

Sept. 21, 1937.

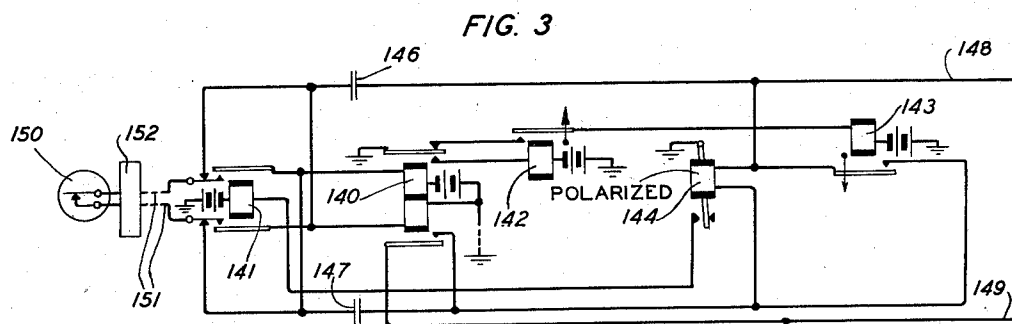
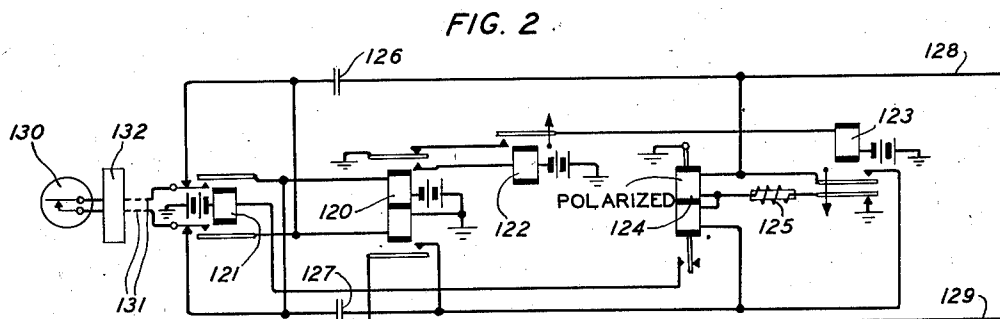
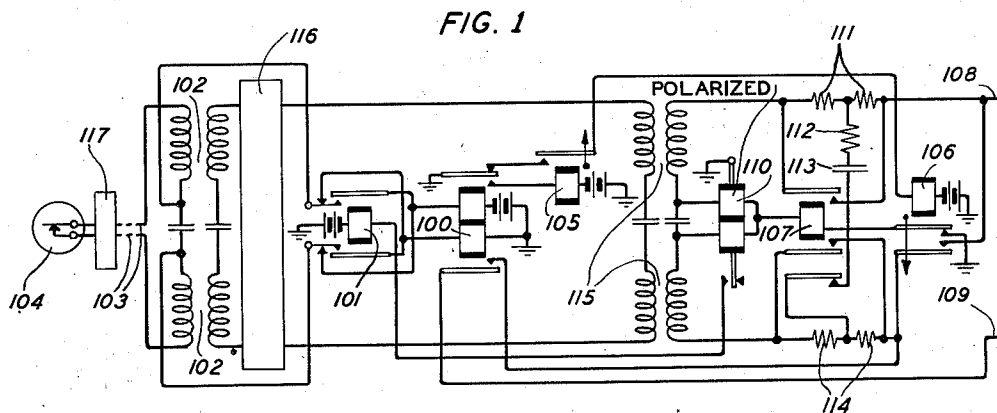
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2,093,667

