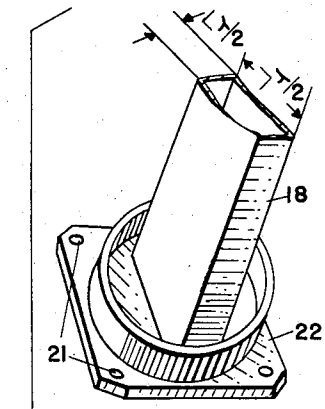
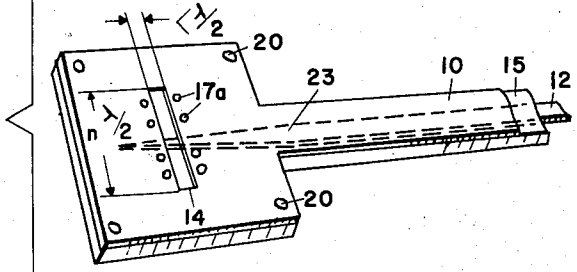
March 10, 1959 D. J. SOMMERS ET AL 2,877,429

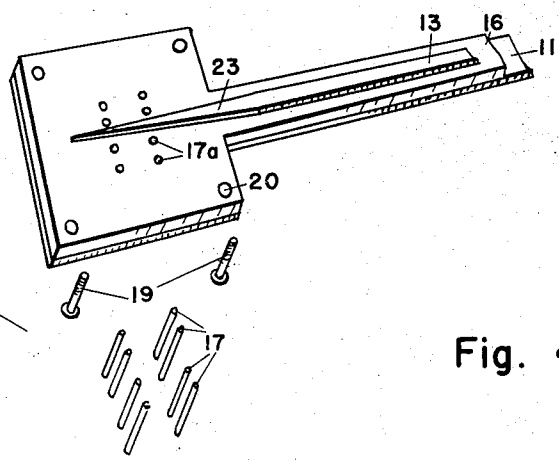
HIGH FREQUENCY WAVE TRANSLATING DEVICE

Filed Oct. 6, 1955

Fig. 1







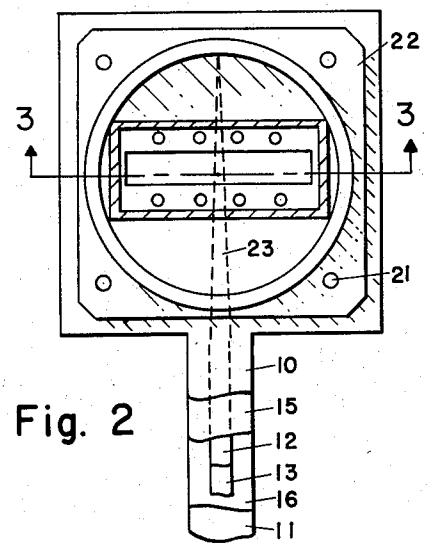


Fig. 2

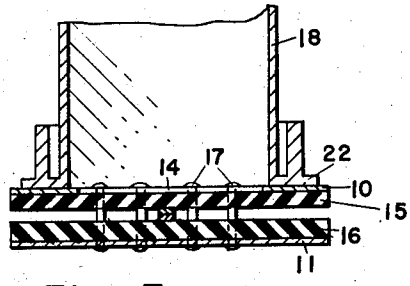


Fig. 3

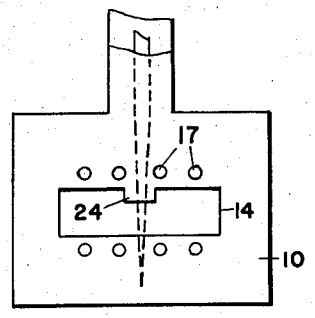


Fig. 4

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HIGH FREQUENCY WAVE TRANSLATING DEVICE

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5 Claims. (Cl. 333—24)

The invention relates to high frequency wave translating devices for propagating high frequency energy from one transmission line to another or from a transmission line to space. More particularly, the invention relates to high frequency transmission lines and antennas.

In the prior art it is common practice to utilize a slot radiator in such wave guide transmission lines for radiating energy into space or translating energy from one type of wave guide to another. In flat-strip transmission lines utilizing an elongated, inner conductor disposed in parallel with and in insulated spaced relation between two outer conductors, resonant slots formed in one of the outer conductors have been found to provide inadequate radiation for practical purposes. One type of flat-strip transmission line is commonly termed "sandwich" line and this line will be the one considered hereinafter.

It is therefore an object of the invention to provide an improved high frequency wave translating device.

