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TRANSMISSION CIRCUITS

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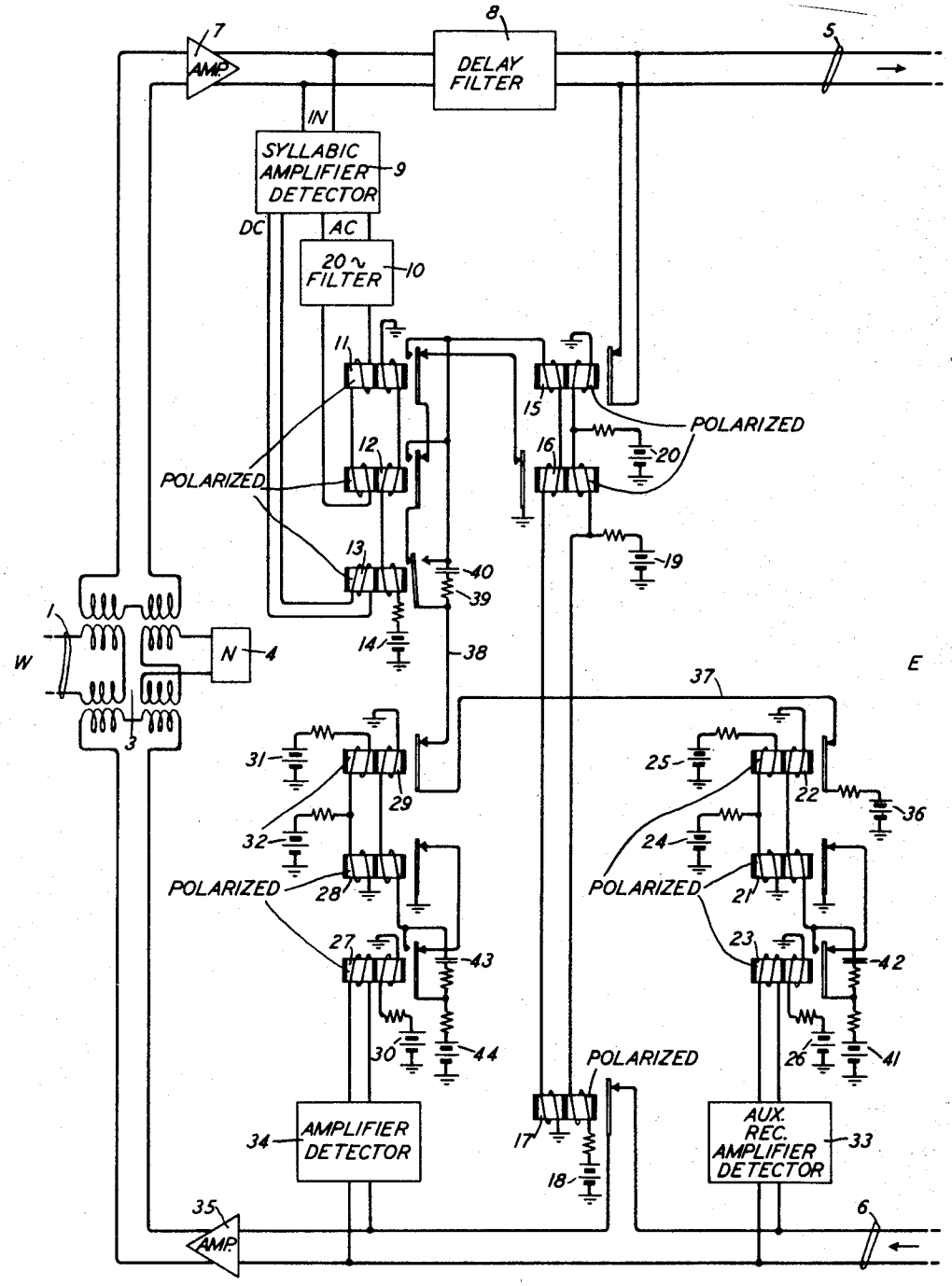

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TRANSMISSION CIRCUITS

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6 Claims. (Cl. 179—170)

This invention relates to the transmission of intelligence by means of electric waves and more especially to such systems involving two-way communication, in which the waves of the same frequency range are present in each one-way path.

