April 29, 1947. H. T. FRIIS 2,419,557

BRANCHING CIRCUITS

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FIG. 1

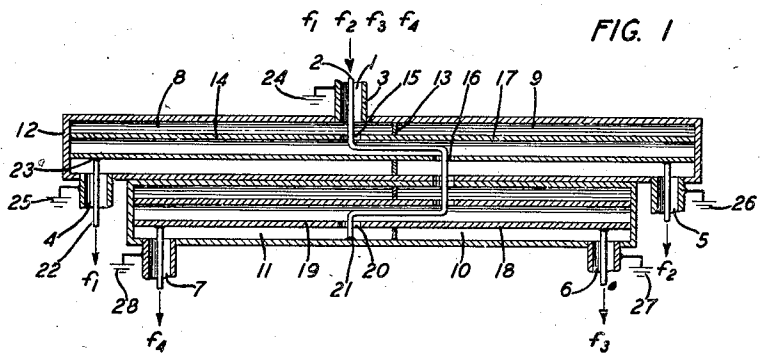
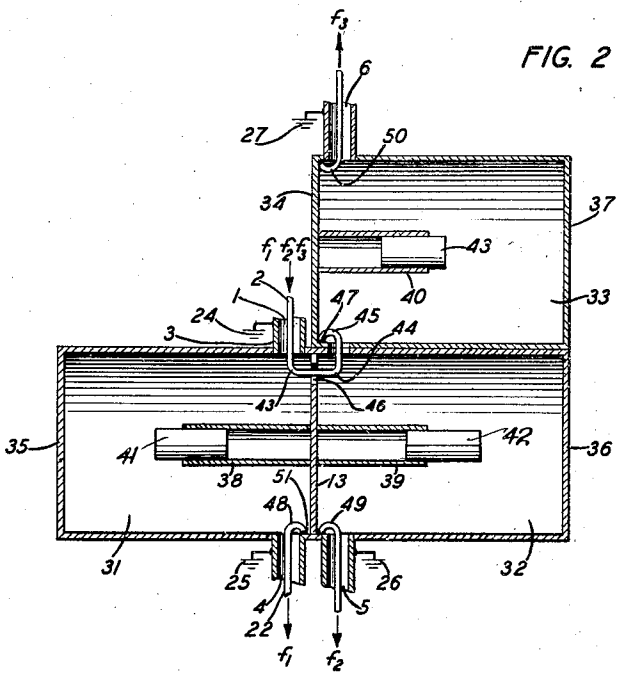


FIG. 2



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This invention relates to wave transmission systems and more particularly to branching circuits for use in such systems.

The object of the invention is to separate into individual channels signal currents of different frequencies which are being transmitted simultaneously over the same transmission line.

A feature of the invention is a branching arrangement in which each branch comprises, as a frequency selective element, a tuned section of coaxial transmission line the outer conductor of which may be grounded.

In high frequency transmission systems coaxial transmission lines are often used because the outer conductor affords excellent shielding. In branching circuits for such a system it is desirable that the outer conductor of each branch be grounded or otherwise fixed in potential.

In accordance with the present invention there may be provided any desired number of branching circuits which meet the above requirement as to grounding. Each branch comprises a section of coaxial transmission line tuned to the frequency to be transmitted by the branch with which it is associated and preferably an integral number of quarter wave-lengths long at that frequency. All of the sections are connected in series at their input ends and each is coupled to the main transmission line only inductively. Such an arrangement permits the grounding of the outer conductor of each section.

The nature of the invention will be more fully understood from the following detailed description and by reference to the accompanying drawings, in which like reference characters refer to similar or corresponding parts and in which:

Fig. 1 is a cross-sectional view showing four branching circuits each comprising a half-wave coaxial line section; and

Fig. 2 is a cross-section of three branches employing quarter-wave coaxial sections.

In the branching arrangement in accordance with the invention shown in longitudinal cross-section in Fig. 1 it is assumed that signal currents including four different frequencies, namely, f_1, f_2, f_3 and f_4, are being transmitted simultaneously over the main transmission line 1, which is of the coaxial type comprising an inner conductor 2 and coaxial therewith a cylindrical outer conductor 3. The incoming signal currents are separated, on the basis of frequency, into the four individual channels 4, 5, 6 and 7, which may also be of the coaxial type, by means of the tuned coaxial line sections 8, 9, 10 and 11, respectively. Each of these sections is short-circuited at each

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end and has a length which is approximately equal to a half wave-length at the frequency to be transmitted by it to the channel associated therewith. The section 8, for example, is shorted at one end by means of the metallic end plate 12 and at the other end by the metallic annulus 13, and has a length approximately equal to half a wave-length, or an integral multiple thereof, at the frequency f_1 associated with the channel 4.

