

June 5, 1923.

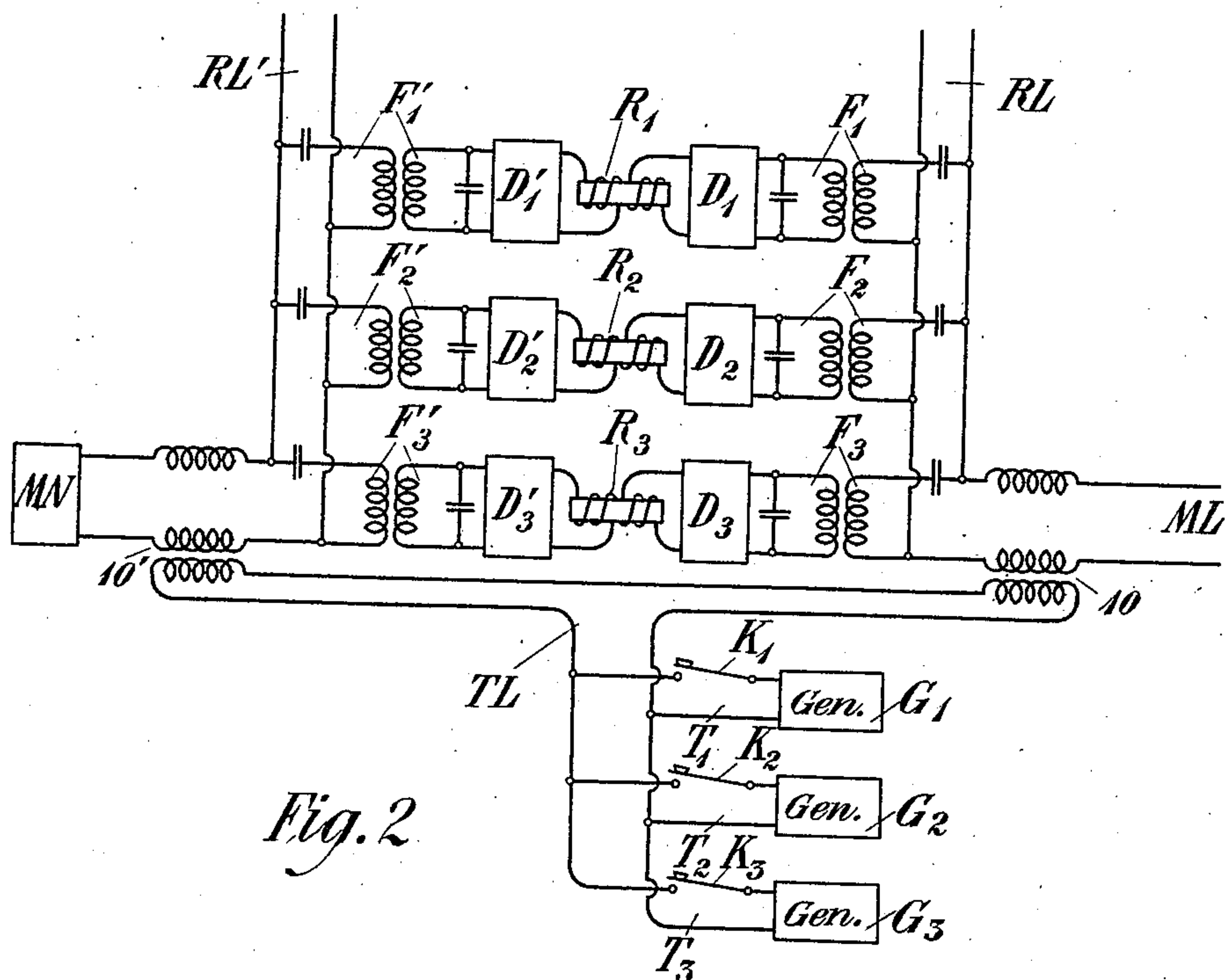
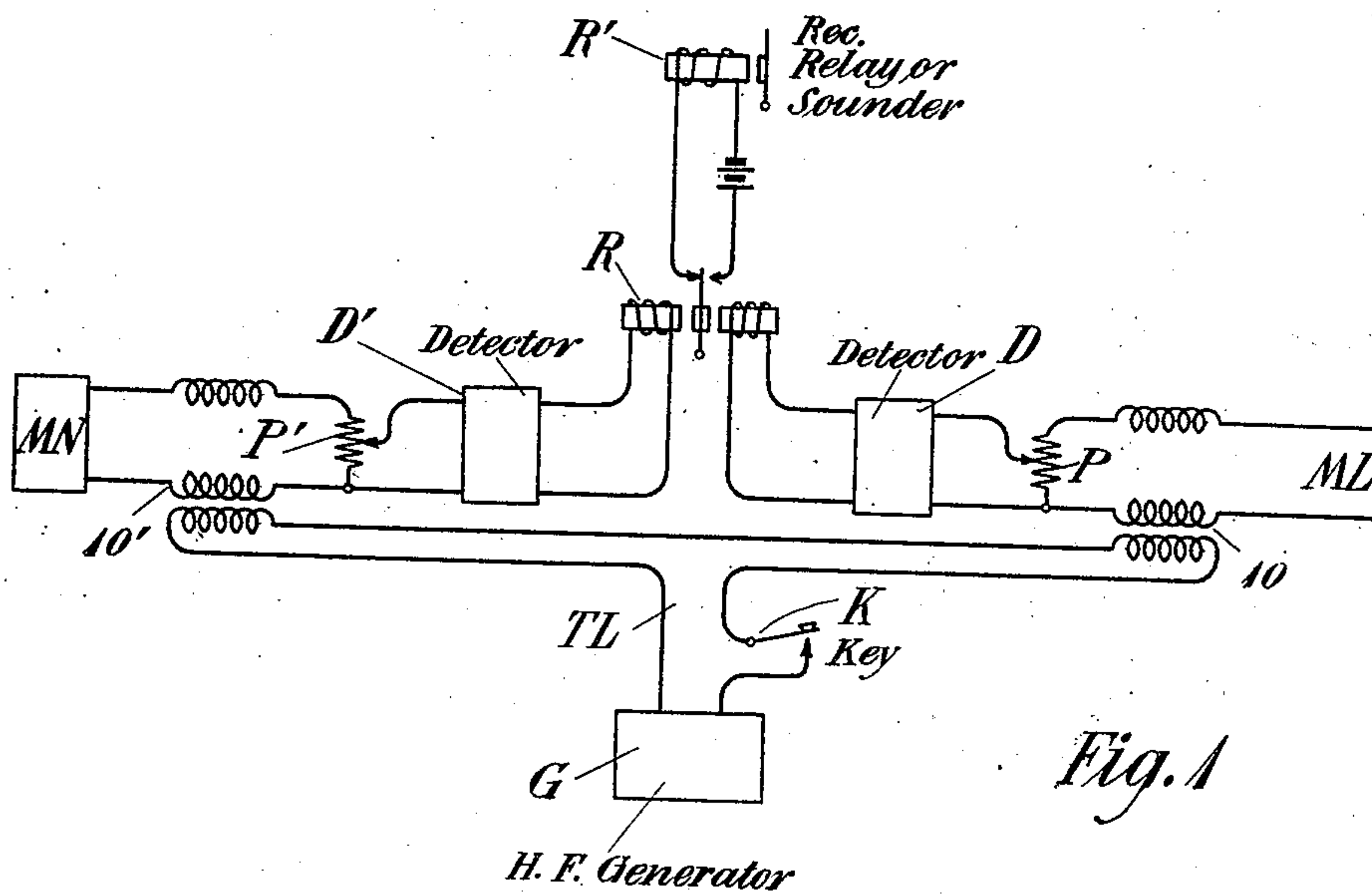
1,457,336