PAD CONTROL SYSTEM

Filed July 11, 1935

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 4

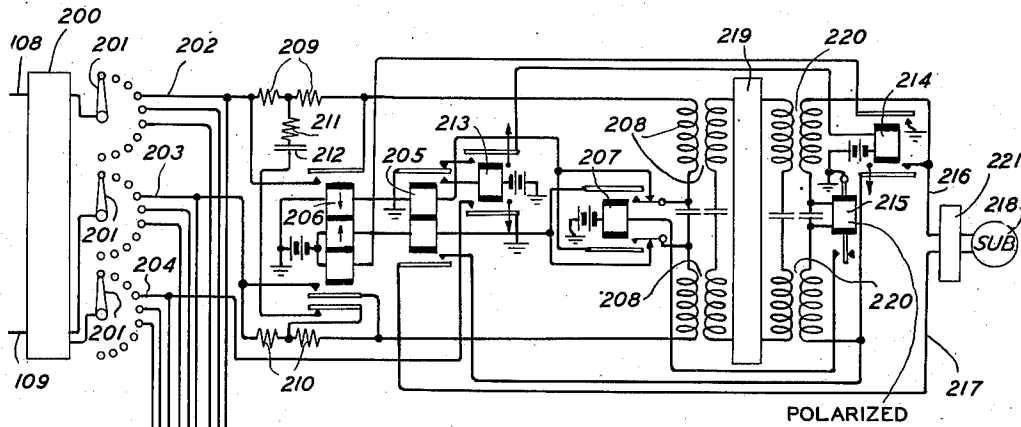


FIG. 5

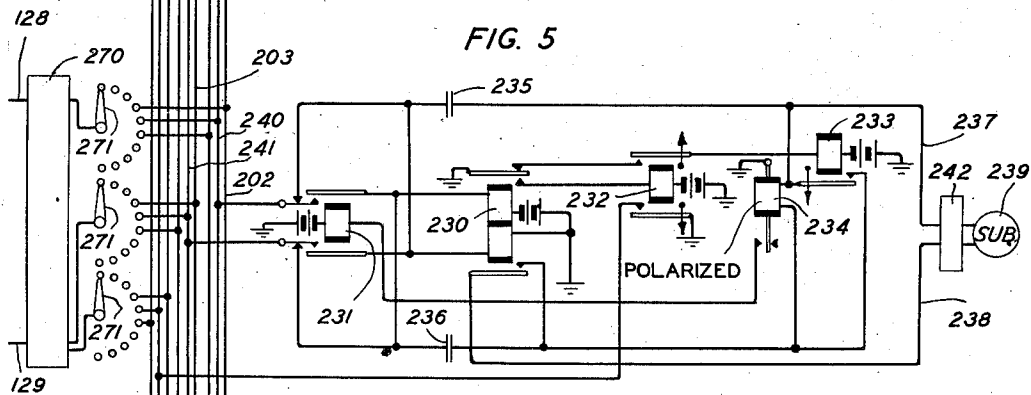
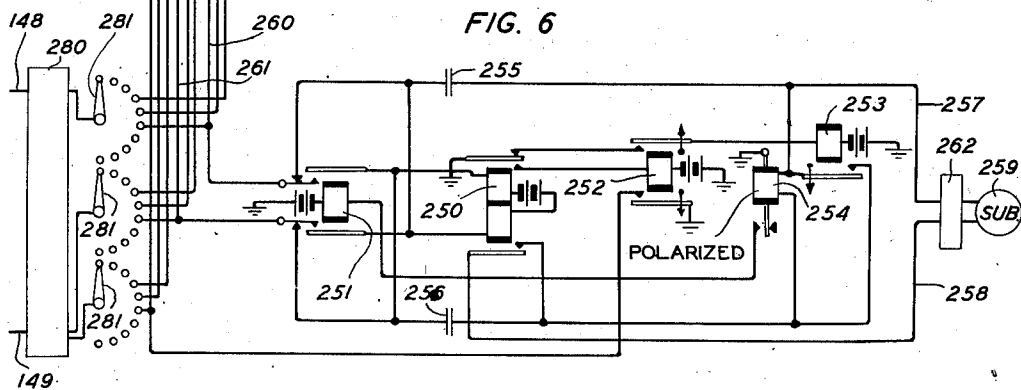


FIG. 6



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## UNITED STATES PATENT OFFICE

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## PAD CONTROL SYSTEM

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Application July 11, 1935, Serial No. 30,827

4 Claims. (Cl. 179—16)

This invention relates to transmission lines and more particularly to means for controlling the transmission efficiency of such lines.

Certain telephone lines, as for example long toll lines or trunk circuits which are adapted to be interconnected in tandem, at a switching point, to establish what is called a built-up circuit, require the inclusion therein of voice repeaters to compensate for the over-all loss when they are so connected together. Usually, conditions require that such circuits be also individually connected at the switching point to short haul or terminal circuits and in such cases certain reasons make it desirable that the transmission level of the repeated line be reduced somewhat and made comparable to nonrepeated lines adapted for connection with terminal circuits exclusively.

Under the foregoing condition, such repeated lines are usually provided, at their terminals, with what are called transmission loss pads, i. e., artificial lines usually comprising resistance and capacity which are normally connected in the lines in such a manner as to introduce a predetermined transmission loss therein. Furthermore, circuit arrangements are provided so that the pads will be removed when two toll lines are connected together but when one repeated line having a normally included pad is connected to a terminal circuit, as for example a switching trunk or subscriber line, the pad will remain connected in the associated line in order to reduce the transmission efficiency of the over-all circuit to the desired level.

Such circuit arrangements usually comprise a relay associated with each pad which, when operated, or released, depending on the specific method employed, effects a short circuit around the pad thereby effectively removing it from the line.

