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ULTRA-HIGH FREQUENCY WAVE-MODE TRANSFORMERS

Filed Aug. 26, 1952

3 Sheets-Sheet 1

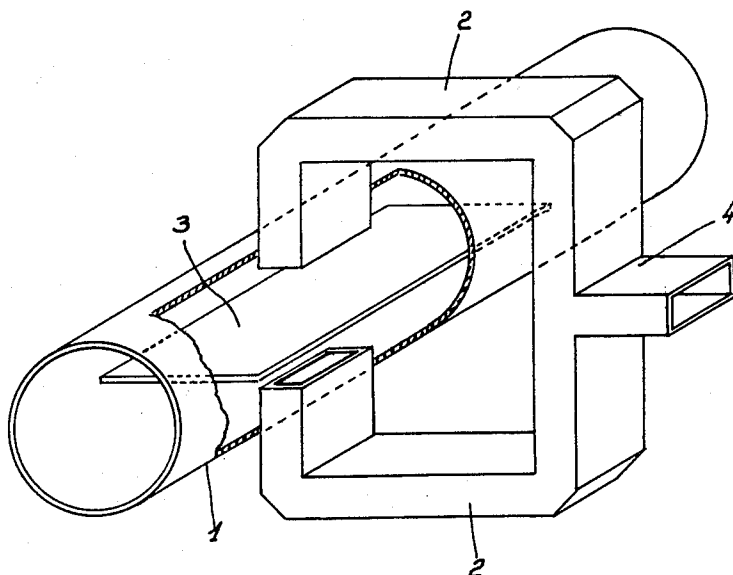


Fig. 1

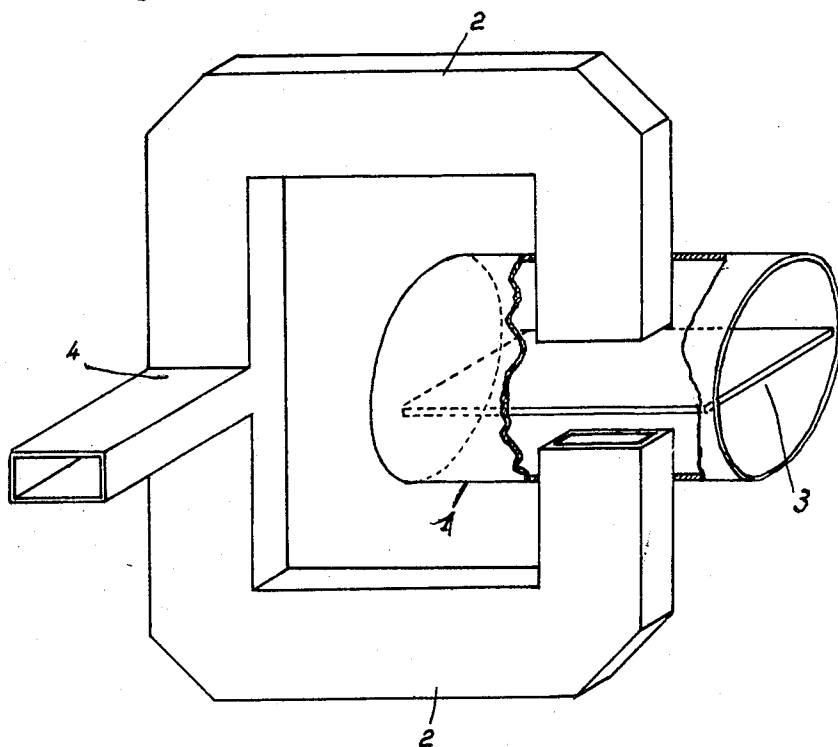


Fig. 2

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3 Sheets-Sheet 2

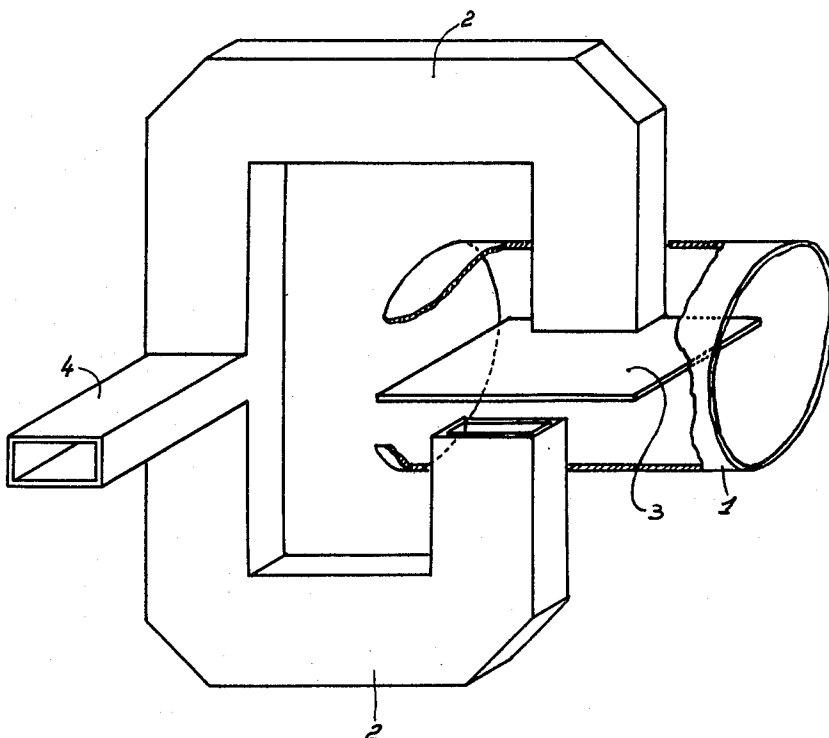


Fig. 3

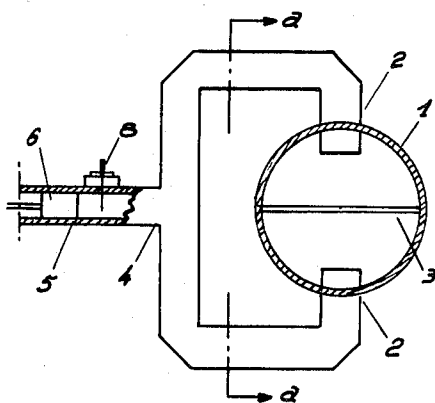


Fig. 4

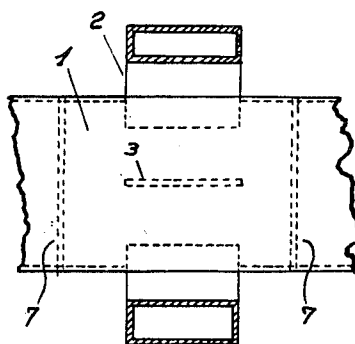


Fig. 5

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3 Sheets-Sheet 3

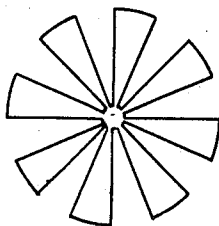


Fig. 6

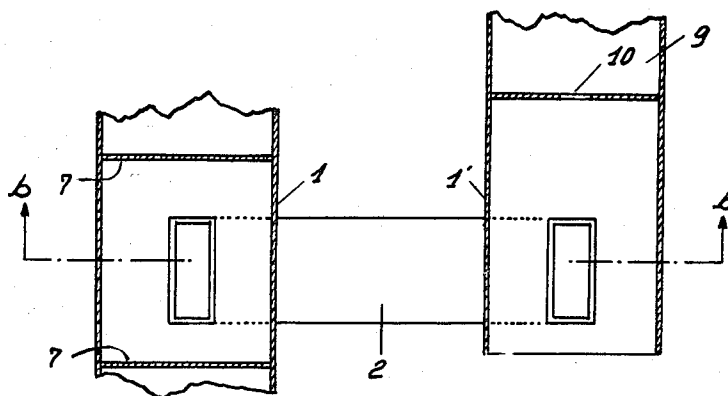


Fig. 7

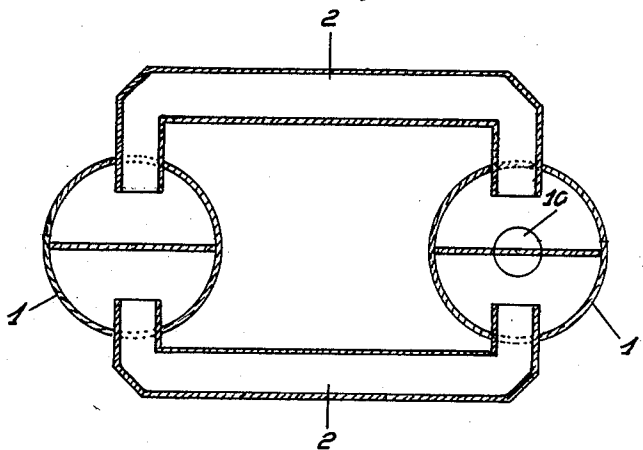


Fig. 8

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ULTRA-HIGH FREQUENCY WAVE-MODE TRANSFORMERS

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2 Claims. (Cl. 333—21)

This invention relates to ultra-high frequency wave-mode transformers.

The H_{01} circular type of wave, sometimes termed the H_0 wave is of considerable importance because it has symmetry of revolution which makes it most suitable for use in installations such as those involving rotating aeri-als which are fed through wave guides with rotating joints and also because its attenuation tends towards zero when the wavelength is reduced.

The transmission of ultra-high frequency energy is very commonly effected by means of rectangular guides traversed by waves of the H_{01} type and accordingly it is often a requirement to convert a wave of this type into an $H_0(H_{01})$ circular type wave and vice versa.

The present invention seeks to satisfy this requirement and provide means for effecting such conversion or transformation, with a regulatable degree of transformation which may attain unity. It also seeks to provide an improved wave transformer of wide pass band and practically negligible production of parasitic waves.

