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DIRECTIONAL COUPLERS

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FIG. 1

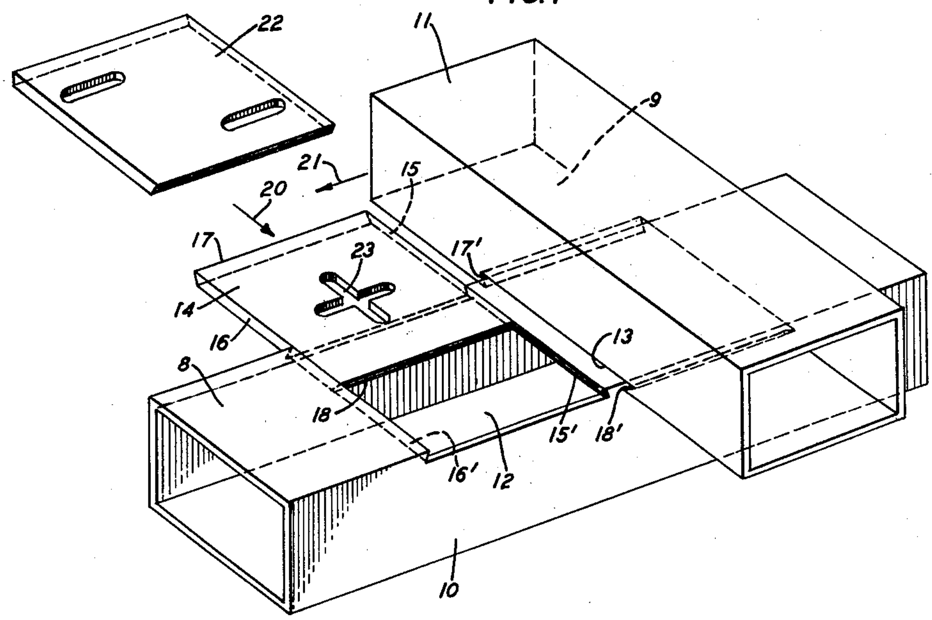
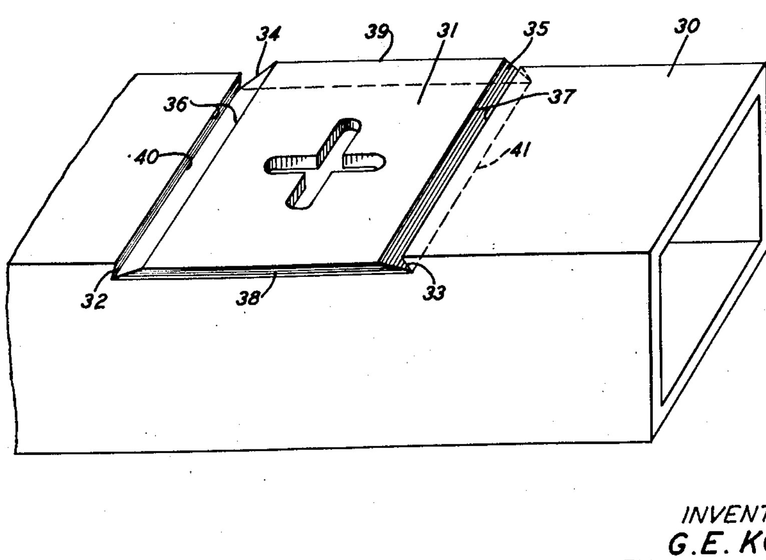


FIG. 2



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DIRECTIONAL COUPLERS

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4 Claims. (Cl. 333—10)

This invention relates to electrical wave coupling devices and more particularly to an improved method of fabricating cross-guide directional couplers.

In both experimental work and in small production runs, there has been a need for an improved method of fabricating cross-guide directional couplers. Presently employed production methods which are both structurally and electrically sound employ casting or electroforming techniques. When only a small number of units are to be made, however, the use of these methods of production is particularly uneconomical. Furthermore, the units so manufactured lack the flexibility required of this type of transmission component in experimental development where changes in the method and amount of coupling between guides are often made in the course of the work.

When only a small number of couplers are to be made, the most popular method of fabrication presently employed utilizes the so called "common wall" coupling plate. In this method of construction a precision square plate, as thick as the waveguide wall and the same width as the waveguide to be used, is soldered into an opening cut to the plate size and thickness between the two waveguides to be coupled. Generally the guides are coupled at right angles to each other. The plate thus forms a "common wall" over the common region or junction of the crossed guides. The size of the coupling holes and their reltaive positions can be controlled to closer tolerances before soldering to a greater extent in this manner of construction than by attempting to put the coupling holes in one guide and removing the wall from only the mating crossed guide. With either method of construction however, the assembly is soft soldered together to avoid the heat distortion caused by the higher temperature but stronger alloys. The result is a component of low mechanical strength which is unable to resist the stress and strain imposed by other microwave components attached thereto. In addition, unless extreme care is used when soldering, poor joints result which impair the electrical performance of the coupler.