All of the sections 8, 9, 10 and 11 are connected in series at their input ends and each is coupled to the line 1 only inductively. The coupling is preferably made in a region of high current and low voltage in the tuned section. Since these are half-wave sections, such regions will be found near the ends. This inductive coupling is provided by passing an extension of the inner conductor 2 of the main line 1 into the hollow interior of the inner conductor 14 of the first section 8 through an aperture 15, out through the end of the inner conductor 14 into the end of the adjoining hollow inner conductor 17 of the second section 9, out through an aperture 16 in the inner conductor 17, through apertures in the outer conductors of the sections 9 and 10, into the hollow interior of the inner conductor 18 of the third section 10, thence into the end of the adjoining hollow inner conductor 19 of the fourth section 11, out through an aperture 20 in the inner conductor 19 and grounding at a point 21 on the outer conductor of the last section.

Each of the channels 4, 5, 6 and 7 is coupled to the appropriate line section by directly connecting the inner conductor of the channel to the inner conductor of the section at a point near one end. For example, the inner conductor 22 of the channel 4 is connected to the inner conductor 14 of the section 8 at the point 23. With such an arrangement the outer conductors of the main line 1, the channels, 4, 5, 6 and 7 and the tuned section 8, 9, 10 and 11 may all be grounded, as shown, for example, at 24, 25, 26, 27 and 28. In this way effective shielding is provided for the entire system. Although four branches are shown in Fig. 1 it is to be understood that any number, either more or less than four, may be provided.

The longitudinal cross-sectional view of Fig. 2 shows another arrangement in accordance with the invention in which a main transmission line 1 branches into three channels 4, 5 and 6. The frequency selection is accomplished by means of the three tuned coaxial sections 31, 32 and 33 associated, respectively, with the channels 4, 5

and 6. The sections are short-circuited at one end by the common end plate 13, for the sections 31 and 32, and the end plate 34 for the section 33, and at their other ends are open-circuited, but closed, for shielding purposes, by the end plates 35, 36 and 37, respectively. Each of the coaxial inner conductors 38, 39 and 40 has a length approximately equal to a quarter wave-length, or an odd integral multiple thereof, at the frequency to be transmitted by the section with which it is associated. The metallic plugs 41, 42 and 43, which fit into the open-circuited ends of the hollow inner conductors 38, 39 and 40, respectively, and may be moved in or out, are provided so that the lengths of inner conductors may be adjusted for fine tuning.

In Fig. 2 the sections 31, 32 and 33 are connected in series and are coupled only inductively to the main line 1 by an extension of the inner conductor 2 which forms the loops 43, 44 and 45 in the interiors of the sections by passing through an aperture 46 in the common end plate 13 and through apertures in the outer conductors of the sections 32 and 33 to a grounding point 47 on the outer conductor of the section 33. It will be noted that, in Fig. 2, the extension of the inner conductor 2 does not enter the interior of the inner conductors of the sections as in Fig. 1. This construction permits the forming of the shorter coupling loops which are required when extremely high frequencies are to be transmitted. However, when the range of frequencies permits, the construction shown in Fig. 1 may be used.

In Fig. 2 the channels 4, 5 and 6 are connected to the sections 31, 32 and 33 by means of the coupling loops 48, 49 and 50, respectively, formed by grounded extensions of the inner conductors of the channels. For example, an extension of the inner conductor 22 of the first channel 4 forms the loop 48 and is grounded at the point 51. The loops 48, 49 and 50 are located near the short-circuited ends of the sections 31, 32 and 33 because these are the regions of high current and low voltage in the quarter-wave sections. As in Fig. 1, the outer conductors of the main line 1, the channels 4, 5 and 6 and the tuned sections 31, 32 and 33 in Fig. 2 may all be grounded as shown at 24, 25, 26 and 27. Fig. 2 shows three branches but, of course, any required number of branches may be provided.

What is claimed is:

1. In combination, a main transmission line and a plurality of series-connected circuits branching therefrom, each of said branching circuits comprising as a frequency selective element a section of coaxial transmission line coupled to said main line only inductively, one of said sections comprising hollow outer and inner conductors and an extension of one of the conductors of said main transmission line passing through apertures in said outer and inner conductors into the interior of said inner conductor and leaving said inner conductor through another aperture.

2. The combination in accordance with claim 1 in which said main transmission line is of the coaxial type comprising an inner conductor and said extension is an extension of said inner conductor of said main line.

3. The combination in accordance with claim 1 in which another of said sections comprises hollow outer and inner conductors and said extension passes from the interior of one to the interior of the other of said inner conductors through apertures in the ends thereof.

4. The combination in accordance with claim 1 in which another of said sections comprises hollow outer and inner conductors and said extension passes from the interior of one to the interior of the other of said inner conductors through apertures in the end thereof and leaves said other inner conductor through another aperture.

5. In combination, a main transmission line and a plurality of series-connected circuits branching therefrom, each of said branching circuits comprising as a frequency selective element a section of coaxial transmission line coupled to said main line only inductively, two of said sections comprising hollow inner conductors joined at their ends and an extension of one of the conductors of said main transmission line leaving the interior of one of said hollow inner conductors and entering the interior of the other of said hollow inner conductors at their point of junction.

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