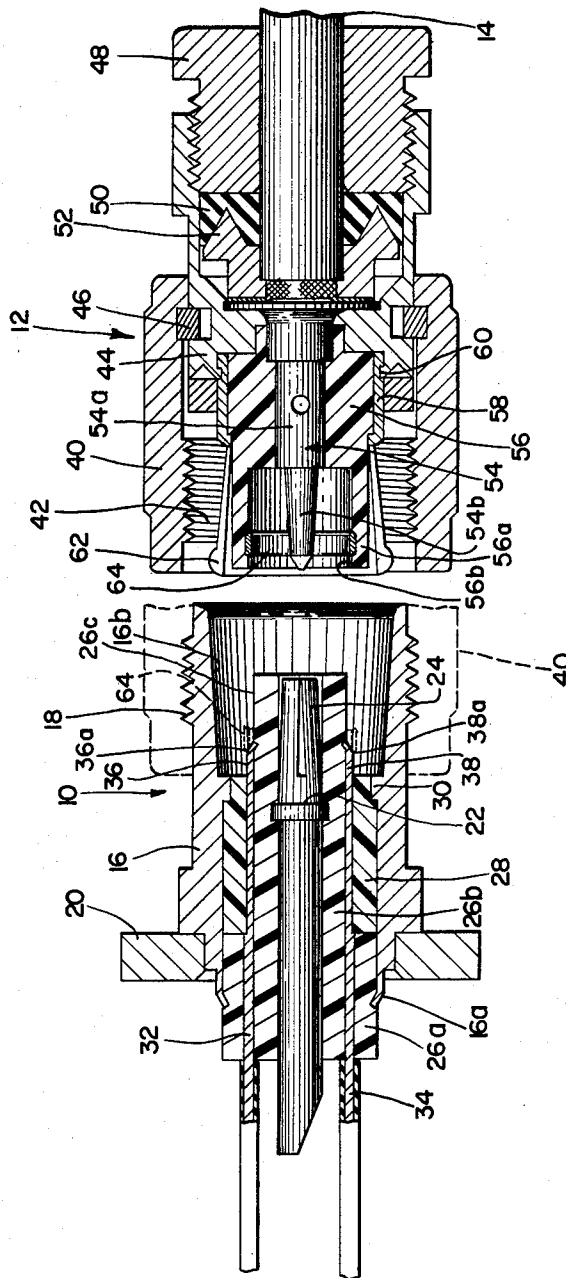


March 10, 1964

O. L. COOK
COAXIAL CONNECTOR

3,124,406

Filed Sept. 20, 1962



INVENTOR
OWEN LEONARD COOK
BY
Blair & Buckles
ATTORNEYS

1

3,124,406

COAXIAL CONNECTOR

Owen L. Cook, Wakefield, Mass., assignor to
General RF Fittings, Inc., Boston, Mass.
Filed Sept. 20, 1962, Ser. No. 225,013
7 Claims. (Cl. 339-89)

This invention relates to a novel high frequency electrical connector assembly provided with means for monitoring the conductive condition thereof. More specifically, it relates to a coaxial plug and receptacle having an auxiliary set of contacts which permit the determination of whether or not an RF connection has been made without disturbing the high frequency circuit associated with the RF contacts.

The monitoring of high frequency connections is of particular importance in equipment which is inaccessible during use or which must be certain of operating properly as soon as it is put into use. In such cases, a check-out must be performed prior to use of the equipment and the check-out should include monitoring of high frequency connectors to make sure that they are secure.

A check-out procedure should be operable without affecting the operation of the equipment being monitored, so that the results of the check will be indicative of performance during actual use. In the case of a high frequency connector this means that the high frequency circuit, of which the connector is a part, should not be interrupted. Furthermore, it is highly desirable that the voltage standing wave ratio in the transmission path including the connector be negligibly affected, if at all, by any structural modifications incorporated for the purpose of monitoring the connection.

Accordingly, it is a principal object of the present invention to provide an improved high frequency connector assembly incorporating means for efficiently monitoring the status of the connection made therewith.

A more specific object is to provide a pair of mating coaxial connectors having means for checking the connection from one of the connectors.

A further object of the invention is to provide connectors of the above type having standard dimensions and yet characterized by characteristic impedances of substantially the same values as the cables interconnected by the connectors.

A further object of the invention is to provide connectors of the above type in which monitoring of the connection is readily accomplished with simple equipment.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, which is a longitudinal section of a pair of connectors embodying the invention.

