

May 14, 1940.

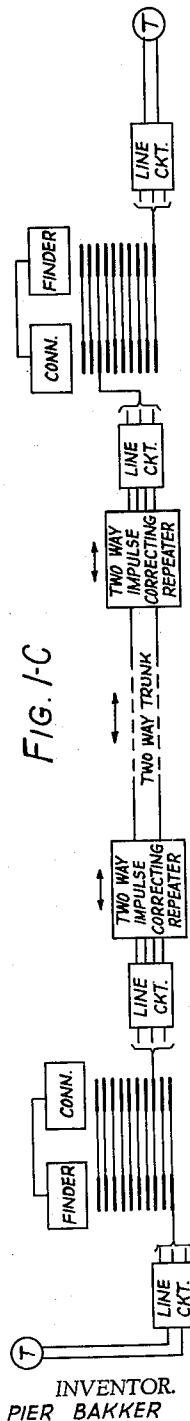
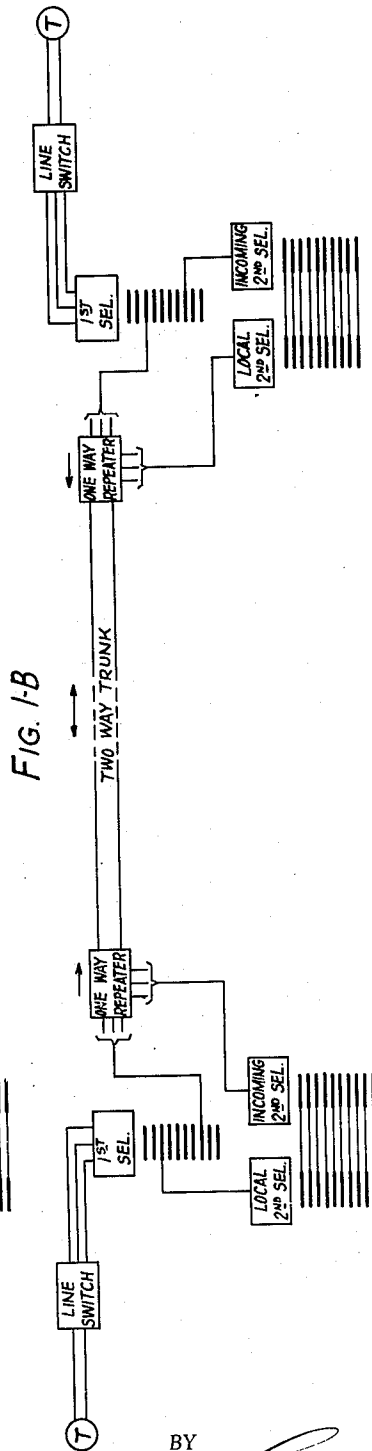
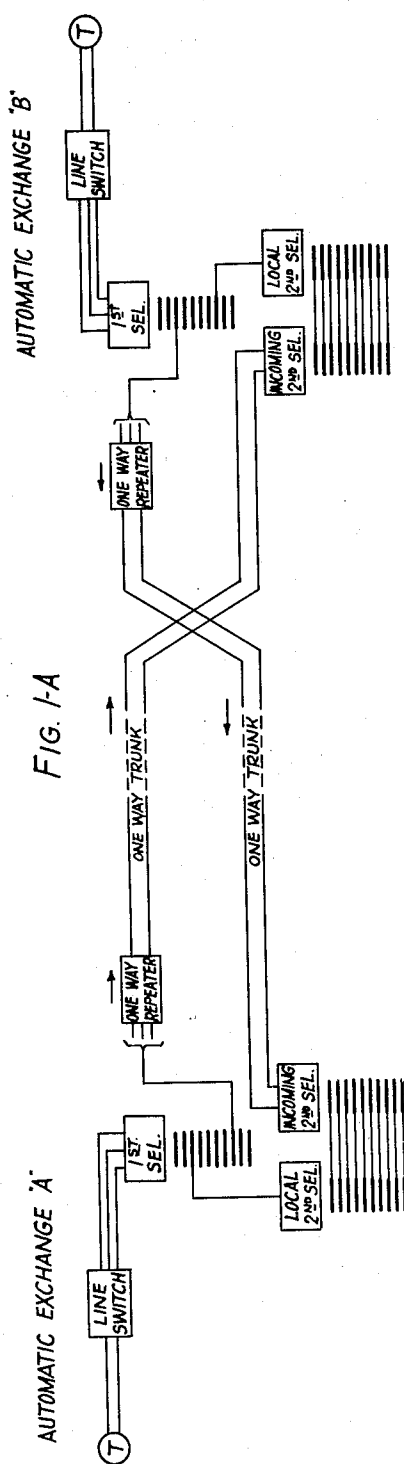
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2,200,817