H. A. AFFEL

BALANCING CIRCUITS

Filed Sept. 30, 1919

2 Sheets-Sheet 1



INVENTOR.
H. A. Affel
BY *[Signature]*
ATTORNEY

June 5, 1923.

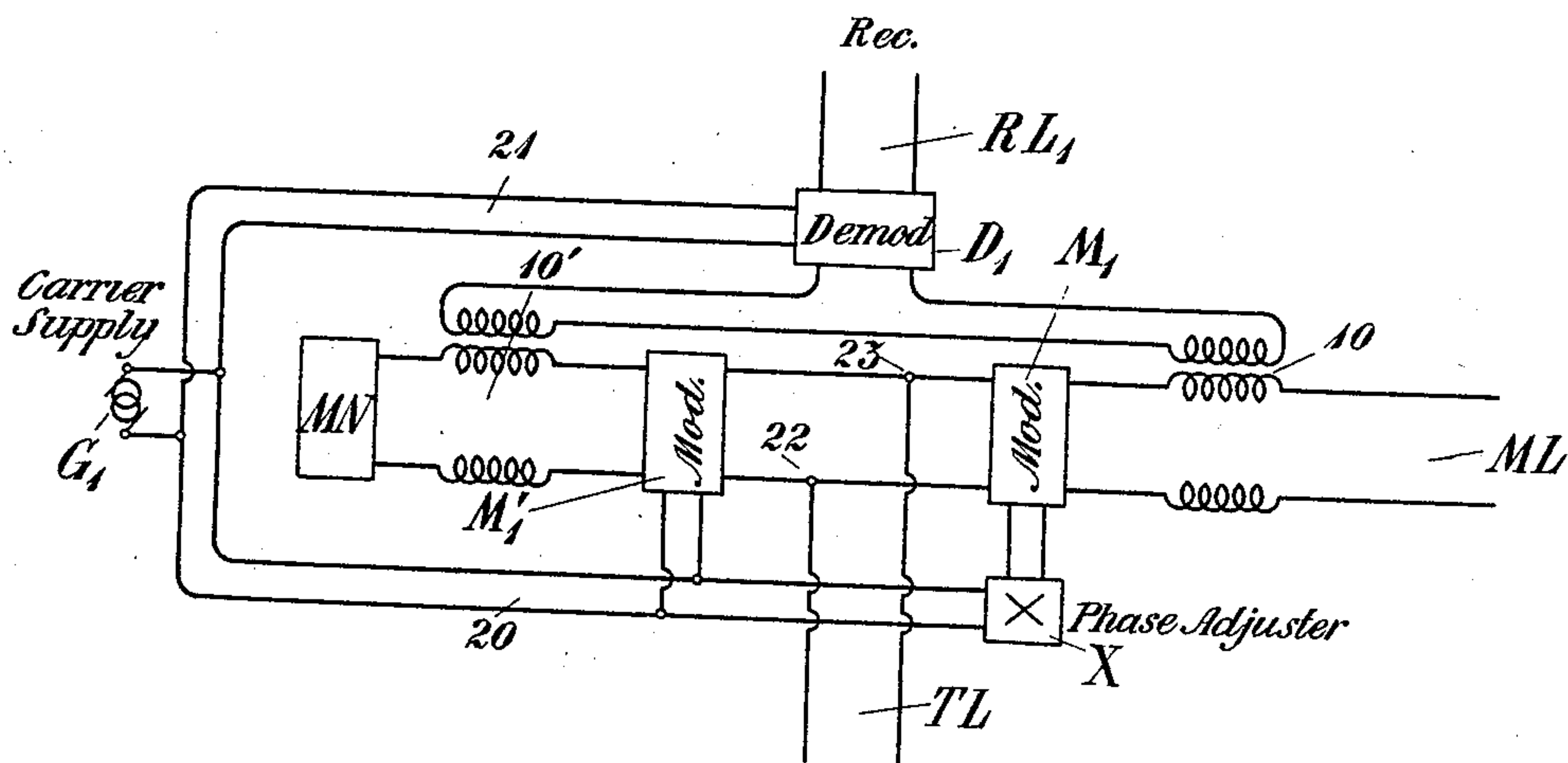
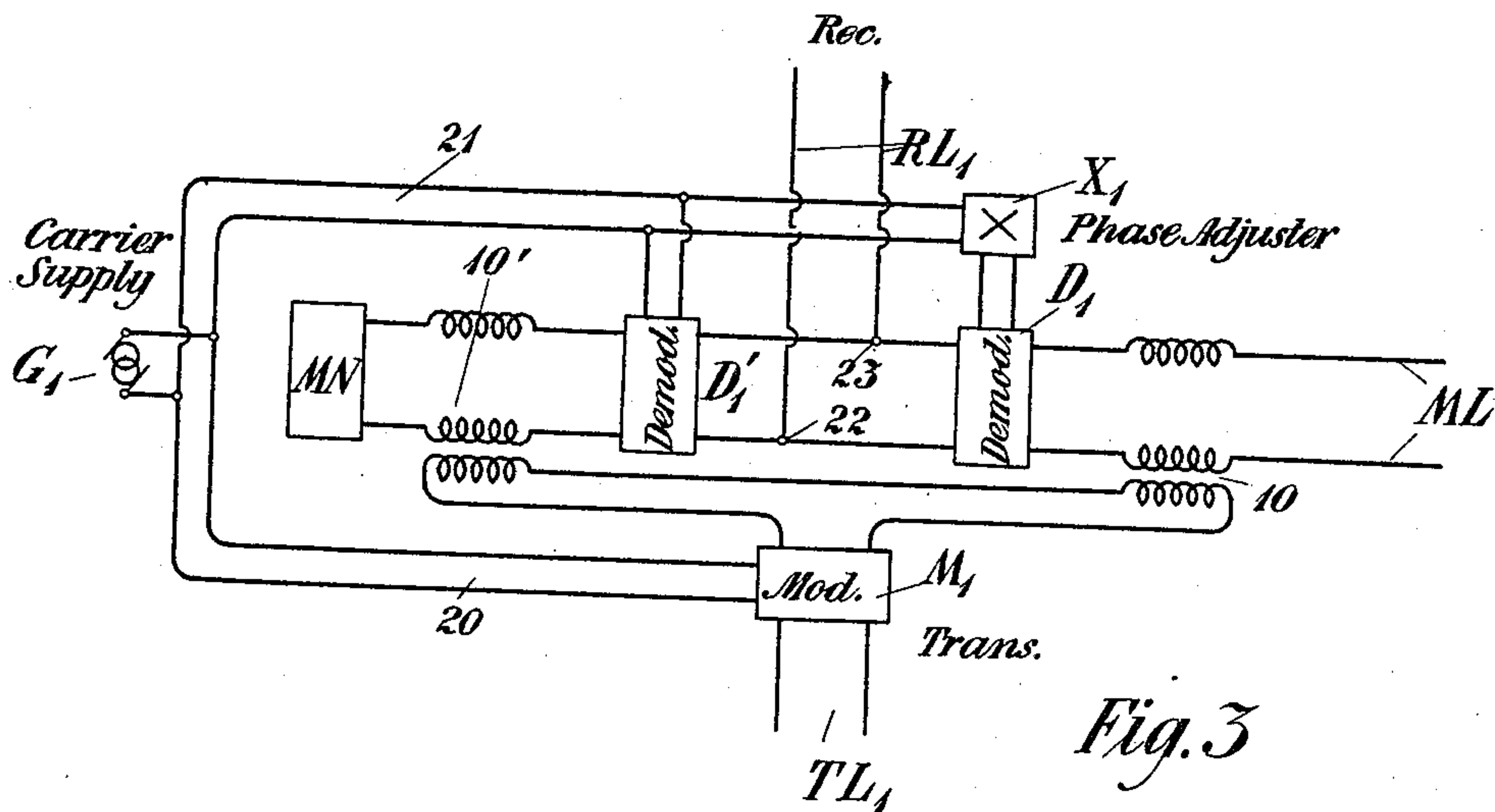
H. A. AFFEL

