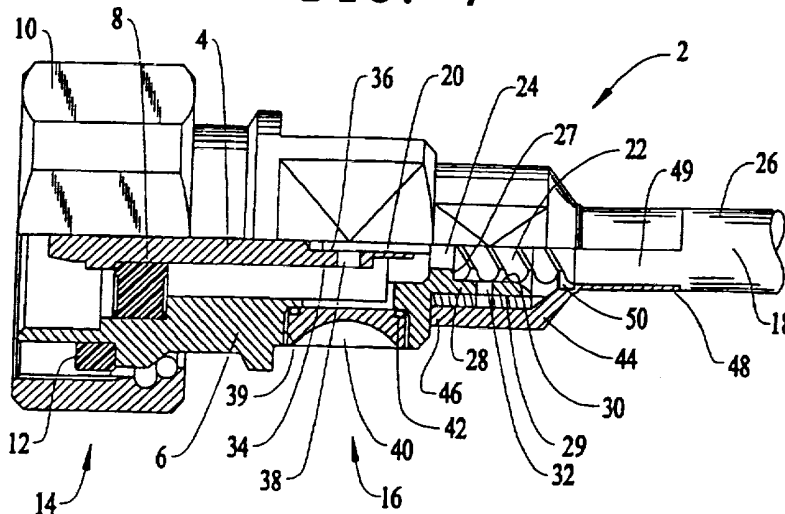


FIG. 1

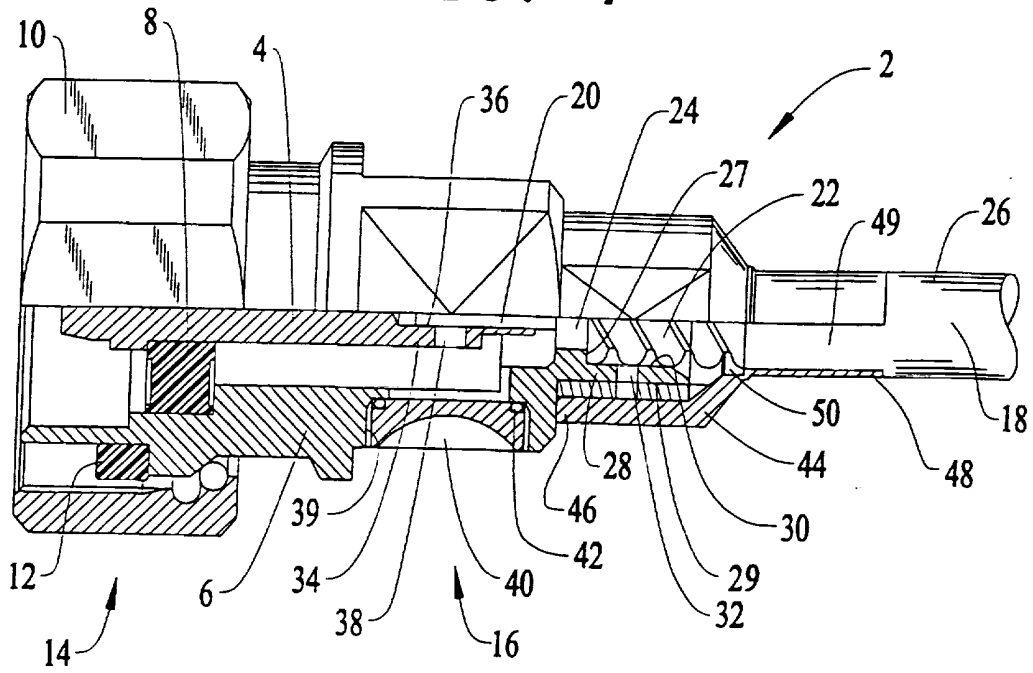


FIG. 2

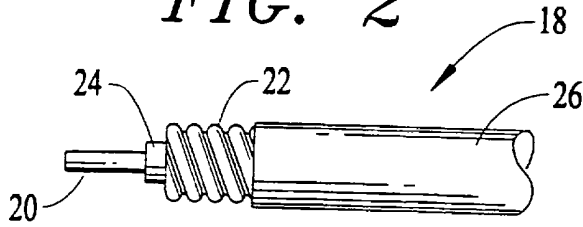


FIG. 3

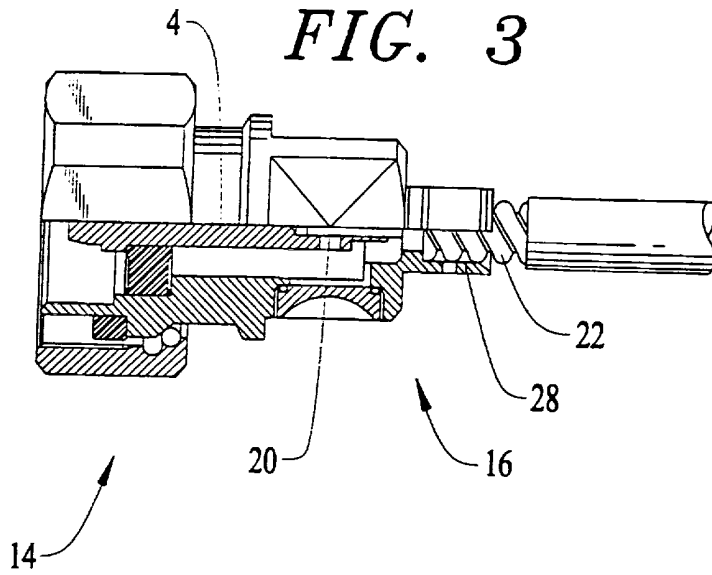


FIG. 4

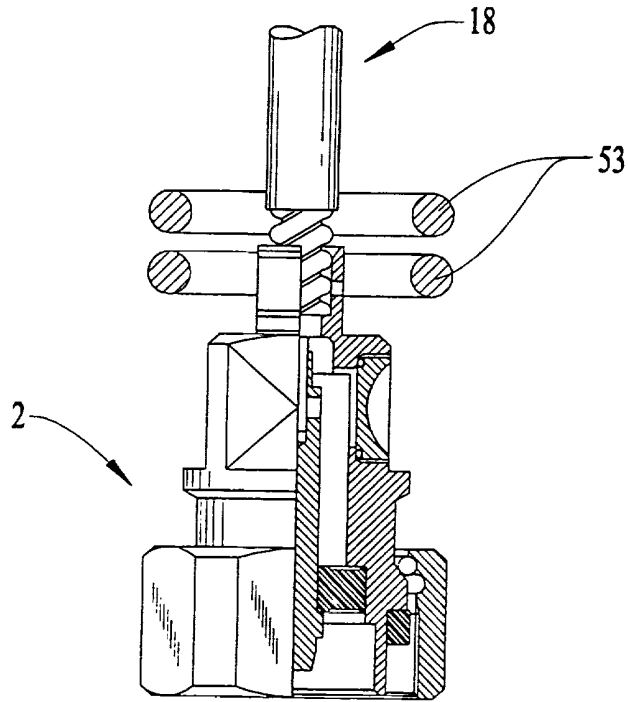
