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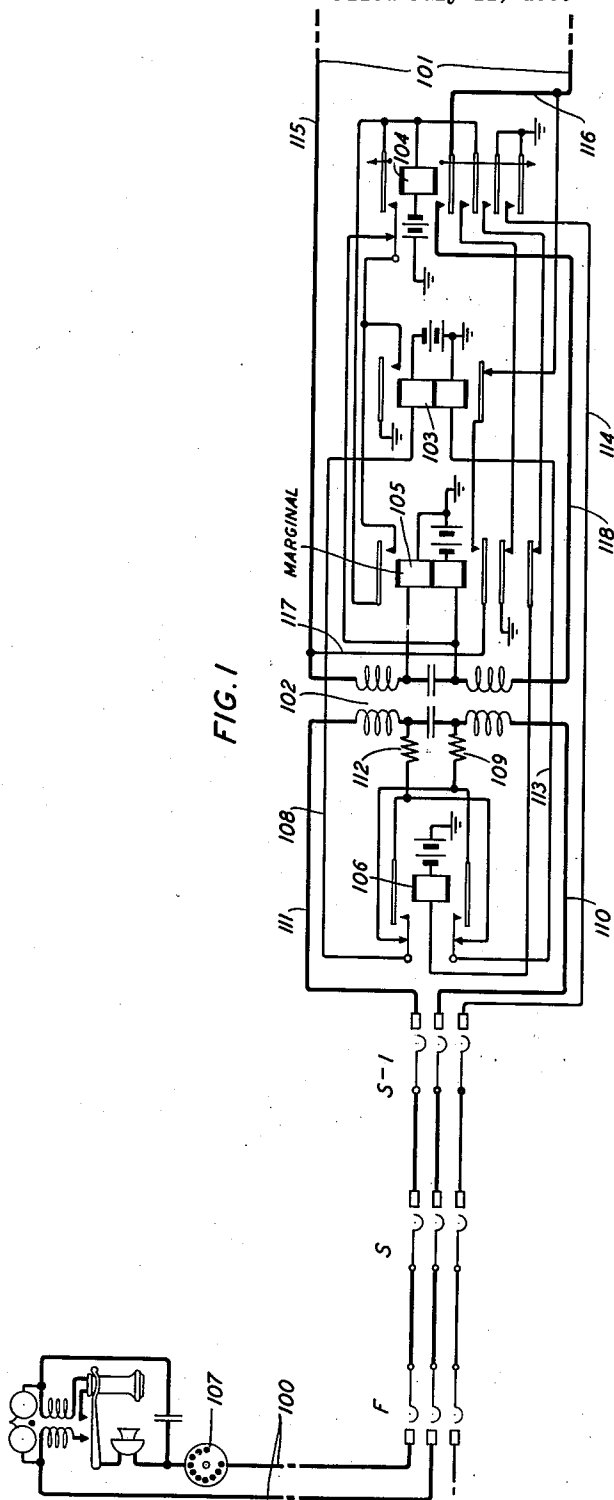
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2,230,562