In certain of these circuit arrangements the pad relays are connected in a simplex circuit to ground, i. e., they are connected between ground and the mid-point of a suitable resistance bridged across the line. Further, for certain reasons, circuit arrangements are provided whereby when the operator connects a cord circuit with a line in which a pad is normally in the circuit, battery on the sleeve of the cord will cause certain other relays to operate, under control of the sleeve relay, to short-circuit the pad thereby effectively removing it from the line. When two such lines are connected together by means of a cord circuit, whose talking conductors are continuous from end to end, the pad control relays of each line will be connected by a simplex circuit extending from ground through the pad relay of

one line over the two line conductor in parallel and to the ground through the pad relay of the other line. Due to the fact that no source of energy for operating either of the pad relays is included in the circuit, these relays remain unoperated and the pads remain short-circuited.

In order to reinsert the pad in a repeated line which has been removed by the connection of the cord circuit, which line is connected to a short line or trunk, means must be provided in the short line or trunk to supply a source of current to the simplex circuit to operate the pad control relay which, when operated, will cause the short circuit around the pad to be removed. This is accomplished in the circuit arrangement referred to by connecting a source of potential such as a battery, between ground and the mid-point of a bridge across the short line or trunk. In practice, this battery is connected, in the case of trunk circuits at the mid-point of the trunk repeating coil.

In other cases where the repeated line is connected to other types of trunks which are of such a nature that a higher degree of transmission efficiency is desired and therefore the pad in the repeated line should remain out of the circuit, no simplex battery is provided in the trunk and hence the pad relay in the repeated line will remain unoperated and the pad will remain short-circuited.

In the arrangement described, the presence of grounded battery on both conductors of lines outgoing from the switching point will interfere with loop dialing between the connected lines in cases where connections are established by means of automatic switches.

An object of the present invention, is therefore to control the inclusion or exclusion of transmission pads in interconnected circuits in such a manner that the pads are controlled over the talking conductors of the connected circuits without interfering with the transmission of dial pulses over the same conductors or the proper operation of supervisory signaling by the well-known reverse battery method.

Features of the present invention whereby the foregoing object is attained will appear from the following description read in conjunction with the accompanying drawings in which:

Fig. 1 shows a long haul incoming dial line or trunk, equipped with a terminal voice repeater whereby the transmission efficiency of the circuit is raised to a suitable level, and in which a transmission loss pad is normally included;

Fig. 2 shows a medium haul incoming dial line

or trunk not equipped with either a repeater or pad, which circuit has a relatively high transmission loss;

Fig. 3 shows a short haul incoming dial line or trunk not equipped with a repeater or pad, which circuit has a relatively low transmission loss;

Fig. 4 shows a long haul outgoing dial line or trunk, equipped with a terminal repeater whereby the transmission efficiency of the circuit is raised to a suitable level, and in which a transmission loss pad is normally inserted;

Fig. 5 shows a medium haul outgoing dial line or trunk, not equipped with a repeater or pad, which circuit has a relatively high transmission loss; and,

Fig. 6 shows a short haul outgoing dial line or trunk not equipped with a repeater or pad, which circuit has a relatively low transmission loss.

A simplified arrangement of switching means for interconnecting the lines or trunks shown in Figs. 1, 2 and 3 with any of the lines or trunks shown in Figs. 4, 5 and 6 for the purpose of completing connections over which conversation may take place, is shown schematically at the left of Figs. 4, 5 and 6. This switching means may consist of automatic switches of the well-known step-by-step type or any other type whose selective operations are controlled by dial pulses.

Referring now to the long haul incoming line or trunk shown in Fig. 1, the seizure of this circuit as its originating end causes relay 100 to operate in a circuit traceable from battery and ground through its upper and lower windings respectively, over the lower and upper normally closed contacts of relay 101, left lower and upper windings of repeating coil 102, trunk 103, through selective switching mechanisms (indicated by block 117) at the originating end and previously operated under control of dial pulses, and through the closed pulsing contacts of dial 104 which is associated with the calling subscriber's station. Relay 100, in operating, operates relay 105 in a local circuit. The first open pulse of the next train of dial pulses from dial 104 opens the operating circuit for relay 100 which releases. Relay 105, which has slow-releasing characteristics, does not release during the time that its operating circuit is opened at the upper front contact of relay 100 as this latter relay follows the dial pulses. The first release of relay 100 operates relay 106 in a circuit from battery through the winding of that relay, over the front contact of relay 105, to ground over the upper back contact of relay 100. Relay 106, in operating, removes the ground from the winding of the transmission loss pad short-circuiting relay 107 and closes the tip conductor 108 of the outgoing end of this line or trunk circuit to the lower front contact of relay 100, the outgoing ring conductor 109 being connected to the lower armature of relay 100.

The reoperation of relay 100 following the first open dial pulse closes the pulsing circuit over its lower front contact. All subsequent pulses of the particular train of pulses under discussion cause the release and reoperation of relay 100, the lower contacts of which repeat these pulses over conductors 108 and 109. Relay 106 has slow-releasing characteristics and remains operated during the interval in which relay 100 is operating and releasing in response to a particular train of dial pulses. When relay 100 reoperates at the completion of a train of pulses, it remains operated for a sufficient length of time, before the dialing of the subsequent train of pulses, to permit relay 106 to release. The release of relay 106 opens the

pulsing circuit to the contacts of relay 100 and also connects ground to the winding of relay 107 to prepare for the subsequent operation of that relay.

