

June 15, 1937.

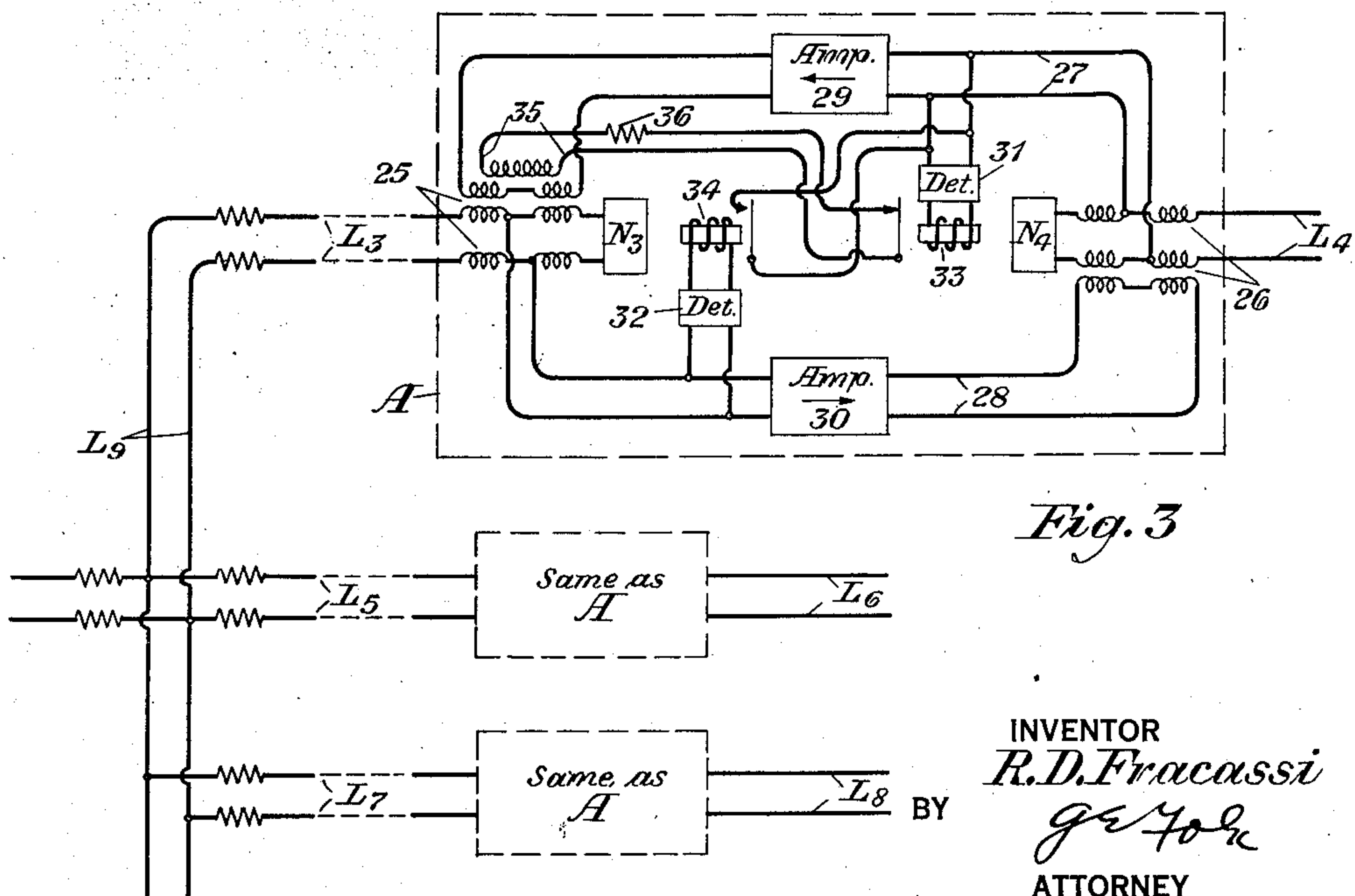
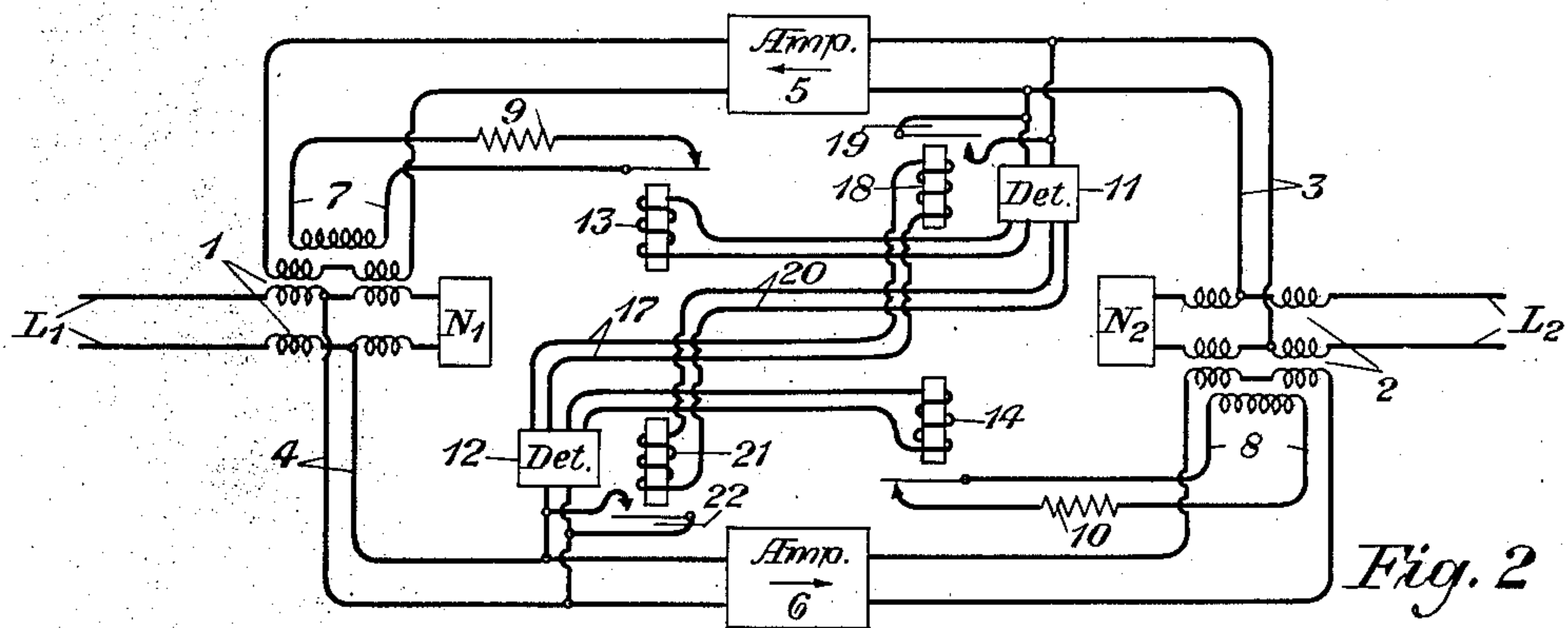
