

Sept. 17, 1935.

W. L. CASPER

2,014,521

WAVE TRANSMISSION NETWORK

Filed Sept. 22, 1933

FIG. 1

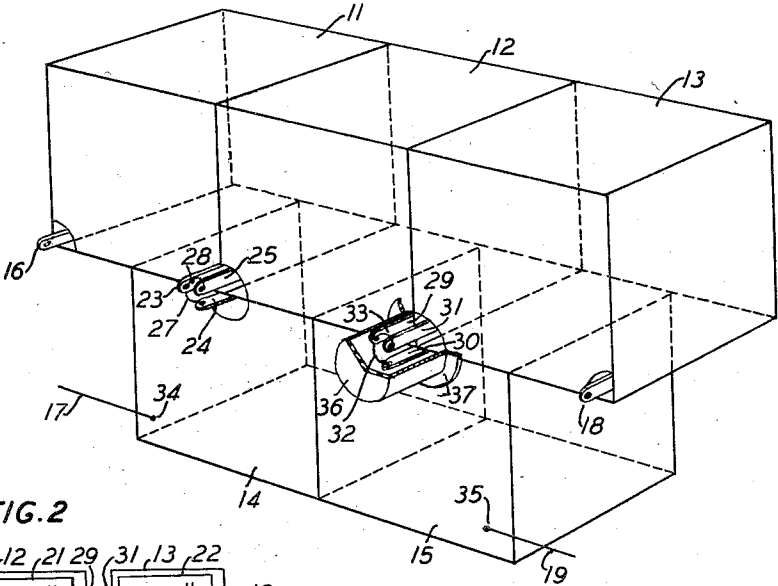


FIG. 2

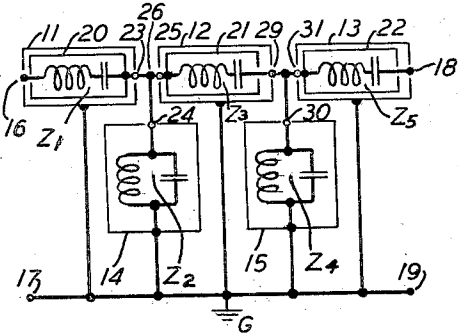


FIG. 3

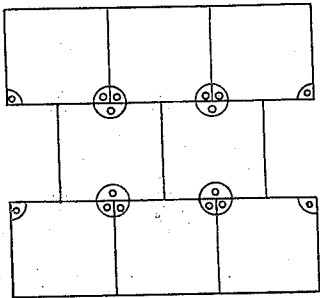
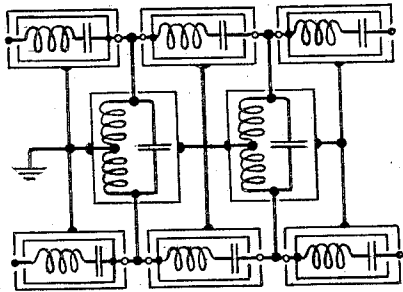


FIG. 4



INVENTOR
W. L. CASPER
BY
E. V. Briggs
ATTORNEY

UNITED STATES PATENT OFFICE

2,014,521

WAVE TRANSMISSION NETWORK

William L. Casper, Summit, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application September 22, 1933, Serial No. 690,554

8 Claims. (Cl. 178-44)

This invention relates to wave transmission networks and more particularly to an arrangement of the terminals of individually shielded impedance branches used in such a network.

The principal object of the invention is to improve the transmission characteristics of wave transmission networks designed for use at high frequencies.

Another object is to reduce the cost of manufacturing a network of this type.

Another object is to minimize the capacity effects caused by the interconnecting wiring used in such a network.

A further object is to reduce the length of wiring required to connect the component branches of a network having individually shielded impedances.

A feature of the invention is a wave transmission network of the ladder type having individually shielded impedance branches in which the series units are arranged in a horizontal row and the shunt units are placed in a second row beneath the first, the terminals of adjoining series branches being brought out at the lower adjacent corners of the individual compartments, and one terminal of the intervening shunt branch being located close to the terminals of the associated series branches.

