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SUPPORTS FOR MICROWAVE TRANSMISSION LINES

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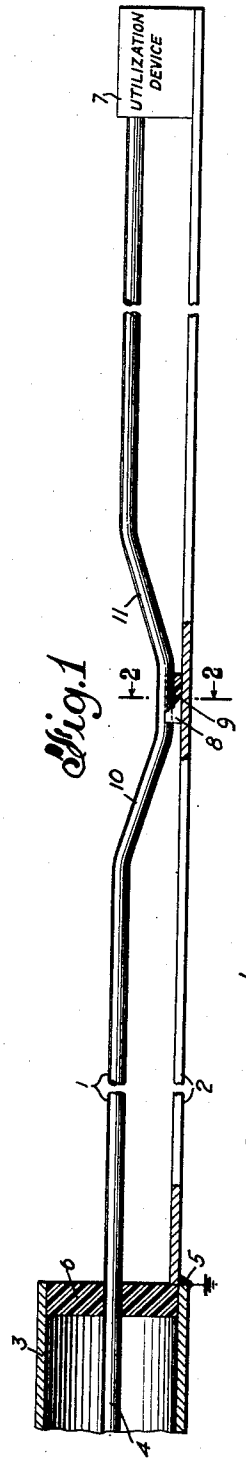

Fig. 1

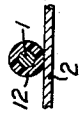

Fig. 3

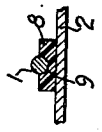

Fig. 2

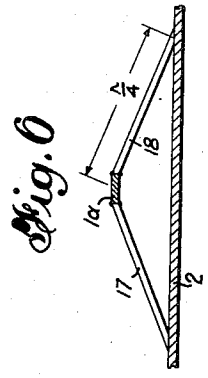

Fig. 6

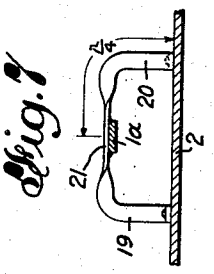

Fig. 7

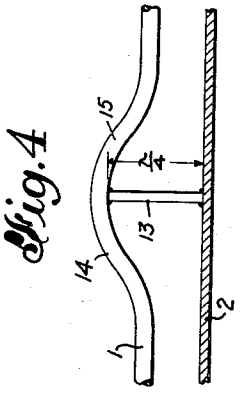

Fig. 4

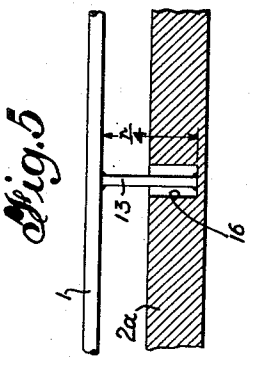

Fig. 5

INVENTORS
DONALD D. GRIEG
HERBERT F. ENGELMANN
JOHN A. KOSTRIZA
BY Percy P. Lantzy
ATTORNEY

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SUPPORTS FOR MICROWAVE TRANSMISSION LINES

Donald D. Grieg, North Caldwell, and Herbert F. Engelmann, Mountain Lakes, N. J., and John A. Kostriza, New Dorp, N. Y., assignors to International Telephone and Telegraph Corporation, a corporation of Maryland

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2 Claims. (Cl. 333—97)

This invention relates to microwave transmission lines and more particularly to supports therefor.

In the copending application of D. D. Grieg-H. F. Engelmann, Serial No. 227,896, filed May 23, 1951, a new type of microwave transmission system is disclosed with which the supporting elements of this invention are particularly applicable. The new system employs, usually, two conductors, one as a "ground conductor" and the other as a "line conductor" spaced close together in substantially parallel relation. The so-called "ground conductor" which may be at ground potential or some other given potential, is considerably wider than the line conductor so that the surface thereof provides in effect an image reflection of the line conductor, whereby the distribution of the electric and magnetic fields between the conductors is substantially the same as the distribution between one conductor and the neutral plane of a two-conductor parallel system. Small variations in size and shape of the line conductor may produce variations in the characteristic impedance of the system but the field distribution with respect to the ground conductor is not materially disturbed. Likewise, certain variations in the surface of the ground conductor do not materially disturb the field distribution with respect to the surface thereof since such variations either neutralize each other or do not adversely affect the field distribution between the two conductors. By this system, microwaves can be easily propagated by the TEM mode along the line-ground conductor system since the microwaves flow in the regions of the electromagnetic field bounded substantially by the opposed surfaces of the line and ground conductors.

The object of the present invention is to provide supporting elements either of insulation or of conductive material to maintain the two conductors of the system described above in proper spaced relation.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a view in side elevation with parts broken away in section to show a transmission line-ground conductor system with one form of support in accordance with the principles of the present invention;

Fig. 2 is a cross-sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a similar cross-sectional view showing a modified form of support;

Figs. 4 and 5 are views in side elevation with parts broken away showing two other forms of support utilizing conductive material as the support; and

Figs. 6 and 7 are cross-sectional views of the transmission line showing two additional forms of support that may use conductive material.

Referring to Fig. 1 of the drawing, the microwave transmission system illustrated comprises a first or line conductor 1 and a second or ground conductor 2. The

ground conductor is preferably of sheet or ribbon form, although other forms may be used, having a width considerably greater than the width of the line conductor 1. The conductor 2, for example, may comprise one of the walls of a chassis or other part of the electric apparatus with which or in which the transmission system is used. The ground conductor 2 may extend a considerable distance laterally with respect to the line conductor but for practical purposes the width of the ground conductor may be twice or three times the width of the line conductor. The purpose of having the ground conductor of a width two to three times greater than the width of the line conductor is to provide in effect an image reflection of the line conductor so that the distribution of the electric and magnetic fields between the conductors is similar to the distribution between one conductor and the neutral plane of a two-conductor parallel system. By making the spacing between the two conductors small, for example, a fraction of the wavelength of the mid frequency of the microwave energy, the flux distribution is concentrated almost entirely between the opposed surface of the two conductors.