AUTOMATIC TELEPHONE SYSTEM

Filed Jan. 11, 1937

4 Sheets-Sheet 1



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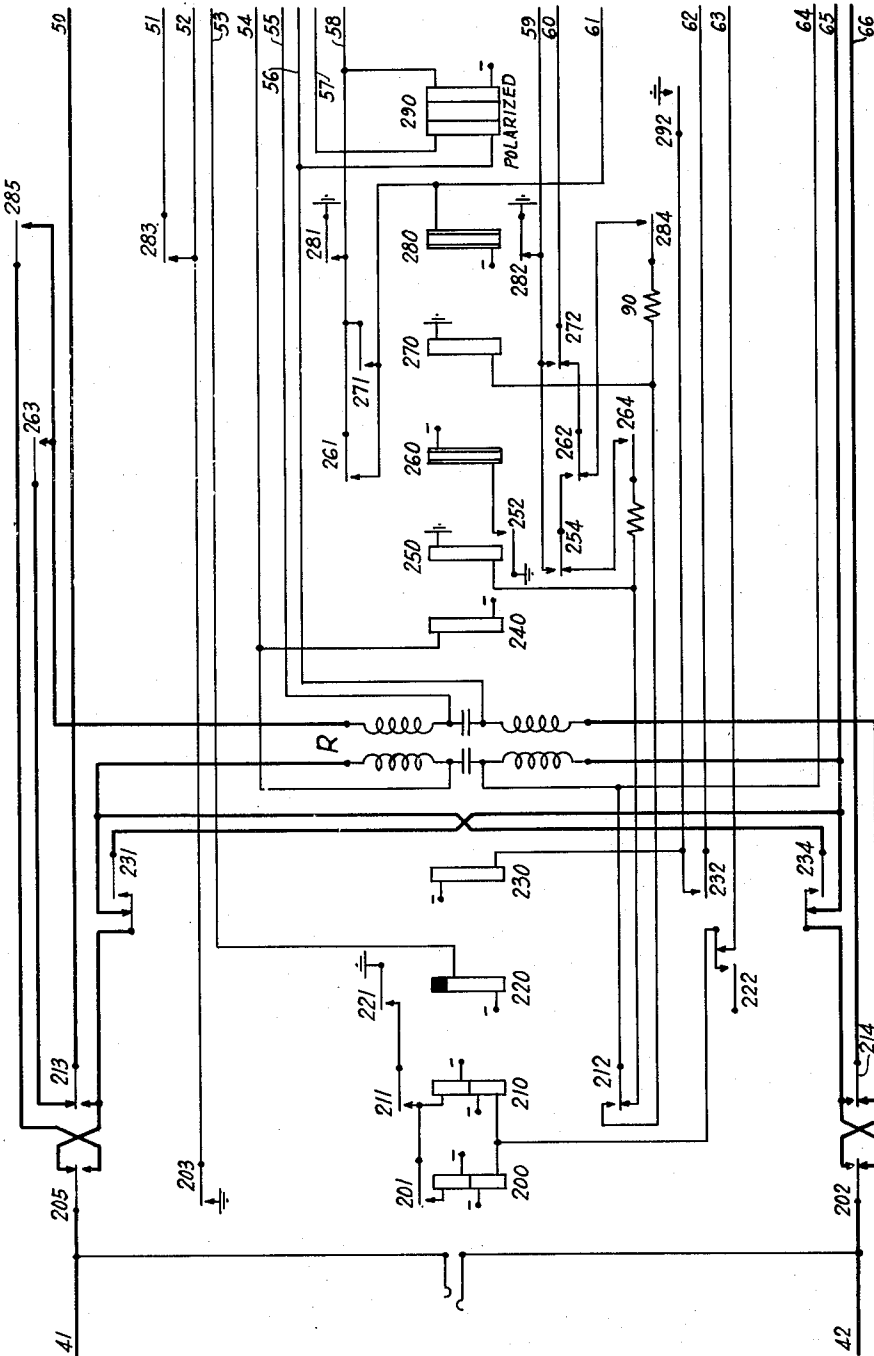
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REPEATER

