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COUPLING SYSTEM

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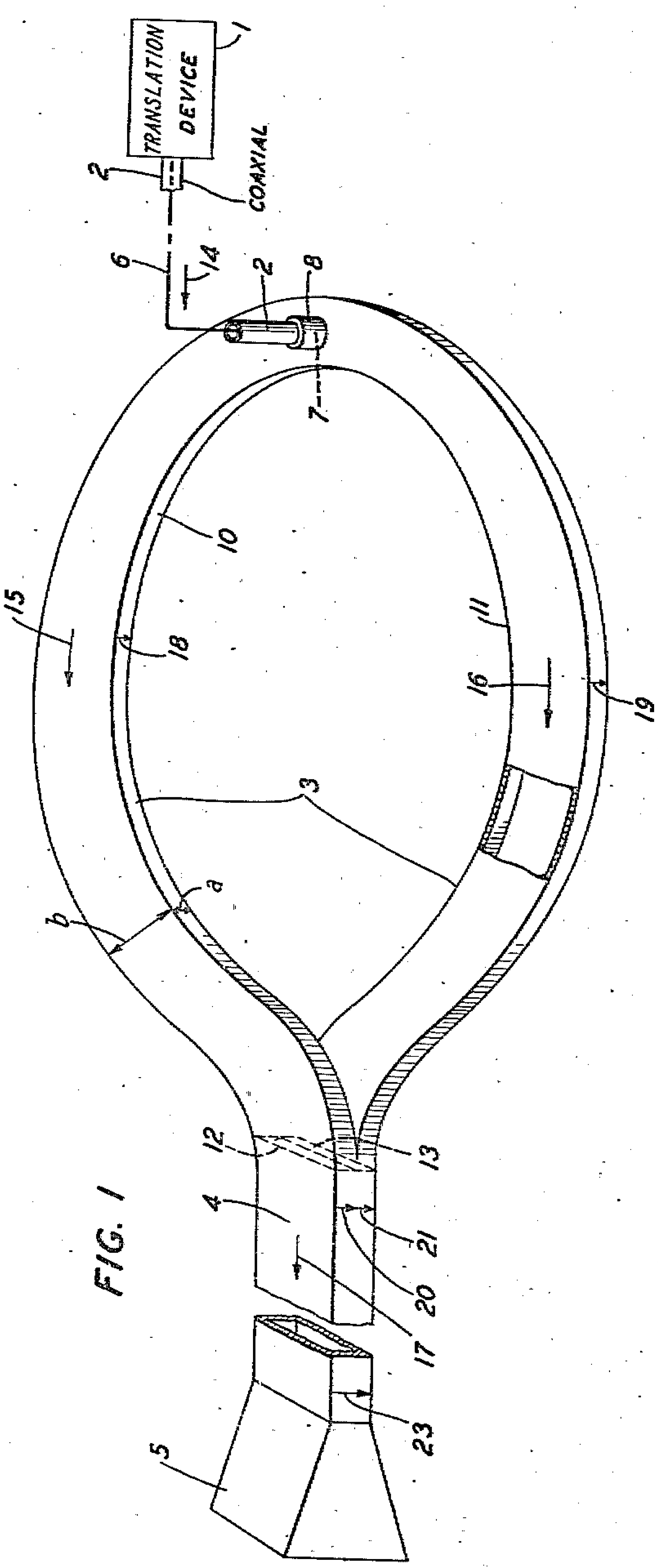

FIG. 1

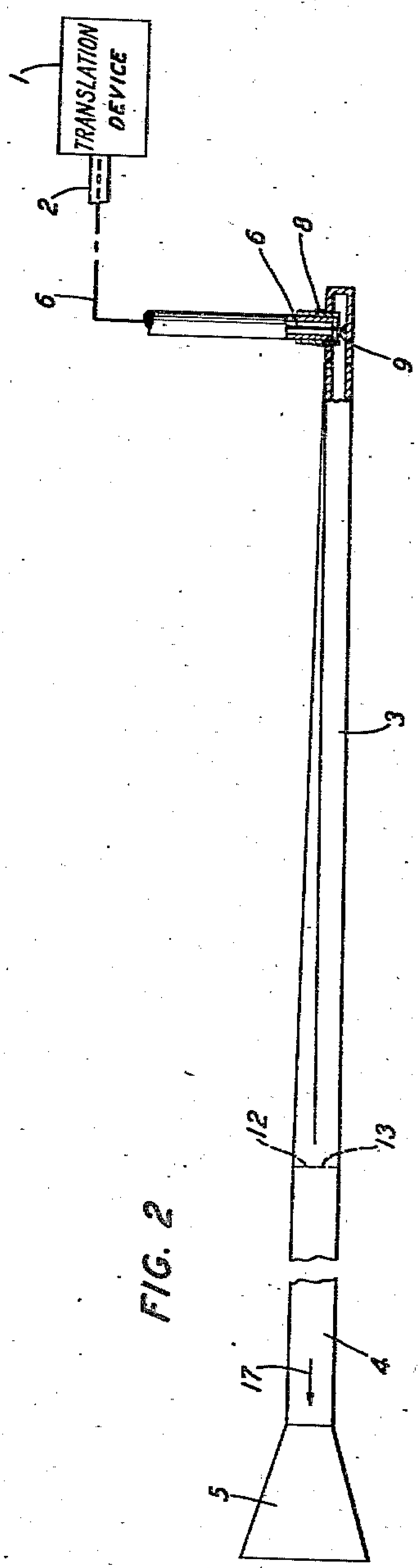

FIG. 2

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COUPLING SYSTEM

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4 Claims. (Cl. 178—44)

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This invention relates to microwave coupling devices and more particularly to wave-guide transmission line coupling arrangements.

