Nov. 3, 1964 H. E. LOVEJOY 3,155,930

FLANGED CONDUCTIVE SLEEVE FOR CONNECTING STRIP LINE WITH COAXIAL LINE

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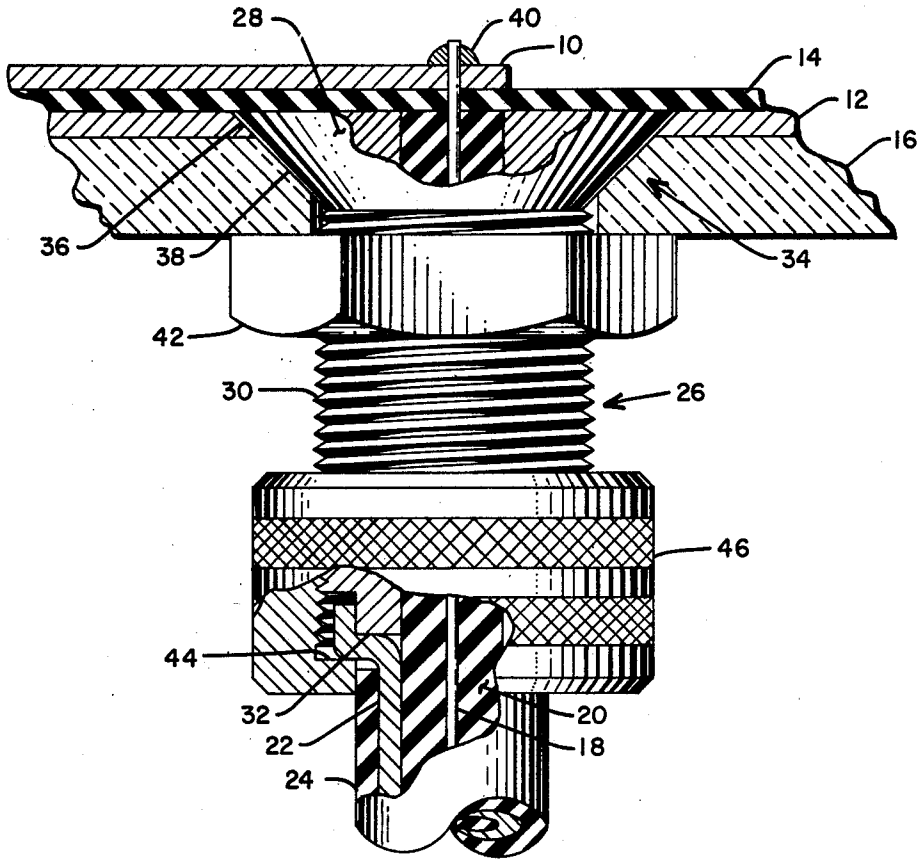


Fig. 1

INVENTOR
HARRY E. LOVEJOY
BY Marvin Jacobson
ATTORNEY

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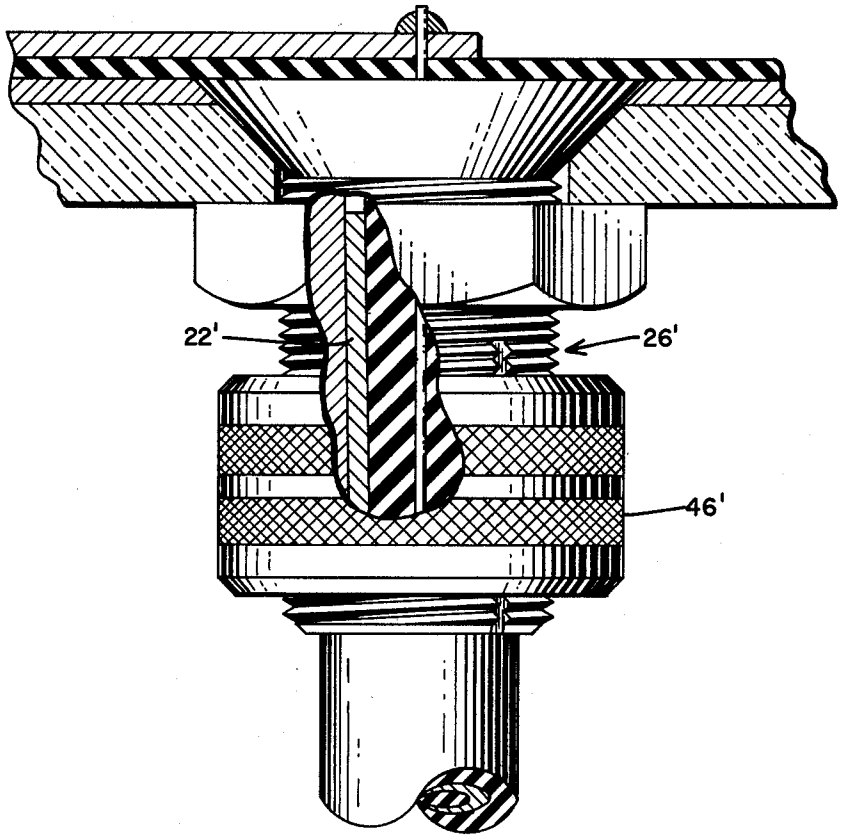


