

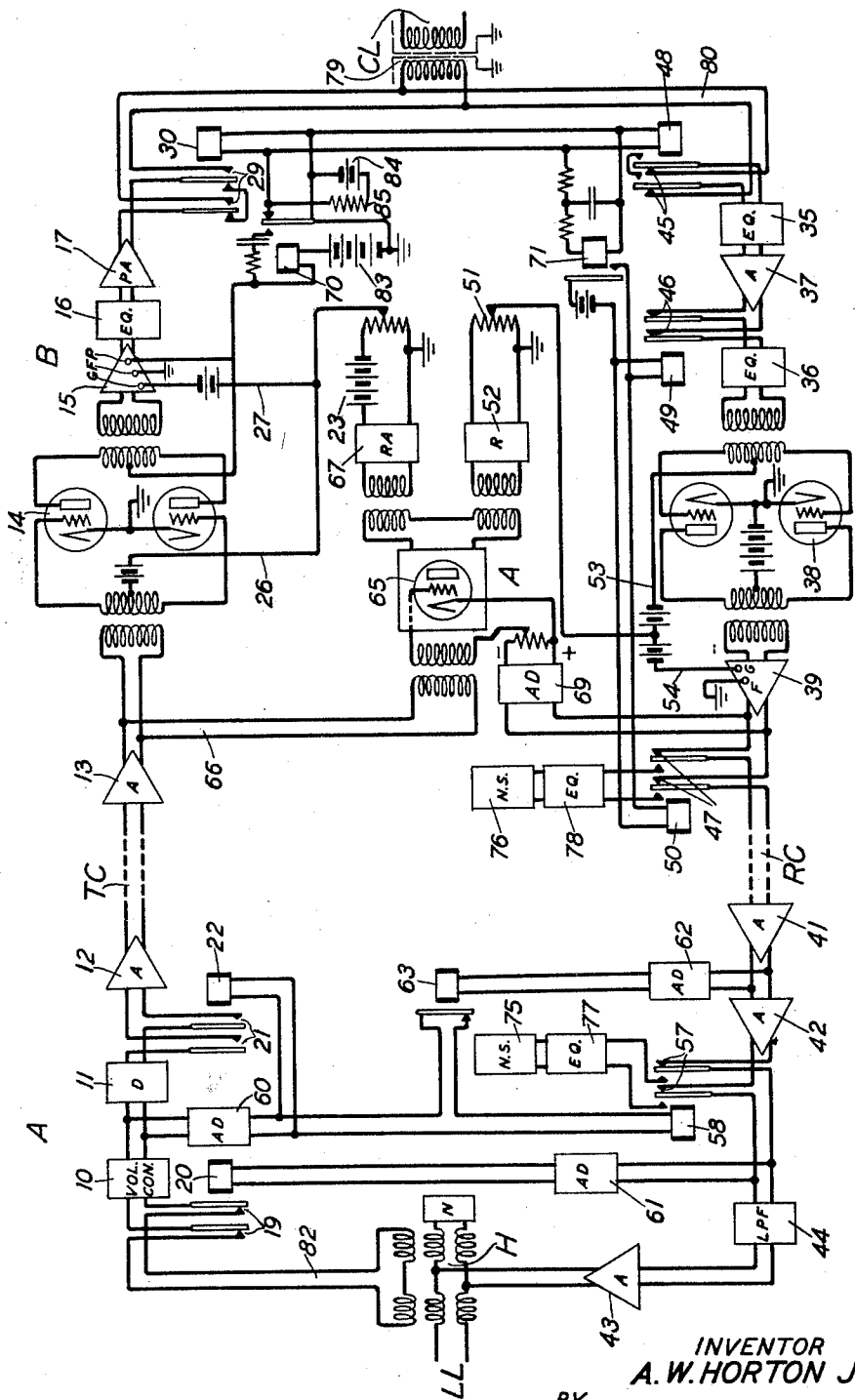
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LONG DISTANCE TELEPHONE SYSTEM

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LONG DISTANCE TELEPHONE SYSTEM

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The present invention relates to telephone systems with directional switching. A particular application of the invention is to a transoceanic telephone cable in which the terminal circuit comprises two branches, one for sending and one for receiving, which are alternately switched into and out of connection with the cable.

