

Apr. 3, 1923.

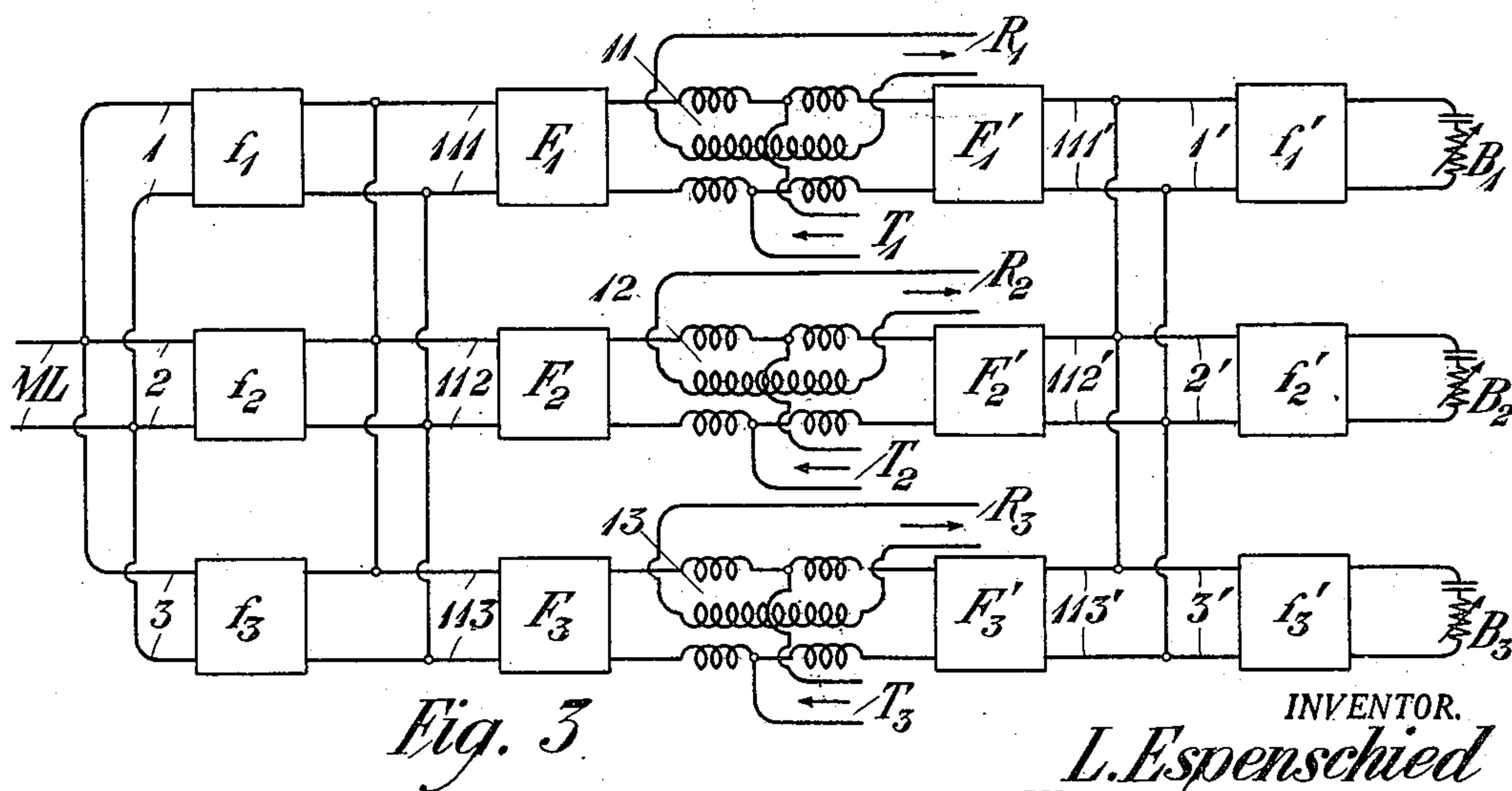
