Feb. 23, 1960 D. BLITZ 2,926,317

TRANSMISSION LINE

Filed March 11, 1954

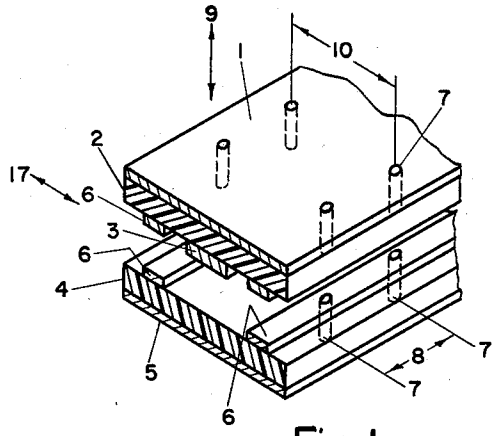

Fig. 1

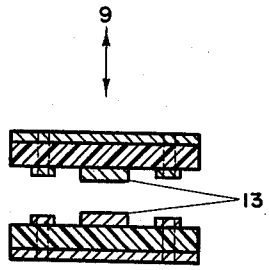

Fig. 2

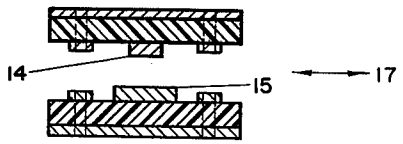

Fig. 3

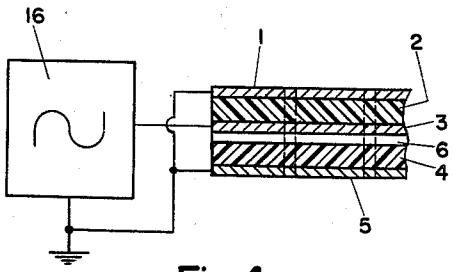

Fig. 4

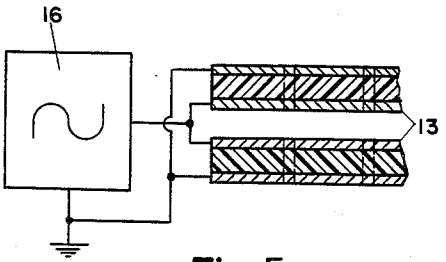

Fig. 5

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TRANSMISSION LINE

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5 Claims. (Cl. 333—84)

The present invention relates to transmission lines. More particularly, the present invention relates to the use of transmission lines such as are used in association with high frequency electronic devices.

In modern shortwave techniques, transmission lines in a form familiarly known as wave guides are widely used. Because of the construction these wave guides occupy a large volume of space, are heavy and are expensive to manufacture.

Theoretically, a transmission line composed of inner conductors of finite width and spaced between outer conductors that are parallel and of infinite width would permit no radiation of high frequency energy from the line. By selecting the width of the outer conductors to be sufficiently greater than that of the inner conductors, a transmission line of relatively low loss due to radiation is obtained.

As an alternative to wave guides, these configurations may be more readily employed with printed and etched circuit techniques. A propensity of these alternative configurations toward the propagation of high frequency energy in undesirable modes has been the source of much difficulty.

It is therefore an object of the present invention to provide an improved transmission line that excludes undesirable propagation modes of high frequency energy; and

A further object of the invention is to provide an improved transmission line of the character described in which the relative movement of its parts has substantially no effect on the electrical characteristics of the line.

Other and further objects of the invention will be apparent from the following description of a typical embodiment thereof, taken in connection with the accompanying drawings.

In accordance with the invention there is provided a composite, high-frequency, electric transmission line. The line includes a pair of thin, elongated, parallel, planar, etched-circuit-type, outer conductors providing electrical ground planes. A thin, elongated planar, etched-circuit-type inner conductor is disposed in parallel with and between the outer conductors. The inner conductor is of lesser width than the outer conductors. A solid dielectric, planar insulating panel wider than the inner conductor is disposed between the inner conductor and one of the outer conductors for securing the inner conductor in insulated spaced relation with respect to the outer conductor. Another solid dielectric planar insulating panel is secured to the other of the outer conductors and is disposed between the inner and the other outer conductor. A pair of thin, elongated, planar, etched-circuit-type, capacitive, strip conductors are affixed to a surface of the first insulated panel adjacent opposite sides of the inner conductor. The capacitive strip conductors are spaced transversely less than a half wave length apart at the highest operating frequency. A second pair of thin, elongated, etched-circuit-type capacitive strip conductors are affixed to the second insulating panel. They are so disposed as to register with the first pair of strip conductors. The

thickness of the strip conductors is so chosen relative to the inner conductor as to provide a space between adjacent ones of the strip conductors in register. Conductive rods extend from the outer conductors through the insulating panel through the adjacent strip conductors corresponding with each outer conductor to effect an electrical coupling between the outer conductors. This enables relative movement therebetween without substantially varying the electrical characteristics of the transmission line.

