Oct. 13, 1925. 1,557,079

L. F. MOREHOUSE

TELEPHONE SIGNALING EQUIPMENT

Filed Sept. 16, 1919 4 Sheets-Sheet 1

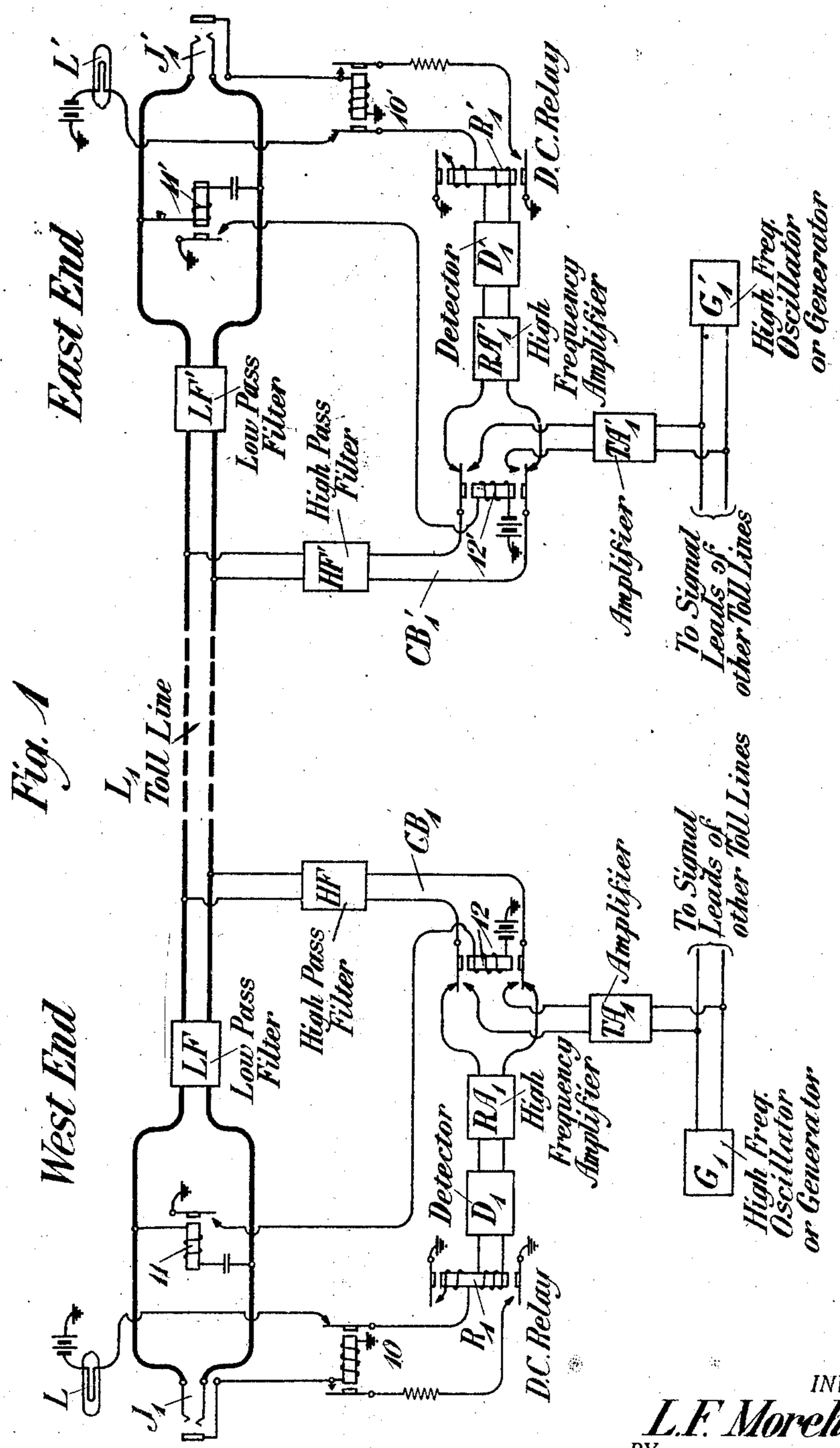

Fig. 1

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Fig. 2

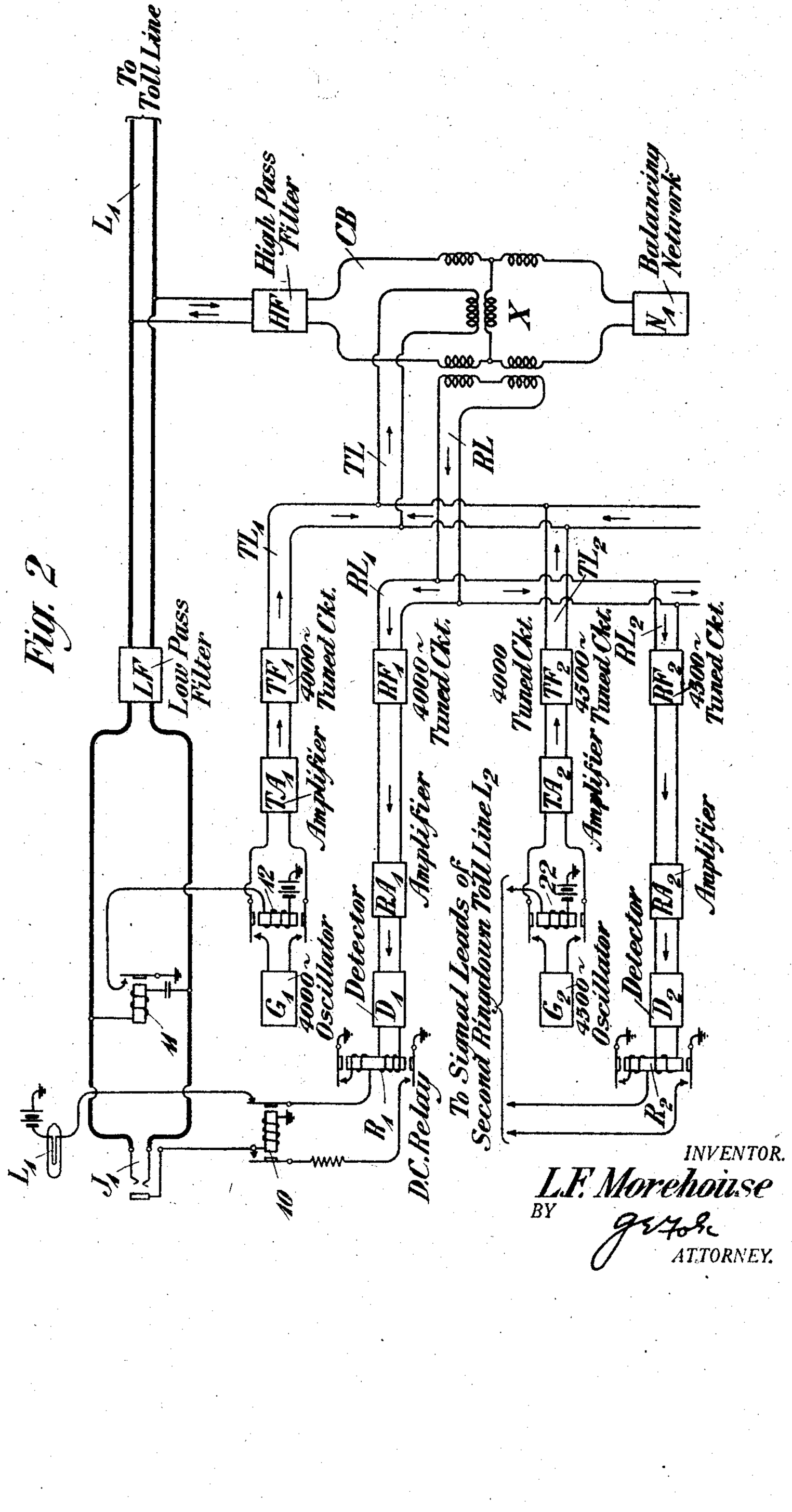