Fig. 2

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FLANGED CONDUCTIVE SLEEVE FOR CONNECTING STRIP LINE WITH COAXIAL LINE

Harry E. Lovejoy, Minneapolis, Minn., assignor to Sperry Rand Corporation, New York, N.Y., a corporation of Delaware

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This invention relates to connectors for use in microwave apparatus and in particular to apparatus for effecting electrical and physical connection between a coaxial cable and a strip transmission line.

Strip transmission lines are finding increasing use in the distribution of extremely high frequency and short duration pulses in electronic equipment. In general, coaxial cables are used to transmit these pulses between particular pieces of equipment or to serve as input and output channels to any given particular piece of equipment which incorporates strip lines for distribution of the pulses. Difficulty is often encountered in adapting coaxial cables into electrical connections with strip transmission lines. Both mechanical and electrical problems occur in making this electrical connection. For example, the difference in geometry between the substantially flat strip transmission line member and the cylindrical coaxial cable often results in poor mechanical connection between the inner signal conductor of the coaxial cable and the signal conductor of the strip transmission as well as the introduction of distortion of the pulse signals. Additionally both mechanically and electrically secure connections between the shielding layer of the coaxial cable and the ground conductor of the strip transmission line is extremely difficult to achieve. Therefore, it is the primary general object of this invention to provide improved means for connecting a coaxial cable to a strip transmission line.

A further object of the invention is to provide a mechanically secure connection between a coaxial cable and a strip transmission line with an accompanying electrical connection which introduces substantially no signal distortion due to said electrical connection.

It is a further object of this invention to provide an electrical connection between a strip transmission line and a coaxial cable while maintaining the geometrical relationships between the conductors of said cable and said strip line at the point of transition.

These and other more specific objects and features will be disclosed in the following specification with reference to the accompanying drawings.

FIG. 1 illustrates a partially cut-away drawing of a preferred embodiment of the invention.

FIG. 2 illustrates a partially cut-away modification of the preferred embodiment.

In FIG. 1, a pair of planer conductors 10 and 12 lying in parallel planes with a layer of dielectric 14 therebetween in a sandwich construction comprises the essential portion of a typical strip transmission line. For descriptive purposes, it will be assumed that the top layer conductor 10 is the signal conductor of the transmission line while the lower layer 12 is the ground plane of the strip transmission line. Of course, additional layers with dielectric therebetween can be added to the three layer sandwich arrangement shown in the figure, as for example by including a further layer of dielectric and ground line conductor above the signal conductor 10. However, for ease of explanation only the two layers of conductor with dielectric therebetween is shown. In general the two conductors 10 and 12 are thin strips of copper of thickness that may be in the order of .014 inch with the dielectric 14 in the order of .005 inch thick laminated on a suitable substrate 16 which provides a fairly rigid support for the strip transmission line. The foregoing dimensions are

only intended to be illustrative and not limitive. The illustrative coaxial cable is of any well known type and comprises a centrally located signal conductor 18 enclosed by a layer of insulating material 20, a further layer of braided copper shielding 22 and may further include an outer protective insulating layer 24.