1,457,336

BALANCING CIRCUITS

Filed Sept. 30, 1919

2 Sheets-Sheet 2



INVENTOR.
H. A. Affel
BY *C. C. Rose*
ATTORNEY

Patented June 5, 1923.

1,457,336

UNITED STATES PATENT OFFICE.

HERMAN A. AFFEL, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

BALANCING CIRCUITS.

Application filed September 30, 1919. Serial No. 327,456.

To all whom it may concern:

Be it known that I, HERMAN A. AFFEL, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Balancing Circuits, of which the following is a specification.

This invention relates to signaling circuits and more particularly to arrangements for translating low frequency signals into higher frequency carrier currents and vice versa.

In multiplex transmission systems employing carrier currents it is customary to separate the east and west channels of a carrier transmission circuit in a manner similar to that employed in the case of the so-called 22 type telephone repeaters. A circuit of this type involves balancing the carrier frequencies by means of an artificial line for simulating the main transmission line at the carrier frequencies. A low frequency balance is usually also provided in connection with the terminal signaling circuit, to maintain the oppositely directed channels conjugate at low frequency. The translation of the ordinary signaling frequencies into carrier frequencies and vice versa is carried out independently of the balancing circuit. In accordance with the present invention the frequency translation is made an integral part of the balancing circuit by locating the translating device, which may be either a modulator or demodulator, in the circuit on either side of the point of neutralization between the real and artificial line. Consequently the energy of an outgoing transmission, for instance, which it is desired to balance with reference to the receiving channel, undergoes a change in frequency before the balance is effected. An arrangement of this character renders it possible to balance the circuit without maintaining a high degree of balance in the artificial line or network for both high frequency phase and magnitude, the fact that the signaling frequencies balanced are relatively low obviating the necessity of accurate phase balance in the high frequency circuit.