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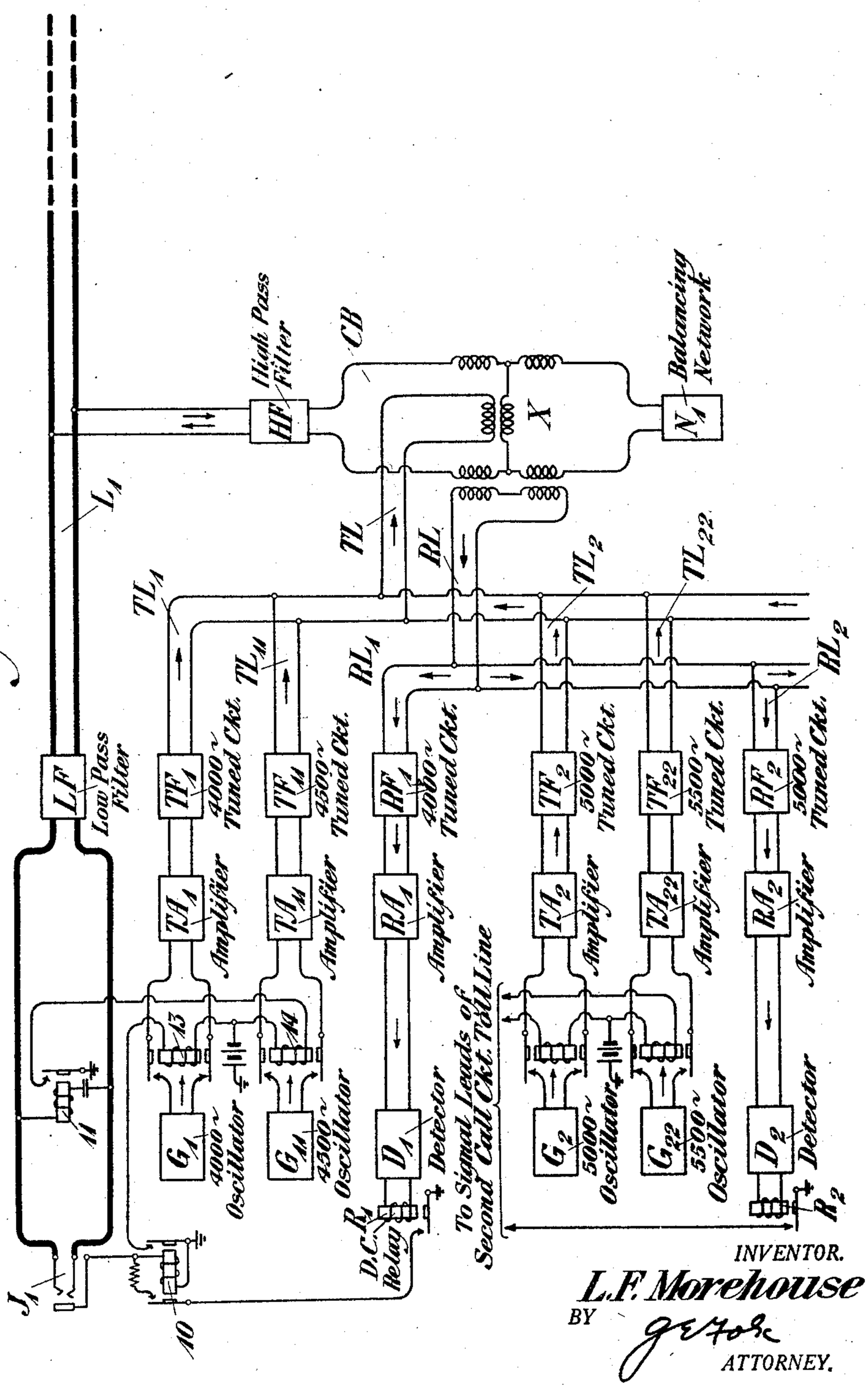
Fig. 3



