

July 15 , 1924.

1,501,103

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CONJUGATE SIGNALING CIRCUITS

Filed Sept. 26 , 1919

2 Sheets-Sheet 1

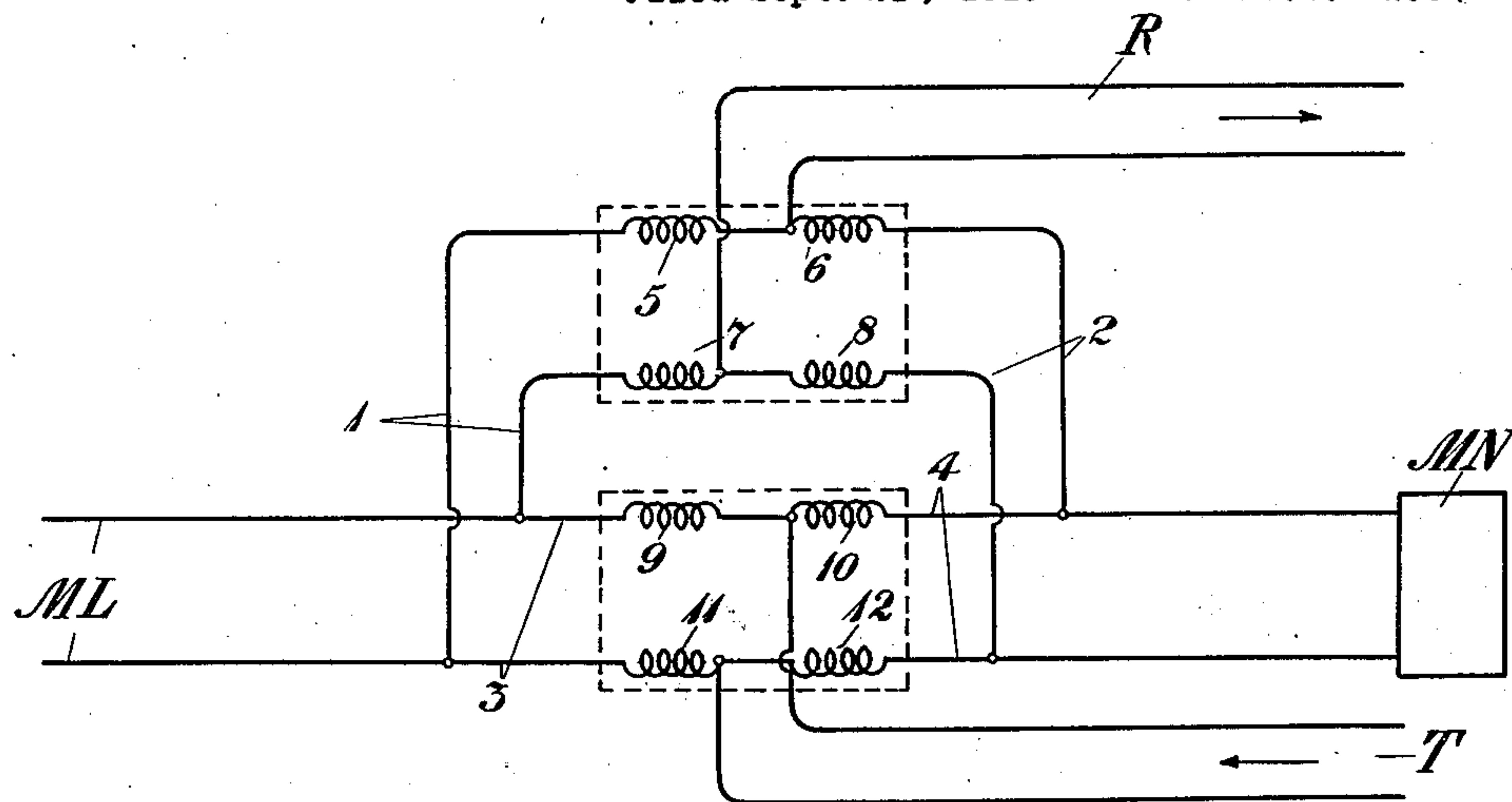


Fig. 1

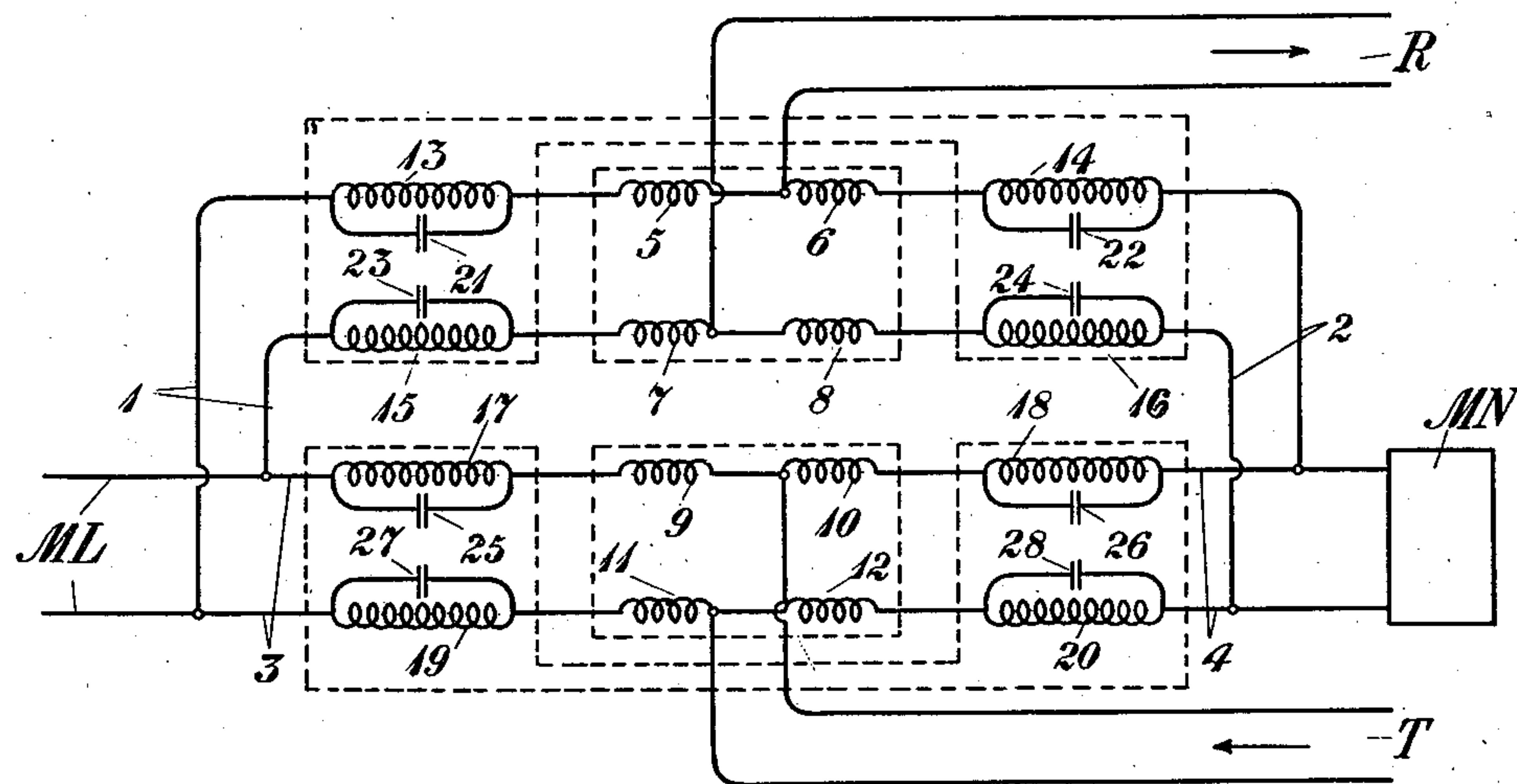


Fig. 2

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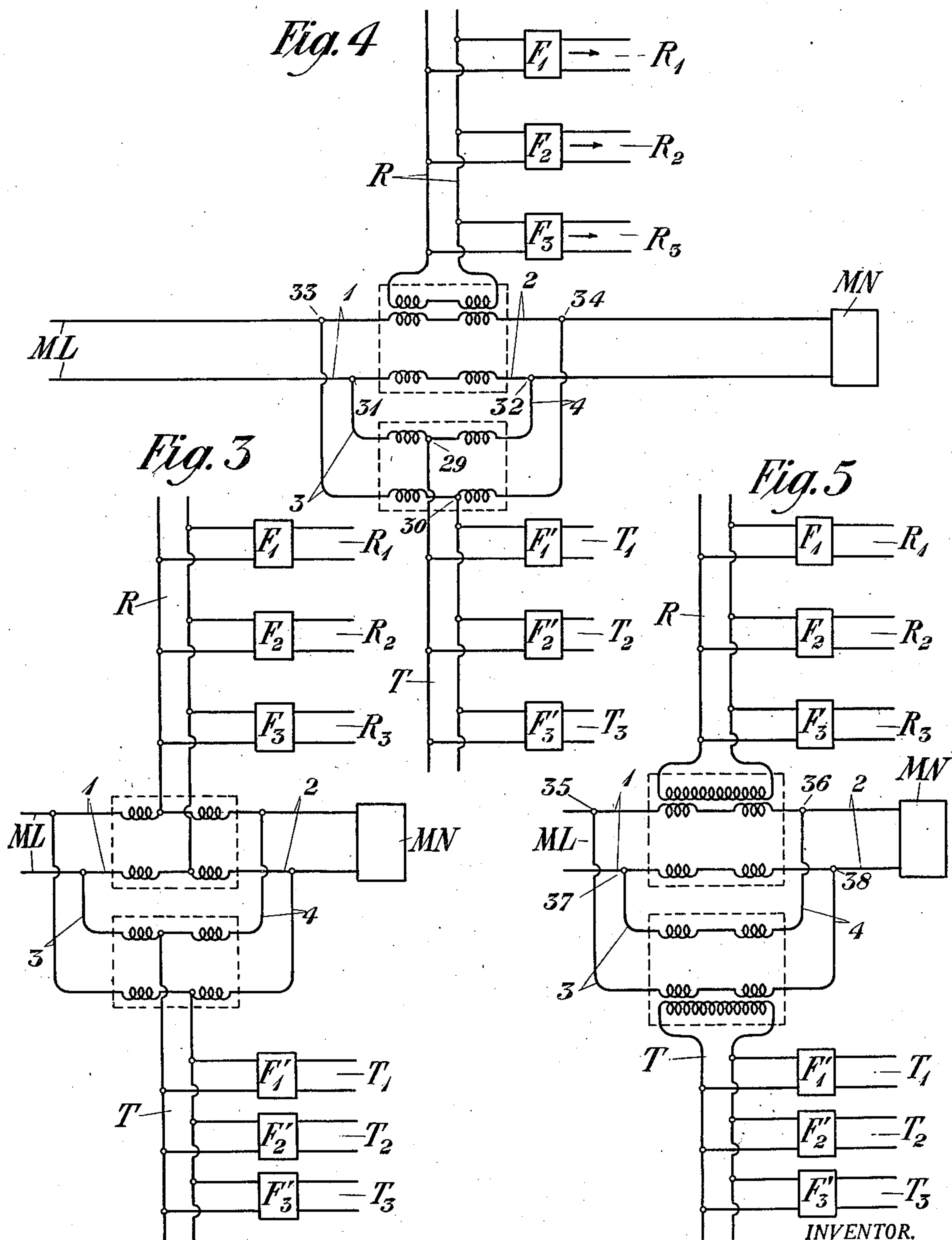
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UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF HOLLIS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

CONJUGATE SIGNALING CIRCUITS.

Application filed September 26, 1919. Serial No. 326,519.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Hollis, in the county of Queens and State of New York, have invented certain Improvements in Conjugate Signaling Circuits, of which the following is a specification.

This invention relates to signaling systems, and more particularly to arrangements for associating transmitting and receiving circuits with a common transmission circuit in such a manner as to render the transmitting and receiving circuits conjugate.