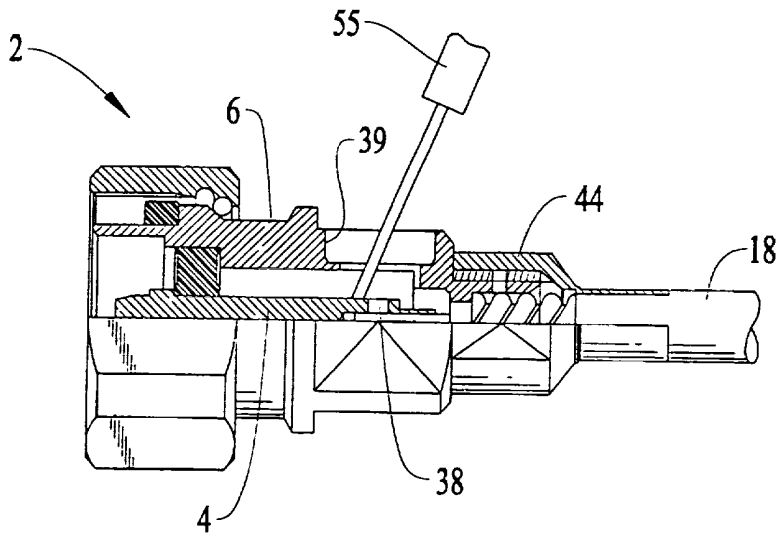


FIG. 5



COAXIAL CONNECTOR FOR HIGH POWER RADIO FREQUENCY SYSTEMS

This invention relates to a coaxial connector for interconnecting a coaxial cable to further conductors of a high power radio frequency transmitter and receiver device.

