Aug. 4, 1959 W. G. HEINARD ET AL 2,898,559

VARIABLE WAVEGUIDE COUPLER

Filed June 26, 1957 2 Sheets-Sheet 1

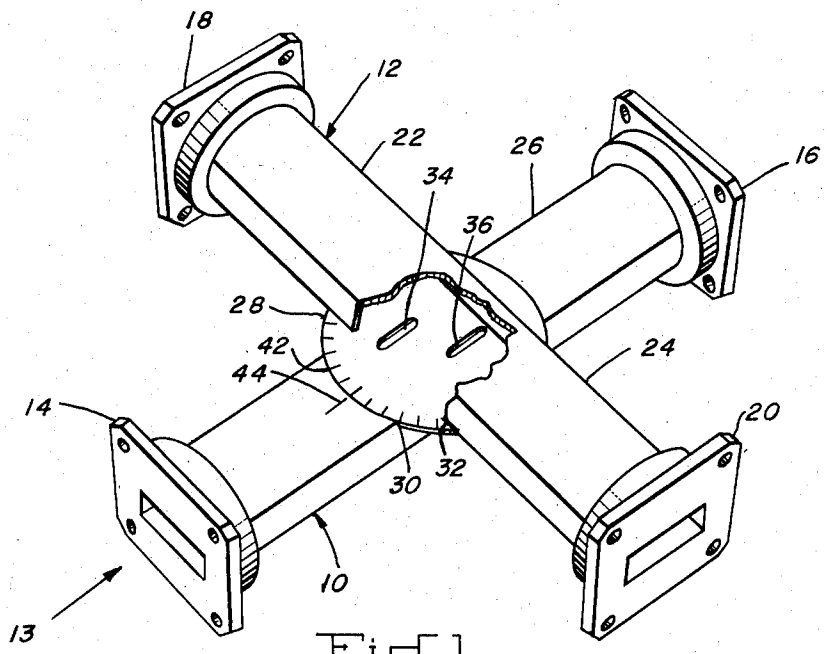


Fig. 1.

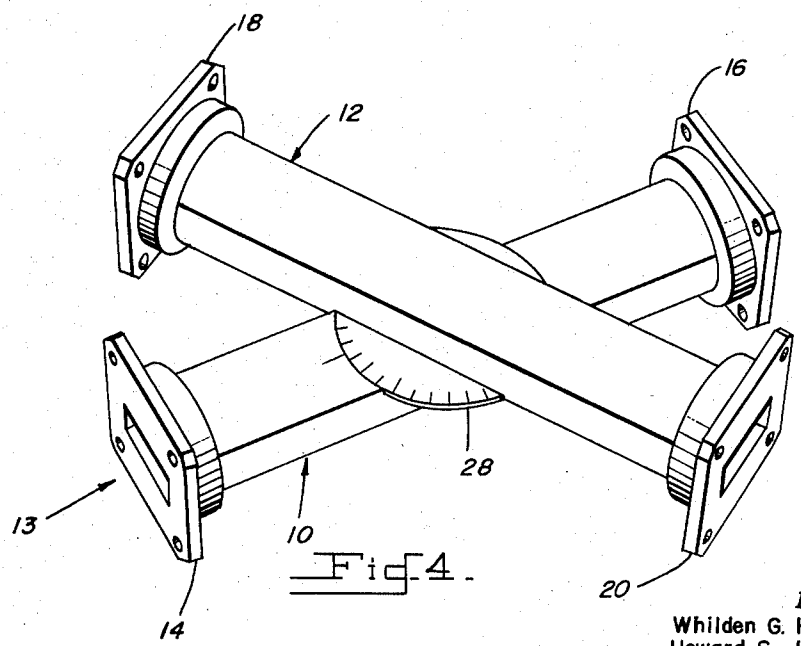


Fig. 4.

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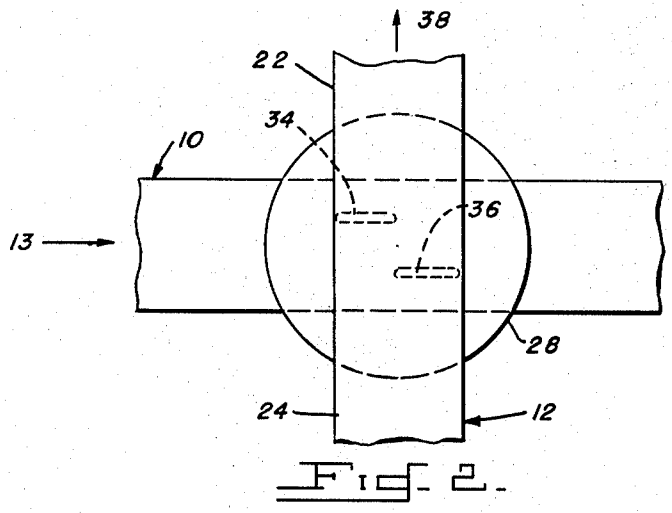


Fig. 2.