A length of the coaxial cable extending back from its terminating end is enclosed by a sleeve member, designated generally as 26, which is of an electrically conductive material. Towards the terminal end of the coaxial cable the sleeve member is flanged as shown at 28 and extending longitudinally along the cable from the end of the flanged portion, the cylindrical sleeve member is externally threaded as shown at 30. At the end 32 opposite the flanged end, the sleeve member is brought into electrical contact with the coaxial cable shield 22. Preferably, the flanged portion is tapered in an inverted conical shape as shown, however, it is in contemplation of the instant invention that other configurations can be utilized within the teaching of this invention while achieving the same objectives and advantages. An internally threaded retaining member is threadably engaged with the external threads of the sleeve member to securely couple the coaxial cable shielding to the sleeve member as shown. Obviously there are many other ways of insuring a good electrical contact between the shield and the sleeve member, for example, as illustrated in FIG. 2, the shield 22' could continue along the length of the cable toward the dielectric layer 14 and be securely clamped to the sleeve member 26' by having the sleeve member at least partially split along its length with a slight taper so that threading the retainer 46' on the sleeve member will secure the mechanical and electrical connections between the shielding and the sleeve member.

As shown generally at 34, a tapered opening extends through the bottom transmission line conductor, ground plane 12, and the substrate 16 with the taper substantially conforming to the configuration of the tapered flange of the sleeve member 26. The tapered flange is in the form of a portion of an inverted cone with the surface of the base of the cone in juxtaposition with the dielectric layer 14, while the outer peripheral surface of the flange is in juxtaposition with the ground plane 12, shown at 36, and the substrate 16, as shown at 38. A further aperture through the dielectric layer 14 allows the inner signal conductor 18 of the coaxial cable to pass through the dielectric layer into contact with the signal conductor 10 of the strip transmission line. Preferably, the coaxial cable signal conductor passes through the signal conductor of the transmission line and is soldered to the latter as indicated in the figure at 40. Nut 42 which is also threadably engaged with the sleeve member serves to secure the flanged portion when seated in the tapered aperture to the ground plane conductor 12, and the substrate 16 to insure a good mechanical and electrical connection respectively with the former and the latter. Mechanical stresses which would normally be placed on the electrical connections are primarily absorbed by the substrate member to insure a solid mechanical and electrical connection between the coaxial cable conductors and the respectively corresponding conductors of the strip transmission line.

The series of steps undergone to effect the connection described in FIG. 1 and above will now be described to further aid in understanding the invention. It should be understood that the following described steps are illustractive and not intended to be limitative. Initially the sandwich construction of the strip transmission line of the substrate is made of two parts with the ground plane conductor, 12, formed on the substrate, 16, using any well-known printed circuit technique to comprise a first part of the construction and the signal conductor 10 with