In the wireless telecommunications industry, base stations receive signals from mobile communication devices such as mobile phones, and transmit high power signals to other base stations or mobile communication devices. In order to increase the distance required between devices communicating with each other, and in particular between the mobile device and the base station, the sensitivity of the base station receiver is increased and/or the power output of the base station is increased. Weak noise signals that were previously insignificant become more significant as the power gain between receiver and transmitter signal increases. Coaxial transmission devices, and in particular coaxial connectors comprise features that produce "intermodulation products", which are noise signals resulting from a non-linear response of signal transmission. Factors that produce a non-linear electrical response create frequencies (non-fundamental harmonics) that may fall in the range of carrier frequencies of the receiver channel. In past systems, intermodulation products were too small relative to the receiver signal to be of importance. As the receiver channel sensitivity increases however, intermodulation products may be confused with receiver signals.

A number of factors which affect intermodulation performance in RF coaxial connectors have previously been identified, such as poor surface finish, convoluted signal path, corrosion, insufficient plating thickness, and dissimilar metals in intimate contact. The quality of electrical connection between inner and outer conductors of a coaxial cable and respective inner and outer conductors

of a coaxial connector is thus important. Solder connections between the cable and respective conductors of a coaxial connector usually provide better electrical performance than crimp connections. Certain solder connections however do not provide the desired performance.

5 It is an object of this invention to provide a coaxial cable connector that has high performance, in particular which reduces the generation of intermodulation products.

Objects of this invention have been achieved by providing the coaxial cable connector according to claim 1. Disclosed herein is a coaxial cable connector comprising a centre contact concentrically surrounded by an outer contact and separated therefrom by a dielectric, the connector having a mating portion for mating with a complementary coaxial connector, and a connection portion adapted to connect to a coaxial cable having an inner conductor concentrically surrounded by an outer conductor and separated therefrom by a dielectric, the centre contact of the connector having a portion for connection to the cable centre conductor, and the outer contact comprises a connection portion adapted for solder connection to the cable outer conductor, wherein the connector further comprises a cable radial support member rigidly mounted to the connector and extending therefrom over a portion of the cable extending from the connection portion, the radial support member having a clamping section adapted for securely clamping the cable at a certain distance from the solder connection such that a length of cable between the solder connection and the clamping portion is securely supported, thereby preventing cable movement at or proximate the solder connection. Advantageously therefore, radially supporting the cable at a distance from the solder connection reduces the generation of intermodulation products by preventing solder cracking and resulting movement of cracks during application of stresses on the

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cable, which introduce non-linearities in the electrical response of the solder connection. A good solder connection provides an enhanced electrical performance over clamping or crimping connections. The radial support member improves the electrical performance of the connector particularly when the cable is pulled or bent. A particularly effective radial support member may be provided with a cable clamp in the form of a ferrule for crimping (i.e. permanent deformation) about a portion of the cable with outer insulation cladding.

Further advantageous aspects of this invention are set forth in the claims, or will be apparent from the following description and drawings.

An embodiment of this invention will now be described by way of example with reference to the figures in which;

Figure 1 is a partial cross-sectional view of a connector according to this invention;

Figure 2 is a view of a portion of cable prepared for connection to the connector;

Figure 3 is a cross-sectional view showing the cable initially inserted in the connection end of the connector;

Figure 4 is a partial cross-sectional view showing the next step in assembly of the connector to the cable, whereby the outer conductor is soldered to the connector by induction heating;

Figure 5 shows a subsequent step in the assembly operations where the cable inner conductor is soldered to the connector inner contact.

