Jan. 24, 1961 D. R. J. WHITE 2,969,510

ULTRA HIGH FREQUENCY CONNECTOR

Filed Feb. 27, 1957 2 Sheets-Sheet 1

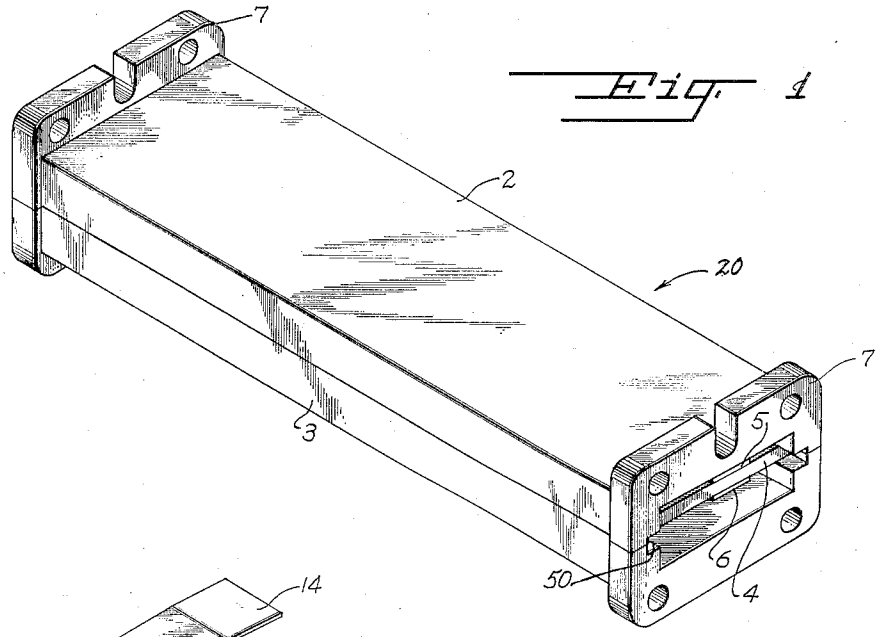


Fig. 1

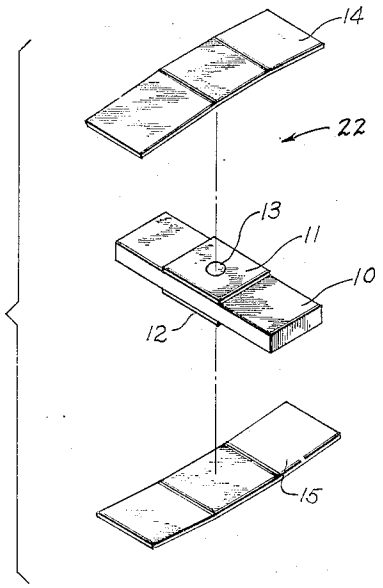


Fig. 3

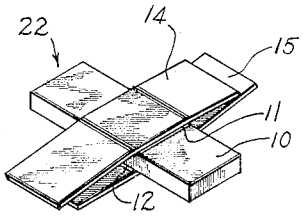


Fig. 2

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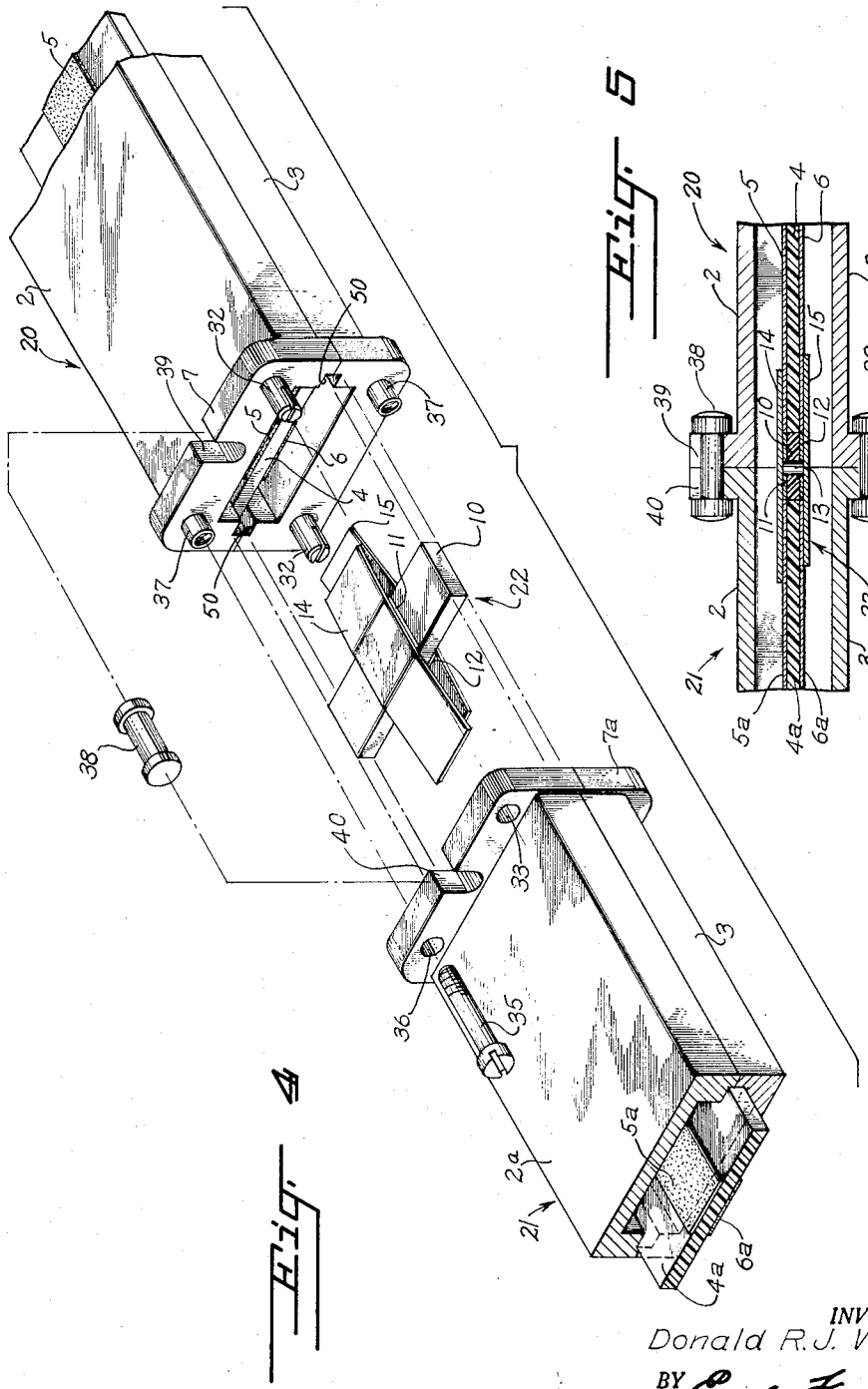


Fig. 4

Fig. 5

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ULTRA HIGH FREQUENCY CONNECTOR

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7 Claims. (Cl. 333—33)

This invention relates to electrical connectors and more particularly to connectors for coupling together ultra and super high frequency transmission lines.

The interest in microwave strip circuits has increased greatly in recent years, and as a result printed microwave transmission lines are being used to guide ultra high frequency electromagnetic waves in many circuit configurations. Printed microwave components are generally smaller in size and weight and less expensively reproduced than the usual coaxial or waveguide structures and therefore their use is highly desirable.

The transfer of electromagnetic energy by the use of microwave strip circuits or printed microwave transmission lines is an established fact and is constantly being employed both in laboratory and field work. Printed microwave transmission lines are produced in a plurality of configurations and designated by many names, such as: "stripline," "microstrip," "tri-plate" or "microwave printed circuits." One commonly utilized structure is derived by deforming a coaxial conductor so that the center and upper conductors are first imagined to be rectangular and then deforming the sidewalls of the outer conductor so that they are extended to infinity and flattening the side walls of the inner conductor to form the resulting flat strip transmission line. A dielectric sheet is utilized to support the strip center conductor which may be printed on one or both surfaces of the dielectric sheet by any of the many well known techniques. The dielectric sheet may then be positioned between the outer conductor ground planes to form a dielectric sheet supported transmission line.

In another common form of printed microwave transmission line dielectric material is utilized to fill the area between the center conductor and the ground planes, thus forming a dielectric sandwich transmission line or dielectrically loaded line.

In still another common form, the center strip conductor is supported at spaced intervals on dielectric rods or supports and the center conductor width is varied to compensate for the discontinuities introduced by the supports. This configuration is often known as a compensated stub supported transmission line.

Still another form of printed microwave transmission line, which has found wide acceptance, comprises a strip-like conductor supported on a dielectric sheet in a spaced parallel relation to a conductive ground plane.