An object of the invention is to improve transmission and to reduce disturbances to conversation and the chances of delay and of unnecessary operation of the directional switching apparatus.

An ocean cable telephone system is subject to noise incident upon the cable from external sources and also to noise which is inherent in the system itself. Assuming that by proper shielding and other suitable means the noise from external sources can be substantially eliminated there still remains noise due to thermal agitation in the cable and terminal circuit and other unavoidable noise such as that arising from amplifiers, etc. When a telephone subscriber has his line connected so as to receive from the ocean cable he hears this residual noise continuously. In a properly designed system this residual noise will not be great enough to disturb speech transmission but the subscriber is conscious of the presence of the noise underlying the speech or other signals being transmitted.

When the subscriber starts to talk the directional switching apparatus alters the circuit connection so that the subscriber no longer hears energy coming in from the cable since the transmitting branch is connected so that his speech may be transmitted out into the cable and the receiving branch is disabled or disconnected. During the short silent periods between words or syllables the subscriber no longer hears the residual noise to which he has become accustomed when receiving and this is liable to distract his attention and become a disturbance to regular conversation. After a subscriber has stopped talking and is waiting for a reply there is first a silent interval of a few tenths of a second after which the resistance noise from the cable suddenly comes in. Right at this time his attention is centered on the speech which he is awaiting

so that the resistance noise coming in is liable to be quite disturbing. It has been observed in actual trials that a talker may pause in his conversation and ask if the opposite party is noticing the same impulses of noise. Thus not only is valuable time wasted but the directional switching apparatus at both terminal stations may be called upon to perform an unnecessary amount of work.

This difficulty is avoided in accordance with the present invention by providing an artificial source of residual noise which is maintained on the subscriber's line all the time that the cable receiving circuit is cut off from the subscriber. In this way the subscriber is not conscious of any change in the noise condition during conversation.

For a better understanding of the invention reference is made to the accompanying drawing showing in the single figure a schematic circuit diagram of the terminal connecting circuit for an ocean telephone cable, and to the following detailed description thereof.

The drawing shows a schematic circuit including two distantly separated stations A and B, the former being the connecting station to a land line telephone system indicated by the single line terminal LL, and the latter being the terminal station for a transoceanic cable CL. In practice station A may be at New York and station B at Newfoundland. It will be assumed that the cable CL has another terminal in, say, Irish Free State similar to that in the drawing in station B, connected in similar manner to a land line switching terminal similar to A at, say, London.

Stations A and B are connected by a four-wire circuit comprising transmitting circuit TC and receiving circuit RC for respectively transmitting from A to B and receiving at A from B.

The directional switching and other apparatus at stations A and B is for the most part known in the art, and only such disclosure of it is made as is necessary or helpful to an understanding of the present invention.

The circuit RC is normally set in an opera-

tive condition to receive from the cable. The circuit TC is, however, normally disabled at both stations A and B and before transmission over it is allowed to take place, it is necessary to remove the disabling means and also to disable the path RC so that the transmitting energy is kept out of the receiving branch. Directional switching means controlled by the speech waves are therefore provided at both stations A and B.

The apparatus disclosed in branch TC comprises, at station A, a volume control 10, delay circuit 11, and suitable amplifiers one of which is indicated at 12; and at station B, amplifiers 13, 14, 15 and 17 and sending end equalizer 16. At station A, there is a disabling point, normally ineffective, at contacts 19 of relay 20, and another disabling point, normally effective, at contacts 21 of relay 22. Throughout the drawing where a relay is indicated as having two or more armatures, it will be understood that in practice a plurality of relays may be used each with but one armature, this being especially preferred where high speed of operation is to be had since it is difficult to use two armatures for a high speed relay.

At station B, amplifiers 14 and 15 are normally disabled by the application to them of high negative grid bias from battery 23, supplied over respective leads 26 and 27. Amplifiers 14 and 15 may be identical in construction; hence the circuit of only one is indicated. There is a further disabling point at contacts 29 of relay 30.

