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Nakagami et al.

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[54] **SQUARE TURNING MEANDER LINE**

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[30] **Foreign Application Priority Data**

Mar. 19, 1973 Japan 48-31581

[52] **U.S. Cl.** ..... **333/31 R**; 333/28 R; 333/84 M

[51] **Int. Cl.²** **H01P 9/00**

[58] **Field of Search** ..... 333/31 R, 84 M, 28 R

[56] **References Cited**

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[57] **ABSTRACT**

A square turning meander line is disclosed which is a kind of strip line having alternating bends, adapted for use as a pulse compressor or a delay equalizer. A continuous line is formed to extend on both the top and bottom surfaces of a dielectric plate, which plate is disposed between top and bottom earth conductors in spaced and parallel relation thereto. The continuous line consists of first and second pluralities of parallel conductor lines arranged on respective top and bottom surfaces of the dielectric plate in opposed relationship; the lines are connected at first commonly disposed ends to the corresponding, opposed conductor lines on the other surface of the dielectric plate and each line is connected at the other end to an adjacent line of the same surface, in alternate succession to those on the other surface of the dielectric plate.

5 Claims, 5 Drawing Figures

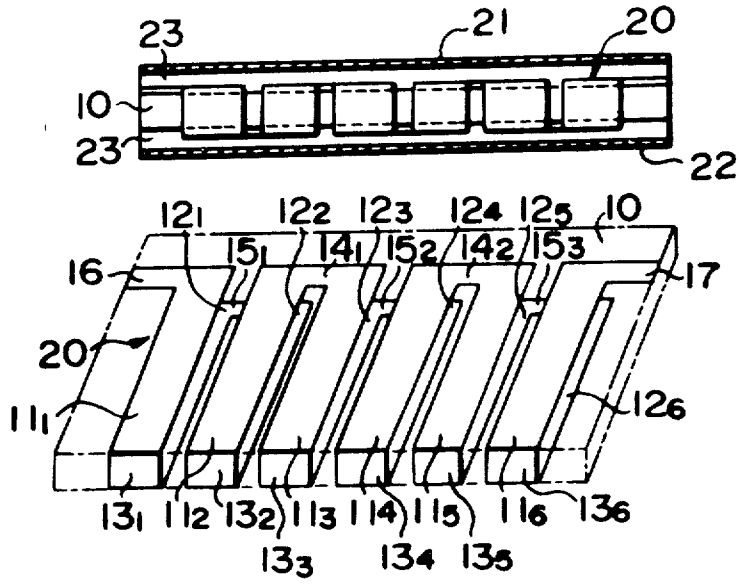


FIG. 1 PRIOR ART

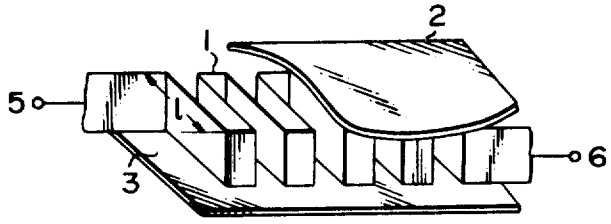


FIG. 2 PRIOR ART

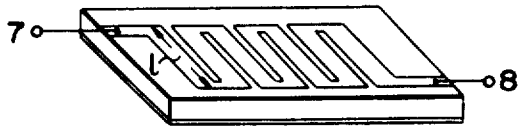


FIG. 3

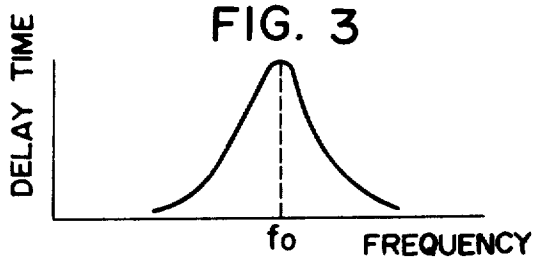


FIG. 4A

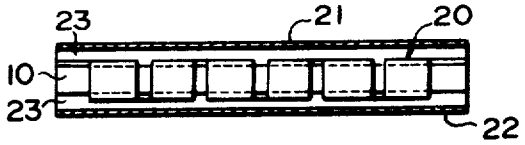
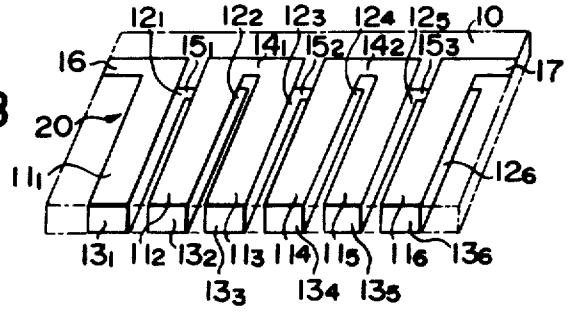


FIG. 4B



SQUARE TURNING MEANDER LINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a square turning meander line for use as a pulse compressor or a delay equalizer in microwave and millimeter wave communication.

The square turning meanderline is a kind of strip line, formed by bending a line, and is designed such that the amount of delay of the line may have a frequency characteristic determined as a function of the degree of electrical coupling between adjacent conductors of the line.

2. Description of the Prior Art

Conventional types of square turning meander lines are shown, for example, in FIGS. **1** and **2**. The square turning meander line depicted in FIG. **1** is disclosed in "New Equalizers Help Waveguide Communication" of Bell Laboratories Record, May, 1970. As shown in FIG. **1**, a tape-like conductor **1** is bent alternately at right angles to its lengthwise direction and held between earth conductors **2** and **3**. In this case, Teflon or like dielectric is packed between adjacent lines of the conductor **1** to hold it. With this construction, however, processing for holding the conductor **1** at equal intervals is complicated and difficult, and hence this construction is not suitable for mass production. To overcome such a defect, a micro-strip-like line such as depicted in FIG. **2**, which is