In two-way transmission systems involving closely related frequencies, trouble has arisen from what has come to be known as singing, that is, some of the transmitted waves are returned to the receiving circuit and the system as a whole tends to become an oscillator.

Another source of trouble is due to reflection currents known as echoes. This is closely allied to the singing difficulty. To obviate such troubles it has become necessary to disable one line when the other line is in use. Because of the necessity of disabling one transmission line when the second line is transmitting signals, a further difficulty is met due to the comparatively long time involved in transmitting the signals from one subscriber at one end of the system to the other subscriber at the other end of the system. A serious result of the long time of transmission over such a system is the increased chance that the two subscribers at the ends of the system will both start talking within the time interval equal to the total time of transmission over the system. Each subscriber therefore obtains control of the signal control apparatus at his end of the system for transmitting and for blocking out the signals received from the other subscriber. Neither subscriber can then hear the other.

To overcome the difficulties mentioned, considerable apparatus has heretofore been used. The present invention has for an object the improvement of two-way communication systems of the general types indicated.

A specific object of this invention is the suppression of singing and echoes in two-way communication systems.

These and other objects of the invention have been accomplished and at the same time the circuits involved have been greatly simplified by the arrangement to be described in connection with the attached drawing, which represents schematically one form which the invention may take.

Referring now to the drawing, line 1 represents a two-wire line leading generally from a telephone switchboard, a subscriber, etc., which terminates in the usual hybrid coil connection 3 and terminating network 4. A two-wire line 5 is adapted to transmit in the direction of the arrow associated therewith, which direction will be referred to as occasion requires as from west to east. Line 5 will therefore be known as the transmit or west line.

A second two-wire line 6 is adapted to transmit in the direction of the arrow associated therewith. This line will therefore be referred to as the receive or east line.

Lines 5 and 6 may lead to a radio transmitter and receiver, respectively, or to the terminating equipment of a submarine cable, etc.

Line 5 is equipped with an amplifier 7, preferably of the space discharge type and a delay filter 8. Amplifiers and filters of the type used are so well known that it is not deemed necessary to show them in detail.

A syllabic amplifier-detector 9 is connected in shunt to line 5 and is adapted to have impressed upon it a small amount of the electric wave energy present in line 5. The output of this amplifier-detector is impressed upon a filter 10, the output of which is again impressed on transmitting master polar relays 11 and 12. A third transmitting master polar relay 13 is connected in the anode circuit of amplifier-detector 9.

Relays 11 and 12 are connected in series in respectively reverse order in the output of filter 10, which filter may have a cut-off frequency of about 20 cycles per second. With the amplifier-detector and filter arrangement shown, it is found that there is produced in the output of the filter a current in one direction at the beginning of a syllable and a current in the opposite direction at the end of a syllable. During the normal speech therefore the armature of relays 11 and 12 continue to vibrate.

Relay 13 is connected in the output amplifier-detector 9 and its armature is normally attracted. The function of this relay is to operate (release its armature) in case of a long wave train of sufficient amplitude and thus to bridge the interval between the operation of relays 11 and 12.

Amplifier-detector 9 is of the type in which the space current is decreased below the normal value when waves are incident upon its input circuit. When sufficiently strong waves are impressed on amplifier-detector 9 and persist for a sufficiently long time, relay 13 releases due to the decrease in space current. The action of amplifier-detector 9, filter 10 and relays 11, 12 and 13 are described in somewhat more detail in the copending application of H. J. Fisher, Serial No. 578,350, filed December 1, 1931.

Relays 11, 12 and 13 are equipped with biasing windings distinct from their operate windings, which are energized from battery 14 as shown. The current through these bias windings op-

poses the action of the current in the operate windings and hence opposes false operation of these relays.