It is therefore an object of this invention to provide an economical method of constructing cross-guide couplers for the transfer of electromagnetic wave energy which are both mechanically strong and electrically efficient.

Couplers built in accordance with the techniques outlined above are fundamentally permanent structures. As such they do not lend themselves to experimental work where it is often very desirable to change the mode of coupling or the amount of coupling between the two coupled guides. As a laboratory component, it would be highly desirable to have a coupler which may be readily disassembled.

It is therefore a further object of this invention to provide cross-guide couplers in which the common wall may be easily and quickly replaced.

In accordance with the present invention a common wall plate and waveguides of dovetailed construction are

provided. In this dovetailed coupler, the edges of the coupling plate are tapered at some angle in contrast to the straight edges previously used. Similarly, the edges transverse to the guide axes along the apertures cut in the guide walls to form the coupling region are also tapered to receive the tapered common wall plate. The plate is slid transversely into place in the first guide thereby replacing the portion previously removed therefrom. The coupling plate is made slightly larger than the first waveguide width to allow for the overlap caused by the dovetailed edges which engage the second waveguide. The latter is similarly slid into place by movement transverse to its axis.

It is a feature of the present invention that a coupler so constructed may be assembled without soldering and when so assembled with be both mechanically strong and electrically efficient. It is a further feature that numerous common wall plates may be made with an assortment of coupling apertures of different design and size which may be easily and quickly replaced in the coupler.

Where a more permanent structure is desired, the edge angles on the common wall plate are made slightly smaller than the corresponding edge angles on the guide walls. In such a case, a small fillet is formed when the plate is in place into which solder may be flowed. It will be noted, however, that the solder is not relied upon for mechanical strength nor for electrical efficiency, the latter being determined to a great extent by the knife edges on the plate which make intimate contact along the length of the junctions of the guide walls and the common wall plate.

These and other objects and features, the nature of the present invention and its various advantages, will appear more fully upon consideration of the specific illustrative embodiments shown in the accompanying drawings and described in the following detailed description of these drawings.

In the drawings:

Fig. 1 is a perspective view of a partially assembled cross-guide coupler made in accordance with the present invention;

Fig. 2 is a perspective view of a partially assembled cross-guide coupler showing the solder fillet formed by the dissimilar dovetail angles.

Referring now to the drawings and in particular to Fig. 1, there is shown a partially assembled cross-guide coupler constructed in accordance with the invention comprising a pair of conductively bounded rectangular transmission lines **10** and **11** for guiding electromagnetic wave energy and the common wall coupling plate **14**. Transmission lines **10** and **11** have a wide internal cross-sectional dimension of at least one-half wavelength of the wave energy to be conducted therein, and a narrow dimension substantially one-half of the wide dimension. A portion of wide walls **8** and **9** of guides **10** and **11** have been cut away leaving apertures **12** and **13**, respectively, in the guides. Extending transversely across the width of guide **10** are the edges **15′** and **16′** in wall **8** beveled at an angle to the plane of wall such that the longitudinal distance along the inside of wall **8** between edges **15′** and **16′** is greater than the longitudinal distance along the outside of wall **8** between edges **15′** and **16′**. Similarly, edges **17′** and **18′** extending transversely across guide **11** in wall **9** are beveled in a like manner at an angle to the plane of wall **9**.

Partially inserted over aperture **12** is the common wall coupling plate **14**. The latter comprises a conductive member in which there is located a coupling aperture **23** for transferring electromagnetic wave energy between guides **10** and **11**. Aperture **23** is designed in accordance with procedures well known in the art as illustrated, for example, in United States Patent 2,473,274, issued to

W. E. Bradley on June 14, 1949. As disclosed therein, aperture 23 may comprise a pair of mutually perpendicular slits so disposed that unidirectional traveling waves in the first guide produce unidirectional traveling waves in the second guide.

The transversely extending edges 15 and 16 of plate 14 are beveled at the same angle as edges 15' and 16' of guide 10. Plate 14 may then be slidably inserted between edges 15' and 16' to cover aperture 12 as indicated by arrow 20. The dimensions of plate 14 and aperture 12 are such that the plate is tightly held in intimate contact with the guide, and forms a smoothly continuous surface along the inside thereof. In addition to forming a good electrical connection for the passage of electromagnetic wave energy within the guide, a strong mechanical bond is achieved between the plate and the guide.