SIGNALING SYSTEM

Filed July 11, 1939

2 Sheets-Sheet 1



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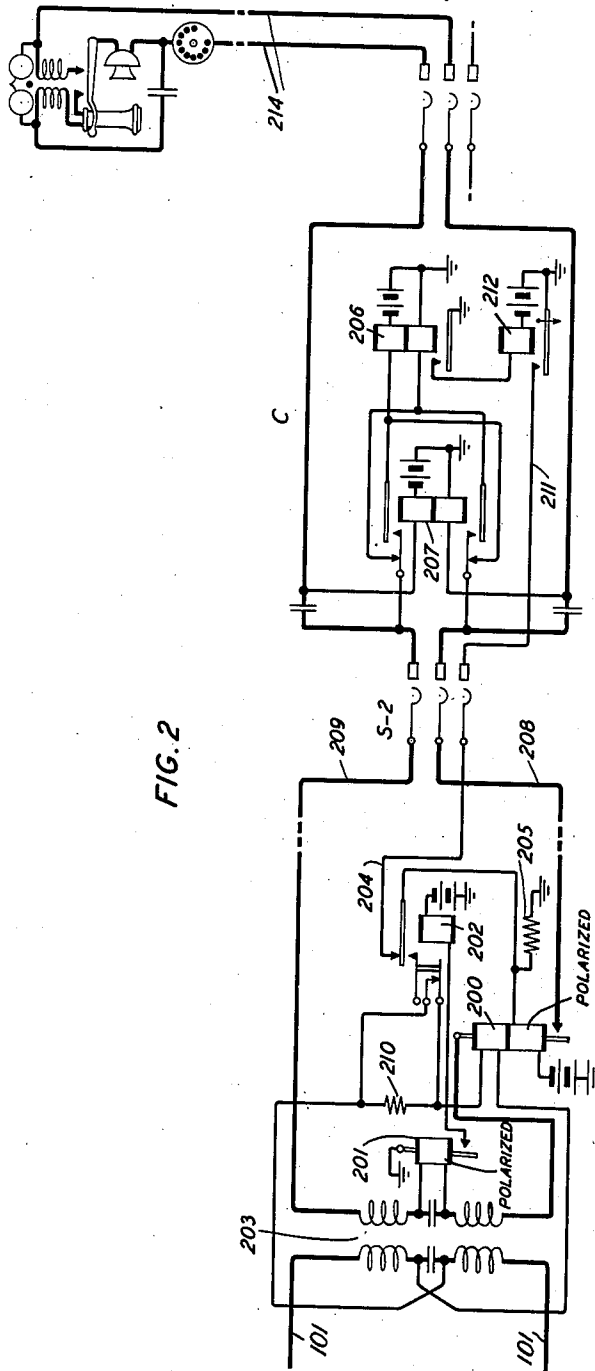
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FIG. 2



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2,230,562

SIGNALING SYSTEM

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11 Claims. (Cl. 179—16)

This invention relates to the transmission of impulses and more particularly to impulse repeaters for use in automatic and semiautomatic telephone systems.

An object of the invention is to increase the effective range of impulse transmission circuits.

Another object of the invention is to enhance the operation of an impulse responsive relay by utilizing the inductive effects produced incidental to the creation of the impulses.

A further object of the invention is to improve the releasing performance of an impulse responsive relay by obviating the detrimental effects of leakage paths and capacities present in the impulse transmission circuit.

It is the common practice in systems arranged for the transmission of impulses over a trunk line from one station or office to another to connect the current supply battery through the windings of the impulse receiving relay at the incoming end of the trunk and to provide a bridge across the trunk at the outgoing end which is opened and closed by the contacts of the impulse sending relay. One of the disadvantages of these prior systems is the opposition imposed upon the release of the impulse receiving relay by any leakage paths that may exist between the conductors of the trunk or between one conductor of the trunk and ground. Another disadvantage is that the impulse receiving relay is opposed in its releasing operation by any capacity that may exist between the trunk conductors, particularly at the outgoing end of the trunk, which is farthest from the relay and the source of current. When the bridge circuit is opened at the outgoing end of the trunk to release the pulsing relay at the distant end, these opposing currents, flowing through the leakage paths and flowing over the trunk to charge the capacity at the outgoing end, pass through the windings of the impulse receiving relay and retard its releasing operation.

According to the present invention these objections are overcome and other advantages are secured by means of an impulse transmission system in which the impulse receiving relay at the incoming end of the trunk is connected across the conductors of the trunk in a circuit free from current sources, in which the current source for operating the relay is supplied to the trunk circuit at the outgoing end thereof through the windings of an auxiliary relay, and in which the impulse transmitting relay at the outgoing end of the trunk serves to open and close a direct short circuit across the conductors of the trunk.