Relays 15, 16 and 17 are controlled as to operation by the operation of any one of relays 11, 12 and 13, as will appear hereinafter. Relays 15, 16 and 17 also are provided with biasing windings in series. Relay 17 obtains its biasing current from battery 18, relay 16 from batteries 18 and 19 and relay 15 from batteries 18, 19 and 20. If desired, only one battery may be used, and the circuit will in such case contain resistances of different values so that the biasing currents through these relays differ. For the best operation of the circuit, it is desirable that relay 15 have the strongest bias while relays 16 and 17 may have substantially the same bias, although preferably relay 17 should have the least. The reason for these different biasing currents will appear as the description proceeds.

Relays 21, 22 and 23, which are under the control of an auxiliary receiving amplifier-detector 33 are also provided with biasing windings. Relays 21 and 22 have their biasing windings in series and, as indicated, are energized from batteries 24 and 25, so that the current is stronger in relay 21 than in relay 22. Relay 23 is independently biased by current from battery 26.

Relays 27, 28 and 29 are associated with the main receiving amplifier-detector 34. These relays are also provided with biasing windings, that of relay 27 being supplied independently from battery 30, while biasing windings of relays 28 and 29 are supplied by batteries 31 and 32.

The auxiliary receiving amplifier-detector 33 is shunted across the receive line 6, which line is also provided with a normally closed switch consisting of the armature and associated contact of relay 17, termination network 3 and 4 and a series amplifier 35.

The operation of the system is as follows: Signals incoming from line 1 after passing through hybrid coil 3 are amplified by amplifier 7. Some of the amplified energy is applied to syllabic amplifier-detector 9, while the main portion of the energy is retarded by delay filter 8. The short-circuit across the line, consisting of armature and associated contact of relay 15, will keep the main portion of the energy from passing along over line 5 unless it is opened. The signals or speech waves impressed on the syllabic amplifier-detector 9 are not a long continuous wave train, but occur as short trains of waves of syllabic duration. The syllables or vocal intervals occur at the rate of 2 to 20 cycles per second. It is found, as pointed out above, when speech waves are rectified, as by amplifier-detector 9, and are passed on through the output transformer of the amplifier and low-pass filter such as 10, that they produce in the output of the filter a current impulse of one sign at the beginning of a syllable and another current impulse of opposite polarity at the end of a syllable.

Relay 11 is arranged to attract its armature upon the initial impulse of a syllable while relay 12 attracts its armature on the final impulse of a syllable. A succession of short syllables therefore has the effect of keeping the armatures of relays 11 and 12 in a state of vibration.

In the case of a long sustained speech sound or of a tone which may be applied to the system for testing or other purposes, relays 11 and 12 would not be caused to vibrate continuously. Relay 11 would operate upon the beginning of such a long wave train, but would then release its armature and relay 12 would not operate until the end of such a wave train. The function of relay 13 is to operate in case of a long wave train of sufficient amplitude and thus to bridge over the interval between the operation of relays 11 and 12. The bias winding of relay 13 causes this relay to be sluggish in its action and also to require a predetermined current to cause its operation so that it will not be operated by the relatively weak continuous noise currents which may be present on the system.

As stated, amplifier-detector 9 is of the type in which the space current is decreased below normal value when waves are incident upon its input circuit. Relay 13 is shown with its armature normally attracted. When sufficiently strong waves are impressed on amplifier-detector 9 and persist for a sufficiently long time relay 13 releases due to the decrease in space current.

When relay 11 operates to shift its armature from the normal position shown in the drawing to the opposite contact, the train of relays 15, 16 and 17 are energized. This takes place in the following manner: As soon as the armature of relay 11 leaves its normal contact, a rush of current is allowed to flow from battery 36, contact and armature of relay 22, conductor 37, contact and armature of relay 29, conductor 38, resistance 39, condenser 40 and the operate windings of relays 15, 16 and 17 in series. This charging current of the condenser 40 causes these relays to operate quickly. When the armature of relay 11 reaches its opposite or front contact, relays 15, 16 and 17 are maintained operated by the direct current from battery 36 through the armatures and contacts of relays 11, 12 and 13.