One of the features of the invention consists in the provision of circuit arrangements for relating a transmitting circuit and a receiving circuit to a common transmission circuit, in such a manner that the transmitting and receiving circuits will be conjugate with respect to each other and will also be conductively connected with the line.

Another object of the invention is to provide an arrangement whereby a transmitting circuit and a receiving circuit may be associated with the common transmission circuit through separate transforming arrangements.

Other and further objects of the invention will appear more fully from the following description when read in connection with the accompanying drawing, Figures 1, 2, 3, 4 and 5 of which are diagrams illustrating different embodiments of the invention.

Referring to Figure 1, ML designates a transmission line such as a telephone line, which is adapted to be balanced by an artificial line or network MN. The line ML is connected with the artificial line MN through a pair of bridge circuits 1—2 and 3—4. The bridge circuit 1—2 contains a transformer or inductance coil arrangement comprising windings 5, 6, 7 and 8 and a receiving circuit R is connected to the midpoints of the windings of the transformer, as indicated. The bridge circuit 3—4 is similarly provided with a transforming device comprising windings 9, 10, 11 and 12, to the midpoints of which a transmitting circuit T is connected. The windings of each transformer or coil unit are disposed upon a common core and so poled as to present maximum impedance for currents flowing circularly around the circuit as in the order 9, 10, 12, 11, and to present a minimum

impedance to currents flowing from say branch T thru windings 9—11 in parallel with windings 10—12.