When the transmitting impulse relay is energized, the short circuit is opened, and current is supplied through the windings of the auxiliary relay over the trunk through the impulse receiving relay to operate the latter. When the impulse transmitting relay is released, it recloses the short circuit, and the impulse receiving relay at the distant end, being deprived of current, releases. The auxiliary relay at the outgoing end of the trunk, being energized, either in a direct circuit through the closed contacts of the transmitting relay or in a circuit including the trunk and the receiving relay, remains operated during impulse transmission. With this arrangement any leakage paths that may exist along the conductors of the trunk do not affect the impulse receiving relay; since the winding of the relay is in a dry bridge across the trunk, and any leakage currents flowing from the battery do not pass through the winding of the relay. Another advantage of this pulsing system is that the capacity of the trunk does not appreciably delay the release of the receiving relay. In the usual pulsing arrangement the capacity of the trunk draws a charging current from the battery through the windings of the receiving relay following the opening of the loop at the originating end of the circuit. This charging current flows during the releasing operation of the relay, and its opposing effect is particularly pronounced if there is substantial capacity in the trunk at the outgoing end thereof. The capacity at this end of the trunk must be charged through the resistance of the trunk conductors, thus prolonging the interval during which the charging and opposing current flows through the winding of the receiving relay at the distant end of the trunk. According to the present invention this disadvantage is obviated since the capacity of the trunk does not draw any charging current through the winding of the receiving relay.

A feature of this invention is an impulse transmitting circuit in which the inductive effect produced by the operation of the transmitting relay at the outgoing end of the trunk line is utilized to obtain a fast and positive operation of the receiving relay at the incoming end of the line. When the short circuit is removed from the outgoing end of the line, the change of flux in the auxiliary relay produces a momentary surge of relatively high voltage which is applied to the line and thence to the winding of the receiving relay at the distant end.

Another feature of the invention is an impulse repeating arrangement in which the auxiliary re-

lay that feeds battery to the trunk at the outgoing end for producing the impulses also serves as a supervisory relay for transferring supervisory signals back over the connection toward the originating end. This auxiliary relay receives sufficient current during the repeating of impulses and the establishment of the connection to maintain its armatures attracted. Being marginal, however, it releases when its current is reduced by the insertion of resistance in the circuit at the terminating end of the connection for the purpose of sending back the supervisory signal. The auxiliary relay responding to this reduced current releases its armatures and causes a reversal of current in the circuit extending toward the calling subscriber's line.

Another feature of the invention is a circuit arrangement in which the release of the established connection is placed under the joint control of the calling and called parties by means including the impulse transmitting relay and the auxiliary supervisory relay that serves to supply battery current to the trunk circuit for sending impulses thereover.

The foregoing and other features of the invention will be described in detail in the following specification.

In the drawings accompanying the specification Figs. 1 and 2 (with Fig. 2 placed at the right of Fig. 1) disclose an automatic telephone system, partly in detail and partly in diagram, incorporating impulse transmission circuits designed in accordance with the present invention. Fig. 1 illustrates the originating part of an established connection, including an outgoing impulse repeater; and Fig. 2 shows the terminating part of the connection, including an incoming impulse repeater, and selector and connector switches.

Although the invention is not necessarily limited to the use of any particular type of automatic switch, it is assumed that the connections are established by switches of the well-known step-by-step type. It is also assumed in the present disclosure that the novel impulse repeating circuits are employed for repeating impulses from an originating office to a distant terminating office over an interconnecting trunk line. While these repeaters are particularly useful for this purpose and enable the effective and safe transmission of impulses over relatively long inter-office trunks, it is, of course, possible that the principal features disclosed might be used to advantage in local transmission systems.

Referring to the drawing, the subscribers' lines in the originating office, such as line 100, appear in a line-finder switch F, which is coupled directly to a first selector switch S. The selector S has access to succeeding selector switches, such as the switch S—1; and it may be assumed that the selector S—1 has access to trunks outgoing to distant offices. Each of these trunks, such as the trunk 101, is equipped at its outgoing end with a repeating coil 102 for voice transmission and with an impulse repeating and supervisory circuit arrangement including relays 103, 104, 105 and 106. The transmitting relay 103 receives the impulses coming from the subscriber's line and repeats them over the outgoing trunk line 101 by opening and closing a short circuit across the trunk conductors. The battery for supplying the current for the impulses is connected to the outgoing end of the trunk line through the windings of a marginal relay 105 and the right-hand windings of the repeating coil 102. Relay 104 is the usual holding and control relay, and relay

106 serves to reverse the direction of current to send supervisory signals back toward the calling subscriber's line.