As disclosed in the copending application of H. T. Friis, Serial No. 435,017, filed concurrently with the instant application, impedance matching over a band of frequencies between a coaxial line or conductive channel and a main wave guide, and unilateral wave propagation in the wave guide, may be effected without the use of a piston reflector by means of a rectangular wave guide folded or looped in the plane of its short transverse dimension, that is, in the plane of polarization of the propagated electric wave component. In this arrangement the end apertures of the folded guide are superimposed and joined to an end orifice of the main guide and the coaxial line is connected to the longitudinal center point of the looped guide. Also, for multifrequency operation, each of the two branches of the folded guide includes a twisted 90 degree polarity changer for securing colinearly polarized wave components in the superimposed folded guide apertures. While the folded guide coupling is suitable for use in many microwave systems, the polarity changers aside from being more or less difficult to manufacture, cause a certain amount of loss and it now appears desirable to employ folded wave guide coupling sections having no quadrature polarity changers of the twisted type. In this connection applicant has discovered that, contrary to the teaching of the prior art, rectangular wave guides may be bent or curved in the plane of the long transverse dimensions or, stated differently, in a plane perpendicular to the polarization plane of the electric component utilized in the wave guide, without substantial loss and, in fact, with only slightly greater loss than that sustained in guides folded or curved in the plane of polarization.

It is one object of this invention to secure in single frequency and multifrequency systems, each comprising a wave guide coupled to a transmission line, unilateral propagation in the wave guide without utilizing a reflecting piston and with minimum loss.

It is another object of this invention to match the impedances of a dielectric channel and a line channel without using auxiliary adjustable apparatus or quadrature polarity changers of the twisted wave-guide type.

It is still another object of this invention to obtain a multifrequency folded wave-guide coupler which does not include twisted portions and which is simpler in construction than the couplers heretofore utilized.

As used herein the term "quadrilateral" generically includes the terms "rectangular" and "square," and the term "rectangular" excludes "square."

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In accordance with the preferred embodiment of the invention a coaxial line having an impedance Z is coupled to a main quadrilateral wave guide having a considerably larger impedance as, for example, 4Z, through a rectangular wave guide having a characteristic impedance of 2Z and folded in the plane containing its long transverse dimension which plane is perpendicular to the plane of polarization of the electric vector. The end apertures of the folded wave guide section are superimposed so that their short transverse dimensions are aligned. The coaxial line is coupled through a multifrequency matching device of the type disclosed in applicant's copending application, Serial No. 429,358, filed February 3, 1942, to the longitudinal center point of the rectangular folded wave guide; and the superimposed end apertures are joined to an end orifice of the main quadrilateral wave guide. In operation, the wave components or wavelets in the two branches of the loop section have, at the longitudinal center point mentioned above, equal phase angles and are similarly polarized. Since the end apertures of the loop are equally distant from the center point and since the folded guide is not bent in the plane of polarization, the wavelets at the superimposed apertures are in phase angle agreement and are similarly polarized, whereby a wave of maximum intensity is propagated unilaterally in the main quadrilateral guide. Moreover, as explained in the copending Friis application, the coaxial line impedance equals the combined parallel impedance of the branches or folded guide sections, and the serially connected apertures of the loop section have a total impedance equal to that of the quadrilateral guide. Hence, the folded guide section functions as a transformer for matching the impedances of the coaxial line and the main wave-guide over a band of microwave carrier frequencies.

The invention will be more fully understood from a perusal of the following specification taken in conjunction with the drawing on which like reference characters denote elements of similar function and on which:

Fig. 1 is a perspective view of one embodiment of the invention; and

Fig. 2 is a side or elevational view of the same embodiment.