When plate 14 is in position covering aperture 12, edges 17 and 18 extend slightly over the sides of guide 10 sufficiently to engage edges 17' and 18' of guide 11. The latter is connected by aligning edges 17 and 17', and 18 and 18' and sliding guide 11 over plate 14 as indicated by arrow 21.

When fully engaged, guide 11 is held in intimate contact with plate 14 forming a continuous conductive surface within the guide for the propagation of electromagnetic wave energy therethrough. In addition, a strong mechanical bond is established between guide 11 and plate 14.

Coupling plate 14, thus provides both the mechanical and electrical link between the two coupled guides. By virtue of the dovetailed construction a strong solderless mechanical bond is established. In addition, plate 14 forms an electrically continuous common wall between the guides in which there is located the desired coupling means in the form of apertures or otherwise.

Also illustrated in Fig. 1 is a second common wall plate 22. The latter is merely illustrative of the many plates which may readily be inserted in place of plate 14 merely by sliding guide 11 off and sliding plate 14 out. This operation may be performed in a matter of seconds thus making this type of dovetailed coupler extremely handy in laboratory work where frequent changes in coupling may be desired.

Where a more permanent structure is required, the coupler as illustrated in Fig. 2 may be used. In this embodiment of the invention, edges 32 and 33 of guide 30 are beveled at a slightly different angle than edges 34 and 35 of plate 31. Thus, when fully engaged, fillets 36 and 37 are formed between the edges. The space thus left may then be filled with solder to form a continuous surface. It should be noticed, however, that the solder is not relied upon either for electrical continuity or mechanical strength. When in place, the knife edges 40 and 41 of plate 31 come in close contact with the inside of the waveguide to provide the necessary electrical path for wave energy being propagated within the guide. Similarly, by undercutting the edges 32 and 33, the plate is firmly held in place with or without the application of solder along the fillets. Thus, soft solders may be used thereby avoiding the danger of warping of the guide due to high temperatures which would be required if the stronger alloy solders had to be used to provide the necessary mechanical strength.

Edges 38 and 39 may be cut either to engage the second waveguide (not shown) or they may be cut at a slightly different angle to form a second set of fillets when the cross-guide is in position.

In all cases it is understood that the above-described arrangements are simply illustrative of a small number of the many possible specific embodiments which can represent applications of the principles of the invention. Numerous and varied other arrangements can readily be devised in accordance with these principles by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An electromagnetic wave energy transfer system comprising a pair of rectangular waveguides each having a portion of a wall removed to form an aperture therein, the guide wall edges defining said apertures and oblique to the axis of said respective guides being beveled at an angle to said walls, and means for physically connecting said guides including a conductive plate having beveled edges dimensioned to be slidably received by said apertures and coupling means disposed along said plate for coupling said wave energy between said pair of wave guides.

2. Means for electrically and mechanically inter-connecting a pair of conductively bounded rectangular waveguides comprising a first waveguide having a portion of a wall removed to form a common wall region, the wall edges along said region oblique to the axis of said first guide being beveled at an angle such that the longitudinal distance between edges along the inside of said first guide is greater than the longitudinal distance between edges along the outside of said first guide, a conductive member proportioned to have the same size and shape as said common wall region having a first pair and a second pair of opposite edges beveled to be slidably received by said first guide in said common wall region forming a tightly fitting contact between said first guide and said member along said first pair of opposite edges, a second waveguide having a portion of a wall removed to form a common wall region, the wall edges along said region oblique to the axis of said second guide being beveled at an angle such that the longitudinal distance between edges along the inside of said second guide is greater than the longitudinal distance between edges along the outside of said second guide, said common wall region in said second guide proportioned to be slidably received by said member along said second pair of opposite edges forming a tight fitting contact along said second pair of edges, and coupling means in said member to electrically couple said first guide to said second guide.

3. The combination according to claim 2 wherein the bevel angle on said member is the same as the bevel angle on said guide walls.

4. The combination according to claim 2 wherein the bevel angle on said member is different than the bevel angle on said guide walls forming fillets along said edges when said member is slidably received by said guide, said fillets being filled with solder to bond said member to said guides.

References Cited in the file of this patent

UNITED STATES PATENTS

2,702,884	Riblet	Feb. 22, 1955
2,786,486	Perkins	Mar. 26, 1957

FOREIGN PATENTS

519,660	Germany	Mar. 2, 1931
17,137/34	Great Britain	May 28, 1935
265,774	Switzerland	Mar. 16, 1950