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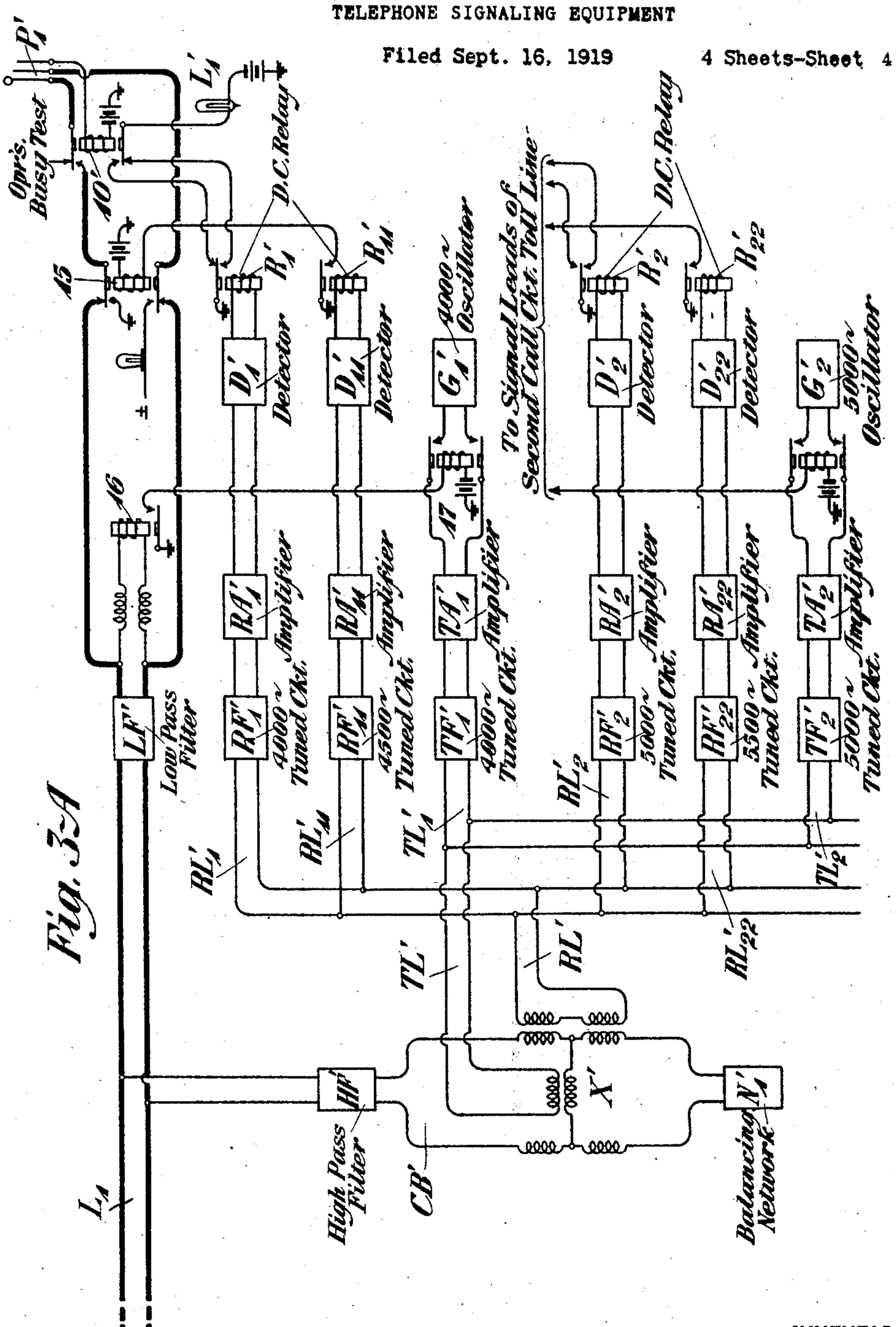

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UNITED STATES PATENT OFFICE.

LYMAN F. MOREHOUSE, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE SIGNALING EQUIPMENT.

Application filed September 16, 1919. Serial No. 324,140.

To all whom it may concern:

Be it known that I, LYMAN F. MOREHOUSE, residing at Montclair, in the county of Essex and State of New Jersey, have invented certain Improvements in Telephone Signaling Equipments, of which the following is a specification.

This invention relates to telephone systems and more particularly to means for transmitting supervisory and other signals incidental to the establishment of connections over telephone lines.

A feature of the invention is the provision of means whereby supervisory signals may be transmitted over the telephone line, without interfering with the use of the metallic circuit of the line for the transmission of metallic circuit Morse signals.

Another feature of the invention is the provision of means whereby supervisory signals may be transmitted over the telephone line, without the use of apparatus at intermediate stations to relay such supervisory signals.

Another feature of the invention has reference to the provision of means whereby the supervisory signals of a plurality of telephone lines may be transmitted over one of the lines, thus leaving the remaining lines of the group free for other purposes.

A further feature of the invention relates to the provision of one or more carrier channels in connection with a telephone line, for the purpose of transmitting the various supervisory signals necessary in the establishment of connections over the line.

A still further feature of the invention is the provision, in connection with one telephone line of a group, of a sufficient number of channels having frequencies lying without the voice range, to transmit the necessary supervisory signals for all of the lines of the group.

Other and further objects of the invention will be clear from the following description when read in connection with the accompanying drawing, in which

Figure 1 is a diagram of an embodiment of the invention, in which a carrier channel is provided for the ringing signals of a ringdown toll line circuit;

Figure 2 is a diagram illustrating the invention as embodied in a system in which a sufficient number of carrier channels are associated with one toll line to transmit the ringdown signals of a plurality of ringdown toll line circuits; and,

Figure 3 and 3 (*a*) together constitute a diagram illustrating the invention as applied to a call circuit toll line.

Referring to Figure 1, L_1 designates a ringdown toll line circuit terminating in jacks J_1 and J_1', whereby connections may be made to various subscriber stations. In order to transmit ringdown signals over the line L_1, branches are led off from the line at each terminal station, through high pass filters HF and HF′, to carrier apparatus for translating transmitted ringdown signals into carrier currents and for translating received carrier currents into ringdown signals. The filters HF and HF′ are preferably of the broad band type of filter disclosed in U. S. patents to George A. Campbell, 1,227,113 and 1,227,114, dated May 22, 1917. The purpose of these filters is to prevent telephone currents from being diverted from the line into the carrier apparatus.

