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LOW FREQUENCY ALTERNATING CURRENT SIGNALING SYSTEM

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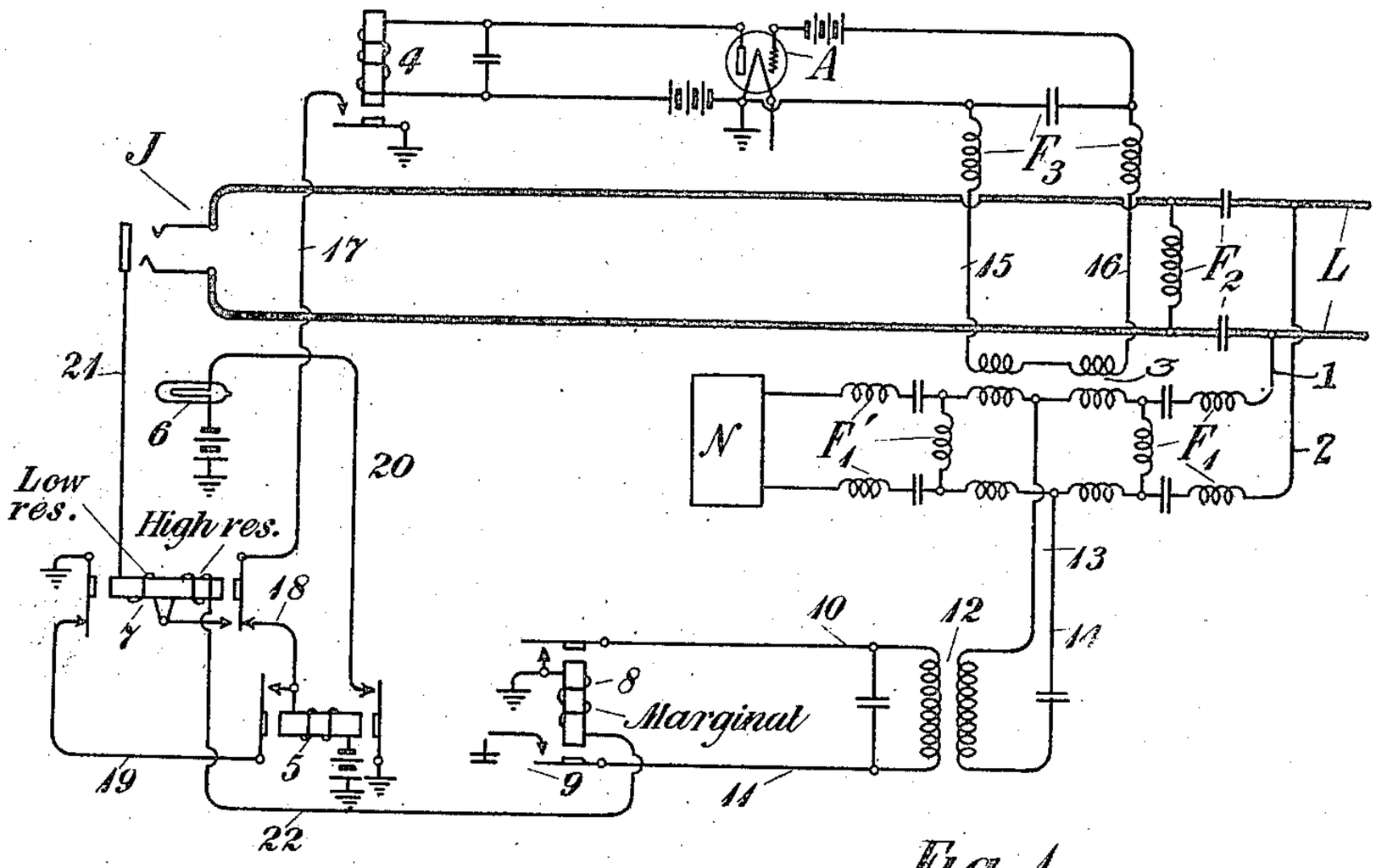