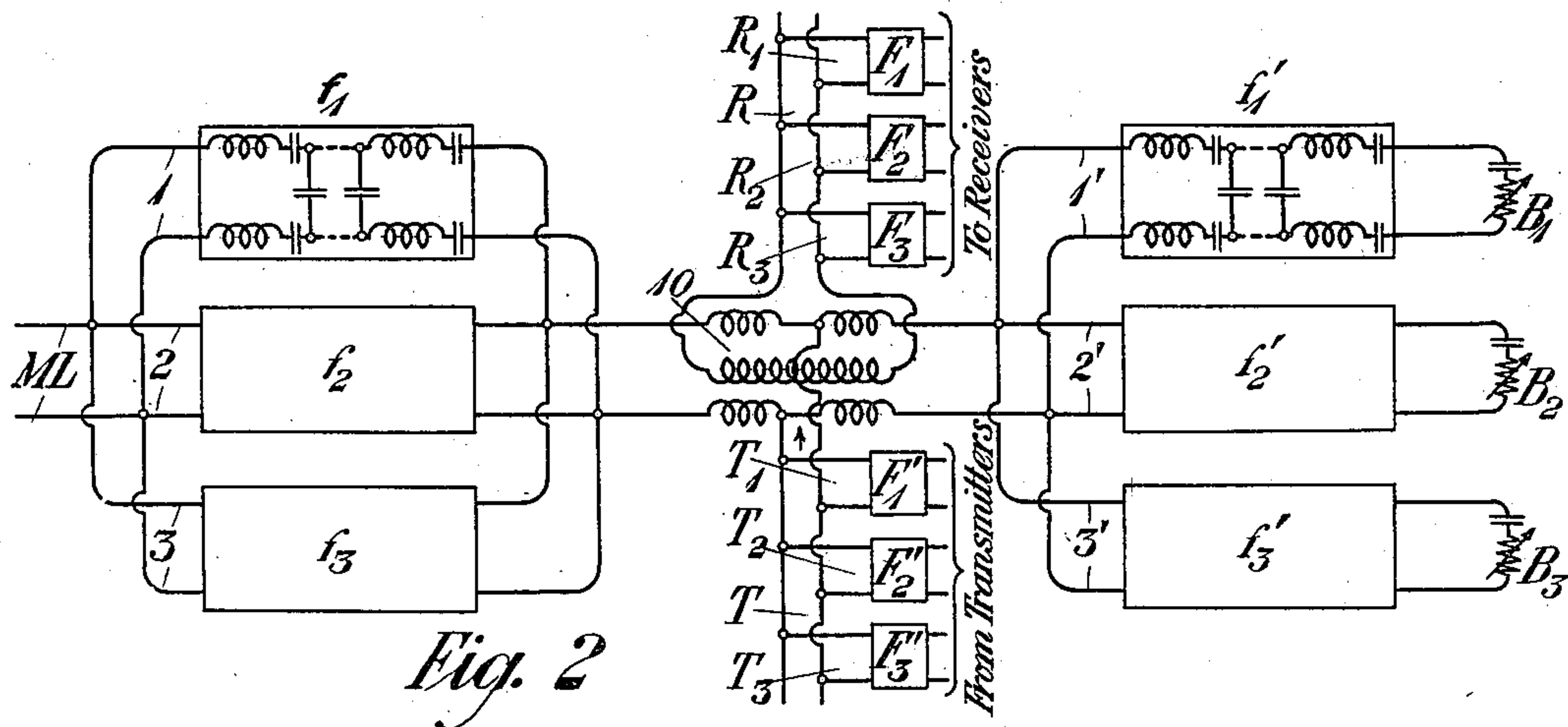