Volume control 10 may be of the type shown in Hogg-Doba Patent No. 1,853,974, granted April 12, 1932 or in Patent No. 1,844,423 of R. C. Mathes, granted February 9, 1932 or any other suitable type, its purpose being mainly to keep the input into path TC substantially constant notwithstanding variable volume levels received over line LL due to different talkers, different length of connected land lines or other causes.

Delay device 11 may be electrical, mechanical or acoustical and of any suitable type for delaying speech transmission until contacts 21 have had time to operate.

Equalizer 16 is similar to the sending-end equalizer disclosed in Mathes-Horton Patent No. 1,844,422, granted February 9, 1932 and has a rising loss characteristic for low frequencies in order to enable the higher and weaker components of speech to be brought up to the proper level to traverse the cable and to override noise. It may be placed ahead of amplifier 15 or 14 or divided up into sections located at different points along the circuit.

The receiving branch RC is shown equipped at station B with equalizers 35 and 36, which may be of the type disclosed in the Mathes-Horton application, supra, and amplifiers

41, 42 and 43 and low pass filter 44. Disabling points, normally ineffective, are provided in the contacts 45, 46 and 47 of relays 48, 49 and 50 respectively. Also amplifiers 38 and 39, which may be similar to each other, are arranged to be disabled during transmission over circuit TC by the application to them of large negative grid bias from resistance 51 in the output of rectifier 52, supplied over leads 53 and 54, as will be more fully explained later on.

At station A, there is a further disabling point in branch RC, in contacts 57 of relay 58, these contacts being, however, normally closed to permit reception over branch RC.

At station A, an amplifier-detector 60 causes operation of relays 22 and 58 when speech is impressed on its input circuit. Similarly amplifier-detector 61 controls actuation of relay 20, and amplifier-detector 62 controls actuation of relay 63 for removing relay 58 from control by amplifier-detector 60.

At station B, amplifier 65 is coupled to branch 66 leading from circuit TC, and supplies speech waves to rectifier-amplifier 67 and rectifier 52 for in turn putting the necessary bias potentials on leads 26, 27 or 53, 54 to cause operation or non-operation of the transmitting and receiving amplifiers. An amplifier-detector 69 controls disabling of amplifier 65 by placing a large negative grid bias on it when speech is received over RC.

In the case of each of the amplifier-detectors shown, it is preferable to have their input circuits tuned or provided with band pass filters to discriminate against noise so as to prevent false operation by noise. In the case of amplifier-detector 69 the input filter should eliminate high frequencies since resistance noise at this point in the circuit is mostly of high frequencies due to the wave shaping effected by equalizers 35 and 36. It should also eliminate very low frequencies in order to discriminate against static.

Relays 30, 48, 49 and 50 are operated from contacts of master relay 70, which in turn is operated by the space current of amplifiers 14 and 15. A relay 71 interposed in the circuit controls the operating sequence of relays 48, 49 and 50.

The foregoing disclosure in and of itself forms no part of the present invention but is helpful to an understanding of the invention.

In accordance with the invention there is provided at either or both stations A and B an artificial source of noise adapted to be connected to the circuit RC by the switching relays. At station A, noise source 75 is arranged to be connected to circuit RC by relay 58. At station B noise source 76 is arranged for connection to circuit RC by relay 50. Each noise source may consist of an amplifier with a resistance in its grid

circuit as disclosed in U. S. Patent of H. Nyquist, No. 1,786,546 granted December 30, 1930, for generating noise due to thermal agitation in the resistance. An equalizer 77 or 78 is used to give the noise the same frequency-amplitude characteristics as that received from the cable, and the level is also adjusted in suitable manner so that whenever either of the noise sources is substituted for the cable, the noise appears of the same character to the listener.

The operation of the system will now be described. Assuming the subscriber connected to the telephone system associated with line LL is not talking, speech incoming over the cable CL will find receiving circuit RC in readiness to receive. The speech passes through shielded transformer 79 into circuit 80 leading through normally closed contacts 45 to equalizer 35, amplifier 37, normally closed contacts 46, equalizer 36, amplifiers 38 and 39, normally closed contacts 47 and out over circuit RC to the distant station A.