The interoffice trunk line 101 terminates in an impulse repeating and supervisory circuit at the distant office, and this circuit is in turn connected to an incoming selector switch S—2. The incoming repeating and supervisory circuit comprises an impulse receiving relay 200, supervisory relays 201 and 202, and a repeating coil 203 for voice transmission. The selector switch S—2 has access through succeeding switches, including the connector switch C, to called subscribers' lines. One of these, line 214, is shown.

The operation of the system will now be described in detail, and it may be assumed for this purpose that the subscriber of line 100 wishes to converse with the subscriber of line 214. When the calling subscriber initiates the call, line finder F is set in motion to seize the terminals of the line 100, extending it to the first selector switch S. The calling subscriber then manipulates his dial 107 to transmit series of impulses which cause the successive operation of selectors S and S—1. Upon the seizure of the outgoing trunk 101 by the selector switch S—1 a circuit is closed from battery through the upper winding of the impulse transmitting relay 103, conductor 108, upper normal contacts of relay 106, resistance 109, lower left winding of coil 102, conductor 110, thence over the lower side of the connection through switches S—1, S and F, over the loop of the calling line 100, and returning over the upper side of the connection to conductor 111, through the upper left winding of coil 102, resistance 112, lower normal contacts of relay 106, conductor 113 to ground through the lower winding of relay 103. Relay 103 operates in this circuit and closes a circuit from battery through the lower winding of relay 105, normal contacts of slow-release relay 104 to ground at the upper contact of relay 103. Relay 105 operates in this circuit and closes an operating circuit for relay 104, traceable from battery through the winding of the latter relay, upper contact of relay 105 to ground at the upper contact of relay 103. Relay 104 closes a holding circuit for itself traceable through its upper closed contacts to ground at the upper contact of relay 103. Relay 104 places ground on the sleeve conductor 114 to hold the preceding switches.

Relay 104 also prepares the trunk for impulse transmission by closing a circuit for the impulse receiving relay 200 in the distant office. This circuit may be traced from battery through the lower winding of relay 105, lower right winding of repeating coil 102, conductor 118, inner lower contact of relay 104, thence over trunk conductor 115 through the lower left winding of coil 203, normal contacts of relay 202, upper winding of the pulse receiving relay 200, upper left winding of coil 203, conductor 115 through the upper right winding of coil 102, to ground through the upper winding of relay 105. Relay 200 operates in this circuit and prepares a circuit for the impulse receiving relay (not shown) of the selector switch S—2. This latter circuit extends from battery through the windings of the selector impulse relay, thence through the right-hand windings of repeating coil 203 and the polarized supervisory relay 201 and the closed contact of the impulse receiving relay 200. The selector switch S—2 now applies a direct ground potential to the sleeve conductor 204 to energize the lower winding of the impulse receiving relay 200, this winding being normally included in series with the high

resistance 205. The impulse receiving relay 200 is shown as a polarized relay, and the energization of its lower biasing winding over the low-resistance sleeve circuit prepares the relay for operation in response to incoming pulses. The direction of current flow through the relay 201 at this time is such that the relay does not attract its armature. The marginal auxiliary relay 105 in the outgoing repeater is also energized in series with the relay 200 and remains operated throughout the period of impulse transmission. It will be noted that the original operating circuit of relay 105 is opened as soon as relay 104 attracts its armatures. Relay 105 at its inner lower armature and contact prepares a low-resistance bridge or short circuit across the conductors of trunk 101. This bridge may be traced from conductor 115, thence over conductor 117, closed contacts of relay 105, through the back contacts of relay 103 to the other trunk conductor 116. The impulse transmitting relay 103 being energized at this time, the low-resistance bridge is opened, and the pulse receiving relay 200 remains energized in the circuit above traced by current flowing through the windings of relay 105 and over the trunk line to the upper winding of said relay 200. The circuits are now in condition for the transmission of the next series of impulses.