In general, the invention makes use of a pair of diametrically opposed auxiliary conductors extending parallel to the axis of one of the mating connectors and into the region where the RF contacts of the two connectors engage each other. In this region the auxiliary conductors are exposed and when the two connectors are joined they are contacted by a ring shaped conductor incorporated in the other connector. The ring shaped conductor, which is coaxial with the high frequency contacts of the assembly, thus provides an electrical conducting path from one of the longitudinal auxiliary

2

conductors to the other. This conductivity may be ascertained by a simple resistance check between the latter two conductors. Moreover, since the auxiliary conductors are interconnected by the ring only when the two connectors are securely fastened together, the check also serves to monitor the reliability of the connection.

Referring now to the drawing, a connector assembly embodying the invention may include a receptacle 10 and a plug 12 which, when joined together, provide a connection between a coaxial cable 14 and components in the interior of a chassis (not shown) to which the receptacle is attached. The illustrated plug and receptacle are type "TNC" units of conventional manufacture, with the exception of modifications incorporating the present invention.

More specifically, the receptacle 10 includes a body 16, provided with a connecting thread 18 and secured to a mounting plate 20, which serves to fasten the receptacle to an electrical chassis or the like. The body 16 serves as the outer conductor for a coaxial system including an inner conductor in the form of a contact 22. The contact 22, which terminates in connecting fingers 24, is enclosed within a plastic insulator 26. The insulator 26 and an interfitting insulating sleeve 28 are secured within the body 16 by means of a shoulder 30 and a rolled-over portion 16a of the body.

Extending through an enlarged portion 26a of the insulator 26 and along the outer surface of the reduced portion 26b thereof, are a pair of auxiliary conductors 32 and 34. The conductors 32 and 34 terminate in the form of contacts 36 and 38 on the exposed surface 26c of the insulator 26. Preferably the auxiliary conductors are flat in the region within the sleeve 28 so as to facilitate assembly of the sleeve to the insulator 26. The flatness extends to the contacts 36 and 38 for reasons set forth in the discussion below.

The plug 12 includes a coupling nut 40 provided with an internal thread 42 which engages the thread 18 on the receptacle 10. The nut 40 is rotatably secured to a body 44 by means of a snap ring 46. The cable 14 is secured in place by means of a clamping nut 48, gasket 50 and clamp 52 which serves to grip the outer conductor of the cable. The inner conductor of the cable is soldered within the enlarged portion 54a of a contact 54. The contact 54 also includes a shank portion 54b which fits within the fingers 24 when the plug and receptacle are joined.

The contact 54 is carried within a cylindrical insulator 56, and the insulator 56, in turn, is surrounded by a shell contact 58. The contact 58 is secured to the body 44 by means of a groove 60 into which the forward edge of the body is swaged. The contact 58 terminates in outwardly flared fingers 62 which, when the plug and receptacle are assembled, contact the inner surface 16b of the receptacle 10.

The insulator 56 includes a hollow portion 56a which mates with the insulator 26 of the receptacle 10 when the units are joined. A ring contact 64, which extends around the inner surface 56b of the portion 56a, is located along the axis of the plug 12 as to engage the contacts 36 and 38 in the receptacle 10 when the plug and receptacle are joined.

More particularly, as shown in the dotted line presentation of the drawing, the ring contact 64 rides over the bent over contact portions 36a and 38a when the plug and receptacle are fully engaged. Thus, the portions 36a and 38a serve as camming surfaces, preventing the ring contact 64 from catching on the ends of the contacts 36 and 38. Furthermore, they relieve tolerance problems by providing for engagement with the ring contact over a short, controllable range of axial position of the parts. The flatness of the contacts provides a reasonably large

contact area between the contacts and also permits full engagement of the contacts without unduly distorting the mating parts.

The contacts 36, 38 and 64 within the receptacle 10 and plug 12 are readily positioned to provide a reliable indication of whether or not the coupling nut 40 has been threaded into its last turn on the receptacle thread 18 when the plug and receptacle are joined. With the nut 40 in this position, it is certain that the units are sufficiently engaged for there to be good electrical connections between the fingers 24 and contact 54, as well as between the fingers 62 and the surface 16b of the receptacle.

However, a good electrical connection does not by itself mean satisfactory operation of a connector assembly. The mating parts are designed to provide a minimum impedance mismatch between the connectors and the coaxial cables connected thereby when the two units are fully engaged. Such engagement occurs during the last turn of the coupling nut and thus electrical engagement between the ring contact 64 and contacts 36 and 38, as ascertained by measurement of the electrical resistance between the auxiliary conductors 32 and 34, is an indication of operation of the plug and receptacle in accordance with their optimum design capabilities.