In the accompanying drawings:

Fig. 1 is a three-dimensional view of a three-plate transmission line embodying this invention;

Fig. 2 is a cross-sectional view of a four-plate transmission line embodying the present invention;

Fig. 3 is a cross-sectional view of a four-plate transmission line illustrating another embodiment of the invention;

Fig. 4 is a schematic diagram of a source of energy connected to the transmission line of Fig. 1; and

Fig. 5 is a schematic diagram of a source of energy connected to the transmission line of Fig. 2.

Referring now in more detail to the drawings, an outer conductor **1** is attached to the upper surface of a dielectric **2** with a suitable cement. An inner conductor **3** is attached to the under surface of the dielectric **2**. An outer conductor **5** is attached to the under surface of a dielectric **4**. Pins **7** pierce outer conductor **1**, dielectric **2** and contact strip **6**. Pins **7** pierce outer conductor **5** and dielectric **4**. Outer conductors **1** and **5** are capacitively coupled through contact strip **6** and pins **7** because of their proximity. The pins **7** are positioned in pairs in the direction of the length of the line at intervals **8** less than a quarter-wave long at the operating frequency and at transverse intervals **10** less than a half-wave long at the operating frequency. This arrangement permits limited relative transverse movement between the line sections as shown, without substantially varying the electrical characteristics of the line.

In Fig. 2 there is shown an embodiment of this invention wherein a four-plate line is provided. The inner conductors **13** are connected to the same voltage source. Since the fields between each inner conductor and its associated outer conductor are maintained relatively constant, limited transverse motion between the inner conductors in the direction as indicated at **9** is permissible without substantially varying the electrical characteristics of the line. As shown in Fig. 3, inner conductor **15** may be wider than conductor **14** to permit limited transverse motion between them in the direction as indicated at **17**.

In Fig. 4 a source **16** of high frequency energy is shown connected to the three-plate transmission line of Fig. 1, viewed in longitudinal cross-section. The inner conductor **3** is connected to one electrical side; the outer conductors **1** and **5** are connected together to the ground side of source **16**.

In Fig. 5 the source **16** is shown connected to the four-plate transmission line of Fig. 2, viewed in longitudinal cross-section. The inner conductors **13** are connected together to one side of the source; the outer conductors are connected together to the ground side **15**, as shown.

Since the physical parameters of the transmission line as described above may be varied without substantially reducing the efficiency of the line, the economy of manufacture and reliability of operation of these devices is greatly enhanced.

While there has been hereinbefore described what is at present considered a preferred embodiment of the invention, it will be apparent that many and various changes and modifications may be made with respect to the embodiment illustrated without departing from the spirit of the invention. It will be understood, therefore, that all those changes and modifications as fall fairly within the

scope of the present invention, as defined in the appended claims, are to be considered as a part of the present invention.

What is claimed is:

1. A composite, high-frequency, electric, transmission line, comprising: a pair of thin, elongated, parallel, planar, etched-circuit-type, outer conductors providing electrical ground planes; a thin, elongated, planar, etched-circuit-type, inner conductor disposed in parallel with and between said outer conductors, said inner conductor being of lesser width than said outer conductors; a first solid, dielectric, planar, insulating panel wider than said inner conductor and disposed between said inner conductor and one of said outer conductors for securing said inner conductor in insulated, spaced relation with respect to said outer conductor; a second solid, dielectric, planar, insulating panel secured to the other of said outer conductors and disposed between said inner and said other outer conductor; a pair of thin, elongated, planar, etched-circuit-type, capacitive, strip conductors affixed to a surface of said first insulating panel adjacent a side of said inner conductor and spaced tranversely less than a half wave length apart at the operating frequency; a second pair of thin, elongated, etched-circuit-type, capacitive strip conductors affixed to said second insulating panel and so disposed as to register with the first said pair of strip conductors, the thickness of said strip conductors being so chosen relative to said inner conductor as to provide a space between adjacent ones of said strip conductors in register; and conductive rods extending from said outer conductors through said insulating panel to said adjacent strip conductors corresponding with each outer conductor to effect an electrical coupling between said outer conductors and to enable relative movement therebetween without substantially varying the electrical characteristics of said transmission line.