Referring to Figs. 1 and 2, reference numeral 1 designates a translation device for transmitting or receiving microwaves and numeral 2 denotes a conductive channel or coaxial line connected thereto. The line channel 2 is connected through a rectangular wave guide section 3 folded or looped in the plane of its long transverse dimension *b* to a quadrilateral main wave guide or dielectric channel 4 and a radiating or receiving antenna such as a horn 5. The inner conductor 6 of coaxial line 2 is attached to the folded guide section 3 at the longitudinal mid-point 7 of the looped guide through a multi-frequency coupling device of the type disclosed in applicant's copending application mentioned above and comprising an adjustable sleeve member 8. As explained in my application mentioned above, the sleeve is adjusted and a particular value for the short transverse dimension a of the loop 3 selected such that the exposed exciter portion 9 of the inner conductor 6 has the proper length and impedance for matching over a carrier band of frequencies the characteristic impedance Z of line 2 to the total folded guide impedance comprising the impedances of the two loop branches 10 and 11 connected in parallel. Thus, assuming the line 2 has a characteristic impedance Z equal to 100 ohms, each of the loop branches 10 and 11 has a characteristic impedance 2Z equal to 200 ohms, and the two impedances in parallel equal the line impedance. The main dielectric channel has a characteristic impedance, 4Z, which may be taken as the value of its input or send end impedance since the length of the main guide 4 is great relative to the wave-length employed and may be considered infinite. Inasmuch as the apertures 12 and 13 are superimposed with their transverse dimensions a aligned, the characteristic impedances of the apertures are serially associated and their total impedance, 4Z, equals the send end impedance and the characteristic impedance of guide 4.

In operation, assuming device 1 is a transmitter, while the energies conveyed between the device 1 and the horn 5, and propagated in the branches 10 and 11, flow relative to point 7 in opposite or bilateral directions, the combination including looped section 3 functions to produce only unilateral propagation in the dielectric channel 4. Arrows 14, 15, 16 and 17 denote the directions of propagation in line 2, branch 10, branch 11 and guide 4, respectively. The wavelets propagated in directions 15 and 16 have, at center point 7, the same (zero) phase angle and are similarly polarized as shown by arrows 18 and 19 in a direction aligned with the short transverse dimension a and the exposed exciter 9, that is, in a vertical direction in the plane of the drawing. Contrary to the effect secured in a system of the copending Friis application, the curvature in the coupling section 3 does not shift the polarity of these wavelets since the curvature is only in a plane perpendicular to the direction of polarization. Moreover, the branches 10 and 11 are of equal length so that in apertures 12 and 13 the wavelets are similarly polarized, as shown by arrows 20 and 21, and combine to form a maximum vector resultant 23 in the main wave-guide channel 4.

Thus, in accordance with the invention the system or combination illustrated by Figs. 1 and 2 and comprising a multi-frequency coaxial line-to-wave guide, coupling device, a wave-guide coupling section folded in the plane perpendicular to the plane of polarization of the electric vector and a main dielectric channel, functions to match the impedances of a line channel and a dielectric channel, without reflection losses and without losses due to changing the polarity of the wave component, over a band of carrier frequencies including several hundred megacycles. At the same time the combination functions to produce unilateral or one way propagation in the quadrilateral wave guide 4.

Although the invention has been explained in connection with a certain embodiment thereof, it should be understood that it is not to be limited to this arrangement inasmuch as other apparatus may be employed in successfully practicing the invention. More particularly, the folded wave-guide coupling section and the main wave guide may each have a square instead of a rectangular cross section. Also, any other type of line, such as a balanced line, and even a dielectric wave-guide channel, may be employed in place of the coaxial line; and the invention may be utilized for coupling a balanced line to a dielectric channel or for coupling two dielectric channels.

What is claimed is:

1. A dielectric channel-transmission line coupling device comprising a rectangular wave-guide section for conveying wave components polarized in the plane of one transverse dimension, said section being looped or curved in the plane of the other transverse dimension and having superimposed apertures, the section being connected at its mid-point to said line and at its super-imposed apertures to said channel.

2. A quadrilateral dielectric wave channel-transmission line coupling device comprising a folded rectangular wave guide having a short transverse dimension equal substantially to one half of the short transverse dimension of said channel, said folded guide having its end apertures superimposed for junction with said channel and an aperture at an intermediate point for junction with said line, the two paths connecting said intermediate point with said channel being electrically equal, said guide being energized with waves polarized in the plane of its short transverse dimension and folded in the plane of its long transverse dimension.

3. In combination, a quadrilateral wave guide having a given impedance and an end orifice, a transmission line having a different impedance, and means for matching said impedances and for producing unilateral propagation in said guide comprising a rectangular wave-guide section having an impedance intermediate said impedances and a curvature in the plane of its long transverse dimension, said section having superimposed end apertures joined to an end orifice of said quadrilateral guide, said line projecting into said section at its mid-point in a direction coincident with the short transverse dimension of said section.

4. In a system for transmitting transverse electric waves, a quadrilateral wave guide having an end orifice, a coaxial line, and means for connecting said guide and line and matching their impedances over a band of frequencies several hundred megacycles wide, said means comprising a rectangular wave guide folded in the plane of the transverse dimension perpendicular to the polarization of the transverse electric wave and having superimposed end apertures joined to an end orifice of said quadrilateral guide, the characteristic impedance of the rectangular guide being equal to twice that of said line and to one-half that of the quadrilateral guide, a multifrequency impedance coupler connecting said line to the mid-point of said folded guide, whereby components transferred between said line and said first rectangular guide have the same polarity and same phase angle at the junction of the superimposed end apertures with said end orifice.

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