Another advantage of this arrangement results from the fact that when the coupling nut 40 has been rotated almost as far as possible on the thread 18, it is highly unlikely that the plug and receptacle will become disengaged because of shock, vibration, etc. Thus, a low resistance between the conductors 32 and 34 also indicates reliability of the connection.

The increase in voltage standing wave ratio due to the presence of the auxiliary conductors 32 and 34 and the ring contact 64 in the otherwise standard "TNC" assembly is of negligible proportions. This is unexpected in view of the positioning of these parts between the inner and outer conductors of the coaxial system and also in view of increases in the standing wave ratio resulting from prior positioning of conductive members within coaxial lines.

Moreover, leakage of RF energy by way of the conductors 32 and 34 is negligible. This results from the symmetrical disposition of the conductors and the ring contact 64. With this orientation, the diametrically opposed portions of the monitoring system comprising these parts are at the same RF magnetic field. It follows that the energy coupled to the conductors 32 and 34 is of a minimal amount.

A further feature of the monitoring system results from the use of an annular or ring shape of the contact 64. Operation of the system does not depend upon the angular orientation of plug 12 with respect to the receptacle 10.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

I claim:

1. In an improved coaxial connector assembly comprising

(a) a first connector having

- (1) a center conductor provided with an aperture at the connecting end thereof, and
- (2) a first insulator around said first center conductor at said connecting end,

(b) a second connector having

- (1) a second center conductor provided with a first end sized to fit within said aperture, and

(2) a second insulator around said second conductor at said end thereof and radially spaced therefrom,

(3) said first insulator fitting within said second insulator when said end of said second conductor is within said aperture;

the improvement comprising monitoring means including (c) a pair of auxiliary conductors extending along the surface of one of said insulators from the region of overlap with the other insulator in a direction away from said ends of said center conductors,

(d) an annular conductor extending circumferentially along the surface of the other of said insulators,

(e) said annular conductor engaging said auxiliary conductors when said connectors are sufficiently joined together to provide reliable radio frequency contacts between them.

2. The combination defined in claim 1 in which said annular conductor and said auxiliary conductors are so positioned that they are in engagement only when said conductors are substantially fully joined together.

3. The combination defined in claim 1 including

(a) a coupling nut on one of said connectors and

(b) a corresponding screw thread on the other of said connectors,

(c) the position of said nut along said screw thread determining the degree of engagement of said connectors,

(d) said annular conductor and said auxiliary conductors being so positioned that they are in engagement only when said nut has been advanced to the last turn on said screw thread during engagement of said connectors.

4. The combination defined in claim 1 in which said auxiliary conductors are diametrically opposed with respect to the axis of said connectors.

5. An improved coaxial connector assembly comprising, in combination,

(a) a first connector including

(1) a first center conductor having an aperture at a first end thereof,

(2) a first outer conductor member disposed around and coaxial with said first center conductor and having an external thread thereon,

(3) an insulator between and secured to said first center conductor and said first member, said insulator having a radius less than the inner radius of said member in the region adjacent to said aperture.

(4) a pair of diametrically opposed auxiliary conductors disposed between said first center conductor and said first member and extending along said first connector from said region to the end of said first connector remote from said region, said auxiliary conductors being disposed on the outer surface of said first insulator in said region,

(b) a second connector including

(1) a second center conductor having an end sized to fit within said aperture,

(2) an outer conductor sized to fit within and in electrical contact with the interior of said first member in said region,

(3) a second insulator disposed between said second inner conductor and said second outer conductor, said second insulator having an inner diameter at said end of said first conductor at least as great as the outer diameter of said first insulator in said region,

(4) a coupling nut rotatably secured to said outer conductor and having an inner thread adapted for engagement with said outer thread of said first connector,

(5) an annular conducting ring extending circumferentially around said inner surface of said second insulator,

5

(c) the axial positions of said annular conductor and the ends of said auxiliary conductors in said region being such that said annular conductor engages said auxiliary conductors only when said first and second connectors are substantially fully engaged.

6. The combination defined in claim 5 in which said auxiliary conductors have inwardly sloping surfaces at the ends thereof, said surfaces engaging said annular ring when said connectors are substantially fully engaged.

7. The combination defined in claim 6 in which said surfaces are engaged by said annular conductor only when

6

said nut has entered the last turn of its travel along said outer thread during engagement of said connectors.

References Cited in the file of this patent**UNITED STATES PATENTS**

2,870,420	Malek -----	Jan. 20, 1959
2,986,720	Chess -----	May 30, 1961
3,082,396	Bernhard -----	Mar. 19, 1963
3,091,748	Takes et al. -----	May 28, 1963