The conductors of the bridge circuits are non-symmetrically connected with the main line and artificial line with respect to the transmitting and receiving circuits, so that the transmitting and receiving circuits are conjugate with respect to each other. For instance, assuming an impulse in the transmitting circuit T of such character that the junction between the windings 9 and 10 is positive, it will be apparent that since this point is connected through windings 9 and 7 to the junction point of windings 7 and 8 and through windings 10 and 6 to the junction point of windings 5 and 6, both of these junction points will be at the same potential, owing to the fact that the two pairs of windings have the same impedance, (and that the effect of the line ML is balanced by that of the network MN), consequently no current will flow to the receiving circuit R.

The arrangement of Figure 1 is quite satisfactory where only telephone currents are transmitted over the line ML, but where Morse currents are also to be transmitted over the line, it may be necessary to supplement the arrangement of Figure 1 with additional apparatus, owing to the difficulty of designing coil arrangements which will have similar transmission efficiencies and impedance effects to currents of both Morse and telephone frequencies. In such a case, that of a composited telephone and telegraph circuit, the arrangement of Figure 2 may be preferable. In accordance with this arrangement a supplemental transforming device comprising windings 13, 14, 15 and 16 is provided in the bridge circuit 1—2, the windings of this transforming arrangement offering a relatively large impedance to Morse current variations, but offering a very small impedance to telephone currents, owing to the fact that each winding is shunted by a condenser, as indicated at 21, 22, 23 and 24. The bridge circuit 3—4 is likewise provided with an additional transforming arrangement comprising windings 17, 18, 19 and 20, similarly shunted by condensers 25, 26, 27 and 28 respectively. It will be apparent that by means of this arrangement the transforming devices may be so designed that the bridge circuits will offer

similar transmission and impedance effects to both voice and Morse currents.

Figure 3 illustrates an arrangement whereby a plurality of transmitting and receiving channels of a carrier system may be superposed upon a common transmission line, such as ML by employing transforming arrangements such as above described. In this arrangement the common transmitting and receiving circuits T and R are associated with the midpoints of the transforming devices in the bridge circuits 1—2 and 3—4 respectively, in the same manner as in Figure 1 and individual receiving channels R_1 , R_2 and R_3 are connected with the common receiving circuit R, while individual transmitting channels T_1 , T_2 and T_3 are associated with the common circuit T. By providing suitable selective devices such as F_1 , F_2 and F_3 in the receiving channels and similar selective devices F'_1 , F'_2 and F'_3 in the transmitting channels a frequency separation between the channels may be obtained. These selective devices may be of any well-known type, depending upon the character of transmission. Where telegraphic signals are to be transmitted by means of carrier currents, simple tuned circuits will be satisfactory. Where telephone currents are to be transmitted by carrier waves, however, it is preferable that these selective devices be broad band filters of the type disclosed in the U. S. patents to George A. Campbell, Nos. 1,227,113 and 1,227,114, dated May 22, 1917.

While in the arrangement of Figure 3 both transmitting and receiving paths are conductively connected to the bridge circuits, in some instances it may be desirable that one of these paths, as for instance the receiving path, should be inductively associated with the corresponding bridge circuit, while still employing separate transformers for transmitting and receiving. Such an arrangement is illustrated in Figure 4, in which the transforming arrangement in the bridge circuit 1—2 comprises three sets of windings, two of which are included in the bridge circuit and the third of which is included in the common receiving circuit R. In this case, since this coupling between the circuit R and the bridge circuit 1—2 associates the receiving circuit serially with the bridge circuit, it is necessary to reverse the connections of the bridge paths with the line ML and artificial line MN, as indicated. It will now be apparent that if an impulse from the circuit T is impressed across the points 29 and 30 points 31 and 32 will be at the same potential and points 33 and 34 will be at equal potentials, although these potentials will differ from the potentials applied to points 31 and 32, consequently no current flows through the windings of the transformers in the bridge

circuits 1—2, and consequently no effect is produced upon the receiving path R.