The invention may be more fully understood by reference to the following description when read in connection with the accompanying drawing, Figures 1, 2, 3 and

4 of which constitute circuit diagrams of different embodiments of the invention.

Referring to Figure 1, ML designates a main transmission line or radio antenna circuit over which signals may be transmitted by means of carrier currents. An artificial line or network MN is provided for balancing the main line with respect to high frequencies. TL designates a transmitting or sending circuit including a source of carrier frequency currents G and a key K. The source G may be of any well-known type, such as for instance a vacuum tube oscillator. The circuit TL is associated with the main line ML and the balancing circuit MN through a balanced transformer arrangement comprising windings 10 and 10', which are wound on separate cores. In order to translate carrier currents into low frequency signaling currents, detectors D and D' are included in the circuit of the main line ML and the balancing line MN, between the points at which the two windings 10 and 10' of the transformers are included in the line and artificial line. These detectors or demodulators may be of any well-known type, such for instance as vacuum tube rectifying detectors. A receiving relay R, with reference to which the transmission circuit TL is to be balanced, is included between the detectors D and D'. The relay R is a balanced or differential relay having two opposed windings in the output circuits of the detectors D and D', so that in response to signals incoming from the main line ML the right hand winding will be effective to operate the relay to close the circuit of a receiving relay or sounder R'. With respect to currents transmitted from the circuit TL, however, both windings of the relay R will receive equal currents and no effect will be produced upon the sounder R'.

It will be seen that with this construction the relay R is balanced at low frequencies since the carrier frequencies are translated into low frequencies by means of the detectors D and D' before being impressed upon the neutral point of the circuit to which the relay R is connected. In order to control the magnitude of the carrier currents impressed upon the detectors and consequently the magnitude of the low frequency signaling currents impressed upon the relay R, potentiometers P and P'

may be included in the circuits of the main line ML and the artificial line MN, respectively.

The operation is as follows: Upon the operation of the key K to transmit low frequency signals, the generator G applies carrier currents to the circuit TL. These currents are impressed through the windings 10 and 10' of the transformers upon the main line ML and the artificial line MN. The components of these carrier currents tending to flow towards the relay R are translated into low frequency currents by means of the detectors D and D' and these low frequency currents balance each other with regard to the relay R, so that the sounder R' is not affected. High frequency currents received from the line ML, however, are impressed upon the detector D and upon being translated into low frequency currents flow through the right hand winding of the relay R to actuate the same, so that the sounder R' responds.

Figure 2 illustrates the manner in which the arrangement of Figure 1 may be applied for multiplex operation. ML and MN designate the main line and artificial line, as before, while TL designates a common transmitting circuit which is associated with transmitting circuits T_1 , T_2 and T_3 , said transmitting circuits including keys K_1 , K_2 and K_3 , as well as the generators G_1 , G_2 and G_3 , respectively. The transmitting circuit TL is associated with the line ML and the artificial line MN through a balanced transformer arrangement 10-10', similar to that indicated in Figure 1. Common receiving circuits at RL and RL' are associated with the main line ML and balancing line MN, respectively. Neutral or differential receiving relays R_1 , R_2 and R_3 are connected in bridged circuits between the common receiving circuits RL and RL'. Demodulators or detectors D_1 and D_1' are included upon either side of the relay R_1 , similar detectors D_2 - D_2' and D_3 - D_3' being included on either side of relays R_2 and R_3 , respectively. The detectors D_1 , D_2 and D_3 are associated with the common circuit RL by means of filters such as tuned circuits F_1 , F_2 and F_3 , which operate to select to each detector the proper carrier frequency. Similar tuned circuits F_1' , F_2' and F_3' serve to associate the detectors D_1' , D_2' and D_3' , respectively, with the common receiving circuit RL'.