The problem of joining various sections of printed microwave transmission lines has been difficult to overcome. Thus, in many instances a complete microwave circuit has had to be fabricated rather than the more desirable procedure of building up a circuit through the use of interconnected "building blocks." Often users of printed microwave circuits requiring interconnection would make the transition from printed circuit to coaxial or waveguide transmission line, and back again to printed circuit lines, only because of the greater efficiency, reliability and knowledge attained of the transition devices and the complete lack of practical and useful printed

circuit connectors. The precision requirements for printed circuit connectors rendered the manufacture thereof difficult and is a prime reason for their lack of practicality.

One of the objects of this invention, therefore, is to provide a simplified form of printed microwave transmission line connector and housing.

Another object of this invention is to provide a simple printed microwave transmission line connector that may be employed to interconnect two portions of a printed microwave circuit.

Still another object of this invention is to provide a novel structure for the interconnection of printed microwave transmission lines which is of a character readily adopted to various printed circuit techniques, easy of manufacture and having low loss characteristics.

One of the features of this invention, therefore, is to provide a printed microwave transmission line connector comprising a central dielectric support for two elongated spring fingers which are clamped over the strip portion of a printed circuit transmission line.

Another feature of this invention is to provide an easily produced practicable printed microwave transmission line connector having two elongated overlapping spring fingers which can be utilized in making a "blind" connection.

The above mentioned other objects and features of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, in which—

Fig. 1 is a perspective view of one embodiment of a printed microwave transmission line including a continuous dielectric supported strip-line in an air medium;

Fig. 2 is a perspective view of one embodiment of the assembled printed microwave transmission line connector in accordance with the principles of my invention;

Fig. 3 is an exploded view of the printed microwave connector shown in Fig. 2;

Fig. 4 is an exploded view of printed microwave transmission lines and the connector therefor in accordance with the principles of my invention; and,

Fig. 5 is a sectional view of the printed microwave transmission lines connected by a connector in accordance with the principles of my invention.

Referring to Fig. 1 of the drawing, one embodiment of a printed microwave transmission line 20 is shown therein to comprise a housing formed of upper and lower metallic ground plane structures 2 and 3 respectively. The ground plane housing structures 2 and 3 support in slots 50 a sheet of dielectric material 4 which has conductive strips 5 and 6 clad thereto; one conductive strip 5 being the mirror image of the conductive strip 6. As will be apparent to those skilled in the art, one of the conductive strips 5 or 6 may be omitted although both are used in the preferred form illustrated. The upper and lower ground plane housing structures 2 and 3 may be extruded, molded, cast or otherwise manufactured by low cost production methods. These metal housing structures 2 and 3 may be aluminum or other suitable conductive material and can be secured together to form the housing through the use of eyelets, rivets or machine screws. It is, of course, obvious that the housing may be formed of one piece of extruded metal with suitable slots 50, into which the printed circuit may be inserted.

The ground plane housing structures 2 and 3 together with the dual strip clad dielectric sheet 4 form a microwave transmission line of the strip or printed circuit type, operating in essentially an air dielectric medium and propogating energy in essentially the TEM mode. Flanges 7 may be provided at both ends of the housing structures 2 and 3 for connecting transmission line 20 to other circuit components.

Referring to Figs. 2 and 3, the printed microwave transmission line connector 22 in accordance with the principles of my invention is therein shown to comprise a dielectric base or supporting strip 10 made of an insulating material preferably similar to that of the main line such as fiber glass or other equivalent dielectric. Copper foil or other conductive material is clad to the dielectric as shown at 11 and 12. A brass pin or equivalent 13 electrically connected to upper and lower copper foil clad 11 and 12 maintains both foils at the same potential. A pair of spring fingers 14 and 15 made of thin beryllium copper or Phosphor bronze or equivalent spring-like conductive materials are soldered or otherwise connected to the copper clad strips 11 and 12 in such a manner that the spring fingers 14 and 15 overlap one another at both ends respectively.

Referring to Figs. 4 and 5 of the drawing, a pair of microwave transmission lines 20 and 21 are interconnected through the use of an inner transmission line connector 22 and outer connector 38. Transmission line 21 is identical to transmission line 20, shown in Figs. 1 and 4. Corresponding parts of transmission line 20 are identified with the same reference numerals with a suffix "*a*." In order to connect the printed dielectric sheets 4 and 4*a* of transmission line circuits 20 and 21 respectively, the lower spring finger 15 is placed under the lower copper clad strip 6 of dielectric sheet 4 and an upward pressure on the dielectric support 10 forces the lower spring finger 15 away from the upper spring finger 14. Spring finger 14 is then slipped over the top of the dielectric sheet 4 into contact with the printed conductive strip 5. The connector 22 is then moved into the opening of the housing 2—3 until the dielectric base 10 enters the slot 50 formed between the housing structures 2 and 3. Further movement of connector 22 will cause the dielectric base 10 to abut against the end of the dielectric strip 4 and, as shown in Fig. 5, the opposing ends of the resilient fingers 14 and 15 will respectively be spring pressed into contact with the printed conductive strips 5 and 6.