A further object of the invention is to provide an improved high frequency wave translating device providing increased radiation efficiency.

A further object of the invention is to provide an improved high frequency slot antenna coupled to sandwich line.

Still another object of the invention is to provide an improved coupling device between sandwich line and wave guide line.

In accordance with the invention there is provided a high frequency wave translating device comprising a pair of elongated, outer conductors providing ground planes. An elongated, inner conductor is disposed in parallel with and in insulated spaced relation between the outer conductors. A resonant, elongated slot is formed transversely in one of the outer conductors. The slot overlays the inner conductor and intersects an axis parallel with the inner conductor. The slot is electrically an integral number n of half-wave lengths long and less than a half-wave length wide at the highest operating frequency of the device. Conductive means couple the outer conductors in the vicinity of the intersection to enable increased coupling of high frequency energy from between the inner and outer conductors through the slot.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring now to the drawings:

Fig. 1 is an exploded view of a preferred embodiment of the invention;

Fig. 2 is a plan view, partly in section, of the embodiment in Fig. 1;

Fig. 3 is a sectional view of the preferred embodiment taken along the lines 3—3 of Fig. 2; and

Fig. 4 is a plan view of a modification of the embodiment in Fig. 1.

Detailed description

Referring now more particularly to Figs. 1, 2 and 3,

there is represented a high frequency wave translating device comprising a pair of elongated, outer conductors 10 and 11 providing ground planes. Elongated, inner conductors 12 and 13 in direct contact with each other and electrically functioning as a single conductor are disposed in parallel with and fixed in insulated spaced relation between the outer conductors by dielectric members 15 and 16. A resonant, elongated slot 14 is formed in the outer conductor 10 intersecting an axis parallel with the inner conductor 12 as shown. The inner conductors 12 and 13 have tapered portions 23 as shown for matching the impedance of the sandwich transmission line to the slot. A plurality of conductive rods 17 connect the outer conductors 10 and 11 through the dielectric members 15 and 16 adjacent the opposite sides of the slot 14. One of the rods 17 is disposed in the vicinity of each corner of the outer conductor as defined by the intersection of the inner conductor and the slot. A wave guide transmission line 18 is connected to the outer conductor 10 with a propagation boundary adjacent each extremity of the slot 14 as shown in Fig. 2. The guide 18 is mounted on the outer conductor 10 with, for example, screws 19 which are inserted through screw holes 21 in a flange 22 of the guide 18 into holes 20 in the sandwich transmission line.

The embodiment shown in Fig. 4 differs from that represented by Figs. 1–3, inclusive, in that in Fig. 4 a conductor tab 24 extends from the outer conductor 10 into the slot 14 for tuning the slot and matching its impedance to that of the transmission line.

Operation

Considering now the operation of the wave translating device just described and referring to Figs. 1, 2 and 3, energy is propagated along the sandwich transmission line toward the slot 14 in the well-known TEM mode. The outer conductors 10 and 11 provide boundary ground planes; the electric lines of force extending from the inner conductors 12 and 13 to the inner surfaces of the outer conductors 10 and 11. Magnetic lines of force surround the inner conductors 12 and 13 normal to the direction of propagation. Without the conductive rods 17 the efficiency of radiation through the slot 14 is less than one percent. Insertion of a single conductive rod 17 connecting the outer conductors 10 and 12 in the vicinity of the intersection between the slot 14 and the inner conductors 12 and 13 substantially increases the radiation efficiency of the slot 14. Inserting a conductive rod 17 in the vicinity of each corner in the outer conductor 10 as defined by the intersection of the inner conductors 12 and 13 and the slot 14 increases the radiation efficiency to approximately 50 percent. Additional rods 17 inserted along the opposite edges of the slot 14 as shown produce an increased efficiency approaching 65 percent. By connecting the wave guide 18 to the sandwich transmission line as described above, conventional modes of propagation within the guide are excited. In the embodiment shown herein in which a rectangular wave guide is utilized as an example, the device becomes a mode transducer in which the TEM mode of sandwich line is transformed into, for example, $TE_{0,1}$ mode in the guide 18. The enhanced radiation efficiency produced by the insertion of the conductive rods 17 clearly establishes the re-enforcement of the forward energy propagated by the slot with energy which tends to be radiated backwardly by the slot. This implies further that the backward radiating energy is reflected and radiated from the slot in phase with the forward propagating energy.