Fig. 1

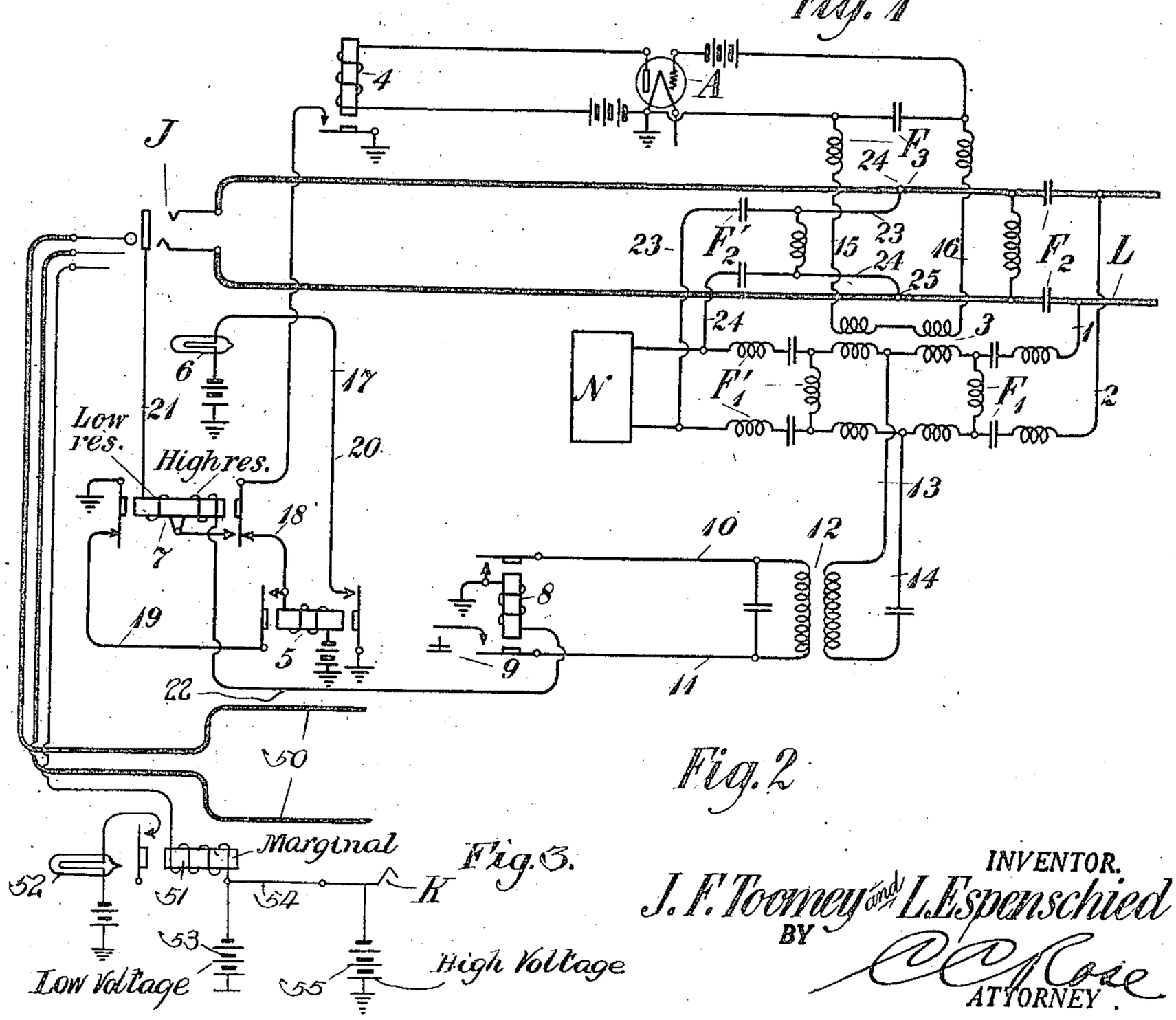

Fig. 2

Fig. 3.

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UNITED STATES PATENT OFFICE.

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LOW-FREQUENCY ALTERNATING-CURRENT SIGNALING SYSTEM.

Application filed September 27, 1919. Serial No. 326,939.