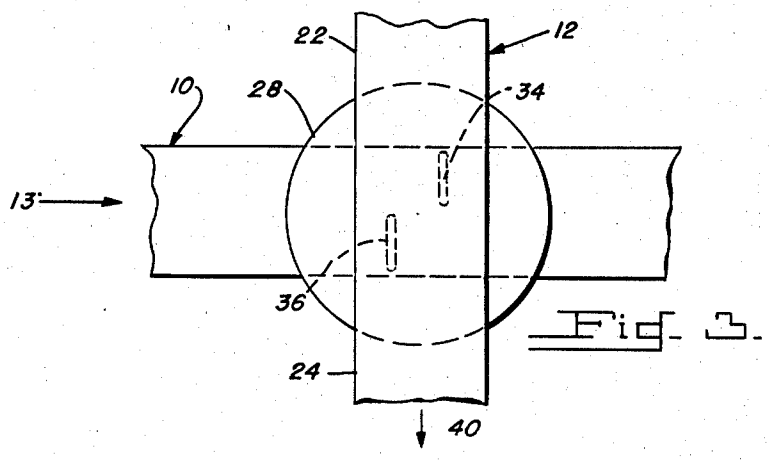


Fig. 3.

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VARIABLE WAVEGUIDE COUPLER

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Application June 26, 1957, Serial No. 668,264

2 Claims. (Cl. 333—10)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to us of any royalty thereon.

This invention relates to waveguide directional couplers, and more particularly to a variable microwave energy directional coupler.

An object of this invention is to provide a waveguide coupler wherein selective microwave energy directivity is attained.

Another object is to provide a selectively variable microwave energy excitation from a transmitting waveguide to a coupled waveguide.

Still another object is to provide a selectively variable microwave energy excitation between a longitudinally disposed transmitting guide and a transversely extending waveguide coupled thereto.

A further object is to provide a microwave directional coupler which may be selectively adjusted to provide the desired microwave energy transmission to a coupled waveguide having preset axes from a transmitting waveguide having preset axes.

Still a further object is to vary microwave energy directivity from a transmitting waveguide having particular axes.

The foregoing objects are achieved by interposing a displaceable plate between a main transmitting waveguide and an auxiliary coupled waveguide. This plate is provided with slotted apertures and is disposed in correspondingly shaped recessed portions in selected walls of the waveguides to act as a common wall segment therefor. Suitable adjustment of the intermediate plate results in a proportionate change in the energy coupled into both the arms of the auxiliary waveguide.

The specific nature of the invention as well as other objects, uses and advantages thereof, will clearly appear from the following description and from the accompanying drawing, in which:

Figure 1 is a perspective view of the waveguide directional coupler of the present invention with certain parts broken away.

Figure 2 is a partial plan view of the coupler of Figure 1 with a displaceable plate in one position with respect to the waveguides.

Figure 3 is a partial plan view similar to Figure 1 with the displaceable plate in another position with respect to the waveguides.

Figure 4 is a perspective view of an alternate arrangement of the coupler of Figure 1.

Referring to Figure 1, numerals **10** and **12** designate the main waveguide and auxiliary waveguide, respectively. Their cross-sectional geometry is preferably rectangular and identical in most respects, and as illustrated in Figures 1–3, guides **10** and **12** may be disposed normal to each other in some practical applications. As in conventional practice, the electric lines of force, established upon excitation by microwave propagation through guides **10** and **12**, are preferably perpendicular to the wider dimensioned walls of the waveguides. The microwave propagation through guide **10** may be taken, for illustration purposes, to be in the direction of arrow **13**.

Main guide **10** may be provided with flanges **14** and **16** for connection with similar flanges of a transmission line of a microwave system. Likewise, guide **12** may present flanges **18** and **20** for connection with similar flanges of utilization apparatus (not shown). As an alternative modification, pick-up probes (not shown) may be suitably mounted within the walls of arms **22** and **24** of auxiliary waveguide **12** and arm **26** of main waveguide **10** to satisfy some desirable requirements. Additionally, arm **26** of guide **10** and either of the arms **22** and **24** of guide **12** may be fabricated to function as a microwave absorbing section by suitably incorporating therein conventional resistance strip means.

The main guide **10** and the auxiliary guide **12** are preferably assembled with one of the wider walls of each lying substantially in the same plane or in planes that may be slightly spaced from one another. At the intersection of the longitudinal axis of guides **10** and **12** and symmetrical with their common transverse axis that is normal to the aforementioned planes is a displaceable plate **28**. As shown, displaceable plate **28** may assume the form of a disk which is adapted to be rotatably fitted in correspondingly shaped recesses **30** and **32** in the waveguides **10** and **12**, respectively. Guides **10** and **12** and plate **28** are adapted to be rotatably displaced one relative to another. Accordingly, plate **28** will function as a common wall for both main guide **10** and auxiliary guide **12**.