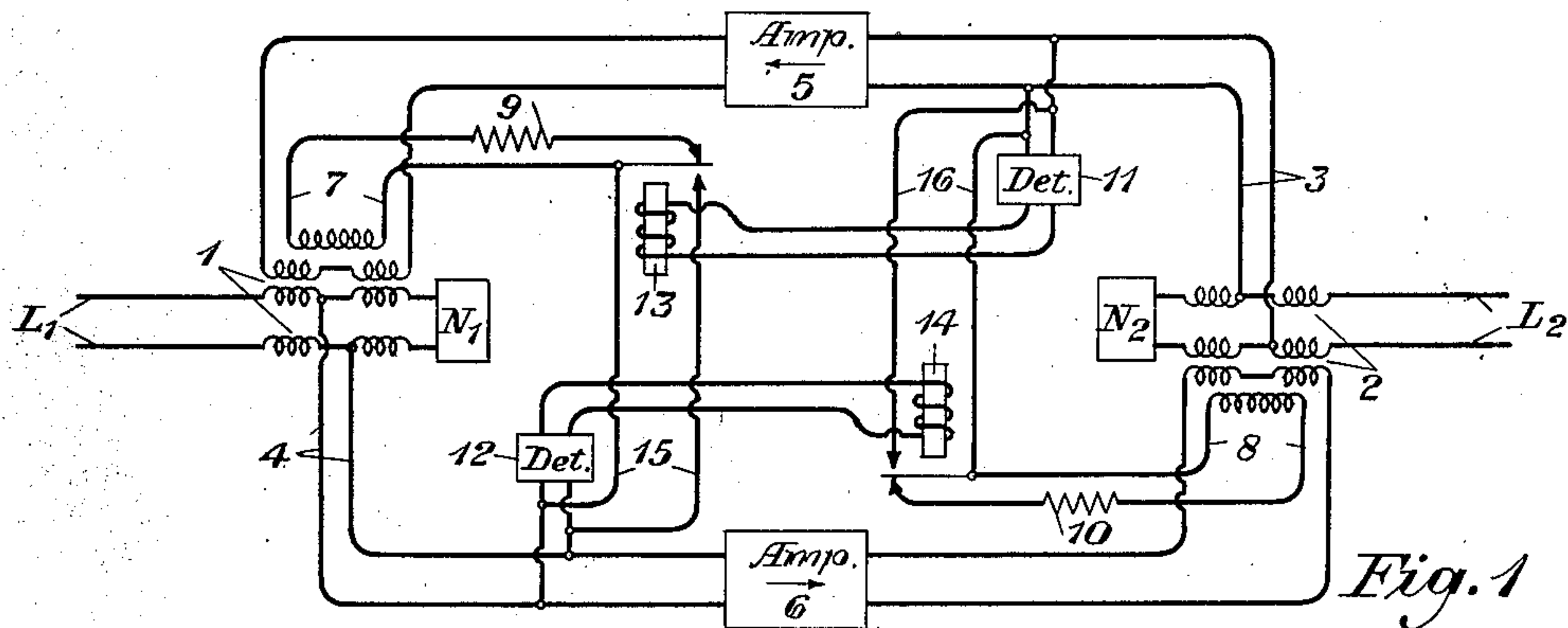
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2,083,645