In response to the train of dial pulses referred to in the preceding paragraph, the selective control equipment indicated by block 200 at the left of Fig. 4 causes the associated automatic switch 201 to establish connections between the line or trunk shown in Fig. 1 and the line or trunk shown in Figs. 4, 5 or 6 depending upon the number of pulses transmitted in that pulse train. Assuming that three pulses are transmitted, switch 201 therefore completes connections between the outgoing conductors 108 and 109 of Fig. 1 and conductors 202 and 203, respectively, of the line or trunk circuit shown in Fig. 4. The transmission loss pad control relays 107 of Fig. 1 and 206 of Fig. 4 and the pulsing relay 205 of Fig. 4 therefore operate in a circuit traceable from battery through the middle winding of relay 206, lower winding of relay 205, lower normally closed contacts of relay 207, left lower winding of repeating coil 208, resistance 210, conductors 203 and 109, lower front or pulsing contact of relay 100 of Fig. 1, resistance 114, right lower winding of repeating coil 115, lower winding of supervisory relay 110, and from this point to ground over two parallel circuits one of which extends through the winding of relay 107 and over the back contact of relay 106, while the other circuit may be traced through the upper winding of relay 110, right upper winding of repeating coil 115, resistance 111, conductors 108 and 202, resistance 209, left upper winding of repeating coil 208, upper normally closed contact of relay 207, and through the upper windings of relays 205 and 206 to ground. The upper and middle windings of relay 206 are differentially wound and oppose each other in the effect that they produce on the armature of the relay. An equal flow of current simultaneously through these aforementioned windings therefore does not cause relay 206 to operate. In the instance set forth above however, relay 206 operates since the flow of current through its middle winding greatly exceeds that flowing through its upper winding.

The operation of relay 107 short-circuits resistances 111 and 114 and opens the circuit extending from the mid-points of these resistances to condenser 113 and resistance 112 thereby making the transmission loss pad composed of these aforementioned resistances and condenser ineffective. Similarly, the operation of relay 206 of Fig. 4 renders the transmission loss pad of that figure ineffective by short-circuiting resistances 209 and 210 and opening the circuit extending from the mid-point of these resistances to condenser 212 and resistance 211.

With relays 100 and 105 of Fig. 1 operated, the first open pulse of the next train of dial pulses causes relay 100 to release and, in turn, operate relay 106. The operation of relay 106 closes the pulsing circuit directly to the lower contact of relay 100, short-circuiting resistances 111 and 114, the right windings of repeating coil 115 and relay 110, and also releases relay 107. Pulsing relay 205 of Fig. 4 is now held operated in a circuit traceable from ground and battery through the upper and middle windings of relay 206, windings of relay 205, upper and lower normally closed contacts of relay 207, left windings of repeating coil 208, resistances 209 and 210, conductors 202 and 203, conductors 108 and 109, resistances 111 and 114, right windings of re-

peating coil 115, and through the two windings of relay 110 in series. Relay 110 is of the polarized type and does not operate at this time as the flow of current through its windings, under the above condition, is in the non-operating direction for that relay. Relay 206 releases at this time since an equal current now flows through its differentially wound upper and middle windings. Relay 205, in operating, as previously set forth, operates relay 213 locally. Relay 213, in operating, connects ground to conductor 204 to hold the control equipment 200 associated with switch 201. Relay 100 of Fig. 1 follows the dial pulses of the train, relays 105 and 106 remaining operated as previously set forth. These pulses are transmitted over conductors 108 and 109 and cause relay 205 to release and reoperate once for each dial pulse. Relay 213 has slow-releasing characteristics and remains operated during the interval in which relay 205 is following the dial pulses. Relay 214 operates over the upper front contact of relay 213 to the ground over the back contact of relay 205 during the first release of that latter relay. Relay 214 has slow-releasing characteristics and remains operated until relay 205 remains operated at the conclusion of the particular train of pulses being transmitted. Relay 214, in operating, operates relay 206 through the lowest winding of that relay in a local circuit and also connects the outgoing tip conductor 216 to the lower front contact of the pulsing relay 205, the outgoing ring conductor 217 being connected to the lower armature of relay 205, thereby short-circuiting the left windings of repeating coil 220 and the winding of relay 215 during pulsing. The purpose of operating relay 206 locally at this time is to remove the transmission loss pad composed of resistances 209, 210 and 211 and condenser 212 from the circuit and thereby improve the pulsing conditions for relay 205. As relay 205 releases and reoperates in response to the dial pulses, it opens the outgoing pulsing circuit over conductors 216 and 217 and causes the succeeding dial pulse controlled automatic switching circuits (indicated by block 221) to function, complete the connection to the called subscriber's station 218, and cause the bell at that station to be rung. These succeeding switching circuits may consist of incoming selector and connector circuits of the well-known step-by-step type or may be of any other type whose operations are controlled by dial pulses and which function in a manner well-known to the art.