Generally, transmission networks designed to operate satisfactorily at high frequencies require the complete electrostatic and electromagnetic shielding of their component impedance elements. This may take the form of an individual shield for each impedance branch, and certain of the branches may require a double shield. After these separately shielded units are assembled to form the complete network their terminals must be interconnected by wiring. If open wiring is employed for this purpose certain parts of the circuit will be left unshielded. On the other hand, if shielded connectors are used the capacitance between the conductor and its shield will be unintentionally introduced into the network, thus altering the effective values of the lumped impedances and adversely affecting the transmission characteristics of the network. As a result, final adjustments in the magnitudes of the component impedance elements must be made after the network is assembled and wired. In accordance with the present invention, however, these undesired effects are practically eliminated by so arranging the terminals of the component branches of the network that an extremely short length of wiring may be used. Shielded connectors may then be employed or, in some instances,

open wiring may be used without appreciably affecting the performance of the network. In this way, the branches may be adjusted separately to have the required impedances with assurance that their values will not be changed when the network is assembled and wired. The final adjustment of the component impedance elements after assembly is thus eliminated, with a consequent reduction in the manufacturing cost.

The nature of the invention will be more fully understood from the following detailed description and by reference to the accompanying drawing, of which

Fig. 1 shows in perspective an assembled wave transmission network of the unbalanced type embodying the invention;

Fig. 2 represents schematically the electrical circuit of the network shown in Fig. 1;

Fig. 3 is a view in elevation of an assembled network of the balanced type to which the invention has been applied; and

Fig. 4 shows the electrical circuit of the network of Fig. 3.

The perspective view of Fig. 1 shows the application of the invention to an unbalanced wave transmission network which comprises five groups of impedance elements enclosed in the separate shields 11, 12, 13, 14 and 15. The shields may be made of medium weight copper sheet or other material of high conductivity. In networks which operate at high frequencies such shielding is required in order to confine the stray magnetic field, and to localize and make definite the capacitative couplings between the various impedance elements and the other parts of the circuit. The schematic diagram of Fig. 2 shows the configuration of the network of Fig. 1, which is an unbalanced ladder type wave filter comprising three impedance branches Z_1 , Z_3 , Z_5 in series with the direction of wave propagation and two alternately disposed shunt impedance branches Z_2 , Z_4 . The network has a pair of input terminals 16, 17 and a pair of output terminals 18, 19, by means of which it may be connected between two sections of transmission line or to other apparatus. One side of the filter, the path between terminals 17, 19, may be grounded or otherwise fixed in potential, as shown at G. The filter consists of two full sections of the type illustrated and described in United States Patent 1,227,113 to George A. Campbell issued May 22, 1917, to which reference is made for more detailed information relating to its design.

The series branches of the network have individual inner shields 20, 21, 22 and separate out-

er shields 11, 12, 13, the latter being at ground potential. The shunt branches are enclosed in the separate shields 14, 15, which are electrically connected to the grounded side of the filter. As shown in Fig. 1, the three individual compartments containing the series impedance branches Z_1 , Z_3 , Z_5 are assembled in a row, end to end, and the compartments enclosing the shunt branches Z_2 , Z_4 are arranged in a second row placed alongside the first, each shunt branch being adjacent the two series branches with which it is associated. It will be noted in Fig. 2 that the terminals 23, 24, 25 of the impedances Z_1 , Z_2 , Z_3 are connected to a common point 26. In accordance with the invention, these three terminals are brought out through holes in the sides of their respective compartments located near the point where the three compartments are mutually adjacent, as shown in Fig. 1. The two short straps 27, 28 will then suffice to make the necessary connections between the terminals. The group of terminals 29, 30, 31 are likewise located close together and joined by means of the short connectors 32, 33. In some instances the three associated terminals may be bent so as to meet at a common point, in which case the strapping may be eliminated entirely.

In order to complete the shielding of the network it may be found desirable, in some instances, to place a shield 36 over each group of exposed terminals. The shield 36 is shown in Fig. 1 partially cut away so that the terminals 29, 30, 31 and strapping may be clearly seen. A flange 37 is provided by means of which the terminal shield 36 may be soldered to the outer compartments 12, 13, 15. A similar shield may be placed over the group of terminals 23, 24, 25 but in the interest of clearness it is omitted in the drawing.

The input terminal 16 and the output terminal 18 of the network are brought out through holes in their respective compartments, as shown in Fig. 1. Since all of the outer shields 11, 12, 13, 14, 15 are at ground potential, the connections to the grounded side of the filter may be made to any of the compartments. In the drawing, the input terminal 17 is soldered to the shield 14 at the point 34 and the output terminal 19 is soldered to the shield 15 at the point 35. In this way the interconnecting wiring of the filter external to the shielded compartments is reduced to a minimum with a consequent reduction in the capacity effects caused by this wiring. As a result, the transmission characteristics of the network are greatly improved and the cost of manufacture reduced.