In order to similarly prevent the carrier currents from being transmitted to the telephone drop instead of to the carrier apparatus, low pass filters LF and LF′ are included in the terminal connections of the toll line L_1, as indicated. These filters are also of the broad band type disclosed in the above-mentioned patents to George A. Campbell and are so designed as to transmit a band of frequencies extending over the voice range.

The transmitting carrier apparatus comprises oscillators or generators G_1 and G_1', and amplifiers TA_1 and TA_1'. The generators are preferably of the well-known vacuum tube oscillator type, although any well-known means for producing oscillating currents may be used. The amplifiers TA_1 and TA_1' may be of any well-known character, but preferably are vacuum tube amplifiers.

The receiving carrier apparatus comprises amplifiers RA_1 and RA_1', detectors D_1 and D_1' and receiving relays R_1 and R_1'. The amplifiers RA_1 and RA_1' are preferably vacuum tube amplifiers similar to the amplifiers TA_1 and TA_1' and function to amplify received carrier currents. The detectors D_1 and D_1' may be of any of the well-known types employed in radio transmission, and are preferably vacuum tube detectors. The receiving relays R_1 and R_1' are

direct current relays which are included in the output circuits of the detectors.

Further details of the apparatus may be understood from a description of the operation, which is as follows:

Assuming that a call originates at the west end of toll line L_1, the operator inserts the plug of a toll card into the jack J_1, thereby operating the sleeve relay 10, which relay, upon being operated, opens the circuit of the line signal L to prevent its operation. When the operator transmits ringing current to the toll line over the tip and ring contact of the jack J_1, the ringing responsive relay 11 is operated and over its front contact completes the circuit of relay 12. Relay 12, upon being energized, connects the carrier branch CB_1 over its front contacts to the amplifier TA_1 so that oscillations from the generator G_1 are amplified by the amplifier TA_1 and transmitted through the high pass filter HF to the toll line. At the receiving station the carrier currents transmitted over the line pass through the high pass filter HF′ and over the back contacts of the relay 12′ to the amplifier RA_1'. The amplifier RA_1' amplifies the received carrier currents which are detected by means of the detector D_1', so that the direct current relay R_1' is operated. The relay R_1' at its upper front contact completes a locking circuit from ground through its locking winding over the extreme lefthand back contact of relay 10′ and through the lamp L′ to battery, thereby causing the lamp to glow, to call the attention of the inward operator at the east end of the line.

When the inward operator answers the call thus indicated, the plug of a toll cord is inserted in the jack J_1', thereby operating the sleeve relay 10′, which opens the locking circuit of the relay R_1' through the lamp L_1', so that the lamp is retired and the relay R_1' restored to normal. If, with the circuit in this condition, it should be necessary for the operator at the west end of the line to recall the operator at the east end of the line, ringing current will be transmitted to the relay 11 with the same results as previously described, up to the point where the relay R_1' is operated in response to detected carrier currents. The relay R_1', upon now being energized, completes a shunt about the high resistance of the winding of the sleeve relay 10′ from ground over the lower front contact of relay R_1' and over the right-hand front contact of relay 10′. This operation decreases the resistance in the sleeve circuit sufficiently to operate a marginal relay in the sleeve circuit of the toll cord, thereby operating the supervisory lamp of the toll cord. Inasmuch as the circuits and apparatus associated with the marginal relay and supervisory lamp above referred to are part of a standard toll circuit well-known in the art and are not a part of the present invention, these features are not illustrated herein. It will be noted that the sets of apparatus associated with the east and west ends of the toll line L_1 are identical in character, so that the circuit is a two-way circuit and can be operated in either direction. The operations incident to transmission in the opposite direction are similar to those already described and need not be further considered.

Figure 2 illustrates an arrangement in which the ringdown signals for a plurality of toll lines may be transmitted over carrier channels associated with one of the toll lines, thereby leaving the remaining toll lines available for the superposition of carrier channels for other purposes. In this form of the invention the carrier branch CB, which includes the high pass filter HF, is associated with transmitting channel TL and receiving channel RL through a balanced transformer arrangement X, of a well-known type. In order that the channels TL and RL may be conjugate with respect to each other, so that electrical disturbances arising in the one circuit will not affect the other, the balancing network N_1 is provided, said net work being so designed as to balance the filter HF, the toll line L_1 etc. The transmitting channel TL is provided with transmitting branches TL_1, TL_2, etc., leading to transmitting carrier apparatus for toll lines L_1 and L_2, etc. The toll lines other than the line L_1 are not illustrated, it being sufficient for the purpose of understanding the invention to illustrate merely the carrier apparatus associated therewith. In a similar manner the receiving channel RL is provided with receiving branches RL_1, RL_2, etc., leading to the receiving carrier apparatus for the several toll lines. The transmitting and receiving carrier apparatus associated with the several transmitting and receiving branches is similar to that already described in connection with Figure 1.