FIG. 2



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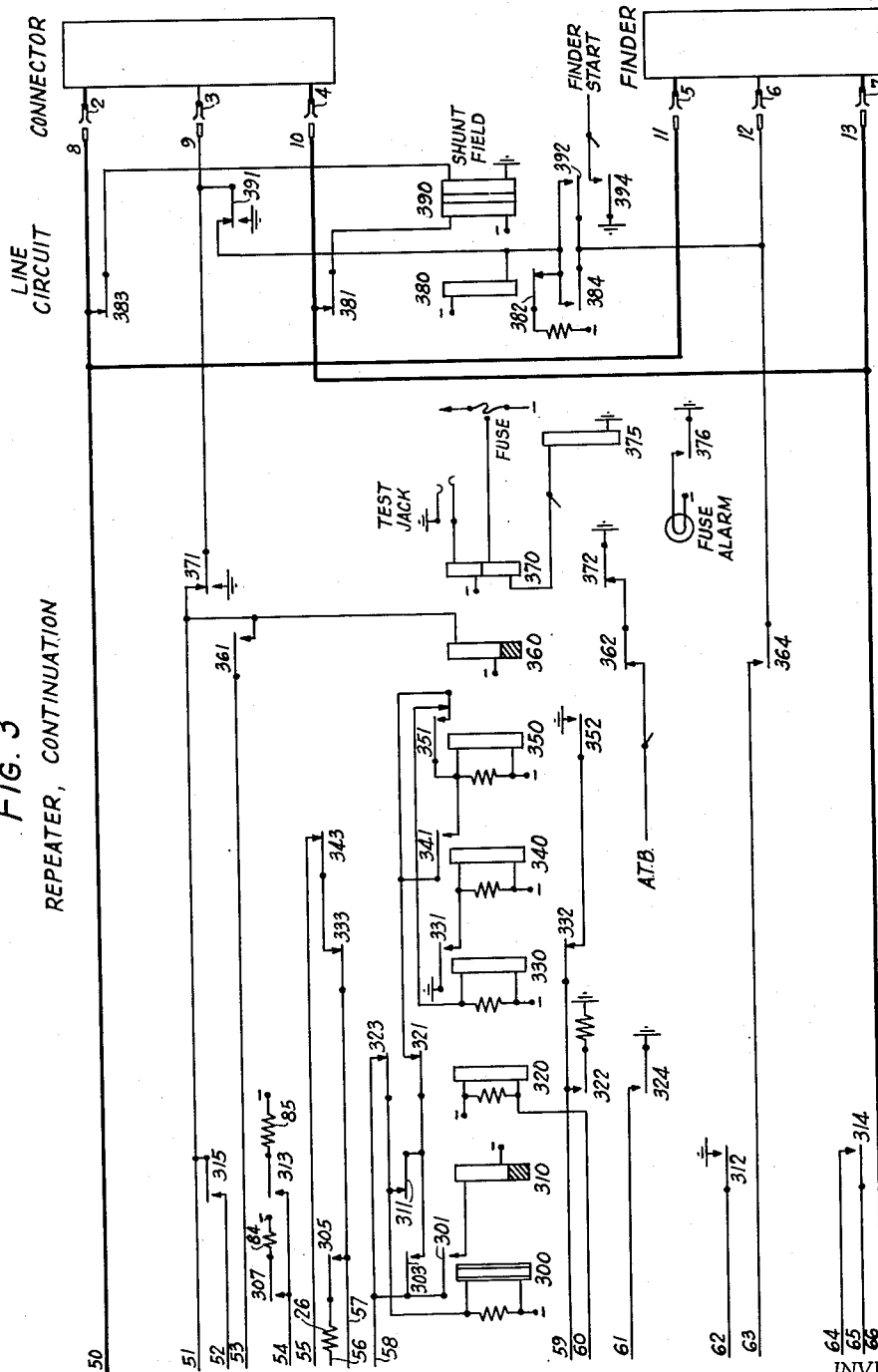
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FIG. 3
REPEATER, CONTINUATION