The operation is as follows: Upon the actuation of the keys K_1 , K_2 and K_3 to transmit low frequency signals, high frequency carrier currents corresponding to the frequencies of the generators G_1 , G_2 and G_3 are supplied to the circuit TL and the energy of these frequencies is transmitted through the two windings 10 and 10' of the respective transformers to the main line

ML and the artificial line MN. A portion of this energy is transmitted to the common receiving circuits RL and RL' and some of this energy may find its way through the selecting circuits represented by tuned circuits F_1 , F_2 , F_3 and to a similar degree through tuned circuits F_1' , F_2' , F_3' on the balancing side, being subsequently impressed on the respective detectors involved. The carrier currents, upon being translated into low frequency signaling currents by the detectors, actuate equally the two windings of each of the receiving relays R_1 , R_2 and R_3 , so that no resultant effect is produced. Received carrier frequencies from the main line ML, however, upon entering the receiving circuit RL, are selected by means of the filters F_1 , F_2 and F_3 and applied to the detectors D_1 , D_2 and D_3 , with the consequent actuation of the right hand windings of the receiving relays R_1 , R_2 and R_3 , so that the low frequency signals actuate said relay.

Figure 3 illustrates the manner in which the principle of the invention may be applied to a carrier channel for the transmission of telephone currents. In this case the transmitting channel TL₁ includes a modulator M_1 , which may be of any type, but is preferably a duplex vacuum tube modulator of the type illustrated in the U. S. Patent to John R. Carson, No. 1,343,307, of June 15, 1920. Carrier currents of the proper frequency are supplied to this modulator from a suitable generator G_1 over a circuit 20. The receiving channel RL₁ is connected to neutral points between the main line ML and the artificial line MN, while the transmitting channel TL₁ is associated with said main line ML and artificial line MN through a balanced transformer arrangement, the two halves 10 and 10' of which are included in the main line and artificial line circuits respectively, on either side of the neutral point. Demodulators or detectors D_1 and D_1' are included in the main line circuit ML and the artificial line circuit MN on either side of the neutral connection of the receiving channel RL₁ and between the points at which the two windings of the balancing transformers are connected. These demodulators or detectors may be of any well-known type, but are preferably duplex vacuum tube detectors of the type illustrated and described in the U. S. Patent to John R. Carson, No. 1,343,308 of June 15, 1920. As the detectors described in said application of said John R. Carson operate upon the so-called homodyne method of receiving, unmodulated carrier currents of the frequency assigned to the channel are supplied thereto over a circuit 21 from the generator G_1 or another separate generator. In order that the phase angle of the carrier currents supplied to the detectors D_1 and D_1' may be controlled, a

phase adjusting network schematically indicated at X may be included in the carrier supply circuit of one of the demodulators, as for instance D_1 . This network may be of any well-known character such as a network including adjustable capacity and inductance for changing the phase angle.

The operation is as follows: Telephone currents incoming from the circuit TL_1 modulate carrier currents from the source G_1 , by means of the modulator M_1 and are supplied through the transformer sections 10 and 10' of the main line ML and MN , respectively. The components of the resultant modulated carrier current energy impressed upon the detectors D_1 and D_1' cause equal and opposite low frequency telephonic currents to flow to the neutral points 22 and 23 of the circuit, so that no current flows to the receiving channel RL_1 . Modulated carrier currents received in the line L_1 , however, are impressed upon the detector D_1 and translated into low frequency telephone currents, which not being balanced by equal and opposite currents from the detector D_1' , flow to the receiving channel RL_1 .

Figure 4 shows an arrangement in which the modulating element may be included in the balancing circuit, instead of the demodulating element. In this figure the transmitting circuit TL_1 is connected to the neutral points 22 and 23 of the circuit, while the receiving channel RL_1 is connected to the main line ML and artificial line MN , through the two windings 10 and 10' of the balancing transformers. A detector D_1 is included in the receiving channel RL_1 and is supplied with carrier currents from a source G_1 over a circuit 21. Modulators M_1 and M_1' are inserted in the line and artificial line circuits respectively, on either side of the neutral points 22 and 23 and are supplied with carrier currents from the source G_1 over a circuit 20. The phase adjusting element X may be included in the supply circuit of one of the modulators, as for instance the modulator M_1 . Low frequency signaling currents incoming from the circuit TL_1 are applied to the neutral points 22 and 23 of the circuit and flow in opposite directions to the modulators M_1 and M_1' . By means of the two modulators the low frequency currents are translated into carrier currents which are transmitted to the line ML and MN , respectively. These carrier currents produce opposite reactions upon the receiving circuit RL_1 and are therefore balanced out with respect to this circuit. Carrier currents incoming from the main line ML are transmitted through the transformer element 10 to the receiving channel RL_1 and after being detected by the detector D_1 and thereby translated into low frequency telephone currents, are transmitted to the receiving apparatus (not shown).