Further details of the apparatus will be clear from the description of the operation, which is as follows:

Upon the insertion of a plug in the jack J_1, sleeve relay 10 is energized and opens the circuit of the lamp L_1. Upon the transmission of ringing current to the line L_1, ringing responsive relay 11 is operated, thereby completing the circuit of the relay 12, which in turn causes the transmission of carrier currents from the generator G_1, over the front contacts of said relay, to the amplifier TA_1. The several generators such as G_1, G_2, etc., corresponding to different toll lines are arranged to generate different frequencies, the frequency for the line L_1 being here illustrated as 4000 cycles. The carrier

currents generated by the generator G_1 are amplified by amplifier TA_1 and pass through a filter arrangement TF_1 to the transmitting channel TL. The filter arrangement TF_1 is preferably a simple tuned circuit tuned to the frequency of the channel which in this instance is 4,000 cycles. The carrier currents impressed upon the channel TL are transmitted over the common branch CB, through the filter HF to the line L_1, without reacting upon the receiving channel RL, since the latter is conjugate with respect to the channel TL.

At the receiving station the carrier currents transmitted over the line actuate receiving apparatus in a manner which will be understood from a description of the operation taking place at the station illustrated, is response to carrier currents transmitted from the distant station. Such carrier currents pass through the filter HF and through the transformer X to the receiving channel RL, from which point they pass into receiving branch RL_1, corresponding to the toll line L_1 through a filter arrangement RF_1, which may be similar in all respects to the filter arrangement TF_1 already referred to. The received currents are then amplified by the amplifier RA_1 and detected by the detector D_1, so that direct current relay R_1 is actuated. Relay R_1 at its upper front contacts completes a locking circuit through its locking winding over the back contact of relay 10, through the lamp L_1 to battery. The lamp is thereby caused to glow, informing the operator that a call has come in from the opposite end of the line. Upon inserting the plug of a toll cord in the jack J_1, the lamp L_1 is retired and the relay R_1 released. A re-ring signal incoming from the distant station will actuate the relay R_1 in a similar manner, thereby shunting the sleeve relay 10 to operate the supervisory lamp of the toll cord, in a manner similar to that described in connection with Figure 1.

If a plug is inserted in the jack of the line L_2, (not shown) and ringing current is transmitted to said line, the ringing relay of said line operates to cause the actuation of the relay 22, thereby causing carrier current from the generator G_2 to be amplified and transmitted to the receiving channel RL and thence through the transformer arrangement X and high pass filter HF to the line L_1. It will be noted in this connection that the ringing signal originated at the line 2 is thus transmitted over the line L_1, after being translated into carrier currents of the frequency assigned to the line L_2, which is herein illustrated as 4,500 cycles.

A ringing signal originating at the opposite end of the line L_2 will, in a similar manner, be translated and transmitted to the line L_1, by a similar apparatus at the other end of the line. Upon receiving the carrier oscillations thus transmitted over the line L_1, said oscillations pass through the filter HF and through the transformer X to the receiving circuit RL, from which point they are branched through the filtering arrangement RF_2 which is tuned to 4,500 cycles, to the amplifier RA_2. The carrier currents are then amplified, detected by the detector D_2 and actuate the receiving relay R_2 associated with the line L_2, thereby actuating signal apparatus similar to that illustrated in connection with the line L_1.