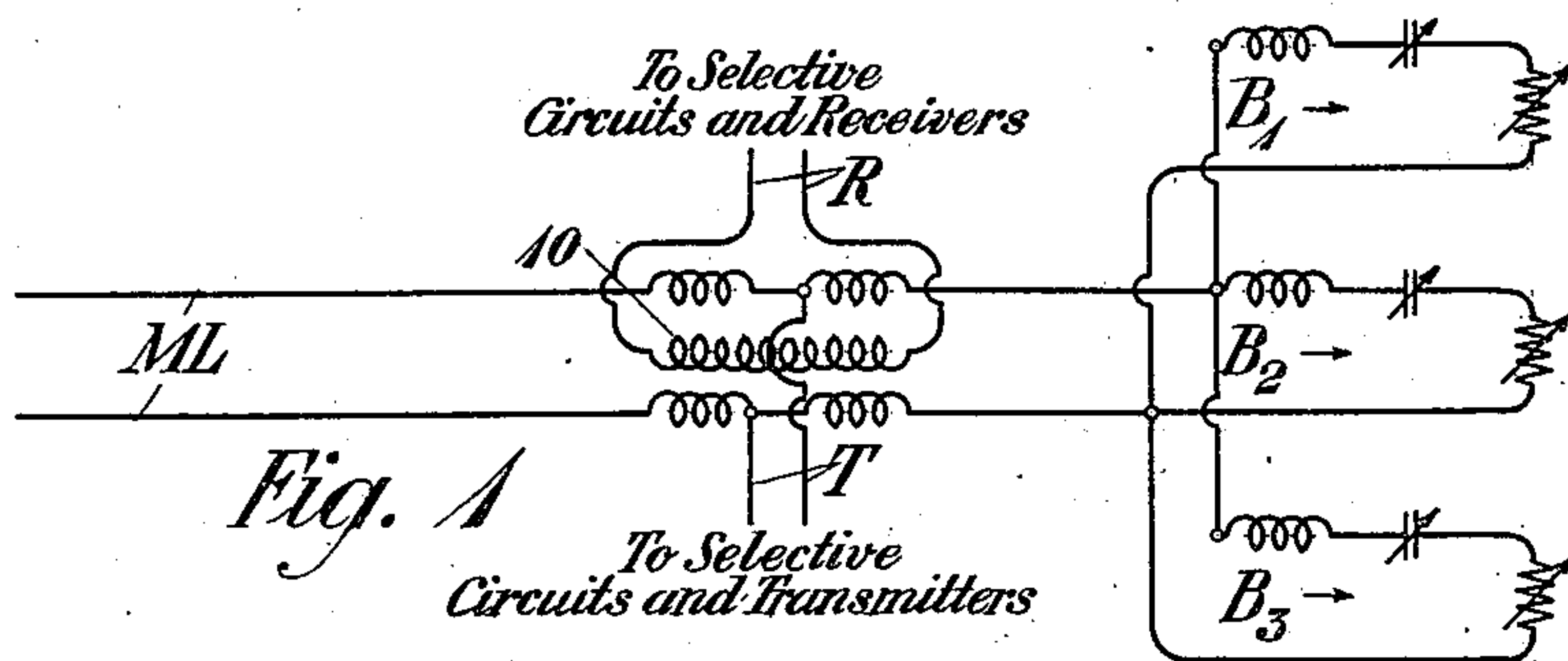
1,450,254