Transmission line 21 is now joined to transmission line 20 by placing the end of the dielectric sheet 4*a* under the projecting end of resilient strip 14 so as to force this end of strip 14 away from the opposing end of strip 15. This permits the insertion of dielectric strip 4*a* between these opposing ends of strips 14 and 15 as the flange of 7*a* of transmission line 21 is brought into abutment with flange 7 of transmission line 20. The portion of the dielectric base 10 extending from slot 50 in flange 7 will enter a corresponding slot (not shown) in flange 7*a*. As disclosed in the sectional view of Fig. 5, the dielectric base 10 is thus positioned between the two housing structures 20 and 21 and is in contact with the two dielectric strips 4 and 4*a*. Also, the dielectric strips 4 and 4*a* are respectively gripped between the opposing ends of the resilient fingers 14 and 15.

Figs. 4 and 5 show several means for locking together the two transmission lines 20 and 21 with flange 7*a* in abutment against flange 7 and corresponding parts in axial alignment. One type of locking means may comprise a split chamfered pin 32 connected to flange 7 of transmission line 20 which fits into a receiving hole 33 in flange 7*a* of transmission line 21. Another form of connection comprises two or more systems made up of a bolt 35 and a chamfered and internally threaded metal bushing 37. The bushing 37 is fixed at one end to flange 7 and at its other end fits into a receiving hole 36 of flange 7*a* to hold the sections of the waveguide in alignment. The bolt 35 is threaded into the internal threads of bushing 37 to hold the sections of the waveguide together. Alternately a simple universal type connector 38 may be fitted into U-shaped slots 39 and 40 in flanges 7 and 7*a*, respectively, in order to secure the printed microwave line systems for quick release.

It is, of course, obvious to one skilled in the art that many other configurations may take place without departing from the spirit of this invention. For example, only one spring finger need be used if there be only a single strip transmission line instead of the dual or mirror image strip line shown, or the edges of the strip transmission line may be narrowed to minimize reflections and assist in achieving a good match or the finger may be made a permanent or integral part of the lines per se, or many other forms of transmission lines may be utilized.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made by way of example only and not as a limitation to the scope of the invention as set forth in the objects thereof and in accompanying claims.

I claim:

1. A printed strip type transmission line comprising a plurality of coaxal sections, each of said sections including a tubular conductor and an inner conductive strip insulatingly supported coaxially within said tubular conductor, and means joining an end of a first one of said coaxial sections to an end of a second one of said coaxial sections so as to obtain an electrical impedance match between said joining means and joined sections, said means comprising a support and a pair of resilient conductive members mounted on opposite sides of said support, said support positioned between said ends of said first and second coaxial sections with said inner conductive strips of said first and second coaxial sections being fractionally held between said pair of resilient members.

2. A printed strip type transmission line comprising a plurality of coaxial conductors, each of said coaxial conductors including a conductive tube and an inner conductive strip insulatingly supported coaxially within said conductive tube, and means joining an end of a first one of said coaxial conductors to an end of a second one of said coaxial conductors the characteristics of said joining means being such as to obtain an electrical impedance match between said joined coaxial conductors, said means comprising a support and a pair of resilient metal fingers each having two end portions thereof extending from said support, each of said two end portions of one of said pair of resilient fingers extending over and bent toward and opposing a different one of said two end portions of the other of said pair of resilient fingers, said support positioned between said ends of said first and second coaxial conductors with said inner conductive strips of said first and second coaxial conductors each being frictionally held between a different pair of opposing end portions of said resilient fingers.

3. A printed strip type transmission line comprising a first and a second coaxial conductor, said first and second coaxial conductors each including a conductive tubular housing and an inner conductive strip insulatingly supported within said conductive housing and extending coaxially substantially the length of said conductive housing, and a coupling means joining one end of said first coaxial conductor to one end of said second coaxial conductor the characteristics of said coupling means being such as to obtain an electrical impedance match between said coupling means and joined coaxial conductors, said coupling means including a support member positioned between said ends of said first and second coaxial conductors and in alignment with said conductive strips thereof and a pair of resilient metal strips mounted on said coupling means support member, one end of each of said pair of resilient metal strips extending into said tubular housing of said first coaxial conductor into frictional engagement with said inner conductive strip thereof, and the other end of each of said pair of metal strips extending into said tubular housing of said second coaxial conductor into frictional engagement with said inner conductive strip thereof.