To all whom it may concern:

Be it known that we, LLOYD ESPENSCHIED and JOHN F. TOOMEY, residing at Hollis and New York, in the counties of Queens and New York and State of New York, respectively, have invented certain Improvements in Low-Frequency Alternating-Current Signaling Systems, of which the following is a specification.

This invention relates to transmission systems and more particularly to lines arranged for the multiplex transmission for currents for different purposes.

It is a general purpose of the invention to provide a transmission system over which alternating currents may be used for signaling or other purposes and may be transmitted over such a system simultaneously with currents used for telephonic purposes and without interference with such latter currents or the terminal arrangements provided for such currents. In order to accomplish this purpose, there is applied to the transmission line simultaneously with the telephone channel, a signaling channel or channels employing alternating currents of various frequencies not included in the telephonic range of frequencies. At the terminal arrangements of the system is provided a path for the telephonic currents and a path for the currents used for the signaling purposes, each path including selective apparatus for preventing the transmission thereover of currents except those for which it was designed. An arrangement of this character whereby a low frequency carrier channel may be employed for signaling or other purposes, is particularly desirable as it is suitable for use with many types of transmission lines such as for purposes of illustration on the physical or phantom circuits of both two wire or four wire toll lines or on lines over which direct currents might not be transmitted. The arrangements of the invention whereby a low frequency carrier channel may be employed for signaling is furthermore desirable in that it may be used both with toll lines employing the so called ring-down system of signaling and on toll lines employing the so called automatic system of signaling. In the ring-down system of signaling over a toll line signaling current is transmitted from one end of the toll line to the other end by the actuation of a ringing key in the operator's cord circuit connected with the line and the signaling current is transmitted over the line only while the ringing key remains operated. In the automatic system of signaling current is transmitted from one end of the toll line to the other merely by inserting the plug of the operator's cord circuit into the jack of the toll line, the ringing current being continuously transmitted over the line until the operator at the distant end responds by connecting with the line. The connection of the distant operator with the toll line automatically transmits signaling current back over the toll line, and thereby operates supervisory means in the cord circuit of the first operator. Furthermore with the arrangements of this invention an alternating signaling current may be employed which may be transmitted through repeater apparatus in the line without providing special equipment at the repeater station to transmit such currents around the repeater apparatus. Another feature of the invention is that with such arrangements, signaling currents may be employed which may be of such a nature that they may be used to control filament circuits of repeaters in the line and to regulate their output. The signaling current which may be used with the arrangements of this invention may also be used for transmitting impulses for operating and controlling switching mechanism for establishing connections between toll lines and toll switching trunks or subscribers' stations or such current may be used in conjunction with a start-stop distributor for providing a common signaling path for a number of toll lines. Other and further features and purposes of the invention will appear from the description hereinafter given.

The invention may be more clearly understood from the following description together with the accompanying drawing in the Figures 1, 2 and 3 of which are illustrated circuit diagrams of a preferred form, and a modification of the invention.

In the Figure 1 is illustrated a transmission line L terminating in the jack J. For purposes of illustration, the transmission line L has been shown as one over which the

ring-down system of signaling is employed. As both low frequency signaling currents and currents of telephonic frequency may be transmitted over the line L, there is provided in the line L a filter apparatus F_2. This filter may be of the type described in the U. S. patents to George A. Campbell, Nos. 1,227,113 and 1,227,114, dated May 22, 1917, and is designed to readily allow the transmission of a band of frequencies including telephonic frequencies, but which attenuates and practically extinguishes currents of all frequencies below the telephonic range. With such an arrangement the signaling currents coming in over the line L will be prevented from being transmitted to the telephonic apparatus associated with the jack J. Bridged across the transmission line L is a circuit suitable for the transmission of the incoming signaling currents. This circuit includes an arrangement of inductances and capacities such as F_1 and F_1', adapted to make the circuit sharply resonant at the frequency of the signaling currents employed. Accordingly such a circuit will readily allow the transmission of the signaling currents coming in over the line L, but will prevent the incoming telephonic currents from being transmitted over said circuit. Included in the circuit is network N, adapted to balance the section of the line L and in parallel therewith the filter apparatus F_2. Included in the signaling circuit is the three-winding transformer 3. Associated with one winding of said transformer is a path for the signaling currents coming in over the line L. This path includes an arrangement F_3 of inductances and capacity so that the path will be sharply resonant to currents of the frequency used for signaling. Included in this path is the amplifier-rectifier A and the relay 4. The relay 4 controls the relay 5 which in turn, controls the signal lamp 6 at the jack J. When the automatic system of signaling is employed, the relay 4 may be used to control supervisory signaling apparatus in the cord circuit associated with jack J as will be pointed out later. Associated with the sleeve contact of jack J are the relays 7 and 8. Relay 8 controls the application of signaling current from source 9 to the mid-points of the three-winding transformer 3, from which it will in turn be transmitted out over the line L.

