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Marchalot

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[54] **OPTIMIZED RECTANGULAR WAVE GUIDE TO CIRCULAR WAVE GUIDE COUPLER**

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[51] **Int. Cl.²** **H01P 5/08;** H01P 1/16

[58] **Field of Search** ..... 333/10, 21 R, 21 A, 98 M

[56] **References Cited**

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[57] **ABSTRACT**

Optimized rectangular wave guide to circular wave guide coupler making it possible to favor, in one version, the circular TE_{01} mode and in the other version, the circular TE_{02} mode, wherein a tongue constituted by a sector portion has a constant arc diametrically opposite to the coupling holes and joined by a sector portion opening out progressively from a fine ridge in the absence of the coupling holes. In the TE_{01} version, the sector having a constant opening has an arc of 60° and in the TE_{02} version, 90°.

3 Claims, 8 Drawing Figures

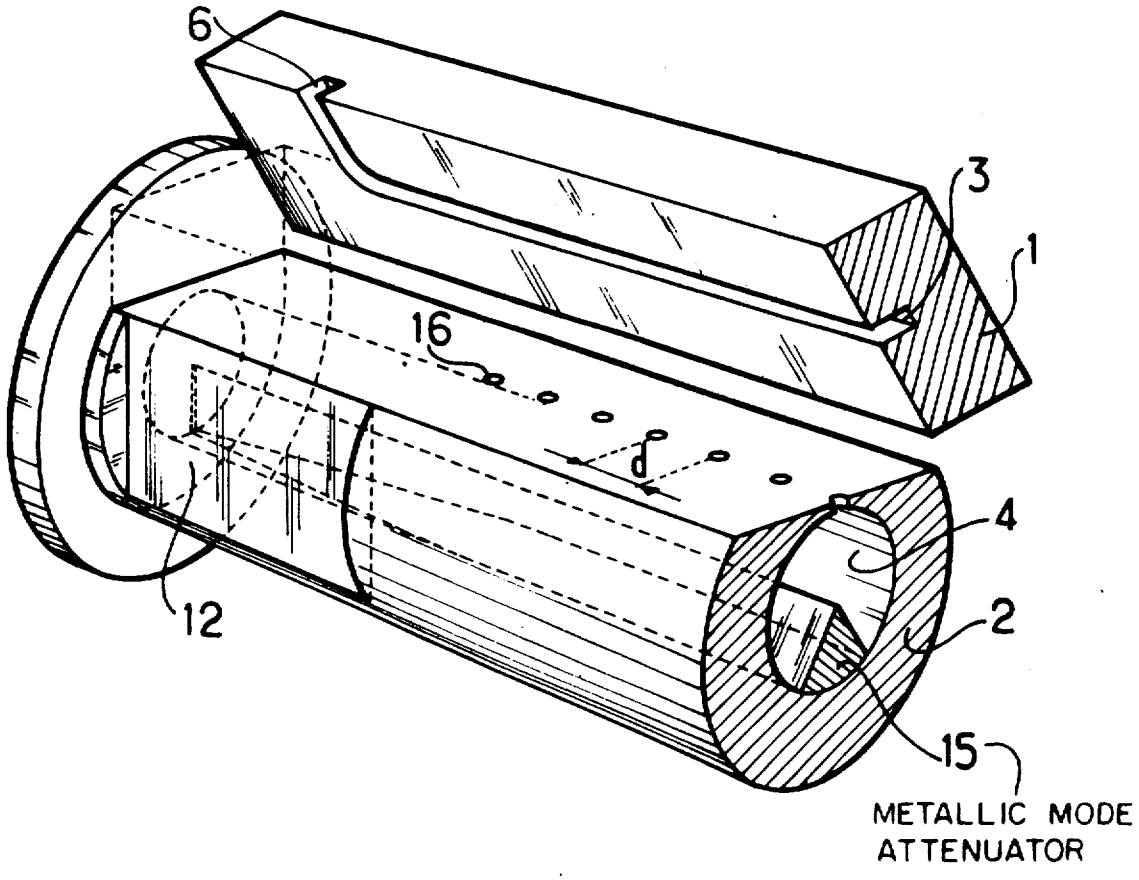


FIG.1a

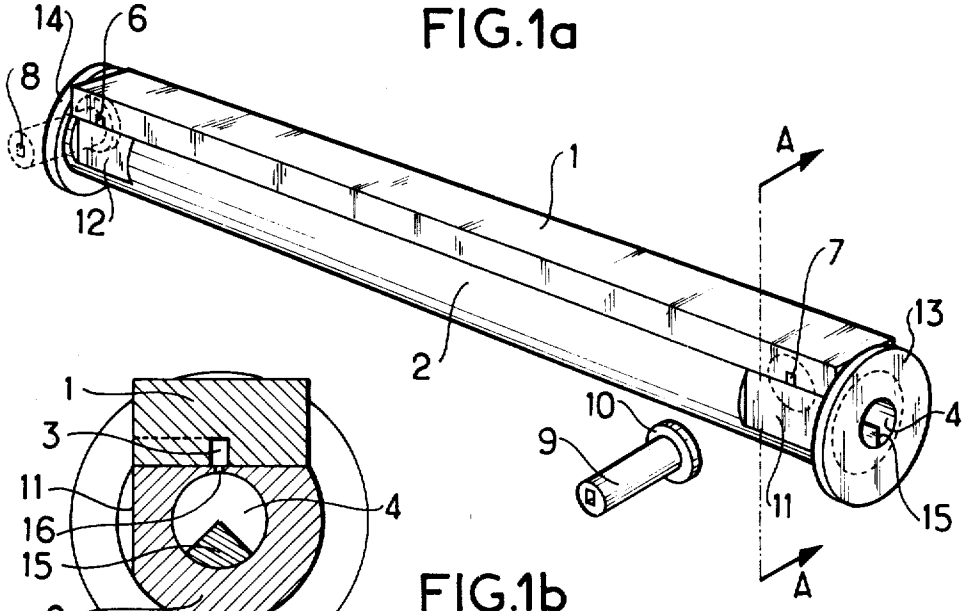


FIG.1b

FIG. 2

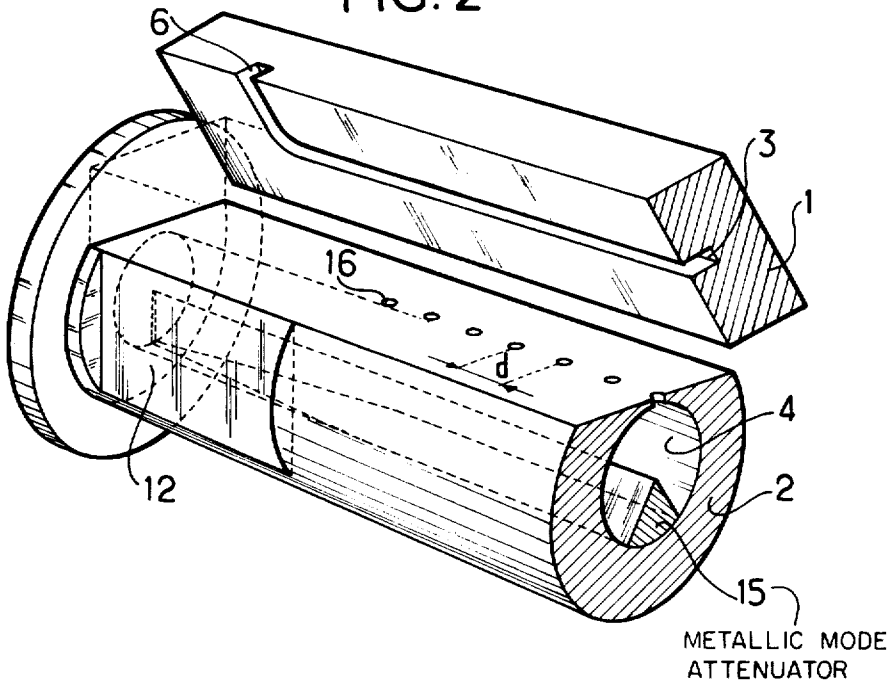


FIG. 3a

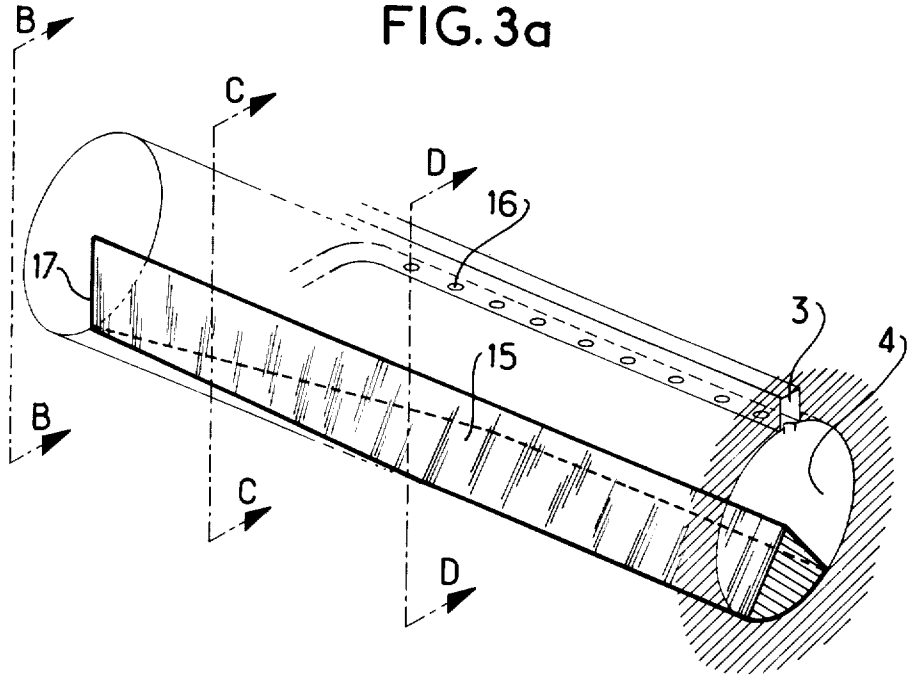


FIG. 3b

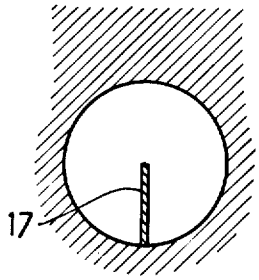


FIG. 3c