When at the end of a syllable relay 12 attracts its armature, the same operation occurs as was just described for relay 11. By the operation of relays 11 and 12 as described relays 15, 16 and 17 are maintained operated as long as speech currents come in over line 1. The condenser 40 in the manner that has been described causes quicker operation of relays 15, 16 and 17 and hence requires less delay of the signal currents in delay filter 8. The function of relay 13 has been described and its operation and its effect upon relays 15, 16 and 17 is identical with that of relays 11 and 12.

The release of all three relays 11, 12 and 13 breaks the discharge circuit for condenser 40 (prior to the release of relay 16) and the condenser is allowed to charge in series with the windings of relays 15, 16 and 17, armatures and rest contacts of relays 22 and 29 and battery 36 preventing their release immediately.

As the charging current of condenser 40 decreases, the biasing currents begin to overcome the operate or condenser current and, in accordance with the strength of the bias currents, relay 15 releases first and then relay 16, after which relay 17 releases. When relay 16 releases, it closes at its back contact a connection to ground from condenser 40, causing the condenser to discharge through the windings of relays 15, 16 and 17 in the opposite direction to the operate current, but since these relays are of polarized type, they are not operated by this current and the circuit is returned to normal condition.

As a result of the chain of operations described, as soon as signals or speech waves come in over line 1, relay 15 operates to clear line 5 and allow speech to proceed, while relay 17 opens line 6 at

its armature and associated contact. These conditions are maintained as long as speech continues in line 5. At the cessation of speech, these relays are released in the sequence noted after a suitable hangover time, which is controlled by the strength of their respective biasing currents and this hangover time is made long enough to allow for all the speech to pass on through line 5 and to prevent echoes or other disturbances in line 6.

In the description which follows and which is directed to the feature of reducing the chance of lock-out as between subscribers starting to talk within the time interval of the transmission time of the system, it should be borne in mind that at the east terminal of the radio or cable link there is an equipment similar to that which has been described for the west terminal.

At the west terminal there is bridged across the line 6 an auxiliary receiver-amplifier-detector 33 ahead of the disabling switch which is controlled by the armature and associated contact of relay 17. The output of this auxiliary amplifier-detector includes the winding of auxiliary master relay 23, which relay has a biasing winding, the current for which is supplied by battery 26.

When on receipt of speech energy in line 6 the armature of relay 23 leaves its back contact, there is a rush of current from battery 41 to charge condenser 42. This current passes through the operate windings of relays 21 and 22, causing these relays to operate quickly.

When the armature of relay 23 makes contact with the front contact, direct current from battery 41 passes through the same winding of relays 21 and 22 and maintains them operated. Upon operation, the armature of relay 22 breaks contact with its back contact, thereby opening the circuit from battery 36, so that no current can flow therethrough to energize relays 15, 16 and 17. Hence, the short circuit cannot be removed from line 5 by relay 15, nor can line 6 be opened by the operation of relay 17.

Speech waves and signals may then pass along line 6 through amplifier 35, hybrid coils 3, etc. to line 1 and the other subscriber. Energy passing along line 6 is impressed on amplifier-detector 34, the output of which includes the operate winding of master relay 27.

Relay 27 upon operating causes the operation of relays 28 and 29 in the same manner as relay 23 causes the operation of relays 21 and 22. That is, when the armature of relay 27 leaves its back contact, a rush of charging current for condenser 43 from battery 44 causes the quick operation of relays 28 and 29. When the armature of relay 27 makes contact with its front contact, there is a direct current flow from battery 44 through the operate windings of relays 28, 29 to maintain them operated as long as relay 27 is operated. The armature of relay 29 upon operating also opens the energizing circuit of relays 15, 16 and 17.

It is therefore obvious that if signal waves from the east terminal reach the point in line 6 across which amplifier-detector 33 is bridged before speech waves from the west subscriber reach the point in line 5 across which amplifier-detector 9 is bridged, the waves of the east subscriber control.