The operation of the arrangements illustrated in Figure 1 is as follows: As has been formerly pointed out, the arrangements illustrated in Figure 1 include a toll line L on which the ring-down system of signaling is employed. Low frequency currents, such as signaling currents coming in over the line L from a distant station in response to the actuation thereat of the operator's ringing key will be prevented from being transmitted to the telephonic apparatus associated with jack J of the line, by means of the filter F_2. Such incoming signaling currents will be transmitted over the following circuit:—from line L over circuit 1, 2, and through the transformer 3, circuit 15, 16 and thence to the vacuum bulb A. Circuit 1, 2, will readily allow the transmission of such incoming signaling currents as it is tuned by the devices F_1 and F_1' to be sharply resonant to currents of such frequency. Accordingly, the signaling currents will be transmitted through the transformer 3 and over conductors 15 and 16 to the amplifier-rectifier A. This last mentioned circuit will readily allow the transmission of these signaling currents as it is sharply tuned by the device F_3 to be resonant to currents of this frequency. The signaling currents are amplified and rectified to direct current in the amplifier-rectifier vacuum tube A and are transmitted through the windings of and actuate relay 4. The direct current relay 4 and the amplifier-rectifier A are provided for the following purposes. When an alternating carrier current channel is superposed on the line L for purposes of signaling or other purposes, it is necessary in order to prevent harmonics of this signaling current from interfering with the carrier channel superposed on the line for other purposes, such as telephonic purposes, to so limit the signaling current as to render it impossible to operate the usual type of alternating current relay directly from the signaling current transmitted over the line. Accordingly the provision of a signaling receiving circuit including the amplifier-rectifier A and the direct current relay 4 makes it possible to further prevent interference between the carrier channels superposed on the line L, as such arrangements may be operated by a type of signaling current which will not interfere with the other carrier channels. The operation of relay 4 will close the following circuit: from ground, armature and contact of relay 4, conductor 17, armature and right hand contact of relay 7, conductor 18, winding of relay 5, to battery and ground. The relay 5 will be locked up over the following circuit: from ground and battery, winding of relay 5, left hand contact and armature of relay 5, conductor 19, contact and armature of relay 7, to ground. The operation of relay 5 closes the following circuit: from ground, armature and contact of relay 5, conductor 20, filament of signaling lamp 6, to battery and ground. The closing of this circuit will light the signal lamp 6. As the circuit including conductors 1 and 2 and the circuit including conductors 15 and 16, are each tuned to be sharply resonant to these relatively low frequency signaling currents, these circuits will not allow the transmission thereover of the

incoming telephonic currents and accordingly such currents will not affect the operation of the signal lamp 6.