The speech in the output of amplifier 39 passes in part also into amplifier-detector 69 and causes disabling of the singing prevention control circuit by placing a large negative bias on the grid of amplifier 65. This prevents speech or noise in circuit TC from reaching rectifiers 67, 52 and operating the switching relays and cutting off the receiver circuit.

The speech in circuit RC arriving at station A operates relay 63 removing relay 58 from control of energy that may be present in branch TC. The speech continues along path RC, through closed contacts 57, filter 44, amplifier 43 and is impressed on line LL through terminals of hybrid coil H. By means of amplifier-detector 61 the speech also causes relay 20 to disable circuit TC at points 19.

It will be noted that if the subscriber connected to line LL starts to talk at a time such that his speech has progressed to any point on circuit TC between stations A and B after speech arriving over branch RC has disabled amplifier 65, the speech in circuit RC will obtain control of the circuit even though relay 58 may have been operated and opened contacts 57. This is accomplished by providing anti-lock-out relay 63 which allows relay 58 to be released if it has already been operated, or prevents its operation under control of speech waves in circuit RC.

The subscriber on line LL hears not only the speech from the distant talker but also any noise present in branch RC or on the cable, the principal noise being generally the resistance noise from the cable.

Upon cessation of speech in branch RC the circuits restore to the condition shown in the drawing.

When the subscriber starts to talk, his speech incoming on line LL and reaching

hybrid coil H, passes into circuit 82. It will be assumed that no speech is present in circuit RC. Contacts 19 are therefore closed and the speech passes through the volume control circuit 10 and into delay device 11. A part of the speech is diverted into amplifier-detector 60 and is rendered capable of actuating relays 22 and 58. Relay 22 closes contacts 21 and enables the speech to pass from delay device 11, through amplifier 12 and out over circuit TC to station B.

Up to the time relay 58 operates the subscriber hears resistance noise traversing the circuit RC, from the cable. Relay 58 in operating as described, opens circuit RC and cuts off this noise so that the subscriber no longer hears it. At the same time, however, the armatures of relay 58 upon their attraction close the circuit leading from noise source 75 and equalizer 77 to the input to filter 44 so that the subscriber now hears noise from this source and is not conscious of any change in the noise condition on the circuit.

The speech in circuit TC upon reaching station B finds amplifiers 14 and 15 inoperative. A portion of the speech is diverted into circuit 66, is amplified at 65 and rectified and reversed in phase by rectifier-amplifier 67 so that a positive voltage is supplied over leads 26 and 27 to the grids of amplifiers 14 and 15, opposing the blocking voltage sufficiently to enable these amplifiers to function and transmit the speech.

When the negative bias on amplifiers 14 and 15 is thus reduced, space current starts to flow in the amplifier tubes, from battery 83, through master relay 70, plates of amplifiers 14 and 15 in parallel and to ground. Relay 70 attracts its armature opening the normal shunt around relays 30, 48 and 71 and these relays now operate from battery 84 through resistance 85. Relay 48 first opens the receiving branch 80 at contacts 45, thus cutting the receiving branch off from the cable. At this time amplifiers 38 and 39 have already been rendered inoperative by the application to their grids of a blocking potential from rectifier 52 over resistance 51 and leads 53 and 54, this potential being derived from the speech waves in circuit TC and having been applied simultaneously with the application of the unblocking potential to amplifiers 14 and 15 from rectifier-amplifier 67.

After the disabling of the receiving branch in these two ways, relay 30 closes contacts 29 and connects the transmitting branch through from power amplifier 17 to the transformer 79 so that the speech now passes into the cable.

Relay 71 is energized over the same circuit as relays 30 and 48 but this relay has associated with it series resistance and shunt capacity, as shown, for rendering it slow to

release, and these same elements delay its operate time. When it operates, relays 49 and 50 operate and open the receiving circuit at 46 and 47. Relay 50 in operating also connects noise source 76 through equalizer 78 to circuit RC but this has no effect at this time, since relay 58 at station A has already operated and cut off the receiving branch RC.