L. ESPENSCHIED

BALANCING ARRANGEMENT FOR MULTIPLEX CARRIER CIRCUITS

Filed Sept. 26, 1919

2 sheets-sheet 1



Apr. 3, 1923.

1,450,254

L. ESPENSCHIED

BALANCING ARRANGEMENT FOR MULTIPLEX CARRIER CIRCUITS

Filed Sept. 26, 1919

2 sheets-sheet 2

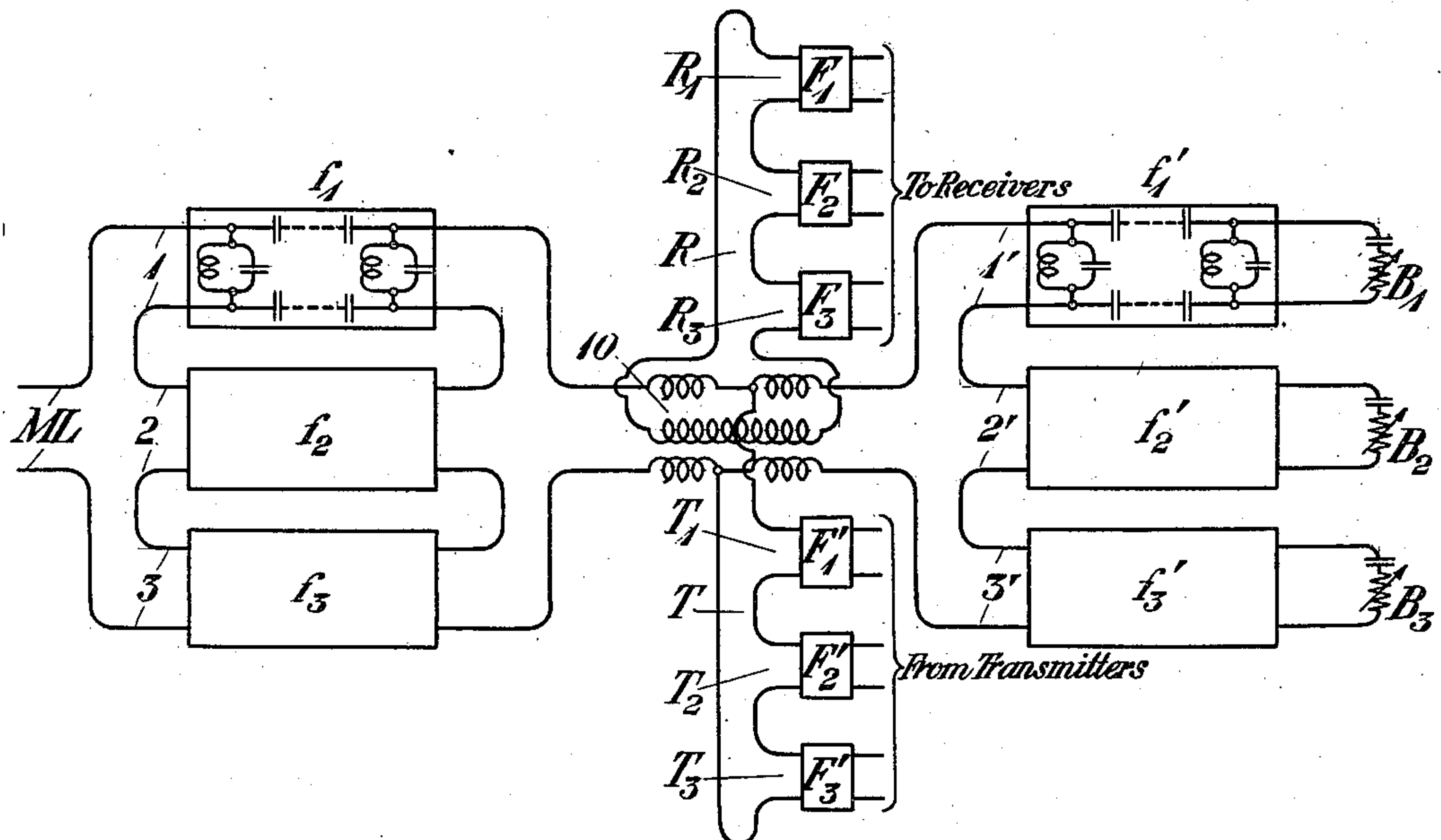


Fig. 4

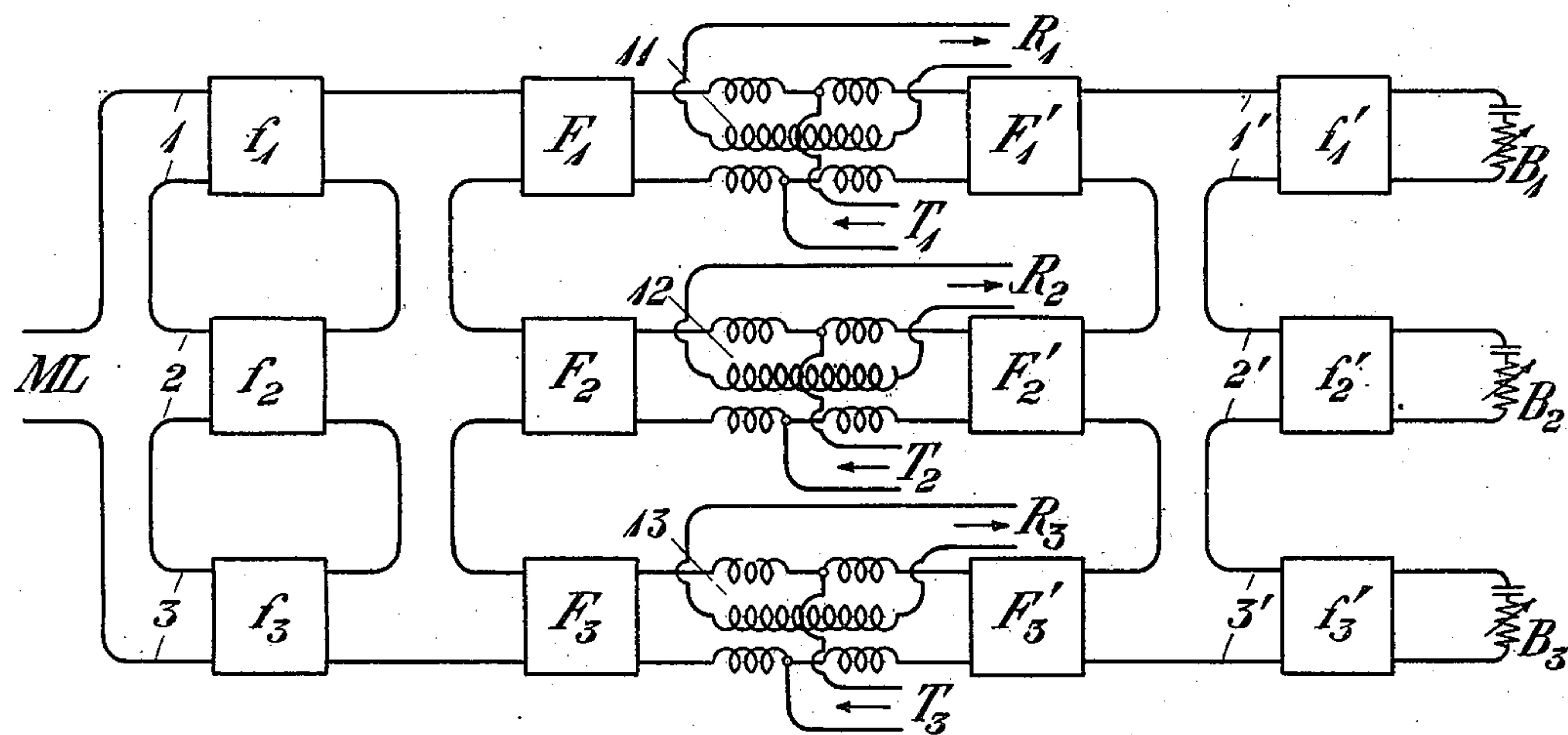


Fig. 5

INVENTOR.
L. Espenschied
BY *[Signature]*
ATTORNEY

UNITED STATES PATENT OFFICE.

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

BALANCING ARRANGEMENT FOR MULTIPLEX CARRIER CIRCUITS.

Application filed September 26, 1919. Serial No. 326,520.

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 Balancing Arrangements for Multiplex Carrier Circuits, of which the following is a specification.

This invention relates to signaling circuits and more particularly to arrangements for balancing a transmission circuit at a plurality of frequencies.

One of the features of the invention resides in the provision of separate balancing arrangements, each adapted to balance a transmission circuit at one frequency or a band of frequencies, of a number of frequencies or bands of frequencies utilized in multiplex transmission over said circuit.

Another feature of the invention relates to the provision of separate networks each adapted to balance a transmission line at different frequencies, together with selective means whereby the transmission to the networks of frequencies other than those at which they are adapted to balance the transmission circuit will be prevented.