If it is desired to transmit signaling current out over the line L to signal the operator at the distant end the operator will connect a cord circuit such as 50 shown in Figure 3 with jack J and will throw the ringing-key K in the cord circuit. This would close the following circuit: from ground and battery 55, contact of key K, winding of relay 51, sleeve conductor of cord, over the sleeve contact of the plug of the cord, sleeve contact of jack J_3, conductor 21, windings of relay 7, conductor 22, winding of marginal relay 8, to ground. The battery 51 included in this last mentioned circuit by the operation of the ringing-key will have a sufficiently high voltage to operate the marginal relay 8. It is pointed out that the marginal relay 8 was not operated merely by connecting the plug of the cord circuit with jack J, as the battery 53 normally connected to the sleeve conductor in the cord being of lower voltage than battery 55 is not of high enough voltage to operate the marginal relay 8. The operation of relay 8 connects a source 9 of signaling current to the conductors 10 and 11. This signaling current will be transmitted through the transformer 12 and over the conductors 13 and 14 to the mid-points of three-windings transformer 3. At such points, the signaling current will divide equally, one portion being transmitted through the network N and the other portion being transmitted over conductors 1 and 2 and thence out over the line L. The currents transmitted out over the line L will operate at the distant station relaying and signaling means similar to relays 4 and 5 and signal lamp 6. The currents transmitted through the network N and the current transmitted out over the line L will be equal and opposite and will accordingly induce no current in the secondary winding of transformer 3 and will not affect the relay 4.

The arrangements illustrated in Figure 2 are substantially similar to the arrangements of Figure 1 and similar reference numerals in each figure indicate like parts. The toll line L of Fig. 2 is shown as a toll line on which is used the so-called automatic system of signaling. In Figure 2 there is provided an additional filtering device F_2', which is included in a bridge across the talking conductors of the line L. This filtering device is similar to the filter F_2. The filtering devices F_2 and F_2' are designed to readily allow the transmission of telephonic currents, but to attenuate and practically extinguish the currents used for signaling purposes. Sometimes the signaling currents may contain harmonics of the original wave, which would be of a frequency within the telephonic range. If such currents were applied to conductors 10 and 11 and thence transmitted over conductors 13 and 14 to the midpoints of the windings of transformers 3, one portion of these currents, which would divide at these midpoints, would be transmitted over conductors 1 and 2 to the line L. The harmonics of such currents being within the telephonic frequency range might not be efficiently attenuated by the filter F_2 and would be transmitted over the line L beyond this filter. However, the other portion of the signaling current which divided at the midpoints of the windings of transformer 3 would be transmitted over conductors 23 and 24. The harmonics of such currents would be transmitted through the filter F_2' and thence over conductors 23 and 24 to the line L at the contact points 24 and 25. At these points this last mentioned current would neutralize any of the signaling current which was transmitted through the filter F_2 and the signaling currents would not be transmitted further over the line L. Furthermore the relay 8 of Fig. 2 is not marginal. As the Fig. 2 is in other respects similar to Fig. 1, no further description thereof will be given.

The operation of the arrangements illustrated in Fig. 2 is as follows: It has been pointed out that the toll line illustrated in Fig. 2 is the type of toll line with which the so-called automatic method of signaling is employed. If it is desired to transmit signaling current out over the line L the operator will insert the plug of her cord circuit such as 50 into jack J and this action will close the following circuit: from ground and battery 53 in the sleeve conductor of the cord circuit, winding of relay 51, sleeve contact of plug of cord, sleeve contact of jack J, conductor 21, low resistance and high resistance windings of relay 7, conductor 22, winding of relay 8, to ground. The relay 8 in the arrangements of Fig. 2 is not marginal and accordingly upon the closing of this circuit both relays 7 and 8 will be operated. The relay 51 is marginal and will not be operated at this time, as the circuit includes the high resistance winding of relay 7. The operation of relay 8 will connect a source 9 of signaling current to conductors 10 and 11. Signaling current will then be transmitted through transformer 12, over conductors 13 and 14, windings of transformer 3, over conductors 1 and 2, and thence out over the line L. In other words signaling current may be transmitted out over line L merely by the insertion of the plug of the operator's cord circuit into jack J. In a similar manner when the operator at the distant end of line L in response to this signaling current makes a connection with the line L, signaling current will automatically be transmitted back over the

line L. This signaling current will be transmitted from line L, over conductors 1, 2 and through transformer 3, over conductors 15, 16 to the vacuum bulb A. The incoming signaling currents will then be amplified and rectified by the vacuum bulb A and will operate the direct current relay 4. As has been formerly pointed out the connection of the operator's cord circuit plug with jack J served to operate relay 7. Accordingly when the relay 4 operates in response to the incoming signaling currents the circuit through the sleeve of the operator's cord will now be completed as follows: from ground and battery 53, winding of a relay 51 in the sleeve conductor of cord 50, sleeve contact of plug of cord, sleeve contact of jack J, conductor 21, low resistance winding of relay 7, right hand make contact and armature of relay 7, conductor 17, contact and armature of relay 4, to ground. As this circuit includes only the low resistance winding of relay 7, the current flow over the circuit will be sufficiently increased to operate the marginal relay 51 in the sleeve conductor of the cord. This relay 51 may control the operation of any suitable signaling means such as lamp 52, or may even control means for switching or for other purposes in the cord circuit.