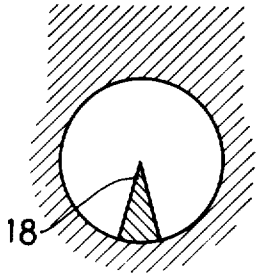


FIG. 3d

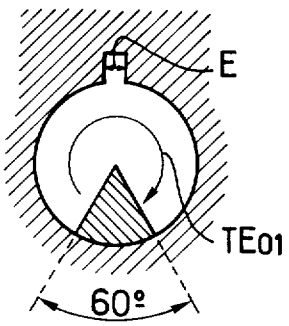
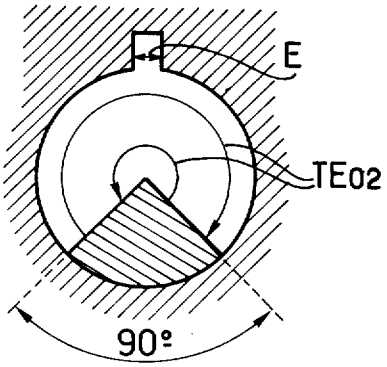


FIG. 3e



OPTIMIZED RECTANGULAR WAVE GUIDE TO CIRCULAR WAVE GUIDE COUPLER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention concerns an optimized coupler between a rectangular wave guide and a circular wave guide and more particularly a coupler making it possible to obtain electromagnetic modes of propagation having high purity.

2. Description of the Prior Art

It is a known practice to couple a rectangular wave guide to a circular wave guide by arranging them one above another longitudinally, the wall along the generatrix of the cylinder formed by the circular wave guide being drilled with holes communicating with one of the faces of the parallelepiped constituting the rectangular wave guide. That face corresponds to the smallest side of the rectangular wave guide. Thus the presence of a fundamental rectangular TE_{10} mode whose magnetic field is parallel to the small sides of the rectangle makes it possible to excite by a hole the coupling of the electric modes such as the main circular mode TE_{01} whose magnetic field is tangent to the rectangular wave guide. It is known that measuring devices are formed with rectangular wave guide connections and that long-distance transmission lines are formed with circular wave guides. The coupling between the two sorts of wave guides is therefore frequently used either for excitation or for analysis of the TE_{01} mode. Nevertheless, the main TE_{01} mode is not isolated; it is accompanied by higher parasitic modes such as the TE_{02} mode, for example. It is necessary to be able to isolate a particular mode from the other modes. This is done by increasing the number of coupling holes, this requiring very long parallel guides.

There are also transitions transforming the rectangular TE_{10} mode into a rectangular TE_{20} mode and into a rectangular TE_{22} mode and into a circular TE_{01} mode. The type of devices which exist at present is also bulky and its efficiency is sometimes insufficient inasmuch as concerns the forming of a pure circular TE_{01} wave.

The coupler according to the present invention makes it possible to overcome these disadvantages. Indeed, the coupler proposed makes it possible to excite or analyze modes such as TE_{01} or TE_{02} in a multi-mode circular wave guide while being suitable for attenuating the most powerful parasitic mode having a value of 20 dB in relation to the level of the mode which is required to be obtained.