When, therefore, the calling subscriber manipulates his dial 107 to transmit the next series of impulses, relay 103 releases and operates repeatedly in response to these impulses. Relay 104, being slow to release, retains its armatures attracted during the brief interruptions of its holding circuit at the upper contact of relay 103. On the first release of the transmitting relay 103 the low-resistance bridge is closed across the conductors of trunk 101. Relay 105, however, remains energized in a circuit including the bridge which may be traced from battery through the lower winding of said relay, lower right winding of coil 102, conductor 118, lower inner contacts of relay 104, conductor 116, lower normal contacts of relay 103, closed contacts of relay 105, conductor 117, upper right winding of coil 102 to ground through the upper winding of relay 105. Since the resistance of the trunk 101 and the relay 200 is now removed, a substantially larger current flows through the windings of relay 105. At the distant office relay 200 releases its armature immediately that the bridge is closed at the originating office to deprive it of current. Relay 200 in releasing opens the circuit of the impulse relay for selector S—2, and this relay releases to cause the switch to take its first step. At the end of the first impulse, when the subscriber's line again closes, relay 103 attracts its armatures and opens the bridge 117. This abrupt opening of the low-resistance circuit of relay 105 and the substitution therefor of the trunk and relay 200 causes a sudden drop in the current flowing through the windings of relay 105. This abrupt reduction in current induces a relatively high voltage across the windings of this relay, and this voltage is applied to the trunk, causing a momentary increase in the current flowing through the winding of relay 200. This momentary increase in the current performs the useful purpose of effecting a quick and positive energization of the relay 200. For each succeeding impulse of the series transmitted by the subscriber relay 103 releases and reoperates, and these impulses are repeated to the distant office to cause the stepping operation of the selector switch S—2. With this arrangement the

surge produced by relay 105 assists the operation of the receiving relay 200, whereas no interfering surge is produced in the line to hinder the release of relay 200.

In like manner succeeding series of impulses sent by the calling subscriber are repeated over the trunk to the receiving relay 200, and this relay in turn repeats them to operate the successive switches including, finally, the connector switch C. When the connection is extended through to the connector C, a circuit is closed from battery through the upper winding of relay 206, lower normal contacts of relay 207, thence over the lower side of the established connection through selector switch S—2, conductor 208, closed contacts of relay 200, lower right winding of coil 203, polarized supervisory relay 201, upper right winding of coil 203, conductor 209, thence over the upper side of the established connection through the upper normal contacts of relay 207, and the lower winding of relay 206 to ground. Relay 206 operates in this circuit, but the direction of current flow is such that the supervisory relay 201 does not attract its armature. Relay 206 energizes the slow-release relay 212, which applies holding ground to conductor 211. Relay 206 responds to the impulses repeated by relay 200, and the connector switch C is positioned on the terminals of the called line 214.

When the called subscriber answers, an obvious circuit is closed for operating relay 207. Relay 207 reverses the direction of current flowing through the relay 201, and this relay attracts its armature to close an obvious operating circuit for supervisory relay 202. Relay 202 opens the circuit of the biasing winding of relay 200 and also opens a short circuit around the relatively high-resistance element 210. The opening of this short circuit includes the element 210 in series with the winding of relay 200 and in series with the windings of relay 105 at the outgoing end of the trunk. Relay 105, being marginal, releases its armatures and closes a circuit for the current reversing relay 106, traceable from battery through the winding of the latter relay, lowermost contacts of relay 105 to ground at the closed contacts of relay 104. Relay 106 reverses the direction of current flowing through the windings of relay 103 back over the extended connection to the subscriber's line 100. This reversal of current constitutes the well-known supervisory signal, which may be used for any desired purpose. Relay 105 in releasing also closes an additional holding circuit for the release relay 104. This circuit may be traced from battery through the winding of relay 104, closed contacts of said relay to ground at the back contacts of relay 105. The purpose of this additional holding circuit is, as will be explained presently, to place the release of the connection under the control of the called subscriber as well as the calling subscriber.