Still another feature of the invention relates to the provision in a circuit of the character just described, of means associated with the transmission circuit for balancing the selective means associated with the networks.

Other and further features of the invention will more fully hereinafter appear from the following description when read in connection with the accompanying drawing, Figures 1 to 5 of which constitute circuit diagrams of a number of embodiments of the invention.

Referring to Figure 1, ML designates a transmission line or circuit over which a plurality of signals may be simultaneously transmitted by the use of carrier circuits of different frequencies. A common transmitting circuit T leading to individual transmitting channels (not shown) and a common receiving circuit R leading to individual receiving channels (not shown) are associated with the line ML through a balanced transformer arrangement 10 of well-known construction. In order to balance the main line ML networks B_1 , B_2 and B_3 are provided, these networks being connected in parallel with each other. Each network as

illustrated consists of an inductance, capacity and resistance in series. By suitably adjusting the elements of the networks, as for instance the capacities and the resistances, each network may be made to offer the same impedance to one of three different characteristic frequencies utilized in connection with the transmission of signals over the line ML, as is offered by the line ML itself to currents of that frequency. The resistance component of the impedance indicated as supplied by a variable resistance element may be resident in part or in whole in the dissipation of the inductance and capacity elements. It will therefore be seen that the line ML is balanced at the three different frequencies utilized in the multiplex transmission of signals and while it is not properly balanced at other frequencies this effect is of no consequence, since such other frequencies are not transmitted to the line. The use of a plurality of balancing circuits, as above described, has the advantage that it is possible to obtain a fairly accurate balance at the desired frequencies, even though the frequencies extend over a considerable range. If it were desired to balance a line at all frequencies over the same range, by means of a single network, difficulty would be experienced in the design of a network which would simulate the electrical characteristics of the line over such a wide range, particularly in cases where the impedance characteristic of the line is not smooth, due for instance to an open wire line passing through sections of cable etc.

A modified arrangement is illustrated in Figure 2, in which the same principle is applied to a circuit adapted for the transmission of signaling bands of frequencies of considerable width, as distinguished from the transmission of extremely narrow bands, such as contemplated in Figure 1. In Figure 2 the transmitting circuit T is provided with transmitting branches T_1 , T_2 , and T_3 over which different signaling bands may be transmitted to the line ML. In order to provide for frequency separation between the channels, filters such as F_1' , F_2' and F_3' are inserted in the branches. These filters may be of any well-known type, but are preferably broad band filters of the general type disclosed in the U. S.

patents to George A. Campbell, Nos. 1,227,113 and 1,227,114, dated May 22, 1917. In a similar manner the receiving circuit R is provided with a plurality of branches R_1 , R_2 and R_3 including the filters F_1 , F_2 and F_3 of a type similar to those described in connection with the transmitting channel.

In order to balance the line ML, networks B_1 , B_2 and B_3 are provided. Each of these networks may consist of a capacity and resistance so adjusted that the network is capable of balancing the line ML at a band of frequencies corresponding to the frequency band transmitted from one of the transmitting channels T_1 , T_2 or T_3 . In order to prevent transmission to the network of frequencies other than those at which it is designed to balance the line, filters f_1' , f_2' and f_3' are associated with the networks B_1 , B_2 and B_3 respectively, by being serially included in the branches 1', 2' and 3', leading to the networks. These filters may be of any type, but are preferably band filters of the type disclosed in the patents to Campbell above referred to and each filter may be similar to a corresponding filter in a transmitting or receiving channel.

The inclusion of these filters in the network renders desirable the provision of similar apparatus in the line, consequently the line ML is provided with three branches 1, 2 and 3, in which are included the networks f_1 , f_2 and f_3 . These networks may be of any suitable structure adapted to simulate the characteristics of the corresponding filters in the circuits 1', 2' and 3'. As illustrated, however, duplicated band filters are employed for this purpose. The filter networks on the line side may, however, be omitted without disturbing the balance, providing that the filters of the line-balancing networks are designed to have line impedance for the transmitted frequency band.