Relay 106 of Fig. 1 releases after pulsing relay 100 of that figure remains operated at the conclusion of dialing. The release of relay 106 opens the short circuit around the right windings of repeating coil 115 thereby completing the transmission circuit to Fig. 4. Pad control relay 107 reoperates over a previously traced circuit and thereby renders the transmission loss pad of Fig. 1 ineffective. Blocks 116 and 219 represent terminal voice frequency amplifiers associated with the long haul line or trunk circuits shown in Figs. 1 and 4, respectively. Relay 214 of Fig. 4 releases after pulsing relay 205 of that figure remains operated at the conclusion of dialing. The release of relay 214 opens the short circuit around the right windings of repeating coil 220 thereby completing the transmission circuit towards the called station, and also opens the circuit through the lowest winding of the transmission loss pad control relay 206. Relay 206 remains operated at this time through its upper

and middle windings over its previously traced circuit initial operating circuit. On connections between the long haul incoming dial line or trunk of Fig. 1 and the long dial line or trunk of Fig. 4, as described above, the respective pad control relays 107 and 206 of these figures are therefore both operated, rendering their associated transmission loss pads ineffective and providing the maximum degree of transmission on the long haul connection.

When the called subscriber answers, the removal of the receiver from the switchhook at the called station 218 causes the terminating switch circuits (indicated by block 221) to function and reverse the polarity of the potential over conductors 216 and 217. Polarized relay 215 thereupon operates and in turn operates reversing relay 207 in a local circuit. Relay 207, in operating, reverses the ground and battery supplied over conductors 108 and 109 thereby causing polarized relay 110 of Fig. 1 to operate. The operation of relay 110 operates reversing relay 101 in a local circuit. Relay 101, in operating, reverses the ground and battery supplied toward the originating switch circuit (indicated by block 117) over trunk or line 103. The originating circuit recognizes this reversal of polarity as an indication that the connection has been completed and functions to cause the calling subscriber to be charged in a manner well-known to the art.

Upon disconnection of the subscribers at the conclusion of conversation the various operated relays of Figs. 1 and 4 and switch 201 of Fig. 4 release thereby restoring the circuits shown in these figures to their normal condition.

In the foregoing description it was assumed that the call incoming over the line or trunk shown in Fig. 1 required extension over a long haul outgoing line or trunk such as is shown in Fig. 4 and the first train of pulses dialed into Fig. 1 contained the required number of pulses necessary to cause switch 201 to establish connections to Fig. 4. Assume now that the call incoming over the line or trunk of Fig. 1 requires extension over a medium haul outgoing line or trunk such as is shown in Fig. 5. This condition also requires the removal of the loss pad in the circuit of Fig. 1 in order to provide the proper grade of transmission on the completed connection. The operation of Fig. 1 under this condition is identical with that hereinbefore set forth. The first train of pulses dialed into Fig. 1, however, contains a different number of pulses, four pulses in the case illustrated. These four pulses actuate the controlling mechanism 200 associated with the switch 201 and cause that switch to take four steps thereby establishing connections between Figs. 1 and 5. Relay 230 operates in a circuit traceable from battery through its upper winding, over the normally closed lower contact of relay 231, conductors 241 and 109, lower front contact of relay 100 of Fig. 1, resistance 114, right lower winding of repeating coil 115, lower winding of relay 110, and from this point to ground over parallel circuits one of which extends through the winding of relay 107 and over the back contact of relay 106, while the other extends through the upper winding of relay 110, right upper winding of repeating coil 115, resistance 111, conductors 108 and 240, upper normally closed contacts of relay 231, and through the lower winding of relay 230. Relay 107 of Fig. 1 also operates in this circuit and short-circuits resistances 111 and 114. Relay 75

110 does not operate since the flow of current through its windings is in the non-operating direction. When relay 106 of Fig. 1 operates following the first release of pulsing relay 100, it short-circuits that portion of the circuit just traced which extends through resistances 111 and 114, the right windings of repeating coil 115 and the windings of relays 110 and 107 thereby improving the pulsing circuit for relay 230 which is now holding directly under control of the back contact of relay 106 and the lower front or pulsing contact of relay 100. Relay 107 also temporarily releases at this time. Relay 230, in operating, operates relay 232 locally which connects ground to conductor 204 to hold the control equipment 200 associated with switch 201. As relay 100 releases and reoperates in response to the dial pulse relay 230 also releases and reoperates. Relay 232 has slow-releasing characteristics and remains operated during pulsing. The first release of relay 230 operates relay 233 in a circuit over the upper contact of relay 232. Relay 233, in operating, short-circuits relay 234 and closes the outgoing tip conductor 237 to the lower or pulsing contact of relay 230, the outgoing ring conductor 238 being connected to the lower armature of relay 230. Relay 230 follows the pulses and transmits these pulses over the outgoing trunk or line causing the selective circuits (indicated by block 242) at the terminating end to function and complete the connection to the called station 239.