Where it is desired that both the transmitting and receiving paths be associated with the bridge circuits through separate transforming arrangements, while being maintained insulated therefrom as regards the flow of direct currents, three-winding transformers may be provided in both bridge circuits, as illustrated in Figure 5, the third winding of each transformer being included in the corresponding transmitting or receiving circuit such as T and R. As both circuits T and R are now serially related to the corresponding bridge path the terminals of the bridge paths should be non-symmetrically connected to the line ML and artificial line MN, in the same manner as in Figure 3, instead of being symmetrically connected as described in connection with Figure 4. From this circuit arrangement it will be apparent that if a current flows across in the path T in such a direction as to induce in one of the secondary windings of the transformer an electromotive force such that point 35 is at a definite positive potential and point 38 at a definite negative potential, an equal electromotive force will be induced in the other secondary winding, so that the point 36 will be at the same positive potential as the point 35 and the point 37 at the same negative potential as the point 38, consequently no current flows through the windings of the transformer in the bridge circuit 1—2 and the receiving path R will therefore be unaffected by disturbances in the transmitting path T.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention as defined in the following claims:

What is claimed is:

1. In a signaling system, a transmission circuit, an artificial line for balancing said circuit, a transmitting path, a receiving path, and a pair of bridge paths, each bridge path having three connections only, two connections of each bridge path being so arranged as to connect the bridge paths in parallel between said transmission circuit and artificial line, the third connection of one of said bridge paths connecting said transmitting path thereto independently of its other two connections, and the third connection of the other bridge path connecting said receiving path thereto independently of its other two connections, the connections being such that said receiving and transmitting paths will be conjugate with respect to each other.

2. In a signaling system, a transmission circuit, an artificial line for balancing said circuit, a transmitting path, a receiving

path, a pair of bridge paths, reactance coil arrangements included in said bridge paths, and each bridge path having three connections only, two of the connections of each bridge path being so arranged as to connect said bridge paths in parallel between said transmission circuit and artificial line, the third connection of one of said bridge paths connecting the transmitting path thereto independently of its other two connections, and the third connection of the other bridge path connecting said receiving path thereto independently of its other two connections.

3. In a signaling system, a transmission circuit, an artificial line for balancing said circuit, a pair of bridge paths connected in parallel between said transmission circuit and artificial line, reactance coil arrangements included in said bridge paths, a transmitting path conductively connected only to one of said bridge paths independently of its connection to the transmission circuit and artificial line, and a receiving path conductively connected only to the other bridge path independently of its connection to the transmission circuit and artificial line.

4. In a signaling system, a transmission circuit, an artificial line for balancing said circuit, a transmitting path, a receiving path, a pair of bridge paths, reactance devices in said bridge paths, and each of said bridge paths having three connections only, two of the connections of each of said paths being so arranged as to connect said bridge paths in parallel between said transmission circuit and artificial line, the third connection of one of said paths connecting said transmitting path thereto independently of its other two connections, and the third connection of the other bridge path connecting said receiving path thereto independently of its other two connections, the third connection of one of said bridge paths being conductive.

5. In a signaling system, a transmission circuit, an artificial line for balancing said circuit, a pair of bridge paths interconnecting said transmission circuit and artificial line, inductive windings in each bridge path, a transmitting path connected to the midpoints of the windings in one bridge path,

and a receiving path connected to the midpoints of the windings in the other bridge path.

6. In a signaling system, a transmission circuit, an artificial line for balancing said circuit, a pair of bridge paths interconnecting said transmission circuit and artificial line, inductive windings in each bridge path, a transmitting path connected to the midpoints of the windings in one bridge path, a receiving path connected to the midpoints of the windings in the other bridge path, and a plurality of signaling channels superposed upon each of said transmitting and receiving paths.

7. In a signaling system, a transmission circuit, an artificial line for balancing said circuit, a transmitting path, a receiving path, a pair of bridge paths, inductive windings in each of said bridge paths, having three connections only, two connections of each bridge path being so arranged as to connect said bridge paths in parallel between said line and artificial line, the third connection of one of said bridge paths connecting said transmitting path thereto independently of its other two connections, and the third connection of the other bridge path connecting said receiving path thereto independently of its other two connections, the third connection of one of said bridge paths being a conductive connection to the midpoints of the windings therein.

8. In a signaling system, a transmission circuit, an artificial line for balancing said circuit, a pair of bridge paths interconnecting said transmission circuit and artificial line, inductive windings in each of said bridge paths, a transmitting path associated with one of said bridge paths, a receiving path associated with the other bridge path, one of said transmitting and receiving paths being conductively connected to the midpoints of the windings in the corresponding bridge path, and a plurality of signaling channels associated with each of said transmitting and receiving paths.

In testimony whereof I have signed my name to this specification this 25th day of September, 1919.

LLOYD ESPENSCHIED.