According to this invention, an ultra-high frequency wave transformer for transforming an H_0 wave in a circular guide into an H_{01} wave in a rectangular guide, or vice versa comprises a circular wave guide, inside which is disposed, along a median plane, a conducting partition, and two rectangular guides penetrating each at one end into said circular guide on the two opposite sides of said partition, the other ends of the rectangular guides being connected to a series T-junction. Preferably the smaller sides of the rectangular guides are disposed in cross-sections of the circular guide at regions of maximum electric field therein.

The two rectangular guides can penetrate into the same cross-section of the circular guide or into two different sections separated by a distance equal to a quarter of a wavelength in the guide. In the first case, the rectangular guides will be of the same length, while in the other their lengths will differ by $\lambda/4$ (where λ =wavelength in the guide).

The invention is illustrated in the accompanying drawings, in which:

Figures 1, 2, and 3 are schematic perspective views of three embodiments of the invention;

Figures 4 and 5 show a measuring device incorporating a wave transformer in accordance with the invention;

Figure 6 shows a detail of the arrangement of Figure 5, and

Figures 7 and 8 show another form of measuring device for ultra-high frequencies incorporating the invention.

The wave transformers of Figures 1 and 2 comprise, in each case, a circular wave guide 1 and two rectangular guides 2. A conductive partition 3 is disposed in a median plane of the guide 1, and the two guides 2 penetrate into the guide 1 on the two opposite sides of this partition. The guides 2 are connected at their outer ends to a series T-junction 4. The principal difference between Figures 1 and 2 is the arrangement of the T-junction 4 which, in