In the embodiment of Fig. 4 the tab 24 provides a means for varying the effective electrical length of the slot 14 for the dual purpose of tuning the slot to its resonant frequency and matching the impedance of the slot to the

line. It will be apparent that where the device is utilized to translate energy from the sandwich transmission line to space, for example, as when used as an antenna, the impedance of the slot differs from the condition where translation to wave guide transmission line is desired. Similarly, the resonance characteristics change and must be compensated.

It will be apparent from the foregoing described operation that the insertion of the conductive rods **17** greatly enhances the radiation efficiency of a resonant slot in sandwich line. The present invention greatly enhances the application of sandwich line to antennas and transmission lines, particularly wave guides.

While applicant does not intend to be limited to any particular dimensions in the embodiment of the invention just described, there follows a set of dimensions for the more important components which have been found to be particularly suitable at a frequency of 9,375 megacycles. The slot, as shown in Fig. 1, is .900 inch long and .060 inch wide. The inner conductor is .165 inch wide and the outer conductors not less than .35 inch wide. The conductive rods **17** are .060 inch in diameter and spaced longitudinally and transversely .250 inch apart. The slot **14** and inner conductors **12** and **13** are centered relative to the four conductive rods in the vicinity of the intersection of the slot **14** and the inner conductors **12** and **13**. The boundary defining surfaces on the guide are .900 inch apart and .400 inch long. The wave guide **18** as used herein silver plated and the conductors of the sandwich transmission line are .00135 inch thick and silver plated to approximately a depth of .0001 inch. The dielectric members **15** and **16** are .067 inch thick and formed from Teflon Fibreglas as manufactured by Continental Dimond Fiber Company.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A high-frequency wave translating device, comprising: a pair of elongated, outer conductors providing ground planes; an elongated, inner conductor disposed in parallel with and in insulated spaced relation between said outer conductors; a resonant, elongated slot formed transversely in one of said outer conductors overlaying said inner conductor and intersecting an axis parallel with said inner conductor, said slot being electrically an integral number of half-wave lengths long and less than a half-wave length wide at the highest operating frequency of said device; and conductive means coupling said outer conductors in the vicinity of said intersection to enable increased coupling of high-frequency energy from between said inner and outer conductors through said slot.

2. A high-frequency wave translating device, comprising: a pair of elongated, outer conductors providing ground planes; an elongated inner conductor disposed in parallel with and in insulated spaced relation between said outer conductors; a resonant, elongated slot formed transversely in one of said outer conductors overlaying said inner conductor and intersecting an axis parallel with said inner conductor, said slot being an integral number of half-wave lengths long and less than a half-wave length wide at the highest operating frequency of said device; and a plurality of conductive rods connecting said outer conductors adjacent opposite sides of said slot with at least one of said rods in the vicinity of each corner in the outer conductor defined by the intersection of an axis parallel with said inner conductor and said slot to enable increased coupling of high-frequency energy from between said inner and outer conductors through said slot.

3. A high-frequency wave translating device, comprising: a pair of elongated, outer conductors providing ground planes; an elongated inner conductor disposed in parallel with and in insulated spaced relation between said outer conductors; a resonant, elongated slot formed transversely in one of said outer conductors overlaying said inner conductor and intersecting an axis parallel with said inner conductor, said slot being an integral number of half-wave lengths long and less than a half-wave length wide at the highest operating frequency of said device; a conductor tab extending from said outer conductor into said slot for tuning said slot and matching the impedance of said slot to said line; and conductive means coupling said outer conductors in the vicinity of said intersection to enable increased coupling of high-frequency energy from between said inner and outer conductors through said slot.

4. A high-frequency wave translating device, comprising: a pair of elongated, outer conductors providing ground planes; an elongated inner conductor disposed in parallel with and in insulated spaced relation between said outer conductors; a resonant, elongated slot formed transversely in one of said outer conductors overlaying said inner conductor and intersecting an axis parallel with said inner conductor, said slot being an integral number of half-wave lengths long and less than a half-wave length wide at the highest operating frequency of said device; conductive means coupling said outer conductors in the vicinity of said intersection; and a wave guide transmission line connected to said outer conductor with a propagation boundary adjacent each extremity of said slot to enable increased coupling of high-frequency energy from between said inner and outer conductors through said slot.

5. A high-frequency wave translating device, comprising: an elongated, planar, inner conductor; a pair of elongated, planar, outer conductors providing ground planes and disposed in parallel with and in insulated spaced relation with respect to opposite sides of said inner conductor, one of said outer conductors having an opening therethrough intersecting an axis parallel with and overlaying said inner conductor; and conductive means coupling said outer conductors in the vicinity of said intersection to enable increased coupling of high-frequency energy from between said inner and outer conductors through said slot.

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