Microwave energy may be launched onto the line-ground conductor system by any suitable means, a coaxial line 3, 4 being shown by way of illustration as one satisfactory form of launching device. The outer conductor 3 of the coaxial line is countersunk with respect to the upper surface of the conductor 2 so as to bring the inner conductor 4 into alignment with the line conductor 1. The reason for the counter-sinking is that the spacing between the conductors 1 and 2 for a given characteristic impedance is usually smaller than the spacing between the inner and outer conductors of the coaxial line of corresponding impedance. Where the line conductor 1 is larger in cross-section than the inner conductor by a proper amount, the spacing between conductors 1 and 2 may be the same as the spacing between the inner and outer conductors for a given impedance characteristic. The outer conductor 3 is connected to the ground conductor 2 as indicated at 5. The discontinuity between the shape of the outer conductor 3 and the ground conductor 2 may cause some perturbation of the waves. The dielectric bead 6 at the end of the coaxial line is so selected with regard to size and dielectric quality as to overcome the effects of this discontinuity.

Where the line conductor 1 extends some distance to a utilization device 7 as indicated in Fig. 1, the line may sag unsymmetrically thereby varying unevenly the spacing between the conductors 1 and 2. To avoid such sagging, one or more supports of the forms herein disclosed may be employed. In Fig. 1, a body of insulating material 8 having a recess 9 in the upper surface thereof of a size and shape to receive the conductor 1 may be used. The body 8 may be of a size corresponding to the desired spacing between the conductors or it may be of a size considerably smaller than the spacing. In the latter case, the line conductor 1 may be provided with symmetrical transformer sections 10 and 11 of lengths equal substantially to a half wavelength of multiples thereof, thereby reducing the spacing between the conductors at the support. The body 8 may be secured to the ground conductor 2 or to the line conductor 1 or to both by any suitable adherent material.

In Fig. 3, the body of insulating material is shown in the form of a bead 12 adapted to surround the line conductor 1. The bead may be preformed of ceramic or other material and threaded onto the line conductor 1, or it may be formed onto the conductor 1 as a plastic material.

The supports shown in Figs. 4 and 5 comprise a supporting element 13 in the form of a rod of conductive material. The rod 13 is selected of a length corresponding substantially to one-quarter or an odd mul-

tiple of quarter wavelengths of the mid frequency of the microwave energy propagated over the system. This length provides the appearance at the connection to the conductors of an open circuit. The connection of the elements may be made by brazing, soldering or by any other suitable means. The spacing between the conductors **1** and **2** is usually considerably less than a quarter wavelength thereby requiring some provision to accommodate the quarter wave support. In Fig. 4, the line conductor **1** is provided with a symmetrical transformer shape **14**, **15** varying from a given spacing normally employed along the line-ground conductor system to the one-quarter spacing at the support element **13**. In Fig. 5, a cup-shaped recess **16** is formed in the ground conductor **2***a* sufficient to accommodate the quarter-wavelength support **13**. Should the ground conductor **2***a* be too thin to accommodate the recess **16**, a depending sleeve may be provided which would correspond to the cup-shaped recess **16**.

In Figs. 6 and 7, symmetrical supporting elements are provided for the line conductor. In some cases the line conductor may preferably be flat as indicated at **1***a*, thus insuring a high concentration of flux between the opposing surfaces of the line-ground conductor system. The supporting element shown in Fig. 6 comprises two support elements **17** and **18** which are selected length equal substantially to a quarter or an odd multiple of quarter wavelengths and are disposed laterally with respect to the ground conductor **1***a*. These elements **17** and **18**, however, need not be at right angles to the conductor **1***a* but may be disposed in any desired angular relationship. In Fig. 7, for example, the symmetrical supporting arrangement comprises two legs **19** and **20** which together form an inverted U-shaped bracket. The legs **19** and **20** of the bracket are supported on the ground conductor **2** and the line conductor **1***a* is brazed, soldered or otherwise secured to the cross piece **21** of the bracket. While the conductor **1***a* of Figs. 6 and 7 is shown rectangular in cross-section, it may be of any cross-sectional shape desired. Likewise, the shapes of the line conductors shown in Figs. 1 to 5 may be rectangular or of other shapes as may be desired.

While we have described above the principles of our invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention, as set forth in the objects thereof and in the accompanying claims.

We claim:

1. In a microwave transmission system having first and second conductors spaced close together in substantially parallel relation a fraction of a quarter wavelength apart, the width of the second conductor being wider than the first conductor so that the electromagnetic field is distributed between the opposed surfaces of said first and second conductors substantially the same as between the conductor and the neutral plane of a two-conductor parallel system, a U-shaped supporting bracket of conductive material straddling said first conductor with the legs thereof in engagement with said second conductor and the mid portion secured to the side of said first conductor facing away from said second conductor whereby the space between said first and second conductors is free of conductive material, each of the legs of said U-shaped bracket plus a portion of the cross piece of the bracket being equal to approximately a quarter wavelength or an odd multiple thereof of the mid frequency of the microwave energy propagated along said system.

2. In a microwave transmission system according to claim 1, wherein the first and second conductors are of ribbon-like cross-section and the legs of the U-shaped bracket extend laterally of the side edges of said first conductor.

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