TRANSMISSION SYSTEM

Filed Oct. 12, 1934

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

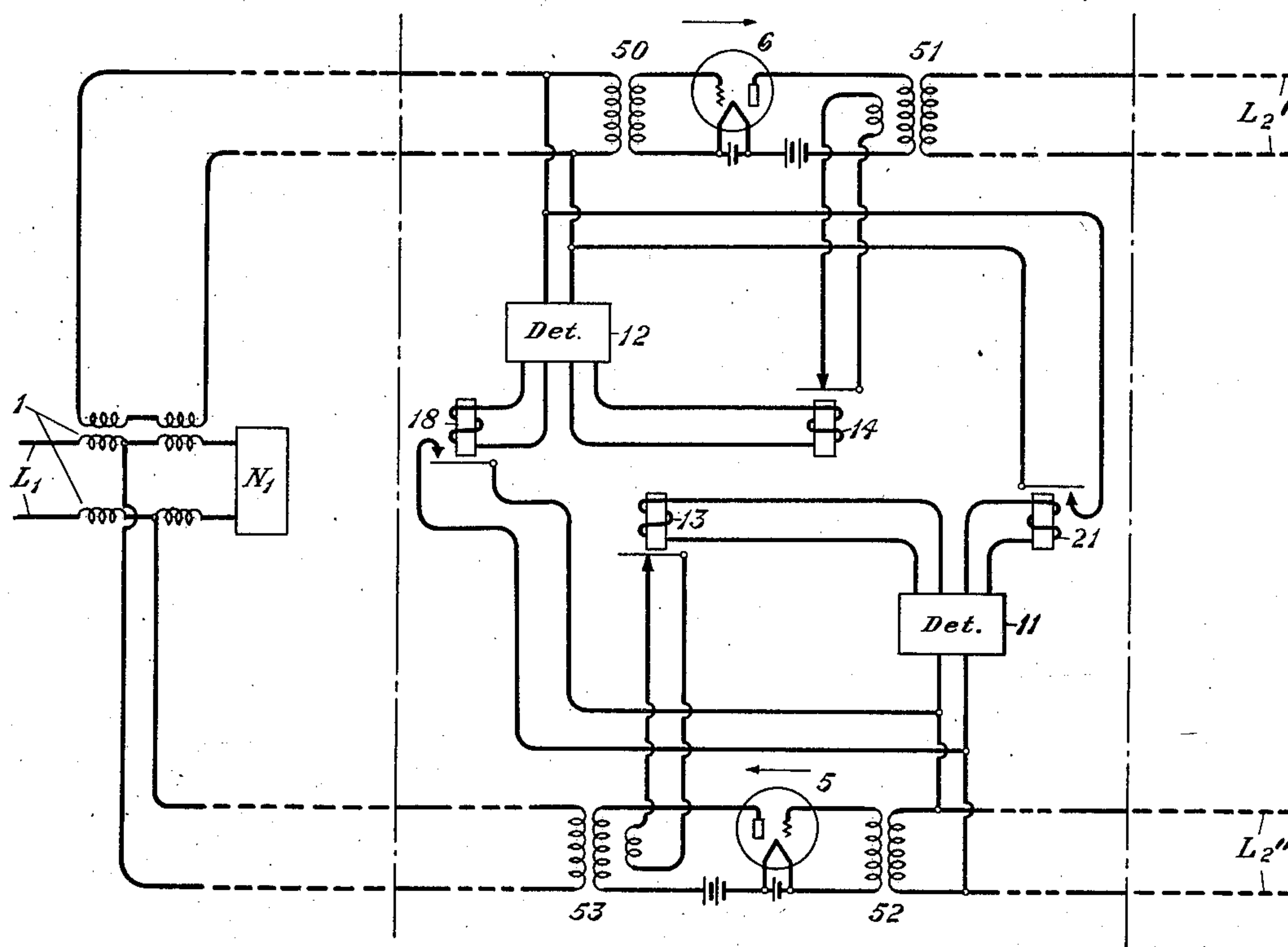


Fig. 4

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TRANSMISSION SYSTEM

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3 Claims. (Cl. 179—170)

This invention relates to transmission lines, and more particularly to transmission lines having repeaters included therein.

In transmission lines having included therein repeaters of the type, for example, comprising two one-way line sections with vacuum tube amplifiers therein for transmission in opposite directions and having these line sections interconnected through hybrid coils, there may be a tendency for the repeater to sing. This might be due to a circulation of energy taking place from one line section through one hybrid coil to the other line section and then through the other hybrid coil back to the first line section. Under certain conditions this circulation of energy will cause singing which will interfere with transmission as is well known in the art.

The arrangements of the present invention are such that when no speech currents are present on the line a loss is introduced in the transmission path of the repeater. This will tend to prevent singing. When speech currents are present on the line, the arrangements of the invention remove the loss in the direction of transmission and also suppress transmission in the opposite direction so as to prevent the occurrence of singing and to prevent echo currents from returning to the talker. Thus the arrangements of the invention will improve the singing margin when no speech currents are present. When speech currents are present the arrangement will permit the introduction of additional gain in the direction of transmission and at the same time its echo suppressor action will prevent singing from occurring and echo currents from returning to the talker. Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1, 2, 3, and 4 of which the invention is illustrated. Fig. 1 is a circuit diagram showing a preferred embodiment of the invention as applied at a repeater station. Fig. 2 is a modification of Fig. 1. Fig. 3 is a circuit diagram showing the arrangements of the invention as applied to a multi-way connection, and Fig. 4 is a circuit diagram showing a further modification of the invention. The arrangements shown by Figs. 1, 2, and 4 may also be used with multi-way connections. Similar reference characters have been used to denote like parts in all of the figures.