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Figure 2, is at right angles to the arrangement adopted for it in Figure 1.

With these arrangements a wave of the H_{01} circular type, (a so-called H_0 wave) traversing the guide 1, gives rise to a wave of the H_{01} rectangular type at the output of the T-junction or vice versa, as will be understood from what follows.

The electric lines of force of an H_0 wave are concentric circles contained in the cross-sections of the circular guide. Since, in the arrangements of Figures 1 and 2 the smaller sides of the rectangular guides 2 are tangential to these circles, the fields penetrating into and propagated in the two guides 2 perpendicularly to their larger sides are in phase opposition. Because of the known properties of the series T-junction these two fields combine and furnish in the rectangular guide constituted by the output of the T-junction a wave of the H_{01} type. Inversely, an H_{01} wave fed into the T-junction is decomposed into two waves de-phased by π in the two branches penetrating into the circular guide, producing in the latter an H_0 wave.

The partition 3, the length of which must obviously be greater than the longer sides of the rectangular guides, prevents the propagation of parasitic electric waves (E_{01} , E_{02} , and so on), and, by reason of the symmetry of the arrangements waves of the type $H_{2n-1, p}$, where n and p are integral numbers, are suppressed.

The opposite ends of the guides 2 in the guide 1 are preferably arranged at points of maximum field in the said guide 1.