bent in a plane, has been proposed. This line can be produced by photoetching a dielectric plate having adhered thereto a conductor, and is convenient for mass production. The delay time between terminals **5** and **6** or **7** and **8** of the above conventional square turning meander lines has such a characteristic as shown in FIG. **3**. The frequency f_o corresponding to the crest is dependent upon the length l of each line and the height or sharpness of the crest is dependent upon how many times the conductor is bent. Further, the greater the degree of the electric coupling between adjacent lines, the sharper the curve becomes and the larger the amount of delay per bend becomes. Therefore, since the tape-like line of FIG. **1** has large confronting areas between adjacent conductors and therefore a large amount of electrical couplings, it has a large amount of delay and a sharp frequency characteristic, but has the aforementioned structural defect. On the other hand, since the microstrip-like line of FIG. **2** has loose, i.e., very small, coupling between adjacent lines, it correspondingly presents only a small amount of delay; in order to obtain a required delay time, it is necessary to increase the number of bends of the conductor, which inevitably lengthens the line and increases transmission loss. Thus, the conventional lines depicted in FIGS. **1** and **2** have their respective advantages and disadvantages, both as to suitability for mass production and as to the electrical characteristics.

SUMMARY OF THE INVENTION

The present invention has for its object to provide a square turning meander line which is excellent both in its suitability for mass production and in its electrical characteristics.

The square turning meander line according to this invention is characterized in that one continuous line is formed to extend on both the top and bottom surfaces of a dielectric plate, and is disposed between top and bottom earth conductors arranged in spaced, parallel relation to each other. The continuous line is arranged in first and second pluralities of parallel conductor lines disposed respectively on the top and bottom surfaces of the dielectric plate with corresponding ones thereof in opposing relation to each other. First commonly disposed ends of the plurality of conductor lines on one surface of the dielectric plate are connected to the corresponding ends of the respectively opposed conductor lines on the other surface of the dielectric plate; the other ends of adjacent lines of each surface are connected to the ends of the respectively next adjacent lines in paired relationship, and in alternate succession as to the lines of the top and bottom surfaces of the dielectric plate.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention will be more fully understood by the following description and the attached drawings, in which:

FIG. **1** is a perspective view of a conventional tape-like square turning meander line;

FIG. **2** is a perspective view of a conventional flat square turning zigzag line;