In Fig. 1, the invention is shown as applied to a repeater interconnecting the line sections L_1

and L_2 . The repeater comprises the usual hybrid coils 1 and 2 and balancing networks N_1 and N_2 . Two circuits 3 and 4 are provided, each having amplifying devices such as 5 and 6. Associated with the hybrid coil 1 is a circuit 7 having included therein an impedance 9. This serves to introduce a loss in the transmission of currents through the hybrid coil 1. Similarly, a circuit 8 is associated with the hybrid coil 2 and includes an impedance 10. This serves to introduce a loss in the transmission of currents through the hybrid coil 2. When speech currents are not transmitted over either of the line sections L_1 or L_2 , these losses are inserted in the system and act to prevent singing due to a circulation of energy through the repeater.

Associated with the circuit 3 is a detector device 11 and associated with the circuit 4 is a detector device 12. When speech currents are transmitted over one of the line sections as, for example, from the line L_2 , these speech currents will actuate the detector device 11 and cause the relay 13 to be operated. This will open the circuit 7 and remove the loss introduced thereby from the system. The operation of the relay 13 will also close a circuit 15 which will short-circuit the circuit 4 in the manner of the well known echo suppressor. In like manner, when speech currents come in over the line L_1 , the detector device 12 will be operated and, in turn, will operate the relay 14. The operation of the relay 14 will open the circuit 8 and remove the loss introduced thereby from the system. The operation of relay 14 will close the circuit 16 and short-circuit the circuit 3 in the manner of the well known echo suppressor. With this arrangement, it will be seen that when no speech currents are being transmitted, a loss will be introduced in the system and will tend to prevent singing from currents other than speech currents. However, when speech currents are transmitted over the system, the loss is removed, or, in other words, additional gain is introduced in the repeater circuit without impairing the singing margin, since singing cannot occur with one circuit disabled by the short circuit.

