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MULTIPLE WAY CONNECTION FOR TRANSMISSION LINES

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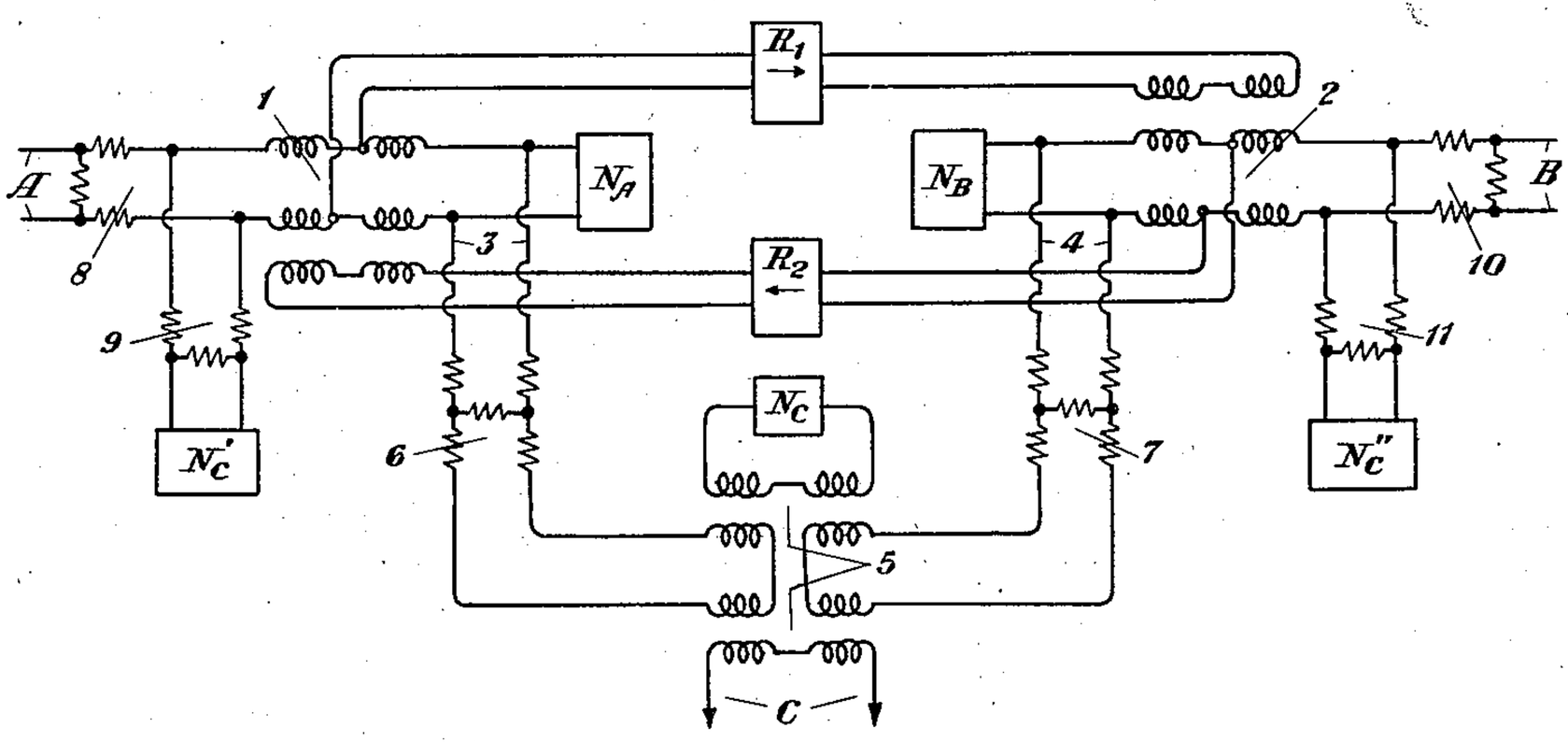