As illustrated in Figure 2, the several transmitting and receiving channels are associated with the main line through a common transformer 10. Figure 3 illustrates a modified arrangement in which each transmitting channel and a corresponding receiving channel is associated with the main line through a separate transformer. In order to secure this result the branches 1, 2 and 3 are connected to branches 1', 2' and 3' by means of paths 111—111', 112—112' and 113—113', respectively. The transmitting channel T_1 and receiving channel R_1 are associated with the first of these paths through a balanced transformer arrangement 11. In a similar manner the transmitting channel T_2 and the receiving channel R_2 are associated through a balanced transformer 12 with the second of these paths and the transmitting channel T_3

and receiving channel R_3 are associated with the third of these paths through the transformer 13.

Selective filters may be provided in each transmitting and receiving channel, if desired, in the same manner as in Figure 2, but, as illustrated, selectivity is obtained by including filters F_1 , F_2 and F_3 in paths 111, 112 and 113 respectively. These filters are balanced on the network side by means of duplicate filters or networks simulating the characteristics of the filters, such as F_1' , F_2' and F_3' .

It will be observed that in the forms of the invention illustrated in Figures 2 and 3 all of the network branches and other branches of the circuit containing filters are arranged in parallel with respect to each other. It is possible, however, to secure the same results by so relating all of these branches that they will not only be in series with respect to each other, but will also be in series with respect to the main line ML and the various balancing networks.

Figure 4 illustrates an arrangement of the invention in which the circuit organization of Figure 2 is modified in this manner. Referring to this figure the transmitting channels T_1 , T_2 and T_3 are all serially related to the common transmitting circuit T and similarly the receiving channels R_1 , R_2 and R_3 are serially related to the common receiving circuit R. The circuits 1, 2 and 3 including the filters f_1 , f_2 and f_3 are serially related to each other and to the main line ML. Similarly the circuits 1', 2' and 3' containing the several networks and the filters f_1' , f_2' and f_3' are serially related to each other and to the transformer 10.

Figure 5 illustrates a modification of the circuit organization of Figure 3, in which the branches are all serially related. Thus the filters f_1 , f_2 and f_3 , as well as the filters F_1 , F_2 and F_3 are serially related to each other and to the main line ML, while all of the filters on the balancing side of the circuit maintain a similar relation with respect to each other.

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, means whereby a plurality of signals may be simultaneously transmitted over said circuit at a plurality of different frequencies, balancing means for said transmission circuit, comprising separate networks, each simulating the impedance of said transmission line at one of said signaling frequencies, band filters associated with each network for preventing the transmis-

sion to said network of other signaling frequencies and means associated with said transmission circuit for balancing said band filters.

2. In a signaling system, a transmission circuit, means whereby a plurality of signals may be simultaneously transmitted over said circuit at a plurality of different frequencies, balancing means for said transmission circuit, comprising separate networks, each simulating the impedance of said transmission line at one of said signaling frequencies, selective means associated with each network for preventing the transmission to said network of other signaling frequencies, and selective devices associated with said transmission circuit, said selective devices being individually similar to the selective devices associated with said balancing networks and being associated with said transmission circuit in the same manner as the selective means associated with the balancing networks.

3. In a signaling system, a transmission circuit, means whereby a plurality of different bands of frequencies may be simultaneously transmitted over said circuit, means for balancing said circuit, comprising networks each adapted to simulate the electrical characteristics of said circuit over one of said frequency bands, band filters associated with each network for preventing the transmission thereto of frequencies lying outside the band of frequencies at which the network is adapted to balance said transmission circuit, and means associated with said transmission circuit for balancing said band filters.

4. In a signaling system, a transmission circuit, means whereby a plurality of different bands of frequencies may be simultaneously transmitted over said circuit, means for balancing said circuit, comprising networks each adapted to simulate the electrical characteristics of said circuit over one of said frequency bands, selective means associated with each network for preventing the transmission thereto of frequencies lying outside the band of frequencies at which the network is adapted to balance said transmission circuit, and means associated with said transmission circuit for balancing the selective means associated with said network, said balancing means comprising a plurality of individual selective devices similar to the selective devices associated with said networks and being related to said transmission circuit in a manner electrically equivalent to that in which the selective devices associated with said networks are related thereto.