The invention is equally applicable to networks of the balanced type such, for example, as the one shown in elevation in Fig. 3. In this case, the additional series units are placed in a third row located directly beneath the shunt units, each of which is provided with two external terminals for connection to the associated series units. In the interest of clearness, the strapping is not shown. The electrical circuit of the balanced structure of Fig. 3 is shown schematically in Fig. 4. The electrical midpoint of each shunt impedance branch is connected to its shield, and all of the outer shields are grounded.

The invention has been described in connection with a wave filter but it is, of course, applicable to other types of transmission networks such, for example, as equalizers, phase correctors, delay networks and balancing networks.

What is claimed is:

1. In a wave transmission network, a plurality of impedance branches, a separate shielded compartment surrounding each of said impedance branches and an external terminal associated with each of said branches, said terminals being connected together in groups of three at a number of different points, and all of said terminals in each of said groups being located in physical proximity to each other, so that short straps will suffice to make the connections between said terminals.

2. In a wave transmission network, a group of three impedance branches, a separate box-like shield surrounding each of said branches, said three shields being so arranged that they are mutually adjoining at one point, and a separate terminal associated with each of said branches, said terminals being brought out of their respective shields near said mutually adjoining point and all of said terminals being connected to a common point.

3. In a wave transmission network, two series impedances, a shunt impedance having one of its terminals connected to the junction point of said series impedances, and an individual electrostatic and electromagnetic shield enclosing each of said impedances, the shields containing said series impedances abutting each other, the shield containing said shunt impedance adjoining both of the shields containing said series impedances, and the connected terminals of said impedances being brought out of the respective shields through holes which are located as near each other as possible, in order to shorten the required interconnecting wiring.

4. In a wave transmission network, a group of three impedances connected to a common point, an individual metallic container for each of said impedances, said containers being assembled in such a way that they all adjoin along a line, a hole in each of said containers, said holes being grouped as close to each other as possible, wiring extending through said holes to connect said impedances to said common point, and a metallic shield covering said holes and said wiring.

5. In a wave transmission network, a plurality of impedance branches, a separate shield of conductive material enclosing each of said branches, said shields being grouped together so as to be mutually adjoining along a line, an opening in each of said shields, said openings being all located as near each other as possible, a terminal of the enclosed impedance branch extending through each of said openings, connectors joining all of said terminals to a common point, and a separate shield of conducting material covering said openings and enclosing said connectors.

6. A wave transmission network of the ladder type comprising a plurality of impedance branches connected in series with the line, other impedance branches alternately disposed in shunt therewith, and a separate metallic compartment enclosing each of said impedance branches, the compartments containing said series branches being arranged in a row, the compartments containing said shunt branches being arranged in a second row alongside said first mentioned row, each of said compartments containing a shunt branch being adjacent the compartments containing the two series branches associated therewith, and each group of three terminals associated, respectively, with a shunt branch and the two ad-

jacent series branches being brought out through the sides of their respective compartments near a point which is mutually adjacent to all three of said compartments.

5 7. A balanced wave transmission network of the ladder type comprising a plurality of impedance branches connected in series in one side of the line, a plurality of other impedance branches connected in series in the other side of the line, shunt impedance branches connected, respectively, between the junction points of the said series branches in the one side of the line and the corresponding junction points of the said series branches in the other side of the line, and a separate metallic compartment enclosing each of said impedance branches, the compartments containing said series branches in the one side of the line being arranged in a row, the compartments containing said shunt branches being arranged in a second row alongside said first mentioned row, the compartments containing said series branches in the other side of the line being arranged in a third row alongside said second row, each of said compartments containing a shunt branch being adjacent the compartments containing the four series branches associated therewith, and each group of three terminals associated, respectively, with a shunt branch and the

two adjacent series branches in one side of the line being brought out through the sides of their respective compartments near a point which is mutually adjacent to all three of said compartments.

5 8. A wave transmission network of the ladder type comprising a plurality of impedance branches connected in series with the line, other impedance branches alternately disposed in shunt therewith, a separate metallic compartment enclosing each of said impedance branches and a terminal shield, the compartments containing said series branches being arranged in a row, the compartments containing said shunt branches being arranged in a second row placed side by side with said first mentioned row, each of said compartments containing a shunt branch being adjacent the compartments containing the two series branches associated therewith, each group of three terminals associated, respectively, with a shunt branch and the two adjacent series branches being brought out through the sides of their respective compartments near a point which is mutually adjacent to all three of said compartments, and said terminal shields covering said holes and said terminals.

WILLIAM L. CASPER.