Fig. 1

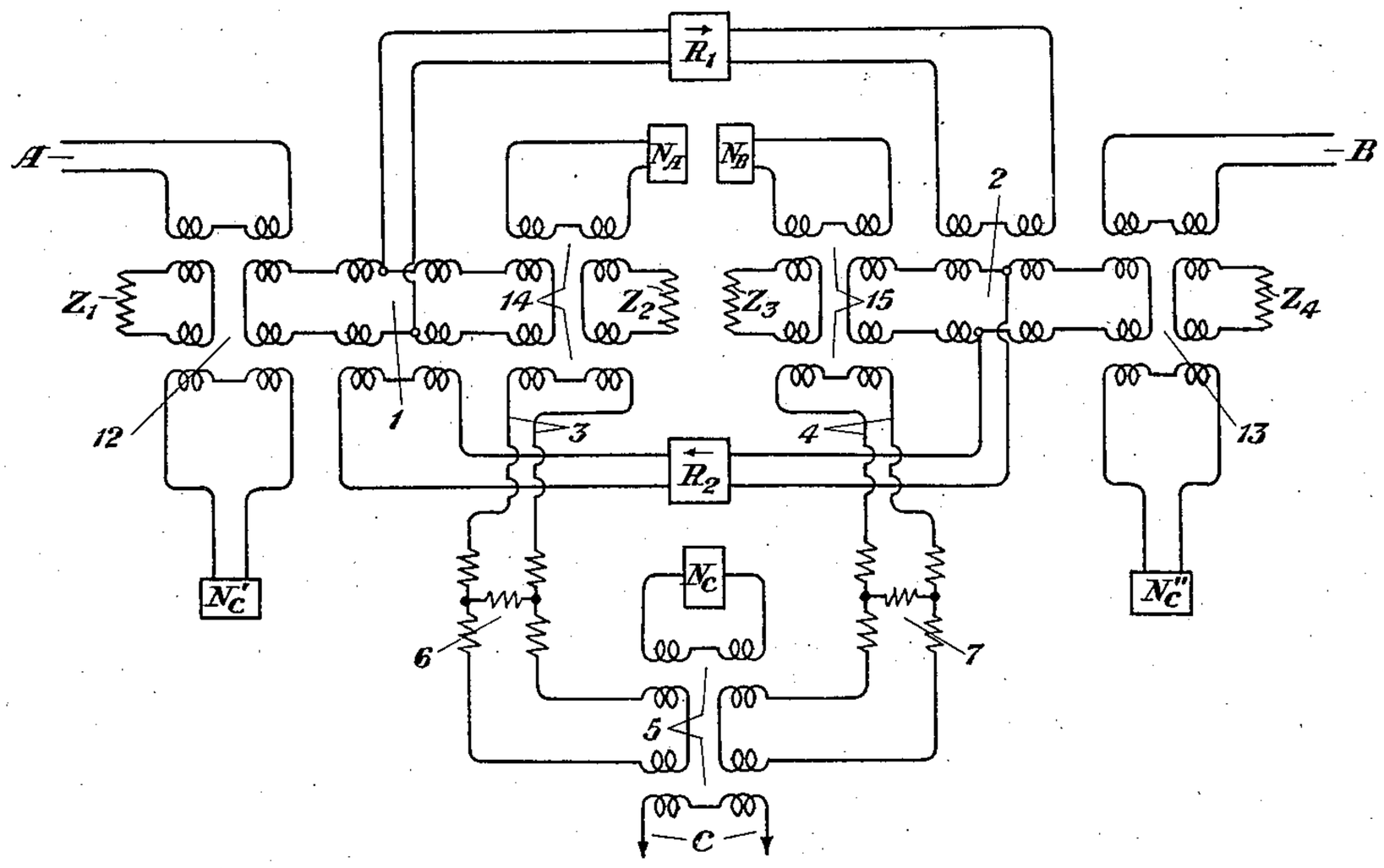


Fig. 2

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# UNITED STATES PATENT OFFICE

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## MULTIPLE-WAY CONNECTION FOR TRANSMISSION LINES

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This invention relates to transmission lines and more particularly to an improved method of and means for establishing a multi-way connection between a plurality of such lines.

By a multi-way connection is meant an arrangement whereby two-way communication may be established between a subscriber connected to one line and a subscriber connected to any of the other lines. In the arrangements of the invention repeater apparatus including the usual repeater elements, balancing networks and hybrid coils, is utilized for establishing a multi-way connection. Two of the transmission lines are interconnected by a two element two-way repeater. Across the network terminals of the hybrid coils of this repeater will be bridged a circuit including the windings of a hybrid coil. The third transmission line will be connected to this latter hybrid coil.

The arrangements of the invention have the advantage that a multi-way connection may be established between a plurality of lines, which connection utilizes only two repeater elements, while at the same time affording desired amplification features between all of the lines. Other features of the invention consist in the provision of means for adjusting impedance values to give desired transmission quality. Further objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawing, in the Figures 1 and 2 of which are shown one form of the invention and a modification thereof. Similar reference characters have been utilized to denote like parts in both figures of the drawing.