2. A composite, high-frequency, electric, transmission line, comprising: a pair of thin, elongated, parallel, planar, etched-circuit-type, outer conductors providing electrical ground planes; a thin, elongated, planar, etched-circuit-type inner conductor disposed in parallel with and between said outer conductors, said inner conductor being of lesser width than said outer conductors; a first solid, dielectric, planar, insulating panel wider than said inner conductor and disposed between said inner conductor and one of said outer conductors for securing said inner conductor in insulated, spaced relation with respect to said outer conductor; a second solid, dielectric, planar, insulating panel secured to the other of said outer conductors and disposed between said inner and said other outer conductor; a pair of thin elongated, planar, etched-circuit-type, capacitive, strip conductors affixed to a surface of said first insulating panel laterally adjacent opposite sides of said inner conductor and spaced transversely less than one-half wave length apart at the highest operating frequency; a second pair of thin, elongated, etched-circuit-type capacitive strip conductors affixed to said second insulating panel and so disposed as to register with the first said pair of strip conductors, the thickness of said strip conductors being so chosen relative to said inner conductor as to provide a space between adjacent ones of said strip conductors in register; and means for supporting and electrically coupling said strip conductors to said outer conductors to enable relative movement of said outer conductors without substantially varying the electrical characteristics of said transmission line.

3. A composite, high-frequency, electric, transmission line, comprising: a pair of thin, elongated, parallel, planar, etched-circuit-type, outer conductors providing electrical ground planes; a pair of solid dielectric, planar, insulating panels secured to said outer conductors and disposed between said outer conductors; a pair of thin, elongated, planar, etched-circuit-type, inner conductors disposed in register and in parallel with and between said outer conductors, said inner conductors being of lesser width than said outer conductors and bonded to the inner surfaces of said solid, insulating panels; pairs of thin, elongated, planar, etched-circuit-type, capacitive, strip conductors affixed to the inner surface of each insulating panel laterally adjacent opposite sides of each inner conductor and spaced transversely less than one-half a wave length apart at the highest operating frequency, the thickness of said strip conductors being so chosen relative to said inner conductors as to provide a space between adjacent ones of said strip conductors in register; and means for supporting said strip conductors to effect an electrical coupling between said outer conductors and to enable relative movement therebetween without substantially varying the electrical characteristics of said transmission line.

4. A composite, high-frequency, electric transmission line, comprising: a pair of thin, elongated, parallel, planar, etched-circuit-type, outer conductors providing electrical ground planes; a pair of solid, dielectric, planar, insulating panels secured to said outer conductors and disposed between said outer conductors; a pair of thin, elongated, planar, etched-circuit-type, inner conductors of differing widths disposed in register and in parallel with and between said outer conductors, said inner conductors being of lesser width than said outer conductors and bonded to the inner surfaces of said solid insulating panels; pairs of thin elongated, planar, etched-circuit-type, capacitive, strip conductors affixed to a surface of each insulating panel laterally adjacent opposite sides of each of said inner conductors and spaced transversely less than one-half wave length apart at the highest operating frequency, the thickness of said strip conductors being so chosen relative to said inner conductors as to provide a space between adjacent ones of said strip conductors in register; and means for supporting said adjacent strip conductors to effect an electrical coupling between said outer conductors and to enable relative movement therebetween without substantially varying the electrical characteristics of said transmission line.

5. A composite, high-frequency, electric, transmission line, comprising: a pair of thin, elongated, parallel, planar, etched-circuit-type, outer conductors providing electrical ground planes; a pair of solid, dielectric, planar, insulating panels secured to each of said outer conductors and disposed between said outer conductors; pairs of thin, elongated, planar, etched-circuit-type, inner conductors of differing widths disposed in register and in parallel with and between said outer conductors, said inner conductors being of lesser width than said outer conductors and bonded to the inner surfaces of said insulating panels; pairs of thin, elongated, planar, etched-circuit-type capacitive strip conductors affixed to the surfaces of each of said insulating panels laterally adjacent opposite sides of said inner conductors and spaced transversely less than one-half wave length apart at the highest operating frequency, said strip conductors being in register and of a thickness chosen relative to said inner conductors as to provide a space between adjacent ones of said strip conductors in register; and conductive rods extending from said outer conductors through said insulating panels to said adjacent strip conductors corresponding with each outer conductor to effect an electrical coupling between said outer conductors and to enable relative movement therebetween without substantially varying the electrical characteristics of said transmission line.

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