It is understood that while reference has been made to low frequency currents for signaling purposes, that these curents may be employed for many purposes other than for merely controlling signaling devices. Furthermore while the arrangements of the invention have been illustrated in connection with toll lines arranged for either ring-down signaling or automatic signaling, it is understood that the arrangements of the invention are capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A transmission line upon which is superimposed a low frequency carrier current and a high frequency carrier current, a terminal station for said line, a filter in said line at said terminal station adapted to readily allow the transmission of said high frequency current and to attenuate and practically extinguish said low frequency current, a circuit tuned to be resonant to said low frequency current bridged across said transmission line on the incoming side of said filter, a network adapted to balance a section of said transmission line included in said tuned circuit, a second circuit, a three winding transformer inductively relating said second circuit to said last mentioned tuned circuit, a signaling means controlled by said last mentioned circuit, and means associated with said transmission line at said terminal station whereby low frequency current may be applied to the mid-points of the primary windings of said three winding transformer.

2. A transmission line upon which is superimposed a low frequency carrier current and a high frequency carrier current, a terminal station for said line, a filter in said line at said terminal station adapted to readily allow the transmission of said high frequency current and to attenuate and practically extinguish said low frequency current, a circuit tuned to be resonant to said low frequency current bridged across said transmission line on the incoming side of said filter, a low frequency receiving circuit associated with said tuned circuit, signaling means controlled by said low frequency circuit, a low frequency transmitting circuit associated with said tuned circuit, means for applying low frequency current to said low frequency transmitting circuit and thence over said tuned circuit and out over said transmission line, means for preventing said last mentioned currents from being transmitted over said low frequency receiving circuit, and means for preventing harmonics of said last mentioned currents from being transmitted to said terminal station over said transmission line.

3. A transmission line upon which is superposed carrier currents for telephonic purposes and carrier currents of infra-telephonic frequency, a terminal station for said line, said line terminating in a jack at said terminal station, a selective circuit for said telephonic currents associated with said line at said terminal station, a selective circuit for receiving said currents of infra-telephonic frequency associated with said line at said terminal station, means in said last mentioned selective circuit responsive to said currents of infra-telephonic frequency coming in over said line, a link circuit adapted to be associated with the jack of said line, at said terminal station, a sleeve circuit associated with said link circuit and said transmission line, switching means in said link circuit controlling said sleeve circuit, and means controlled by said sleeve circuit whereby currents of infra-telephonic frequency may be transmitted out over said transmission line.

4. A transmission line upon which is superposed carrier currents for telephonic purposes and carrier currents of infra-telephonic frequency, a terminal station for said line, said line terminating in a jack at said terminal station, a selective circuit for said telephonic currents associated with said line at said terminal station, a selective circuit for receiving said currents of infra-telephonic frequency associated with said line at said terminal station, responsive means in said last mentioned selective circuit responsive to said currents of infra-tele-

phonic frequency coming in over said line, a link circuit adapted to be associated with the jack of said line at said terminal station, a sleeve circuit associated with said link circuit and said line, said sleeve circuit being closed upon the connection of said link circuit with said jack, means controlled by the closing of said sleeve circuit for transmitting currents of infra-telephonic frequency out over said transmission link, supervisory signaling means in said link circuit and associated with said sleeve circuit, and means controlled by said responsive means in said second mentioned selective circuit whereby the resistance of said sleeve circuit may be varied so as to operate said supervisory signaling means.

In testimony whereof, we have signed our names to this specification this 25th day of September 1919.

LLOYD ESPENSCHIED.
JOHN F. TOOMEY.