Elongated slots or apertures **34** and **36** extend through plate **28** to provide the necessary electromagnetic coupling between main guide **10** and auxiliary guide **12**. As is well known, primary microwave energy transmission in the main waveguide **10** may now be able to excite secondary microwave energy in auxiliary waveguide **12**. The magnitude of this energy transfer is of course dependent on such factors as the microwave frequency, the thickness of the plate **28**, the size and shape of coupling apertures **34** and **36**, and the relative positioning of the axes of the coupling apertures **34** and **36**. However, for a suitably chosen pair of coupling apertures the dependency of energy transfer upon the change in microwave frequency is relatively small. Additionally, the amount energy excitation in either arm **22** and **24** of auxiliary guide **12** will assume a definite proportion of the microwave energy transmission in main guide **10**. These amounts may be readily predetermined with reasonable accuracy from empirical, graphical or mathematical analysis.

Referring now to Figures 1 and 2, elongated apertures **34** and **36** may have their major axes parallel to and on different sides of the longitudinal axis of main guide **10**. Hence, apertures **34** and **36** will extend in the direction of the primary wave energy transmission in main waveguide **10**. The peculiar disposition of the coupling slots will give rise to excitation of secondary wave energy of a particular magnitude in arm **22** of auxiliary guide **12** in the direction indicated by arrow **38** (Figure 2). A relatively small amount of microwave energy will be induced in arm **24** of auxiliary guide **12** and if desired it may be considered negligible. Suitable conventional energy absorbing means may be provided in arm **24** or the energy may be permitted to be dissipated along the length of arm **24** or into any attached waveguide component.

When plate **28** is rotated sufficiently, as in Figure 3, so that elongated apertures **34** and **36** are perpendicular to the longitudinal axis of main waveguide **10**, the

primary microwave energy in main waveguide **10** will excite secondary microwave energy having a particular magnitude in arm **24** of auxiliary guide **12** in the direction of arrow **40**. Again, the amount of energy excited in arm **22** is relatively small and may be considered negligible for most practical application. If it be significant in amount and undesirable a microwave absorbing means may be incorporated in arm **22**.

If it be desirable to excite microwave energy through arms **22** and **24** of auxiliary waveguide **12** in amounts between the maximum and minimum contemplated by the present invention, plate **28** may be rotated through a suitable angular displacement. Hence, by empirical determination, a specific plate may be properly calibrated to represent a specific microwave combination induced in arms **22** and **24**, respectively, of waveguide **12** upon a particular controlled orientation or displacement of calibrations **42** with respect to index **44**.

In some applications of the instant directional coupler, it may be desirable to secure waveguide **10** to waveguide **12** by clamping or the like, to prevent angular rotation or displacement therebetween so that one can be maintained in a normal position with respect to the other. In this position, plate **28** will be rotatable with respect to both guides **10** and **12**.

A further significant application of this invention resides in the fact that high directivity may be obtained at a particular microwave frequency, by a suitable angular adjustment of the microwave coupler components. Thus, with slots **34** and **36** of plate **28** positioned as illustrated in Figures 1 and 2, and with auxiliary waveguide **12** free to rotate through an angular displacement with respect to guide **10** while fulcrumed about plate **28**, variations in induced microwave energy are possible in guide **12**. Accordingly, with both auxiliary waveguide **12** and plate **28** free to rotate with respect to main waveguide **10**, many variations and combinations of directivity and excited wave energy in auxiliary waveguide **12** are made possible for numerous desirable applications (Figure 4).

It will be appreciated by those skilled in the art that the present invention is not restricted to any size of waveguide and plate. An extremely desirable replacement for stock sizes of fixed couplers is attained and is capable of use with high power sources. Similarly, the instant coupler may be calibrated to function as a limited range variable attenuator.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claims.

We claim:

1. A microwave energy coupler comprising in combination: first and second intersecting lengths of rectangular waveguide having their wider walls adjacent and substantially coplanar, and a displaceable disc interposed at the intersection of said wider walls parallel thereto and rotatably fitted in correspondingly shaped recesses in said wider walls so that said disc functions as a common wall capable of being rotatably displaced about an axis perpendicular to said disc, said disc having two spaced elongated apertures adapted to be symmetrically disposed on either side of the longitudinal axis of said first and second lengths of waveguide upon predetermined rotations of said plate, said first and second lengths of waveguide being adapted to be rotatably displaceable with respect to one another about said axis independently of the rotation of said disc, the rotation of said disc and said lengths of waveguide permitting the direction and amount of the energy coupled between said first and second waveguides to be varied.

2. The invention in accordance with claim 1, wherein said disc is provided with calibration markings to facilitate obtaining a desired degree of coupling.

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