4. A printed strip type transmission line comprising a first and a second coaxial conductor, said first and second coaxial conductors each including a conductive hous-

ing and a strip of dielectric material supported within said conductive housing and extending coaxially substantially the length of said conductive housing, a layer of conductive material extending the length of each of said dielectric strips and on one surface thereof, and a coupling means joining one end of said first coaxial conductor to one end of said second coaxial conductor the configuration of said coupling means being such as to obtain an electrical impedance match between said coupling means and joined coaxial conductors, said coupling means including a support member positioned between said ends of said first and second coaxial conductors and in alignment with said dielectric strips thereof, a pair of resilient metal strips mounted on said coupling means support member with one end of each one of said pair of resilient metal strips extending into said tubular housing of said first coaxial conductor and the other end of each of said pair of resilient metal strips extending into said tubular housing of said second coaxial conductor, said dielectric strip of said first coaxial conductor being frictionally held between said one ends of said pair of resilient metal strips, and said dielectric strip of said second coaxial conductor being frictionally held between said other ends of said pair of resilient conductive strips.

5. A printed strip type transmission line comprising a first and a second coaxial conductor, said first and second coaxial conductors each including a conductive tubular housing, a strip of dielectric material supported within said conductive housing and extending coaxially substantially the length of said conductive housing and a layer of conductive material extending substantially the length of said dielectric strip on one surface thereof, a coupling means joining one end of said first coaxial conductor to one end of said second coaxial conductor, said coupling means including a support member positioned between said ends of said first and second coaxial conductors and in alignment with said dielectric strips thereof, a pair of resilient metal strips mounted on said coupling means support member between said strips and with one end of each one of said pair of resilient metal strips extending into said tubular housing of said first coaxial conductor and the other end of each one of said pair of resilient metal strips extending into said tubular housing of said second coaxial conductor, said dielectric strip of said first coaxial conductor being frictionally held between said one ends of said pair of resilient metal strips, and said dielectric strip of said second coaxial conductor being frictionally held between said other ends of said pair of resilient conductive strips, one of said pair of resilient metal strips conductively joining said layer of conductive material in said first coaxial conductor with said layer of conductive material in said second coaxial conductor so as to obtain an electrical impedance match between said metal strips and said joined conductive layers.

6. A printed strip type transmission line comprising a first and a second coaxial conductor, said first and second coaxial conductors each including a conductive tubular housing, a strip of dielectric material supported within said conductive housing and extending coaxially substantially the length of said conductive housing and layers of conductive material extending substantially the length of said dielectric strip on opposite surfaces thereof, and a coupling means joining one end of said first coaxial conductor to one end of said second coaxial conductor, said coupling means including a support member positioned between said ends of said first and second coaxial conductors and in alignment with said dielectric strips thereof, a pair of resilient metal strips mounted on said coupling means support member with said member between said metal strips and with one end of each one of said pair of resilient metal strips extending into said tubular housing of said first coaxial conductor and the other end of each one of said pair of resilient metal strips extending into said tubular housing of said second coaxial conductor, said dielectric strip of said first coaxial conductor being frictionally held between said one ends of said pair of resilient metal strips, and said dielectric strip of said second coaxial conductor being frictionally held between said other ends of said pair of resilient conductive strips, each one of said pair of resilient metal strips conductively joining one of said layers of conductive material in said first coaxial conductor with one of said layers of conductive material in said second coaxial conductor, said metal strips having a configuration to obtain an electrical impedance match between said metal strips and joined conductive layers, and means conductively joining said pair of resilient metal strips.

7. A printed strip type transmission line comprising a plurality of coaxial sections, each of said sections including a tubular conductor conductively joined at each end to a flange and an inner printed conductive strip insulatingly supported coaxially within said tubular conductor; and connecting means joining a flanged end of a first one of said coaxial sections to a flanged end of a second one of said coaxial sections, said connecting means comprising a pair of resilient conductive members and an insulating support between said members with a configuration for obtaining an electrical impedance match between said resilient strip members, support and both said joined inner conductive strips, said support positioned between said ends of said first and second coaxial sections with said inner conductive strips of said first and second coaxial sections being frictionally held between said pair of resilient members, and fastening means for conductively fastening said joined flanges together.

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