The object of the present invention is an optimized rectangular wave guide to circular wave guide coupler for wave guides set side by side and parallel to each other, one on top of another and comprising coupling holes with the rectangular wave guide on a generatrix of the circular wave guide, the said coupling holes being arranged on either side of the middle of the length of the circular wave guide over a part of the length of that guide, characterized in that the said circular wave guide (2) comprises, moreover, a tongue (15) whose cross-section opposite the coupling holes is a constant arc and full sector portion whose arc is diametrically opposite to the said coupling holes and whose cross-section outside the coupling holes is a sector portion progressively reduced to a fine ridge (17) at the ends of the circular wave guide, the said tongue being intended to attenuate the propagation modes other than TE_{01} or TE_{02} in the circular wave guide.

According to one embodiment of the invention, the optimized coupler comprises a circular wave guide favoring the TE_{01} mode such that its diameter has a length which is less than that of the propagation of the TE_{02} mode, that the said coupling holes (16) have diameters and spacing adequate for favoring the TE_{01} mode and that the arc of the said constant sector is equal to 60°.

According to another embodiment of the invention, the optimized coupler comprises a circular wave guide favoring the TE_{02} mode such that its diameter is sufficiently great to allow the TE_{02} mode to pass, that the said coupling holes (16) have diameters and spacing adequate for favoring the TE_{02} mode and that the arc of the said constant sector is equal to 90°.

On referring to the accompanying diagrammatic FIGS. 1 to 3, an example of the implementing of the present invention, given only by way of an illustration and having no limiting character, will be described hereinafter.

The same elements shown in several of these figures bear, in all these latter, the same references.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1*a* is a general perspective view of the coupler according to the invention.

FIG. 1*b* is a cross-section through A—A in FIG. 1a.

FIG. 2 is a part perspective and cutaway view of the same coupler.

FIG. 3*a* is a diagrammatic perspective view of the tongue arranged inside the coupler.

FIGS. 3*b*, 3*c*, 3*d* are, respectively cross-sections through B—B, C—C, D—D in FIG. 3*a* of a tongue corresponding to a coupler whose favoured mode is the circular TE_{01} mode.

FIG. 3*e* is a cross-section through D—D in FIG. 3*a* of a tongue corresponding to a coupler whose favoured mode is the circular TE_{02} mode.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIGS. 1*a* and 1*b*, a coupler comprises a rectangular wave guide 1 arranged parallel to and above a circular wave guide 2. The first is fixed on the second by screws which have not been shown.

The inside space or slot 3 of the rectangular wave guide 1 is coupled to the cavity 4 of the circular guide 2 by coupling holes such as 16. In FIG. 2, it will be seen that the inside space or slot 3 of the rectangular wave guide 1 is curved at the ends of the coupler and emerges transversally through the openings 6 and 7. Connectors 8 and 9 having a circular flange such as 10 may be screwed against the body of the two wave guides 1 and 2 and may be fitted to the openings 6 and 7; the portions 11 and 12 facing the flanges such as 10 being made plane. In FIG. 1, the flanges 13 and 14 for connecting to the circular wave guide 2 may be seen.

The coupler according to the invention has, all along the cavity 4 of the circular wave guide 2, a tongue 15 whose shape will be described further on.

The rectangular guide 1 operates in the fundamental rectangular TE_{10} mode. The rectangular wave guide 1 is fitted to standard measuring devices by the connections 8 and 9. When the coupler operates in the excitation mode, a generator injects electromagnetic waves of TE_{10} mode in one of the connections 8 or 9 and there

emerges from one of the terminals of the circular wave guide a wave of main circular TE_{01} or TE_{02} mode, the other terminal ending in a load. When the coupler operates as an analyzer of the mode, electromagnetic energy is collected on one of the connections **8** or **9** in rectangular TE_{10} mode from the energy existing in the circular TE_{01} or TE_{02} modes in the circular wave guide **2**, the latter being connected to the multi-mode circular wave guide line which is to be analyzed. Consequently, there exist two versions of coupler: the one operating in circular TE_{01} mode and the other in circular TE_{02} mode, the two versions corresponding to the general shape in FIGS. 1*a* to 3*e* and differing only in the dimensions of the components.

FIG. **2** shows the coupling holes such as **16** between the rectangular wave guide **1** and the circular wave guide **2**. These coupling holes are drilled in a row on the generatrix of the cylindrical cavity **4** on either side over a certain length starting from the middle of the assembly. Thus a coupler operating in the 40 to 50 Gc/s band creating an attenuation of about 20 dB between the rectangular wave guide and the circular wave guide has a number of holes equal to 36 spaced out over a length of 100 millimetres approximately, the total length of the assembly being 335 millimetres. Another coupler operating in the same band and creating an attenuation of 10 dB only will have a greater number of holes 60 spaced out over 167 millimetres approximately, the total length of the assembly then being 429 millimetres.