Fig. 2 is a modification of the arrangements of Fig. 1. The arrangements of Fig. 2 are substantially similar to those of Fig. 1 except that two additional relays such as 18 and 21 are provided. In Fig. 2, when speech currents come in over the line L_2 , the detector device 11 is actuated and operates relay 13. This will open the circuit 7 and remove the loss introduced thereby from the system. The operation of the detector

11 will also, through the agency of circuit 20, actuate the relay 21 which, in turn, will close a short circuit 22 over the circuit 4 in the manner of the well known echo suppressor. In like manner, speech currents coming in over the line L₁ will actuate the detector device 12 which will operate the relay 14 which, in turn, will open the circuit 8 and remove the loss introduced thereby from the system. The operation of detector 12 will, through circuit 17, operate the relay 18 and close a short circuit 19 across circuit 3 in the manner of the well known echo suppressor. It will be seen that in this arrangement as in the previous arrangement, a loss is introduced in the system when speech currents are not on the line and this loss is removed when the speech currents are transmitted thereover. At the same time the line in the direction opposite to that of speech transmission is disabled.

Fig. 3 shows an arrangement of the invention which may be used when multi-wave connections are established as, for example, between the line L₄ and other lines, such as L₆ and L₈. The line L₄ is connected to the line L₃ through repeater apparatus A shown within the dotted lines. This repeater apparatus comprises the usual hybrid coils 25 and 26 and the balancing networks N₃ and N₄. It comprises two circuits 27 and 28 which have included therein amplifier devices such as 29 and 30. Associated with the hybrid coil 25 will be a circuit 35 having included therein an impedance 36. This will serve to introduce a loss in transmission of currents through the hybrid coil 25. This loss will tend to prevent singing which would be caused by currents other than voice currents. When the voice currents come in from line L₄, the detector device 31 will cause the relay 33 to be operated. This will open the circuit 35 and remove the loss introduced by the impedance 36. When voice currents come in over the line L₃, the detector device 32 will actuate the relay 34 and cause a short circuit across the circuit 27 in the manner of the well known echo suppressor. The line L₃ would be associated with a common line L₉. Bridged across this line might be other lines such as L₅ and L₇. These lines would be connected to apparatus similar to A, originally referred to and enclosed in the dotted lines. This apparatus would be connected to other lines such as L₆ and L₈.

With such an arrangement loss is introduced in only one direction of each repeater, said loss being removed when speech currents are transmitted in that direction. When speech currents are transmitted in the other direction echo suppressor action takes place which disables the side of the repeater transmitting in the direction opposite to that of speech transmission. This arrangement is particularly adapted for use on circuit arrangements where two or more such devices can be used at specified points, such as the separate points along a transmission line or in a multi-way connection as shown in Fig. 3. When properly used one of the arrangements removes loss in the direction of transmission while the remaining devices act to suppress echoes. The action of each arrangement is reversed when the direction of transmission through it is reversed.

Referring to Fig. 3 when transmission is from L₄ to L₃ and thence to L₅, L₆, L₇, L₈, etc., the loss is removed from the path through the hybrid coil 25 but remains in all other paths associated with L₆, L₈, etc. Echo suppressor action takes

place in the apparatus designated A associated with L₆, L₈, etc.

In multi-repeatered two-wire circuits or in multi-way interconnecting circuits, such as represented by Fig. 3, a plurality of singing paths exists as enumerated below.

First, there are so-called "local" paths, that is, involving only one repeater. Referring to Fig. 3 such a path begins at L₄, thence through the amplifier element 29, thence to the hybrid coil 25, thence to the amplifier element 30 by means of the transmission path brought about by the unbalance between L₃ and its associated network N₃ and finally back to L₄ through hybrid coil 26. In the passive state (no speech currents) the loss introduced by the impedance 36 decreases the tendency to sing around this local path.