Referring to the Figures, a coaxial connector 2 comprises a centre contact 4 concentrically surrounded by an outer contact 6 and separated therefrom by a dielectric 8 that supports and positions the centre contact with respect to the outer contact. The connector further comprises a threaded locking ring 10 for coupling to the thread of a complementary coaxial connector matable

therewith, and an elastomeric seal member 12 for environmentally sealing the connectors when mated. The connector comprises a mating portion 14 and a connection portion 16, the mating portion 14 mating with the complementary coaxial connector, and the connection portion 16 for termination to a coaxial conductor 18. The coaxial conductor 18 comprises an inner conductor 20 concentrically surrounded by an outer conductor 22 and separated therefrom by a dielectric 24, the cable further comprising an outer insulative cladding 26 surrounding the outer conductor 22. The cable 18 is a semi-rigid cable, whereby the outer conductor 22 is in the form of a helical thread that improves the flexibility thereof.

The outer contact 6 has a connection portion 28 that may be provided with a helical thread complementary to that of the cable outer conductor 22, such that the outer conductor may be screwed into the connection portion 28. The connection portion 28 may however also have a smooth cylindrical inner surface 30 for receiving the outer conductor 22 therein. The connection portion 28 is further provided with one or more inspection holes 32 that facilitate verification of the quality of the solder connection between the cable and outer contact 26.

The cable inner conductor 20 is received in a connection portion 34 of the centre contact 4, the connection portion 34 provided with a bore receiving the centre conductor 20 therein. The bore 36 is accessible through one or more flow holes 38 that assist soldering of the centre conductor 20 in the bore 36. In alignment with the flow hole 38, is a cap 40 in the outer contact 6 that can be closed with a conductive seal 42 tightly against the outer conductor.

The connector further comprises a cable radial support member 44 that has a connector attachment portion 46 and a cable attachment portion 48. The connector attachment

portion 46 comprises a female thread for screwing over a complementary thread provided on the outer surface 29 of the outer contact connection portion 28. The radial support member 44 can thus be rigidly and securely fastened to the connector. Other fixing means such as bonding, welding or crimping are also possible. The cable attachment portion 48 is for securely clamping to a portion 49 of the cable, at a certain distance separated by a gap 50 from the outer contact connection portion 28. In this particular embodiment, the attachment portion 48 is in the form of a deformable tube that can be crimped by plastic deformation, to the cable portion 49. For example the tube 48 may be deformed into a hexagonal shape similar to a conventional crimp for electrical connection between coaxial outer conductors and connector outer contacts. Preferably, the cable attachment portion 48 is secured around the portion of cable 49 provided with outer insulative cladding 26 such that electrical currents do not pass through the radial support member 44, or are negligible. Alternatively, the radial support member 44 could be coated with or provided out of a non-conductive material. It is also possible to provide other attachment means between the cable and the cable attachment portion 48 such as screw clamps, bonding with glue, overmoulding, etc.

The radial support member 44 advantageously eliminates or substantially reduces stresses and movement of the cable outer conductor 22 relative to the outer contact connection portion 28 during bending, pulling, or exertion of other forces on the cable 18 externally of the connector. It has been found that for particularly high performance, a solder connection between the cable outer conductor 22 and cable outer contact 6, is preferred over a crimp connection therebetween. It has however been found that the intermodulation performance of the solder connection may not be satisfactory or sufficiently consistent. The

application of stresses on a cable may generate cracks in the solder connection which may increase the non-linear response of high frequency electrical signals passing therethrough. In order to improve the dynamic intermodulation, movement of the cable outer conductor 22 relative to the connector outer contact connection portion 28 is thus substantially eliminated by the provision of the radial support member 44 that supports the cable at a certain distance from the connection portion. Providing the radial support member 44 in the form of a metallic crimping ferrule enables a simple yet robust support, utilising crimping technology commonly used in electrical connectors.