Figures 3 and 3A illustrate the invention as applied to a call circuit toll line. In order to understand the diagram, the two sheets containing these figures should be placed end to end. The call circuit toll line L_1 terminates at the outgoing end in a jack J_1, adapted to cooperate with the plug of a toll cord and, at its incoming end, terminates in a plug P_1', adapted to cooperate with the jack of a toll switching trunk. Inasmuch as a larger number of supervisory signals must be transmitted for each line in connection with the establishment of a connection over such line, it is necessary to assign a larger number of carrier channels to each line. As illustrated, the carrier branch CB has associated therewith two transmitting circuits and one receiving circuit for each line at the outgoing station, while the carrier branch CB' has associated therewith two receiving circuits and one transmitting circuit at the incoming end of each line; for instance, at the outgoing end transmitting channels TL_1 and TL_{11} having frequencies at 4,000 cycles and 4,500 cycles respectively, are assigned to the line L_1, while transmitting channels TL_2 and TL_{22} of 5,000 cycles and 5,500 cycles respectively, are assigned to the line L_2. Likewise, the receiving channel RL_1 of 4,000 cycles frequency and the receiving channel RL_2 of 5,000 cycles frequency are assigned to the lines L_1 and L_2 respectively. At the incoming end receiving channels RL_1' and RL_{11}' are associated with the line L_1 and corresponding channels RL_2' and RL_{22}' are associated with the line L_2. The transmitting channels TL_1' and TL_2' are also associated with lines L_1 and L_2 respectively at their incoming ends. The frequencies of these several channels will be as indicated in the drawing, although it will be understood that the particular frequencies indicated upon the drawing are merely illustrative and that in practice other frequencies than those indicated may be used.

When the originating operator has passed the details of the desired connection over the call circuit (not shown), to the tandem position at the incoming end of the line and has received the toll assignment, she inserts the plug of a toll cord into the jack J_1, thereby operating the sleeve relay 10, which at its

righthand front contact completes the circuit of relay 13. Oscillations from the generator G_1 are now transmitted over the front contacts of relay 13, amplified by the amplifier TA_1 and pass through the tuned circuit TF_1 to the transmitting circuit TL and thence through the transformer arrangement X to the carrier branch CB. The oscillations are then passed through the high pass filter HF and transmitted over the toll line L_1 through the filter HF′ to the carrier branch CB′ at the incoming end. From this point they are transmitted through the transformer arrangement X′ to the receiving circuit RL′ and thence into the receiving channel RL_1' through the tuned circuit RF_1'. After being amplified by the amplifier RA_1', they are detected by the detector D_1', so that the receiving relay R_1' is operated. This relay, at its front contact, completes the circuit for the guard lamp L_1', the circuit of the guard lamp passing over the lower back contact of the sleeve relay 10′.

The incoming operator, upon observing the glowing of the guard lamp L_1', inserts the plug P_1' into the jack of a toll switching trunk, thereby causing the sleeve relay 10′ to be actuated to open the circuit of the guard lamp. When the toll switching trunk has been connected to the subscriber's line, battery is connected to the toll switching trunk in a wellknown manner, so that direct current flows from the toll switching trunk over the tip and ring contacts of the plug P_1' upper make contact of sleeve relay 10′, back contacts of the ringing relay 15, to the winding of the direct current bridge relay 16. Relay 16 is therefore actuated and completes the circuit of relay 17, whereby oscillations are transmitted from the generator G_1' over the front contacts of relay 17 to the amplifier TA_1'. Upon being amplified, the oscillations are passed through the tuned circuit TF_1' and over the transmitting circuit TL′ through the transformer arrangement X′ to the carrier branch CB′. The oscillations then pass through the high pass filter HF′ and are transmitted over the toll line L_1 and through the filter HF to the carrier branch CB. From this point they are transmitted through the transformer X to the receiving circuit RL, from which they are selected by the tuned circuit RF_1 and pass to the amplifier RA_1. After being amplified, the oscillations are detected by the detector D_1, so that the direct current relay R_1 is actuated. The relay R_1 connects a shunt about the high resistance winding of the sleeve relay 10, thereby causing the actuation of supervisory lamp in the toll cord, in a manner similar to that described in connection with Figure 1.

The outgoing operator, upon receiving this signal, applies ringing current over the tip and ring contacts of the jack J_1, thereby actuating the ringing responsive relay 11. The actuation of relay 11 completes the circuit of relay 14, so that oscillations from the generator G_{11} flow over the front contacts of said relay, through the amplifier TA_{11}, through the filter TF_{11}, over the circuit TL, through the transformer arrangement X, through the high pass filter HF, over the toll line L_1, through the filter HF′, through the transformer X′ into the receiving circuit RL′, from which point they are selected into the channel RL_{11}', by the filter RF_{11}'. The oscillations are then amplified by the amplifier RA_{11}' and detected by the detector D_{11}', with the consequent actuation of relay R_{11}'. Relay R_{11}' at its upper front contact completes the circuit of the ringing relay 15, which at its front contact applies ringing current over the tip and ring contacts of the plug P_1' and over the toll switching trunk to the called subscriber's line.