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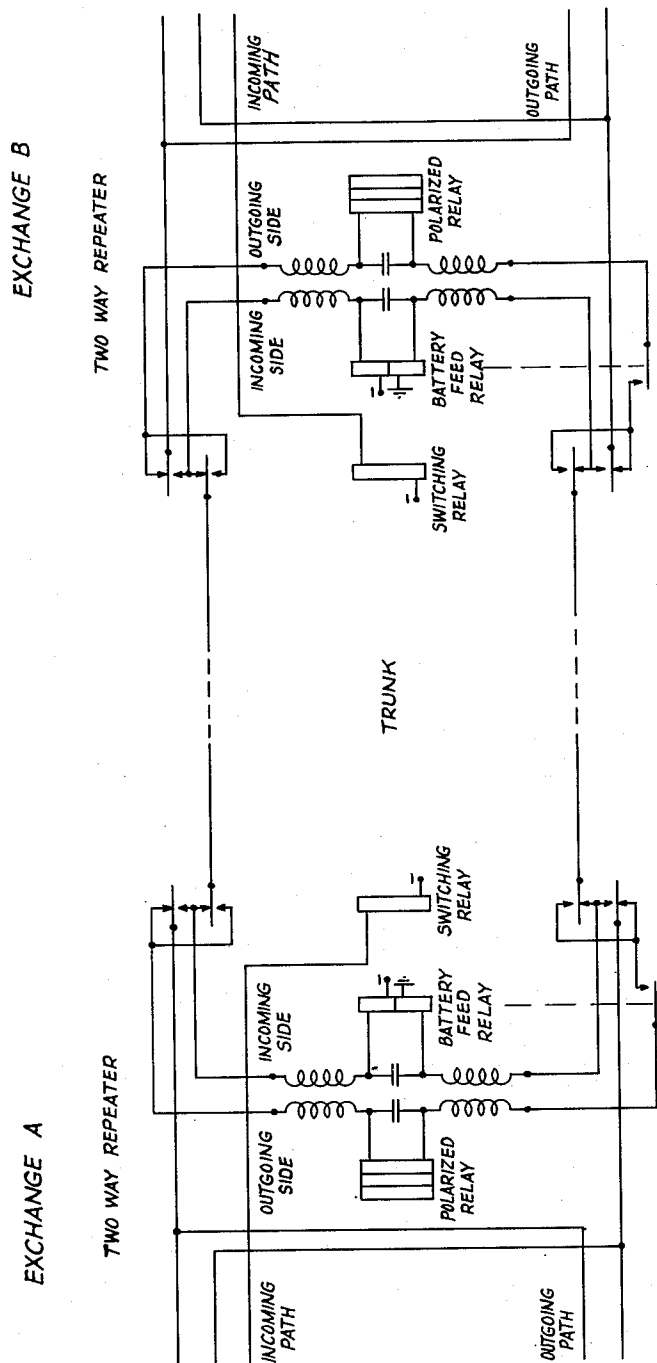
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AUTOMATIC TELEPHONE SYSTEM

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4 Sheets-Sheet 4

FIG. 4



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AUTOMATIC TELEPHONE SYSTEM

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5 Claims. (Cl. 179-16)

The present invention relates in general to automatic telephone systems, and more particularly to such systems as comprise two or more exchanges which are interconnected by trunk lines. The object of the invention, briefly stated, is to provide new and improved trunk circuits for interconnecting two automatic exchanges.

A special feature of the invention is a new and improved repeater which will repeat impulses in two directions, i. e., on either "out" or "in" calls, as will be more fully pointed out in the detailed specification which is to follow, reference being had to the accompanying drawings.

Referring to the drawings, comprising Figs. 1, 2, 3, and 4, there is shown by means of the usual circuit diagrams sufficient of the apparatus in the system to enable the invention to be explained and understood.

In Fig. 1 is shown three alternative trunking schemes adaptable for use between two automatic telephone exchanges. The scheme shown in Fig. 1A is illustrative of the use of a simple repeater as shown in the Martin Patent No. 1,260,424, granted March 26, 1918. The object of the repeater as here used is to eliminate the third conductor between exchange A and exchange B. It is evident that this is a one way repeater and repeats impulses only on "out" calls.