In addition to the above there are so-called combined paths, that is, paths involving a plurality of repeaters. For illustration one such path involving two repeaters begins at L₄, thence through the amplifier 29 to the hybrid coil 25, thence to L₃, thence through L₉ to L₅, thence through the amplifier to the hybrid coil associated with L₆, thence through the unbalance between L₆ and its associated network N₆, thence through the amplifier transmitting back toward L₅, thence to the hybrid coil associated with L₅, then to L₅, thence to L₉, thence to L₃, thence to the hybrid coil 25, thence to amplifier 30, thence through the hybrid coil 26 to L₄.

In the passive state (no speech currents) each path involves a number of losses introduced corresponding to that introduced by the impedance 36, the number of such losses corresponding to the number of repeaters involved in the path.

In a multi-way connection as illustrated by Fig. 3 in the active state (speech currents existing) only one of the above losses is removed, said removed loss being that associated with the repeater connected to the talker's line. The removal of this loss impairs the singing margin around the local path as such but singing is assumed to be prevented by the balance between L₃ and N₃ and also between L₄ and N₄. All other paths are short-circuited by the echo suppressor action taking place in the devices associated with the other repeaters.

In the arrangement shown in Fig. 4 there is illustrated a two-wire line section L₁ and a four-wire line section composed of sections L₂' and L₂'. These line sections are interconnected by repeaters 5 and 6. Repeater 6 is connected to the line section L₁ by means of the hybrid coil 1 and transformer 50. The repeater 6 is connected to the line section L₂' by means of the transformer 51. The repeater 5 is connected to line section L₂' by means of transformer 52 and to the line section L₁ by means of transformer 53 and the hybrid coil 1.

When speech currents are transmitted from the line section L₁ over the hybrid coil 1 they act upon the detector 12 and the detected currents operate the relays 14 and 18. The relay 14 will open the circuit of its contact and remove the loss introduced by the coil which is connected in series with that contact. At the same time the operation of relay 18 will place a short-circuit about the primary winding of the transformer 52 for the purpose of echo suppressor action. The removal of the loss by the action of relay 14 will cause an increase in the level of energy transmitted through the repeater 6 and over the line section L₂'.

When speech currents are received from the

line section L_2'' they will reach the detector 11, which will act upon these currents, and the detected currents will operate relays 13 and 21. The relay 13 will open the contact associated therewith and hence remove the loss provided by the coil which is coupled to the primary winding of the transformer 53. The operation of the relay 21 will place a short-circuit across the line connected to the primary winding of the transformer 50 for the purpose of echo suppressor action. The removal of the loss by the operation of relay 13 will cause an increase in the level of energy transmitted through repeater 5 and through the transformer 53 and the hybrid coil 1 to the line section L_1 .

Thus it is evident that the use of the arrangements shown in any of their forms tends to improve greatly the over-all singing margin since it adds attenuation or completely removes the so-called combined singing paths, leaving at the most a single open path wherein sufficient singing margin may be easily maintained.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. In a two-way communication system, the combination of a two-way telephone repeater having two hybrid coil networks adapted to transmit signaling currents in the two directions over different paths, means responsive to signaling currents in one path to remove loss from said path and to insert loss in the other path, one of said losses being inductively coupled to its associated hybrid coil network, said means consist-

ing of an amplifier-detector, an impedance, short-circuiting means and a relay, said relay removing said impedance from across one of the windings of the hybrid coil network in the path transmitting signaling currents and connecting the short-circuiting means across the bridge points of the same hybrid coil network.

2. A transmission line comprising two line sections interconnected by a repeatered transmission system, said repeatered transmission system comprising two one-way circuits having amplifiers therein and two hybrid coils for connecting said one-way circuits to said line sections, a pair of resistances each connected across one of the windings of said hybrid coils and inductively coupled to the respective one-way circuits, and means responsive to the transmission of currents of a certain type over the corresponding one-way circuit for opening the circuit of the corresponding resistance and for shunting the circuit of the other one-way circuit.

3. In a two-way communication system, the combination of a two-way telephone repeater having two hybrid coil networks adapted to transmit signaling currents in two directions over different paths, means responsive to signaling currents in one path to remove loss from said path and to insert loss in the other path, said means consisting of an amplifier-detector, an impedance coupled to each hybrid coil network, short-circuiting means, and a relay, said relay removing one of said impedances from across one of the windings of its corresponding hybrid coil network in the path transmitting signaling currents and connecting the short-circuiting means across the bridge points of the same hybrid coil network.

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