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, a sending circuit, a receiving circuit, a balancing circuit for balancing said transmission circuit, whereby said sending and receiving circuits may be made substantially conjugate, means for translating signals originating in said sending circuit into high frequency currents, means for translating received high frequency currents into low frequency signaling currents to be transmitted over said receiving circuit, one of said translating means being included in tandem between said transmission circuit and said balancing circuit independently of the corresponding signaling circuit, so that the energy to be balanced undergoes a change of frequency before the balance is effected.

2. In a signaling system, a transmission circuit, a pair of signaling circuits, one for sending and one for receiving, a balancing circuit for rendering said signaling circuits substantially conjugate, means for translating signals originating with said sending signaling circuit into high frequency currents, and means for translating received high frequency currents into low frequency signaling currents for transmission over said receiving signaling circuit, one of said translating means being included in tandem between said transmission circuit and said balancing circuit independently of the corresponding signaling circuit whereby the energy which it is desired to balance undergoes a change of frequency before balance is effected, the other translating means being included directly in the corresponding signaling circuit.

3. In a signaling system, a transmission circuit, a pair of signaling circuits, one for sending and one for receiving, a balancing circuit for rendering said signaling circuits substantially conjugate with respect to each other, one of said signaling circuits being associated with said transmission circuit and balancing circuit at a point between said two last mentioned circuits, means for translating signals originating with the sending signaling circuit into high frequency carrier currents, means for translating received carrier currents into low frequency signals for transmission over the receiving signaling circuit, one of said translating means being arranged in duplicate, with the duplicate elements on either side of the point at which one of said signaling circuits is associated with said transmission circuit and balancing circuit, the other signaling circuit being associated with said transmission circuit and balancing

circuit at points in said two last mentioned circuits beyond the points of their connection with said duplicate translating means.

4. In a signaling system, a transmission circuit, a pair of signaling circuits, one for sending and one for receiving, a balancing circuit for rendering said signaling circuits substantially conjugate with respect to each other, one of said signaling circuits being associated with said transmission circuit and balancing circuit at a point between said two last mentioned circuits, means for translating signals originating with the sending signaling circuit into high frequency carrier currents, means for translating received carrier currents into low frequency signals for transmission over the receiving signaling circuit, one of said translating means being arranged in duplicate, with the duplicate elements on either side of the point at which one of said signaling circuits is associated with said transmission circuit and balancing circuit, the other signaling circuit being associated with said transmission circuit and balancing circuit at points in said two last mentioned circuits beyond the points of their connection with said duplicate translating means, the other translating means being included in said last mentioned signaling circuit.

5. In a signaling system, a transmission circuit, a balancing circuit, a receiving circuit associated with said transmission and balancing circuits at a point between said two last mentioned circuits, means for translating carrier currents into low frequency

signaling currents arranged on either side of said point in said transmission and balancing circuits respectively, a sending circuit associated with said transmission and balancing circuits in said two last mentioned circuits beyond the points of their connection with said translating means, and means to translate low frequency signals originating in said sending circuit into high frequency carrier currents.

6. In a signaling system, a transmission circuit, a balancing circuit, a plurality of receiving means associated with said transmission and balancing circuits at a point intermediate said two last mentioned circuits, means for translating high frequency carrier currents into low frequency signaling currents to be transmitted to said receiving means, said translating means being arranged in duplicate and associated with said transmission and balancing circuits respectively on either side of said receiving means, a sending circuit associated with said transmission and balancing circuits at points in said two last mentioned circuits beyond the points of their connection with said translating means, a plurality of sending means associated with said sending circuit, and means for translating low frequency signals originated by said sending means into high frequency carrier currents.

In testimony whereof, I have signed my name to this specification this 29th day of September, 1919.

HERMAN A. AFFEL.