When the subscribers have finished conversation and replaced their receivers on the switch-hooks, the connection is released. The replacement of the calling subscriber's receiver releases relay 103, which opens one of the holding circuits of relay 104. Relay 104, however, remains operated over its other holding circuit including the back contact of relay 105. Relay 103 also closes one point in the bridge 117, but the bridge remains opened at the contacts of relay 105. Relay 104 continues to maintain ground potential on the sleeve conductor 114 to hold the switches in the originating office, and relays 200, 206 and

212 remain energized to maintain ground potential on the sleeve conductor 211 to hold the switches in the terminating office. As soon, however, as the called subscriber replaces his receiver, relay 207 releases, reversing the current direction and causing the release of polarized relay 201. Relay 201 releases relay 202, and the latter relay excludes resistance 210, thereby causing the reoperation of marginal relay 105. Relay 105 closes the second break point in the bridge 117, and relay 200 is deprived of current. Relay 200 releases and opens the circuit of relay 205, causing relay 206 and relay 212 to release. The removal of ground potential from conductor 211 thereupon causes the release of the switches in the terminating office. Relay 105 also opens the second holding circuit of relay 104, permitting the latter relay to release. The release of relay 104 removes ground potential from conductor 114, and the switches in the originating office now restore to normal. Also, relay 104 opens the bridge 117 to permit relay 105 to release. Thus the release of the switches involved in the established connection is placed under the joint control of the calling and called subscribers by means of the auxiliary relay 105 which serves both for supervision and for supplying current to the trunk circuit for the transmission of impulses.

From the foregoing description it will now be clear that the relay 200 at the incoming end of the trunk is substantially free from the adverse effects of leakage paths and trunk capacity. Immediately that the relay 200 is deprived of operating current it is free to release its armature, since no leakage currents can flow through its winding and since no capacity charging currents are permitted to flow from battery through the winding of this relay.

What is claimed is:

1. In an impulse repeating system, an impulse transmission line, a receiving relay having its winding connected across the incoming end of said line, a source of current connected across the outgoing end of said line, a low-resistance bridge connected across the outgoing end of said line, an impulse transmitting relay having contacts for interrupting said low-resistance bridge to cause the repeated operation of said receiving relay, and an auxiliary relay having its windings in series with said source and responsive to the change of current caused by each opening of said low-resistance bridge for inducing a relatively high voltage which is applied to said line to assist in the operation of said receiving relay.

2. The combination in an impulse repeating system of an impulse transmission line, a receiving relay at one end of said line, a source of current connected across the other end of said line, an auxiliary relay having windings in series with said source, a low-resistance bridge across said line and auxiliary relay windings, and an impulse transmitting relay having contacts which alternately close said bridge to hold said auxiliary relay operated and to deprive said impulse receiving relay of current for causing its release and which alternately open said bridge to permit current to flow through said auxiliary relay and said receiving relay for holding said auxiliary relay and for causing the operation of said receiving relay.

3. The combination in an impulse repeating system of an impulse transmission line, a receiving relay having its winding connected across the conductors of said line at the incoming end

thereof, a low-resistance bridge connected across the outgoing end of said line, a source of current, an auxiliary relay having its windings connected in series with said source of current and across the outgoing end of said line in parallel with said bridge, and an impulse transmitting relay for closing and opening said bridge to include said auxiliary relay in a holding circuit either in series with said bridge or in series with said receiving relay and for causing the repeated operation and release of said receiving relay.

4. The combination in an impulse repeating system of an impulse transmission line, an impulse receiving relay having its winding connected across the conductors of said lines at the incoming end thereof, a source of current and reactance means connected in series with each other and across the conductors of said line at its outgoing end, a short circuit connected across the outgoing end of said line in parallel with said source and reactance means, and an impulse transmitting relay at the outgoing end of said line responsive to impulses incoming thereto for closing and opening said short circuit to cause the repeated operation of said receiving relay at the incoming end of the line.

5. In an impulse transmitting system, an impulse transmission line, an impulse receiving relay having its winding connected across the incoming end of said line, a source of current connected across the outgoing end of said line, a low-resistance bridge connected across said line in parallel with said source of current, an auxiliary relay in series with said source of current and held energized during the transmission of impulses by current flowing from said source either through said low-resistance bridge or through the winding of said receiving relay, an impulse transmitting relay for interrupting said bridge to cause the transmission of impulses over said line, and supervisory means at the incoming end of said line for causing the release of said auxiliary relay to transmit a supervisory signal to the outgoing end of said line.