The transmission loss pad control relay 107 of Fig. 1 reoperates in series with relay 230 of Fig. 5 upon the release of relay 106 of Fig. 1 following the completion of dialing, over the previously traced initial operating circuit for relays 230 and 107. Relay 107, in operating, short-circuits resistances 111 and 114 and opens the circuit of resistance 112 and condenser 113 thereby rendering ineffective the transmission loss pad composed of these resistances and condenser.

When relay 230 remains operated at the conclusion of dialing, the slow-to-release relay 233 which remained operated during dialing releases and removes the short circuit around the winding of relay 234 and across one side of the transmission condensers 235 and 236. Relay 234 is of the polarized type and operates when the polarity of the potential over conductors 237 and 238 is reversed in response to the answer of the called subscriber, this reversal being accomplished by the terminating circuit (indicated by block 242) in a manner well-known to the art. The operation of relay 234 operates reversing relay 231 locally, this latter relay reversing the polarity of the potential over conductors 240 and 241. Relays 110 and 100 of Fig. 1 thereupon operate and function in the manner hereinbefore set forth. Upon disconnection of the subscribers the operated relays of Figs. 1 and 5 and switch 201 of Fig. 4 release and restore the circuits shown in these figures to normal.

On a call incoming over the long haul line or trunk shown in Fig. 1 and requiring completion over the short haul outgoing line or trunk shown in Fig. 6 which has a relatively low transmission loss, the proper grade of transmission is obtained by the inclusion of the loss pad of Fig. 1 in the transmission circuit. The circuit of Fig. 1 functions in a manner identical with that hereinbefore set forth in connection with its operation when extended to Figs. 4 or 5 up to and including the closure of the outgoing conductors 108 and 109 to the automatic switch control mecha-

nism 200 shown in Fig. 4. At this point it will be assumed that the first train of dial pulses transmitted to Fig. 1 contain five pulses. Switch 201 therefore takes five steps and extends conductors 108 and 109 of Fig. 1 to conductors 260 and 261, respectively, of Fig. 6. Relays 250 to 254, inclusive, condensers 255 and 256 and outgoing conductors 257 and 258 of Fig. 6 correspond to relays 230 to 234, inclusive, condensers 235 and 236 and outgoing conductors 237 and 238, respectively, of Fig. 5 and function in a manner identical with that hereinbefore set forth in detail under the description of the operation of Fig. 5 on its connection with Fig. 1, with the exception of the operating circuit for relay 250 which differs for the purpose of effecting the inclusion of the transmission loss pad in Fig. 1 as set forth in the succeeding paragraph.

It will be noted that the two windings of relay 250 connect to the terminals of an undergrounded source of potential thereby differing from relays 205 and 230 of Figs. 4 and 5, respectively, which latter relays have their windings connected to a source of potential on one side of which is grounded. Relay 250 initially operates over a circuit similar to the initial operating circuit for relay 230 of Fig. 5, previously traced. At the conclusion of dialing, however, with relay 100 operated and relay 106 released, the circuit over which relay 250 remains operated differs from that previously described for relays 205 or 230 and may be traced from negative potential, through the upper winding of relay 250, over the lower normally closed contacts of relay 251, conductors 261 and 109, lower front contact of relay 100, resistance 114, lower right winding of repeating coil 115, both windings of relay 110 in series, upper right winding of coil 115, resistance 111, conductors 108 and 260, upper normally closed contacts of relay 251, lower winding of relay 250, to the positive side of the potential source. Since this potential is ungrounded it will be obvious that there is no flow of current through the winding of the pad control relay 107 of Fig. 1 and, since relay 107 does not operate, the loss pad of Fig. 1 is included in the connection extending from the calling station 104 to the called station 259 over the low transmission loss short haul outgoing line or trunk of Fig. 6 and through the terminating circuits (indicated by block 262), thereby giving the desired grade of transmission. The operation of Figs. 6 and 1 upon the answer by the called subscriber at station 259 and upon disconnection is identical with that previously described in connection with the operation of Fig. 5 with Fig. 1.

Referring now to the medium haul incoming line or trunk shown in Fig. 2 which has a relatively high transmission loss, the seizure of this circuit at its distant end operates relay 120 in a circuit from battery and ground through its windings, over the normally closed contacts of relay 121, line or trunk 131, through the selective switch mechanism (indicated by block 132) at the originating end, and through the pulsing contacts of dial 130 at the calling subscriber's station. The operation of relay 120 operates relay 122 locally. During the subsequent transmission of dial pulses, the first release of relay 120 operates relay 123 through the contacts of relay 122 which, being of the slow-to-release type, remains operated during any train of dial pulses. The operation of relay 123 removes the ground through retardation coil 125 from the windings of relay 124 and also closes conductor 128 to the pulsing contact of

relay 120. Relay 123 has slow-to-release characteristics and remains operated until pulsing relay 120 remains operated at the end of a pulse train.