As soon as the called subscriber answers the ringing signal by removing his receiver from the switch hook, the direct current is disconnected from the toll switching trunk, in a well understood manner, thereby causing the de-energization of the relay 16. Oscillations are no longer supplied from the generator G_1', to actuate the relay R_1 at the outgoing end of the line, so that said relay is deenergized, thereby removing the shunt from the sleeve relay 10 and extinguishing the supervisory signal of the outgoing operator's cord circuit, thus indicating to the operator that the called subscriber has answered. Should the called party flash his switch hook, the relay 16, will be intermittently operated by the alternate connection and disconnection of direct current to the toll switching trunk. Consequently, successive groups of oscillations of 4,000 cycles frequency will be transmitted from the generator G_1', thereby intermittently operating the receiving relay R_1 at the outgoing operator's position. This results in intermittently shunting the sleeve relay, with the consequent flashing of the supervisory signal in the operator's toll cord.

Where it is desired to take the connection down, the originating operator withdraws the plug of the toll cord from the jack J_1. This operation releases the sleeve relay 10, which in turn releases the relay 13, so that oscillations of 4,000 cycles frequency from the generator G_1 are no longer transmitted over the line L_1 to maintain the receiving relay R_1' at the incoming end operated. Said relay is therefore de-energized and at its upper back contact completes the circuit from ground, over the lower front contact of sleeve relay 10′ and through the guard lamp L_1' to battery. The guard lamp now glows, indicating to the incoming operator

that the connection is to be taken down. The plug P_1' is therefore withdrawn from the toll switching trunk and the guard lamp L_1' is extinguished. The apparatus is now in normal condition.

The operations incident to the establishment of a call over the toll line TL_2 (not shown) are similar to those already described, except that in this case the carrier channels TL_2, TL_{22} and RL_2 at the outgoing end, together with the corresponding channels RL_2' and RL_{22}' and TL_2' at the incoming end, are utilized for transmitting the signals. The carrier frequencies are, however, transmitted over the toll line L_1 and not over the toll line L_2. The latter line is therefore available for the superposition of carrier channels for other purposes.

It will be seen that by means of this invention an efficient and simple means is provided for transmitting supervisory signals in connection with toll lines.

It will also be obvious that the general principles of the invention 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 low frequency telephone transmission line, a plurality of carrier channels associated therewith for the transmission of frequencies without the voice range, and means whereby, when the operator initiates a supervisory signal of one character, alternating carrier currents will be transmitted over said line through one of said channels and when the operator initiates a supervisory signal of another character, carrier currents will be transmitted over said line through another channel.

2. In a signaling system, a low frequency telephone transmission line, a plurality of carrier channels associated therewith, means whereby, when the operator initiates a guard signal, alternating carrier currents are transmitted over said line through one of said channels, and means whereby, when the operator initiates a ringing signal, carrier currents are transmitted over said line through another channel.

3. In a signaling system, a low frequency telephonic transmission line, a carrier circuit associated with said line, for transmitting in either direction over said line supervisory signals incidental to the establishment of low frequency telephone connection over said line and means at terminal stations of said line for separating oppositely directed carrier transmissions, said means comprising a pair of separate circuits for the oppositely directed transmissions, said circuits being associated with each other and with the telephone line, through a balancing arrangement comprising a balanced transformer and a balancing artificial line.

4. In a signaling system, a group of telephone transmission lines, and means associated with a special one of said lines for transmitting supervisory signals for all of said lines, said means comprising alternating current carrier channels associated with said special lines and employing frequencies without the voice range, each of said carrier channels being individual to a corresponding telephone line of said group.

5. In a signaling system, a group of telephone transmission lines, a plurality of carrier channels associated with a special one of said lines, each of said carrier channels being individual to a corresponding line of said group, and means whereby in response to the initiation of a supervisory signal for any one of the lines of said group, alternating carrier currents without the voice range will be transmitted over said special line through the carrier channels corresponding to the line in connection with which the supervisory signal originated.

6. In a signaling system, a group of telephone transmission lines, a group of carrier channels associated with a special line of said group, said group of carrier channels being divided into sub-groups and each sub-group being individual to a corresponding telephone line of said group of telephone lines, means whereby when a supervisory signal of one character is initiated in connection with any one of said telephone lines, alternating carrier currents are transmitted over said special lines through one of the carrier channels in the sub-group corresponding to the line with which the supervisory signal originated, and means whereby when a supervisory signal of another character is initiated in connection with the same line, alternating carrier currents will be transmitted over said special line through another channel of the same sub-group.

In testimony whereof, I have signed my name to this specification this 15th day of September, 1919.

LYMAN F. MOREHOUSE.