Also, if the signal waves pass along line 5, but have not reached the point at the east terminal where the duplicate of amplifier-detector 33 is bridged across the line by the time waves from the east reach amplifier-detector 33, these latter waves will control since by the operation of relay 23 and the subsequent operation of relay 22, the holding circuits of relays 15, 16 and 17 will be opened. These relays will release short-circuiting line 5 at relay 15 and closing line 6 at relay 17.

The chance of lock-out of both subscribers is materially reduced since in order for lock-out to occur the second subscriber must start talking after the first subscriber has started within the time interval of the transmission time between terminals.

Upon the cessation of signal waves in line 6 and the consequent deenergization of relay 23, relays 22 and 21 drop off in sequence dependent upon their biasing currents. The same operation occurs in connection with relays 27, 28 and 29. Relays 29 and 22 are adjusted to have sufficient hangover time for all speech to clear.

It is to be understood that auxiliary receiver amplifier detector 33 is less sensitive than the main amplifier detector 34. If this were not so noise currents incoming over line 6 might cause the operation of relay 23 and the subsequent disabling of transmitting line 5, cutting off the outgoing speech. However, with the sensitivity adjustment as stated, noise currents are ineffective to disable line 6, but still the distant talker's speech, at least some of the stronger impulses of it, is able to operate relay 23 and thus obtain control of the circuit. If the initial weak portions are lost this is of no consequence since there is assumed to be outgoing speech on circuit 5 at this time and the talker producing that speech would be unable to catch the initial weak sounds of the distant talker anyway.

Many changes may, of course, be made in the circuits disclosed while still retaining the features of simplicity of circuit arrangement, positive and fast operation and release characteristics provided by the invention as defined in the appended claims. It is further to be understood that in order to simplify the description and drawing individual batteries have been shown for the operating and biasing currents but that in actual operation a single battery may be used.

What is claimed is:

1. In combination, voice-operated relays, switching relays, each of said switching relays being provided with a bias winding and an operate winding, a condenser, a source of current, an armature and a front and a back contact associated with each of said voice-operated relays, a circuit comprising said condenser, said source of current and the armatures and contacts of said voice operated relays whereby when an armature leaves its back contact charging current is caused to flow through said condenser and through the operate windings of said switching relays and when said armature makes contact with its front contact current passes through said operate windings to maintain said switching relays operated.

2. A combination in accordance with claim 1, characterized in this that individual means are provided to regulate the flow of current through said bias windings.

3. A combination in accordance with claim 1, characterized in this that when the armature of said voice-operated relay leaves its front contact to open the circuit through the operate windings of said switching relays, said switching relays become deenergized in a sequence in accordance with the current flow through the individual bias windings.

4. In combination, voice-operated relays,

switching relays controlled thereby, biasing windings on all said relays, a condenser, current means in circuit with said condenser and said relays whereby operation of said voice operated relays causes a sudden flow of operating current in the condenser circuit and through said switching relays, which switching relays release upon the decline of operating current in a sequence dependent upon the current through their biasing windings.

5. In combination, voice-operated relays, switching relays controlled thereby, said switching relays being provided with a bias winding and an operate winding, a source of current, said source of current being connected to said bias windings, individual means associated with said bias windings to control the amount of current flow therethrough, a condenser associated with the operate windings of said switching relays, contact means associated with said voice-operated relays, the opening of which causes charging current to flow through said condenser and through said operate windings of said switching relays in series, causing said relays to operate and other contact means associated with said switching relays which open upon operation of said switching relays which latter contact means upon closure, when the circuit releases, cause said condenser to discharge with the attendant discharge current flowing through the operate windings of said switching relays in the opposite direction to that of said condenser charging current to thereby restore the circuit to its initial condition.

6. In combination, a voice-operated relay, an armature and a front and back contact associated with said voice-operated relay, a condenser, a source of current, a switching relay and circuits associated with said voice-operated relay, said switching relay, said condenser and said source of current so arranged that when said armature of said voice-operated relay leaves its back contact, charging current is caused to flow through said condenser and through the winding of said switching relay and when said armature makes contact with its front contact a circuit is closed from said source of current through the winding of said switching relay.

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