Assuming that the first train of pulses dialed into Fig. 2 contains three pulses, the switch control mechanism 270 causes switch 271 shown at the left of Fig. 5 to step three times and extend conductors 128 and 129 of Fig. 2 to conductors 202 and 203, respectively, of Fig. 4. Relay 205 operates in a circuit traceable from battery through the middle winding of relay 206, lower winding of relay 205, lower normally closed contact of relay 207, lower left winding of repeating coil 208, resistance 210, conductors 203 and 129, lower front contact of relay 120 of Fig. 2, lower winding of relay 124 and from this point jointly to ground through retardation coil 125 and over the back contact of relay 123, which released at the end of the pulse train, and also through the upper winding of relay 124, over conductors 128 and 202, resistance 209, left upper winding of repeating coil 208, normally closed upper contacts of relay 207, and through the upper windings of relays 205 and 206. From this point on the long haul outgoing trunk circuit shown in Fig. 4 functions in the same manner as hereinbefore set forth and the connection to the called station 218 is completed in the manner identical with that described for the operation of Fig. 4 with Fig. 1. Since the flow of current through its middle winding is greater than the flow through its upper winding, the differentially wound pad control relay 206 remains operated after the release of relay 214 opens the operating circuit through its lower winding and thereby excludes the loss pad of Fig. 4 thus providing the higher grade of transmission required by this type of connection. Polarized relay 124 of Fig. 2 operates when relay 207 reverses the potential over conductors 128 and 129 upon the answer by the called subscriber in the manner previously described. The operation of relay 124 operates reversing relay 121 which causes charge supervision to be returned to the originating end as previously set forth. Upon disconnection the operated relays in Figs. 2 and 4 and switch 271 of Fig. 5 release and restore the circuits to their normal condition.

Should a call incoming over the line or trunk shown in Fig. 2 be extended over a medium haul or short haul outgoing line or trunk such as are shown in Figs. 5 and 6, respectively, its connection to either of these latter figures is effected by the operation of switch 271 under control of the first train of pulses transmitted from the originating end to Fig. 2. The operation of Fig. 2 upon its connection to Fig. 5 or Fig. 6 is identical with that previously described in connection with its operation with Fig. 4. The operation of Figs. 5 and 6, when connected with Fig. 2, is identical with that hereinbefore set forth for their operation in connection with Fig. 1. Since there are no transmission loss pads in Fig. 2 or Figs. 5 and 6 no further description of their operation in connection with each other will be given, these connections being illustrated merely to show that Fig. 2, which is arranged to operate the loss pad control relay 206 of Fig. 4, is equally capable of functioning with Figs. 5 and 6, the grounded battery supplied through the windings of relay 230 of Fig. 5 and the ungrounded battery supplied through the windings of relay 250 of Fig. 6 being equally effective in operating relay 124 of Fig. 2 when the reversing relays 231 or 251 of Figs. 5 or 6,

respectively, operate upon the answer of the called subscriber.

Referring now to the short haul incoming line or trunk shown in Fig. 3, this circuit having a low transmission loss, a connection extended over it to a long haul terminal repeater equipped outgoing line or trunk such as is shown in Fig. 4, requires the inclusion of the transmission loss pad in this latter circuit in order to reduce the overall transmission on the connection to the desired level. Relays 140 to 144, inclusive, and condensers 146 and 147 of Fig. 3 correspond to relays 120 to 124, inclusive, and condensers 126 and 127 of Fig. 2 and function in a manner identical with that previously set forth for these latter relays and condensers under the description of the operation of Fig. 2. The first train of pulses transmitted to Fig. 3 under control of the dial 150 at the calling station causes relays 140, 142 and 143 to function and repeat these pulses over the outgoing conductors 148 and 149 which extend to the control equipment 280 associated with the automatic switch 281 shown at the left of Fig. 6 thereby causing switch 281 to function and establish connections between the circuit of Fig. 3 and the circuits of Figs. 4, 5 or 6 depending upon the number of pulses contained in the pulse train.