the dielectric layer 14 comprising the other portion of the construction. The tapered aperture designated generally at 34 is formed either through drilling and counter sinking, or punching, or a combination of same, through the substrate and the ground plane conductor. The sleeve member 26 is inserted in the aperture with the flanged portion seated in the aperture to provide a feed-through for the coaxial cable. Obviously, the tapered aperture for receiving the flanged portion of the sleeve member could be preformed in the substrate by casting and the layer of copper, which forms the ground plane conductor, later laminated upon the substrate with the proper configurations. Nut 42 is then threaded on the sleeve member to firmly seat the flanged portion of the sleeve member in the tapered aperture to effect a secure mechanical connection between the substrate and the sleeve member and also to make a secure electrical connection between the sleeve member and the ground plane conductor of the transmission line. The second portion of the strip transmission line, including signal conductor 10 and the dielectric layer 14 is then laminated onto the ground plane conductor so that the bottom of the dielectric layer is flush with the top surface of the flanged portion of the sleeve member thereby insuring that the conductors of the strip transmission line are in substantially parallel planes. An opening extending through the signal line conductor and the dielectric layer of sufficient size to receive the inner conductor 18 of the coaxial cable is made either by drilling or, of course, could have been initially formed during the printed circuit operational steps when forming the signal conductor on the dielectric layer. At this juncture the terminating end of the coaxial cable is prepared prior to insertion in the sleeve member. A small length of the inner insulating layer 20, the copper shielding 22 and the outer insulating layer 24 is stripped and removed from the coaxial cable to provide a length of the inner conductor 18 to pass through the dielectric layer and the signal conductor 10. A further length of the braided shielding is also stripped back and flared away from the inner insulating layer and a further portion of the outer insulating layer is also removed. The terminating end of the coaxial cable is then passed through the feed-through sleeve member so that the inner signal conductor passes through the dielectric layer and the signal line of the transmission line and the inner insulating layer of the cable is brought flush to the bottom of the dielectric layer 14. The flared away shielding forms itself around the shoulder 32 of the sleeve member so that when retainer 46 is threaded onto the sleeve member the over hanging lip portion 44, thereof forces the braid or shielding into close electrical contact with the sleeve member. The end of the signal conductor of the coaxial cable is then soldered to the signal line conductor of the transmission line, as shown at 40, and any portion thereof jutting out above the solder connection is removed. It can be seen then that in the construction shown and described there is substantially no discontinuity of geometrical arrangement of the coaxial cable and the strip transmission line since the inner signal conductor of the coaxial cable is enclosed by the electrical shielding throughout substantially all its length, except for the very thin layer of dielectric and the signal line as well as the ground line of the transmission line retain their geometrical relationships with each other and with respect to the corresponding conductors of the coaxial cable.

It is thus apparent that there is provided by this invention a method and apparatus in which the advantages and objects set forth hereinabove are achieved.

It is understood that suitable modifications may be made in this structure as disclosed provided such modifications come within the spirit and scope of the appended claims. Having now, therefore, fully illustrated my invention, what I claim to be new and desire to protect by Letters Patent is:

1. In combination: A strip transmission line comprising a pair of substantially flat, parallel conductors with a dielectric therebetween; a substantially flat, non-conducting, rigid support member for said transmission line; a coaxial cable having at least an inner signal conductor and a shielding conductor with a dielectric therebetween, a length of said cable extending from one end oriented substantially perpendicular to said transmission line with the signal conductor passing insulatively through one of the transmission line conductors into electrical contact with the other transmission line conductor; an electrically conductive sleeve member having a flanged portion, said sleeve secured to said cable and in electrical contact with the shielding conductor; and means for securing the flanged portion of the sleeve member into supporting relationship with said support member and into electrical contact with said other transmission line conductor.

2. In combination: A strip transmission line comprising a pair of substantially flat, parallel conductors with a dielectric therebetween; a substantially flat, non-conducting, rigid support member for said transmission line; a coaxial cable having at least an inner signal conductor and a shielding conductor with a dielectric therebetween, a length of said cable extending from one end oriented substantially perpendicular to said transmission line with the signal conductor passing insulatively through one of the transmission line conductors into electrical contact with the other transmission line conductor; an electrically conductive sleeve member having a cylindrical portion and a flanged portion; said cylindrical portion securely enclosing said length of cable and in electrical contact with the shielding conductor; the flanged portion abutting the support member in supported relationship therewith and in electrical contact relationship with said one transmission line conductor; and means for securing the flanged portion in said relationships.

3. In combination: A strip transmission line comprising a top layer signal conductor, a bottom layer ground conductor and a dielectric layer therebetween; said transmission line lying in supported relationship on a substantially flat layer of insulating substrate; an electrically conductive feed-through member disposed substantially perpendicular to the transmission line and passing through said substrate, said feed-through member having a flanged portion seated in supported relationship in said substrate and in electrical contact with said ground conductor; means for securing the feed-through member in said position; a coaxial cable having at least an inner signal conductor, an inner insulating layer and a shielding layer; said coaxial cable signal conductor passing insulatively through said feed-through member and the transmission line ground conductor into electrical contact with the transmission line signal conductor; and means for releasably attaching the coaxial cable shielding to said feed-through member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,774,046	Arditi et al.	Dec. 11, 1956
2,794,174	Arditi et al.	May 28, 1957
2,825,875	Arditi	Mar. 4, 1958
2,922,968	Van Potter	Jan. 26, 1960
2,983,884	Rueger	May 9, 1961