In Fig. 1 are shown two transmission lines A and B interconnected by a well known type of repeater apparatus, which comprises the gain elements $R_1$ and $R_2$, the hybrid coils 1 and 2, and the balancing networks $N_A$ and $N_B$. Bridged across the network sides of the hybrid coils 1 and 2 are the circuits 3 and 4, which terminate in the windings of the hybrid coil 5. Connected to windings of the hybrid coil 5 is a third transmission line C. It is pointed out that with the arrangements of this invention, transmission from A to C is amplified by the gain element $R_1$ before passing on to line C. Similarly, transmission from C to A will be ampified by the opposite gain element $R_2$ of the repeater in passing from C to A. In like manner, transmission from B to C would be over a path comprising hybrid coil 2, repeater $R_2$, hybrid coil 1, bridged circuit 3, and through hybrid coil 5 to line C. Transmission from C to B would take place over a path comprising hybrid coil 5, bridged circuit 3, repeater $R_1$, hybrid coil 2, and line B.

Included in the bridged circuits 3 and 4 are the pads 6 and 7. These are loss producing networks. These pads or networks may have such a value of loss as to make the loss from A to C bear the desired relationship to the loss from A to B, i. e., the loss between any two subscribers connected to the circuit may be made always the same, or varied as desired. The pads 6 and 7 may be made unsymmetrical to reduce their bridging loss.

It is necessary to apply auxiliary networks $N_C'$ and $N_C''$ to the lines A and B, respectively, to balance the effects of the bridged circuits 3 and 4. From a transmission standpoint, it is desirable that the impedance connected to the end of line A should match approximately the line impedance and that the impedance connected to the repeater terminals should match approximately the impedance of the repeater. To this end the correcting networks 8 and 9 may be connected between the line and the repeater and the net work $N_C'$ and repeater, respectively. To prevent unbalancing the repeater similar correcting networks may be connected between the repeater and circuit 3 and between the repeater and network $N_A$ or suitable alterations may be made in the pad 6 and the network $N_A$. Similar impedance correcting networks 10 and 11 are shown associated with line B and the auxiliary balancing network $N_C''$.

An alternative arrangement for establishing a multi-way connection in accordance with the principles of the invention, is shown

in Fig. 2. Similar reference characters have been utilized to denote like parts with respect to Fig. 1. The two lines A and B are interconnected by a two element repeater, as heretofore. This repeater comprises the gain elements $R_1$ and $R_2$, the balancing networks $N_A$ and $N_B$, and the hydrid coils 1 and 2. The bridged circuits 3 and 4 are also provided. However, instead of being bridged across the network side of the hybrid coils 1 and 2, these circuits are associated therewith by the hybrid coils 14 and 15, respectively. The lines A and B and the auxiliary balancing networks $N_C'$ and $N_C''$ are also connected to the hybrid coils 1 and 2 by means of the hybrid coils 12 and 13, respectively. With such an arrangement, it is pointed out, the division of energy is made through the agency of hybrid coils in such a manner that the impedance termination of the bridged circuit to the line is not materially impaired. Hence, the impedance correcting pads 8, 9, 10 and 11 may be eliminated. In other respects, the arrangements are similar to those of Fig. 1.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. Two line sections interconnected by repeater apparatus comprising hybrid coils, balancing networks, and repeater gain elements for transmission in opposite directions, circuits connected to the network side of each of said hybrid coils and terminating in the windings of another hybrid coil, and a third line section connected to said last mentioned hybrid coil.

2. Two line sections interconnected by repeater apparatus comprising hybrid coils, balancing networks, and repeater gain elements for transmission in opposite directions, circuits connected to the network side of each of said hybrid coils and terminating in the windings of a third hybrid coil, loss producing devices in each of said circuits, and a third line section connected to said third hybrid coil.

3. Two line sections interconnected by repeater apparatus comprising hybrid coils, balancing networks, and repeater gain elements for transmission in opposite directions, circuits connected to the network side of each of said hybrid coils and terminating in the windings of a third hybrid coil, auxiliary balancing networks connected to the line side of each of said first mentioned hybrid coils for balancing said last mentioned circuits, and a third line section connected to said third hybrid coil.

4. Two line sections interconnected by repeater apparatus comprising hybrid coils, balancing networks, and repeater gain elements for transmission in opposite directions, circuits connected to the network side of each of said hybrid coils and terminating in the windings of a third hybrid coil, auxiliary balancing networks connected to the line side of each of said first mentioned hybrid coils for balancing said last mentioned circuits, impedance correcting devices associated with said lines and auxiliary balancing networks for correcting the impedance relations between said lines and said repeater apparatus, and a third line section connected to said third hybrid coil.

In testimony whereof, we have signed our names to this specification this 22nd day of August 1928.

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