Assuming that the first pulse train contains three pulses, switch 281 therefore extends conductors 148 and 149 of Fig. 3 to conductors 202 and 203 of Fig. 4. Upon the operation of both relays 140 and 143 of Fig. 3, relay 205 of Fig. 4 operates in a circuit traceable from ground through the upper windings of relays 206 and 205, upper normally closed contact of relay 207, left upper winding of repeating coil 208, resistance 209, conductors 202 and 148, front contact of relay 143 of Fig. 3, lower front or pulsing contact of relay 140, conductors 149 and 203, resistance 210, left lower winding of repeating coil 208, lower normally closed contact of relay 207, lower winding of relay 205, to battery through the middle winding of relay 206. Relay 206, the upper and middle windings of which are differentially wound, does not operate since an equal amount of current flows through both of these aforementioned windings at this time. The operation of relay 205 operates relay 213 locally. During the transmission of the subsequent trains of pulses from dial 150, the release and reoperation of relay 140 of Fig. 3 repeats these pulses over conductors 148 and 149 in turn causing relay 205 of Fig. 4 to release and reoperate. Upon the first release of relay 205, a circuit is completed from ground over its back contact, over the upper front contact of the slow-to-release relay 213 which remains operated during pulsing, to battery through the winding of relay 214. Relay 214 operates and short-circuits the right windings of repeating coil 220 and the winding of relay 215. Relay 214 also operates relay 206 through the lowest winding of that relay. Relay 206, in operating, short-circuits resistances 209 and 210 during pulsing, after relay 205 remains operated at the conclusion of pulsing, relay 214 releases in turn opening the circuit through the lowest winding of relay 206, this latter relay now releasing since the current flowing through its upper and middle differentially wound windings is equal as hereinbefore set forth. Relay 206 in releasing, opens the short circuit around resistances 209 and 210 and closes the circuit to resistance 211 and condenser 212 thereby inserting the loss pad composed of these resistances and condenser into the transmission circuit.



The opening and closure of the circuit between the outgoing conductors 216 and 217 of Fig. 4 under control of the lower contacts of relay 205 causes the connection to the called station 218 to be completed as previously set forth. When the called subscriber answers, the polarized relay 215 operates on the reversal of potential from the terminating circuit, in turn operating the reversing relay 207 which reverses the polarity of the potential supplied over conductors 148 and 149 of Fig. 3. Relay 144 of Fig. 3, which is a polarized relay, thereupon operates in turn operating reversing relay 141 of Fig. 3 thereby providing charging supervision to the originating circuits (indicated by block 152). Upon disconnection all operated relays of Figs. 3 and 4 and switch 281 of Fig. 6 release and thereby restore the circuits shown in Figs. 3 and 4 to normal.

Should a call incoming over the short haul incoming line or trunk of Fig. 3 require extension over a medium or short haul outgoing line or trunk such as shown in Figs. 5 or 6, switch 281 functions under control of the proper number of dial pulses and effects the connection between Fig. 3 and either Fig. 5 or Fig. 6 as the case may be. The operation of Fig. 3 with either Fig. 5 or Fig. 6 is identical with that described for its operation in connection with Fig. 4. The operation of Figs. 5 and 6 is identical with that previously described for the operation of these figures with Fig. 1 and, since there are no transmission loss pads in Figs. 2, 5 and 6, no further description of the operation of Fig. 2 with either Fig. 5 or Fig. 6 will be given.

What is claimed is:

1. In an automatic telephone exchange, groups of incoming and outgoing lines thereat, automatic switching means for connecting any incoming line to any outgoing line, individual transmission loss pads associated with certain of said lines independent of the switching means, and means for automatically connecting the pads in, or disconnecting the pads from, any line of either group responsive to connection of the line with certain predetermined lines of the other group.
2. In an automatic telephone exchange, a group of incoming lines and a group of outgoing lines terminating thereat, automatic switching means controlled over the incoming lines for connecting any two lines of the different groups together, individual transmission loss pads normally connected in the talking conductors of certain of

said lines independent of the switching means, and means for automatically disconnecting the pads from any line in either group responsive to connection of the line with certain predetermined lines of the other group, said disconnecting means being controlled over the talking conductors of the connected lines.

3. In an automatic telephone exchange, a plurality of lines of different transmission characteristics outgoing therefrom, a plurality of incoming lines also differing in their transmission characteristics and terminating thereat, automatic switching means at said exchange and selectively controllable over the talking conductors of the incoming lines for connecting any incoming line to any outgoing line, means in each line for effecting reverse current supervision over an established connection, transmission loss pads normally connected in the talking conductors of certain of said lines, a relay associated with each pad and adapted when operated to effectively disconnect the respective pads from the line, and circuit means including said reverse supervision means for controlling, in a predetermined manner, the pad relays associated with any pair of connected lines.

4. In a telephone exchange, two groups of lines terminating thereat, means for interconnecting any line of one group with any line of the other group, transmission loss pads normally connected in certain of said lines, a bridge including a source of direct current connected across each line of one group, a dry bridge connected across each of the lines of the other group, a connection to ground at the mid-point of certain of said dry bridges, a ground connection to the current source bridged across certain of said lines, a pad control relay associated with each transmission loss pad adapted when operated to effectively remove the pad from its associated line, the relays associated with lines having a dry bridge being connected between the mid-point of the bridge and ground and the relays associated with lines of the other group having a pair of differential windings connected serially in the direct current bridge whereby the connection of a line having a ground connection at the mid-point of a dry bridge to a line having a grounded current source in bridge thereto will cause the operation of pad control relays associated in said lines.

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