The two rectangular guides 2 may be of the same length as illustrated in Figures 1 and 2, or they may be of different lengths, as indicated for example in Figure 3. In this latter case, the rectangular wave guide mouths in the circular guide should be spaced by $\lambda/4$ and the difference in length of the rectangular guides should also be $\lambda/4$ where λ is the wavelength in the guide, the median partition 3 being of course sufficiently long to extend beyond the mouths of the rectangular guides in both directions.

The above described arrangements are remarkable for their facility of adaptation in practical use and for their practically negligible production of parasitic waves. Such arrangements may be arranged to act as what may be termed total wave transformers, entirely transforming the energy of waves of one type into energy of waves of the other with an efficiency approaching unity, or, if desired they may be arranged to act as what may be termed partial transformers. As is well known, the introduction of a coupling probe into a circular hole or into a slot in a guide will disturb the shape of the wave being propagated on the two sides of the probe. In consequence it is impossible to make direct measurements of an H_0 wave merely by inserting a probe. By using an arrangement in accordance with this invention, set up to act as a partial transformer, it is possible readily to effect such measurement. Figures 4 and 5 show arrangements of this nature. Figure 5 being a section on the line $a-a$ of Figure 4.

Referring to Figures 4 and 5, a fraction of the ultra-high frequency H_0 wave energy in the guide 1 is directed towards a rectangular guide 5 which is connected to the T-junction 4 and is fitted with a movable piston 6. Elimination of parasitic modes of the $H_{2n, p}$ type is effected by two sector vaned filters 7 which are equidistant from the plane of symmetry of the coupling and are shaped as illustrated in Figure 6. By means of a probe 8, which is connected to a detector (not shown), measurements are made of the wave in the rectangular guide 5 and required variation of the degree of coupling is determined by adjusting the position of the piston 6, to adjust the impedance at each opening of the rectangular guide, and also by suitable selection of the width of the smaller side of the latter.

Measurements of stationary waves may thus be effected by displacing the detector assembly longitudinally by

means of two circular guides sliding one within the other. Similarly, measurements of parasitic waves may be made by turning this assembly in a cross-sectional plane.

Such a partial transformer arrangement may also be used for an absorption wavemeter. In the case of a wavemeter of the H_0 type, an arrangement as illustrated in Figures 7 and 8 may be used. Figure 8 being a section on the line $b-b$ in Figure 7.

Referring to Figures 7 and 8 a main circular guide 1 communicates, by means of two rectangular guides 2, with an auxiliary circular guide 1' which is completely closed at one end and communicates at the other with the cavity 9 of the wavemeter through an aperture 10 in a partition.

We claim:

1. An ultra-high-frequency wave transformer for transforming a wave of the H_{01} type propagated in a rectangular guide into a wave of the H_0 type propagated in a circular guide, or vice versa, said transformer comprising a circular first guide inside which a conductor partition is disposed in a median plane, a rectangular second guide, and two rectangular guide portions having respective extremities penetrating into the circular guide on the two opposite sides of said partition, the axes of said rectangular guide portions being perpendicular to said partition, the other ends of said rectangular guide portions being connected together and to said second guide in a series T junction, the smaller sides of the rectangular guide portions being disposed in transverse planes of the circular guide, the two said rectangular guide portions opening into said circular guide at locations axially separated by $\lambda/4$, and the two said rectangular guide portions having lengths which differ

by $\lambda/4$ where λ is the operating wavelength in said guides.

2. In an ultra-high-frequency wave transformer of the type comprising a first, rectangular wave guide transmitting waves of the $H_{0,1}$ mode, a second, circular wave guide propagating waves of the H_0 mode, and two rectangular guide portions each having its longitudinal axis extending in a plane perpendicular to the longitudinal axis of said circular guide, each of said portions being connected at one of its ends to said first, rectangular guide and forming a series T junction therewith, said portions being provided with respective extremities opening into said circular guide on diametrically opposite sides thereof, with the narrower sides of said extremities disposed in transverse planes of said circular guide: the improvement whereby said extremities penetrate each radially into said circular guide, for a distance substantially equal to one-half the radius of the latter, and are axially offset from each other by a distance equal to a quarter of the operating wavelength of said guides, said guide portions differing in length by a quarter of said operating wavelength.

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