Indeed, an isolated coupling hole would excite in the circular wave guide a great number of modes of propagation among those which are not above the cut-off frequency in the frequency band considered. On the other hand, a great number of coupling holes spaced out over a given length will favor, the greater the length, that of the modes excited which has the phase velocity which is the nearest to the incident rectangular mode.

In the examples cited, certain modes have phase velocities relatively close to that of the mode required. The length of coupling making it possible to discriminate the useful mode would then be excessive if the tongue **15** forming an arc whose angle is such that these detrimental modes be considerably attenuated were not used.

The distance d between the centres of the holes **16** is chosen so as to eliminate the retrograde wave which could propagate in the opposite direction to that of the incident mode.

The diameter of the holes and the distance *d* between centres are chosen as a function of the number of holes fixed by the length of coupling, to obtain the required attenuating between the rectangular wave guide and the circular wave guide.

In the case of the coupler operating in circular TE_{01} mode, the holes will have a diameter of 1.62 millimetres and a distance d between centres of 2.86 mm. In the case of the coupler operating in circular TE_{02} mode, the holes will have a diameter of 1.7 millimetres and a distance *d* between centres of 2.84 millimetres.

Moreover, the size of the diameter of the cavity **4** of the circular wave guide **2** makes it possible to improve the discrimination between the modes. In the case of the circular TE_{01} coupler, that diameter is 10 millimetres, this making it possible, in the 40 to 50 Gc/s band, to cut the circular TE_{02} mode. In the case of the circular TE_{02} coupler operating in the same band, that diameter is 18.4 millimetres, this making it possible to pass the circular TE_{02} mode.

In FIGS. 3*a* through 3*e*, the embodiment of the tongue **15** may be seen. This latter, which is metallic, is in the form of a sector having a constant opening or fixed arc portion at the places where it is diametrically opposite to the coupling holes **16**. At the ends of the circular wave guide **2**, the tongue **15** narrows until it forms a fine line ridge **17**. Between these two extremes (sector portion in the form of a ridge and sector portion having a constant opening), there is a transition portion in which the optimized sector **18** opens progressively (FIG. 3*c*).

In the case of the circular TE_{01} coupler (FIG. 3*d*) the sector having a constant opening or arc portion forms an arc of 60°. In the case of the circular TE_{02} coupler (FIG. 3*e*the sector having a constant opening or arc portion forms an arc of 90°.

The tongue **15** particularly attenuates the magnetic modes TM and the electric modes other than TE_{01} and TE_{02} in which the electric fields are parallel to the radial walls of the sector.

The coupler according to the invention makes it possible to discriminate modes other than the TE_{01} mode in the case of the TE_{01} coupler and in the case of the TE_{02} coupler, modes other than the TE_{02} mode of more than **20** dB.

The coupler which is the object of the invention may be used in all cases where it is required to obtain an excitation or an analysis either of the circular TE_{01} mode or of the circular TE_{02} mode.

Particularly interesting applications may be found within the branch of micro-wave telecommunications requiring experimenting on particularly pure modes.

I claim:

1. In an optimized rectangular wave guide to circular wave guide coupler set parallel to each other and one on top of another and including coupling holes within the rectangular wave guide on a generatrix of the circular wave guide, said coupling holes being arranged on either side of the middle of the length of the circular wave guide over a part of the length of that guide, the improvement wherein: said circular wave guide comprises, a metallic tongue whose cross-section opposite the coupling holes is a constant arc and full sector portion whose arc is diametrically opposite to the said coupling holes and whose cross-section outside the coupling holes is a sector portion progressively reduced to a fine line ridge at the ends of the circular wave guide, with said tongue attenuating propagation modes other than TE_{01} or TE_{02} in the circular wave guide.

2. The optimized coupler according to claim **1**, wherein: the circular wave guide favors the TE_{01} mode and is such that its diameter is less than the length necessary for the propagation of the TE_{02} mode, the coupling length is such that it attenuates modes other than the TE_{01} mode and the arc of the said constant arc sector portion is equal to 60°.

3. The optimized coupler according to claim **1**, wherein: the circular wave guide favors the TE_{02} mode and is such that its diameter is sufficiently great to allow the TE_{02} mode to pass, the coupling length makes it possible to attenuate modes other than the TE_{02} mode and the arc of the said constant arc sector portion is equal to 90°.

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