When the speech waves on line LL cease, the circuits of stations A and B restore to the condition shown in the drawing.

Considering first the circuits of station A, when speech waves cease in the amplifier-detector 60 relay 22 releases after sufficient hang-over to allow the speech stored up in the delay device 11 to have passed through its contacts. Relay 58 also releases its armatures and closes the contacts 57. This relay in releasing disconnects the noise source 75 from the receiving circuit RC, but at this instant there is a noise potential on the contact 57 due to the fact that noise source 76 of station B has been connected to the circuit RC as described during substantially the entire talking period. When relay 58 transfers its armatures from their front to their back contacts therefore, the subscriber notices no change in the noise condition since he now hears noise from source 76 instead of from source 75 as previously.

At station B when the speech in circuit 66 ceases the rectified current in rectifier-amplifier 67 and that in rectifier 52 drops to zero. There is then applied a large negative grid bias potential to the grids of amplifiers 14 and 15 rendering these two amplifiers inoperative to transmit. Also when their space current reduces to zero as the result of application of this large negative bias potential, relay 70 releases its armature. This relay does not immediately release, however, since it is provided with a resistance and capacity as shown for giving the relay a hang-over time. When the armature is attracted the condenser is charged from battery 83 through the resistance and when at the cessation of speech the current from battery 83 no longer flows through the space paths of amplifiers 14 and 15 the condenser discharges through the winding of relay 70 at a rate determined by the constants of the circuit including the resistance and thus the relay holds its armature attracted for a sufficient time to permit all of the speech current to pass on out into the cable.

When relay 70 releases, its armature closes at its back contact a shunt across the windings of relays 30, 48 and 71 causing these relays to release their armatures. Relay 30 in releasing opens the transmitting circuit from the power amplifier 17 to the cable. Relay 48 in releasing its armatures reconnects the receiving circuit RC to the cable by closure of contacts 45. In the meantime it should be noted that the cessation of current

in rectifier 52 as described, has removed the large negative bias potential from the grids of amplifiers 38 and 39 so that these amplifiers are now restored to operative condition.

Relay 71, as already described, is provided with resistance in series with its windings and capacity in shunt of its windings as shown, to give the relay a slow operate characteristic. It therefore holds its armature attracted for a short interval after relays 30 and 48 have released their armatures. One purpose of this is to permit relaxation current from the cable to have been dissipated in equalizer 35 during the interval that contacts 45 are closed before relays 49 and 50 release their armatures. Since the circuit RC is open at contacts 46 and 47 this relaxation current has time to die away to such an extent that the subscriber is prevented from hearing the click produced by the discharge of this current from the cable. When relay 71 releases after a sufficient interval, relays 49 and 50 release their armatures thus closing the circuit RC through so that the subscriber is now connected to the cable on the receiving side of the circuit.

When relay 50 releases its armature, the source of noise 76 is cut off from the receiving circuit RC. At the time relay 50 releases, however, the cable circuit has already been connected to conductor 80 and through the now closed contact 45, equalizer 35, amplifier 37, equalizer 36 and amplifiers 38 and 39 which are now in an operative condition so that the resistance noise from the cable is present at the contacts 47 at the instant when relay 50 releases. The subscriber, therefore, is not conscious of any change in the noise condition having taken place on the circuit since he now receives the resistance noise from the cable instead of from the noise source 76 as formerly.

It is not essential to the present invention that artificial noise sources be provided at both stations A and B. In a system in which relays 63 and 58 are not present, it is quite sufficient to provide noise source 76 at station B and to omit noise source 75 at station A. Since noise source 76 is at the same geographical location as the cable terminal itself, one source of noise such as 76 is substituted for the other, the cable itself, without any appreciable transmission time between the two points at which the sources are alternatively applied to the circuit. The subscriber, therefore, is not conscious of any change in the noise condition.