Assembly of the cable to the connector will now be briefly described by referring to Figures 2-5. Firstly, as shown in Figure 2, the cable connection end is prepared by exposing successive portions of the inner conductor 20, dielectric 24, and outer conductor 22. The cable end is subsequently inserted into the connection section 16 of the connector as shown in Figure 3 whereby the exposed portion of inner conductor 20 inserts into the bore 36 of the centre contact 4 and the exposed portion of outer conductor 22 inserts into the bore 30 of the outer contact connection portion 28. The outer contact abuts a shoulder 27 (see Figure 1) defining a foremost secure position of the cable with respect to the connector. Prior to insertion of the cable in the connector, tin solder film, or powder, or paste may be applied to the outer conductor exposed portion 22 or in the bore 30 of the outer contact. As shown in Figure 4, induction coils 53 are then placed around the connection section 16 whereby the heat generated melts the solder material which flows between the outer conductor 20 and connection portion 28.

As shown in Figures 1 and 5, solder may be applied through the solder flow hole 38 accessible via the port 39

in the outer contact 6. Subsequently a heating element 55 may be introduced through the port 39 for melting and flowing the solder between the inner conductor 20 and inner contact bore 36. Subsequently, the cap with conductive seal 40,42 is closed as shown in Figure 1. The radial support member 44, which was slid over the cable prior to insertion into the connector, is attached (in this embodiment threaded) to the outer contact connection portion 28 and subsequently the cable attachment portion 48 is crimped to the cable.

CLAIMS

1. A coaxial connector comprising a centre contact concentrically surrounded by an outer contact and separated therefrom by a dielectric, the connector having a mating portion for mating with a complementary coaxial connector, and a connection portion adapted to connect to a coaxial cable having an inner conductor concentrically surrounded by an outer conductor and separated therefrom by a dielectric, the centre contact of the connector having a portion for connection to the cable centre conductor, and the outer contact comprises a connection portion adapted for solder connection to the cable outer conductor, wherein the connector further comprises a cable radial support member rigidly mounted to the connector and extending therefrom over a portion of the cable extending from the outer contact connection portion, the radial support member having an attachment portion securely holding the cable at a certain distance from the solder connection, such that a length of cable between the solder connection and the cable attachment portion is securely supported, thereby preventing cable movement at or proximate the solder connection.
2. The connector of claim 1 wherein the radial support member is a separate part from the connector and has an attachment portion rigidly securable to the connector outer contact.
3. The connector of claim 1 or 2 wherein the cable attachment portion is in the form of a crimping ferrule for crimping to the cable.

4. The connector of any one of the preceding claims wherein the radial support member is made of metal suitable for crimping connection.
- 5 5. The connector of any one of the preceding claims wherein the centre contact has a conductor connection portion having a bore adapted for solder connection to the cable centre conductor.
- 10 6. The connector of any preceding claim wherein the outer contact comprises a port over the connection portion of the centre contact in order to allow access for soldering of the centre contact to the cable inner conductor.
- 15 7. A coaxial cable assembly comprising a coaxial connector according to any one of the preceding claims, and a cable therefor, wherein the cable comprises an exposed portion of outer conductor received in a bore
- 20 (30) of the outer contact connection portion.
8. The cable assembly of claim 7 wherein the radial support member attaches to the cable at the attachment portion in a substantially insulating
- 25 manner.
9. The assembly of claim 7 or 8 wherein the attachment portion of the radial support member crimps around a portion of the cable provided with
- 30 insulative cladding.
10. A coaxial cable connector substantially as hereinbefore described with reference to the accompanying drawings.



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Claims searched: 1-10

Examiner: A J Rudge
Date of search: 16 March 1999

**Patents Act 1977
Search Report under Section 17**

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK CI (Ed.Q): H2E(EDD,EGFA,EGCA)
Int CI (Ed.6): H01R-9/05;-13/56;-13//58;-13/595;-43/02
Other: Online databases: WPI,EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	GB 2 306 802 A (Progreessive Tool) - See Fig.2 and abstract	1 at least
Y	GB 2 257 574 A (Chin-Lu Chang) - see whole document	"
Y	US 5,281,167 (Dykstra) - see abstract and Figs.	"
Y	US 3,732,526 (Bendix) - see Fig. 5 and abstract	"
Y	US 3,720,906 (Bendix) - see Fig 5 and abstract	"
Y	EP 0 188 041 A1 (Sobin) - see whole document	"

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.