5. In a signalling system, a transmission circuit, balancing means for said transmission circuit comprising separate networks, each simulating the impedance of said trans-

mission circuit over a different band of frequencies, a circuit arrangement for interconnecting said transmission circuit and said networks, a plurality of transmitting circuits and a plurality of receiving circuits associated with said connecting circuit arrangement, said transmitting and receiving circuits being arranged in pairs each pair corresponding to a band of frequencies to be transmitted to an individual network, and means associated with said connecting circuit arrangement on each side of said transmitting and receiving circuits to permit the transmission to each network of the band of frequencies at which the network simulates the impedance of the transmission circuit, while preventing the transmission of frequencies lying without said band.

6. In a signalling system, a transmission circuit, balancing means for said transmission circuit comprising separate networks, each simulating the impedance of said transmission circuit over a different band of frequencies, a circuit arrangement for interconnecting said transmission circuit and said networks, a plurality of transmitting circuits and a plurality of receiving circuits associated with said connecting circuit arrangement, said transmitting and receiving circuits being arranged in pairs, each pair corresponding to a band of frequencies to be transmitted to an individual network, and band filters associated with said connecting circuit arrangement on each side of said transmitting and receiving circuits, said band filters transmitting to each network the band of frequencies at which it simulates the impedance of the transmission circuit while preventing the transmission of frequencies lying without said band.

7. In a signalling system, a transmission circuit, balancing means for said transmission circuit comprising separate networks, each simulating the impedance of said transmission circuit over a different band of frequencies, branch circuits leading to each network, selecting means in each branch circuit for transmitting to the network the band of frequencies at which it simulates the impedance of the transmission circuit while suppressing frequencies lying without said band, corresponding branch circuits leading to the transmission circuit, selecting means in each of said last mentioned branch circuits leading to the transmission circuit, a circuit arrangement interconnecting the two sets of branches, and a plurality of transmitting and receiving circuits associated with said connecting circuit arrangement, said transmitting and receiving circuits being arranged in pairs corresponding to the bands of frequencies transmitted to the individual networks.

8. In a signalling system, a transmission circuit, balancing means for said transmis-

sion circuit comprising separate networks, each simulating the impedance of said transmission circuit over a separate band of frequencies, branch circuits leading to each network, band filters in each branch circuit for transmitting to the corresponding network, the range of frequencies at which said network simulates the impedance of the transmission circuit while suppressing frequencies lying without the band, branch circuits leading to said transmission circuit and band filters in each of said last mentioned branch circuits corresponding respectively to the band filters in said first mentioned branch circuits, a circuit arrangement for interconnecting said branch circuits and a plurality of transmitting and receiving circuits associated with said connecting circuit arrangement, said transmitting and receiving circuits being arranged in pairs corresponding to the bands transmitted to each network.

9. In a signalling system, a transmission circuit, balancing means for said transmission circuit comprising separate networks, each simulating the impedance of said transmission circuit over a different band of frequencies, branch circuits extending from each network to said transmission circuit, a transmitting circuit and a receiving circuit

associated with each branch circuit and means in each said branch circuit on each side of said transmitting and receiving circuit for transmitting to each network the band of frequencies at which said network simulates the impedance of the transmission circuit while suppressing frequencies lying without the band.

10. In a signalling system, a transmission circuit, balancing means for said transmission circuit comprising separate networks, each simulating the impedance of said transmission circuit over a different band of frequencies, branch circuits extending from each network to said transmission circuit, a transmitting circuit and a receiving circuit associated with each branch circuit and band filters in each branch circuit on either side of the transmitting and receiving circuits for transmitting to each network the band of frequencies at which said network simulates the impedance of the transmission circuit while suppressing the frequencies lying without said band.

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

LLOYD ESPENSCHIED.