6. In an impulse transmitting system, an impulse transmission line, an impulse receiving relay having its winding connected across the incoming end of said line, a source of current connected across the outgoing end of said line, a low-resistance bridge connected across said line in parallel with said source of current, a marginal auxiliary relay in series with said source of current and held energized during the transmission of impulses by current flowing from said source either through said low-resistance bridge or through the winding of said receiving relay, an impulse transmitting relay for interrupting said bridge to cause the transmission of impulses over said line, supervisory means at the incoming end of said line for altering the resistance of said line to cause the release of said marginal auxiliary relay, and supervisory means at the outgoing end of said line controlled by said auxiliary relay.

7. In an impulse transmission system, a transmission line, an impulse receiving relay having a relatively low-resistance winding connected across the incoming end of said line, a source of current connected across the outgoing end of said line, a low-resistance bridge connected across the outgoing end of said line in parallel with said source of current, a marginal auxiliary relay having its windings in series with said source of current and energized during the transmission of impulses by current flowing from said source

either through said low-resistance bridge or the winding of said receiving relay, and an impulse transmitting relay responsive to a series of impulses for interrupting said low-resistance bridge to cause the repeated operation of said receiving relay, a relatively high-resistance element, means for including said resistance element in series with said line to cause the release of said marginal auxiliary relay, and supervisory means at the outgoing end of said line controlled by said auxiliary relay.

8. The combination in a telephone system of subscribers' lines, a trunk line, automatic switches controlled by a calling subscriber for seizing the outgoing end of said trunk line, an impulse receiving relay having its winding connected across the incoming end of said line, other automatic switches controlled by said relay for extending a connection to a called subscriber's line, a source of current connected across the outgoing end of said trunk line, a low-resistance bridge across said trunk line in parallel with said source of current, an auxiliary relay having its windings in series with said source of current and energized during the transmission of impulses by current flowing either through said low-resistance bridge or through the winding of said receiving relay, an impulse transmitting relay at the outgoing end of said trunk for interrupting said low-resistance bridge to cause the repeated operation of said receiving relay, supervisory means controlled by the called subscriber for causing the release of said auxiliary relay to transmit a supervisory signal over said trunk, and release means controlled by said auxiliary relay.

9. The combination in a telephone system of subscribers' lines, a trunk line, automatic switches controlled by a calling subscriber for seizing the outgoing end of said trunk line, an impulse receiving relay having its winding connected across the incoming end of said line, other automatic switches controlled by said relay for extending a connection to a called subscriber's line, a source of current connected across the outgoing end of said trunk line, a low-resistance

bridge across said trunk line in parallel with said source of current, an auxiliary relay having its windings in series with said source of current and energized during the transmission of impulses by current flowing either through said low-resistance bridge or through the winding of said receiving relay, an impulse transmitting relay at the outgoing end of said trunk for interrupting said low-resistance bridge to cause the repeated operation of said receiving relay, supervisory means controlled by the called subscriber for causing the release of said auxiliary relay to transmit a supervisory signal over said trunk, and means under the joint control of the calling and called subscribers including said auxiliary relay and said impulse transmitting relay for causing the release of an established connection.

10. In an impulse repeating system, an impulse transmission line, a receiving relay at the incoming end of said line, a source of current at the outgoing end of said line, a circuit for said relay including said source of current and the conductors of said line in series, a local circuit at the outgoing end of said line including said source of current and connected in parallel with the first-mentioned circuit for said relay, and an impulse transmitting relay at the outgoing end of said line for repeatedly closing and opening said local circuit to cause the repeated operation of said impulse receiving relay.

11. In an impulse repeating system, an impulse transmission line, a receiving relay at the incoming end of said line, a source of current at the outgoing end of said line, a circuit for said relay including said source of current and the conductors of said line in series, a local circuit at the outgoing end of said line including said source of current and connected in shunt relation to said impulse receiving relay, and an impulse transmitting relay at the outgoing end of said line for repeatedly interrupting said local circuit to cause the repeated operation of said impulse receiving relay.

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