FIG. **3** is a graph, for explaining the characteristic of the square turning meander line of FIG. **1** and FIG. **2**; and

FIGS. **4A** and **4B** are front and perspective views respectively illustrating the construction of one embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIGS. **4A** and **4B**, there are shown front and perspective views of the construction of one embodiment of this invention, respectively. As depicted in FIG. **4A**, a dielectric plate **10**, which has a line **20** formed on the top and bottom surfaces thereof, is disposed centrally between parallel earth conductors **21** and **22** by means of a dielectric **23**; alternatively, **23** may indicate an air gap as the dielectric and suitable support means (not shown) may be provided. FIG. **4B** shows in detail the line **20** and other elements as seen in FIG. **4A** are removed or shown in phantom lines for clarity of illustration. First and second pluralities of opposed parallel conductor lines 11_1 to 11_6 and 12_1 to 12_6 are formed on corresponding, opposite surfaces of the dielectric plate **10** (shown in phantom view). At one marginal edge of the dielectric plate **10** the commonly disposed ends of the lines of one surface are joined to the ends of the corresponding, opposed lines of the other surface. For example, the lines 11_1 and 12_1 are interconnected through a line end 13_1 and the other lines on the top and bottom surfaces of the dielectric plate **10** are similarly interconnected through line ends 13_2 to 13_6, respectively, forming side-long U-shaped lines. On the top surface of the dielectric plate **10**, the lines 11_2 and 11_3 are interconnected through a line connecting part 14_1 and the lines 11_4 and 11_5 are similarly interconnected through a line connecting part 14_2. On the bottom surface of the dielectric plate **10**, the lines 12_1 and 12_2, 12_3 and 12_4, and 12_5 and 12_6 are interconnected through line connecting parts 15_1, 15_2 and 15_3, respectively. Namely, the paired interconnection of adjacent lines on the top surface of the dielectric plate **10** and that on the bottom surface alternate with each other. Connecting terminals **16** and **17** are provided for the lines 11_1 and 11_6 respectively. There thus is provided

therebetween a single, continuous conductor line of parallel component lines bent back upon itself at one marginal edge of the dielectric plate. With such a construction, tight coupling exists between the opposing lines through the dielectric plate, and loose, additional coupling exists between the adjacent lines on each surface of the dielectric plate. As a result a large amount of delay can be obtained with only a small number of bends of the line.

Further, this line can be produced by photoetching of a dielectric plate having conductors affixed to each of the opposite surfaces thereof; hence, this line is very simple to process, rendering it ideally suited for mass production.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of this invention; it is intended by the appended claims to cover all such modifications and adaptations which fall within the true spirit and scope of the invention.

What is claimed is:

1. A square turning meander line comprising:

a dielectric plate having first and second parallel, generally planar surfaces,

a continuous conducting line formed on said plate and disposed to include first and second pluralities of parallel conducting lines on said first and second surfaces, respectively, of said dielectric plate with corresponding ones of said lines of said first and second pluralities in opposed relationship, first commonly disposed ends of corresponding, opposed lines of said first and second pluralities thereof being connected and the other ends of adjacent lines of each plurality being connected in

paired relationship and in alternate succession as to said first and second pluralities thereof,

each of said lines being of a common length and of a common width selected in accordance with a desired frequency characteristic of the said meander line and adjacent said parallel lines of each said plurality plate being separated by a distance less than the said common width thereof, and

first and second parallel, spaced earth conductors, said dielectric plate with said continuous line thereon being positioned in parallel relationship in the spaced between said first and second earth conductors.

2. A square turning meander line as in claim 1, wherein there is further provided dielectric material filling the spaces between the said first and second surfaces of said dielectric plate and said first and second earth conductors, respectively.

3. A square turning meander line as in claim 1, wherein said continuous line is formed on said dielectric plate by photoetching of conducting material initially provided on at least the corresponding surfaces of said plate.

4. A square turning meander line as in claim 1, wherein said continuous line further comprises first and second portions extending from the first and last of the parallel conducting lines of said continuous line to corresponding edges of said plate, to afford external electrical connections to said line.

5. A square turning meander line as in claim 4, wherein said first and second portions extend transversely of the parallel direction of said pluralities of lines.

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