If the anti-lock-out relays 58 and 63 are provided, it may be sufficient in some cases to supply artificial noise source 75 at station A and to omit source 76 at station B. In this case, however, it will be necessary to give relay 58 a sufficient hang-over time to compensate for the transmission time of speech from station A to station B and the trans-

mission time of the resistance noise from the cable back to station A. This will mean that relay 58 must have a hang-over time equal to twice the transmission time of the circuit between stations A and B plus the hang-over time of relay 50, it being assumed that relay 50 is the last of the three relays 48, 49 and 50 to release after the cessation of speech at station B. Since it is somewhat difficult to synchronize the operate and release time of relays at geographically separated points sufficiently accurately to take care of these different times, it is preferable to supply noise sources at both stations A and B where anti-lock-out relays 58 and 63 are provided at station A and the drawing has been disclosed as including both of these sources.

It will be understood that the system may depart widely from the details as specifically shown without departing from the spirit of the invention, the scope of which is defined in the attached claims.

What is claimed is:

1. In a transmission system comprising a two-way transmission path and a terminal circuit therefor including transmitting and receiving branches with directional switching apparatus for alternatively connecting said branches to said path, an artificial source of residual noise, said directional switching apparatus connecting said source to the receiving branch when the receiving branch is disconnected from the transmission path.

2. In a signaling system, a circuit on which the continuous noise is appreciable, a terminal circuit having a signal receiving path adapted to be coupled to and dissociated from said circuit, switching means for coupling and dissociating said circuit with said signal receiving path, and a source of continuous noise currents, said switching means connecting said source to said signal receiving path whenever the switching means dissociates the signal receiving path from said circuit whereby the noise condition on said signal receiving path is maintained substantially constant.

3. In a telephone system, a subscriber's line, a toll system to which said line may be connected, said toll system having a continuous noise of appreciable level as heard on said subscriber's line, voice-operated switching means for at times associating said line with said system to receive speech therefrom, so that noise is also received by the line, a substitute source of continuous noise currents, and means controlled by said switching means for operatively associating said source with said subscriber's line whenever said switching means renders said line incapable of receiving noise energy from the toll system.

4. In a telephone system, a long transmission circuit of high attenuation on which

the continuous noise level is appreciable when heard over a connecting telephone line, a connecting telephone line for receiving speech from said transmission circuit, voice-operated switch mechanism for alternately effectively coupling said line to and dissociating it from said circuit so as to render said line alternately capable and incapable of receiving speech from said circuit during a conversation period, and means for maintaining substantially constant the noise condition on said connecting line comprising a substitute source of noise coupled to said line by said switching means whenever said switching means effectively renders said line incapable of receiving from said circuit.

5. In a telephone system, circuits for building up a toll telephone connection including a subscriber's line, a long toll line and interconnecting circuits, voice-operated switching means at separated points along said connection for disabling portions of the connecting circuit during a conversational period, the continuous noise level on said line being appreciable, and a substitute source of noise currents operatively associated with the system by operation of certain of said voice-operated switching means whenever said means disables a portion of the circuit over which noise from said toll line may reach said subscriber's line, such that the noise condition on said subscriber's line is maintained substantially constant.

6. In a telephone system, a transoceanic cable, a land line having a speech receiving path, voice-operated means for operatively associating said speech receiving path with and dissociating it from said cable, a substitute source of noise currents simulating noise on said cable, and switching means associating said noise source with said land line whenever said switching means dissociates the cable from said speech receiving path.

7. In a telephone system including a deep sea cable, a subscriber's line and a long toll line interconnecting said subscriber's line and said cable, a plurality of repeater points along said toll line, voice-operated switching means at certain of said repeater points for alternately rendering the circuit operative and inoperative as regards transmission from the cable to the subscriber's line, and a source of artificial noise currents simulating noise on the cable, located at a repeater point on the toll line adjacent the point to which the subscriber's line has connection, said voice-operated switching means connecting said source to the circuit leading to said subscriber's line whenever the switching means renders the circuit inoperative to transmit from the cable to the subscriber's line.

In witness whereof, I hereunto subscribe my name this 5th day of December, 1930.

ARTHUR W. HORTON, JR.