The scheme shown in Fig. 1B is illustrative of the use of two way trunks between automatic exchanges, and in general conforms to the trunking scheme shown in Lomax Patent No. 1,735,328, granted November 12, 1928. Even though the trunk is used in both directions, it is still evident that the repeater is a one way repeater and repeats impulses only on "out" calls.

Aside from the mere elimination the third inter-office conductor, repeaters are found to be of value in the matter of impulse correcting, as shown in Lomax Patent No. 1,521,821, granted January 6, 1925. It follows then that the two repeaters of Fig. 1B might have incorporated within them certain impulse correcting features. Attention is called to the fact that any correction made by the repeater in Fig. 1B can only compensate for the condition of the dial and line leading to the repeater, no compensation can be made for trunk conditions as this is a one way repeater.

In Fig. 1C are shown two small exchanges employing finder connector links for setting up connections, as shown in the Saunders Patent No. 1,999,788. The two exchanges are connected by a two way trunk terminating in each exchange upon the "two way impulse correcting

repeater" which forms the subject of this invention. It is to be noted that the repeater repeats impulses both on "out" and "in" calls. It is further to be noted that impulse correction is made by the first repeater for dial and line conditions, and by the second repeater for trunk conditions, thereby presenting greatly improved pulses to the switches of the distant exchange.

Figs. 2 and 3, when arranged with Fig. 2 to the left of Fig. 3, show sufficient detail to enable a clear understanding of the invention. The equipment here illustrated is all located in one exchange, which may be assumed to be exchange "B" of Fig. 1C, and discloses in detail the circuits of the two way repeater and the associated line circuit. The inter-exchange end of the trunk comprises the two conductors 41 and 42 at the left of Fig. 2. A portion of the repeater is shown in Fig. 2 and a continuation thereof in Fig. 3. The finder and connector branches of the trunk appear at the right of Fig. 3, which also indicates one finder and one connector having access to the trunk line. The equipment at the other end of the trunk line may be exactly the same and for convenience it will be assumed that such is the case.

In Fig. 4 is shown a schematic diagram of the trunk circuit depicted in Fig. 1C, without regard to circuit details. In exchange B will be recognized a well known form of impulse repeater in which a repeating coil is utilized to separate the incoming and outgoing circuits. A polarized relay is shown inserted at the mid point of the outgoing side of the repeating coil, and a battery feed relay supplies current to the mid point of the incoming side of the repeating coil. A pair of make contacts on the battery feed relay are arranged to complete the outgoing circuit.

The repeater at exchange A is identical with that at exchange B, and the circuit connections are such that the incoming side of each repeater is normally connected to the inter-office trunk. No current will flow over the trunk at normal for the battery connections at each exchange are the same, and presumably the potentials of the two batteries are equal.

When a repeater is seized over the incoming path a circuit will be closed to the associated switching relay which will function to reverse the repeating coil with respect to the incoming and outgoing circuits, thereby placing the repeater in a position to respond to dial pulses from the calling line and repeat the same over the trunk loop.

Outgoing calls—Seizure

In the following description of the operation the exchange at which the equipment shown in the drawings is located will be referred to as exchange B, and the exchange at the other end of the trunk will be referred to as exchange A.

Assuming now that a subscriber in exchange B desires to call a subscriber in exchange A, he will first remove his receiver, whereupon his line is picked up by the finder switch of a finder connector link. The calling subscriber then dials the digit or digits assigned to exchange A, with the result that the connector of the link in use will be operated to select the group of trunks extending to that exchange, and will then proceed to select an idle trunk line in the group. Assuming that the connector indicated in the drawing is used, and that the trunk shown is the trunk selected, when the connector wipers 2—4 engage the bank contacts 8—10 a ground will be placed in test wiper 3. A circuit is thus completed by way of 3, 9, and 391 to cut off relay 380 in the line circuit, which energizes and disconnects the line relay 390.

Ground also extends from bank contact 9 by way of 371 to relay 360, which now energizes and simultaneously extends two circuits from the originating ground at bank contact 9. The first circuit is by way of 371, 361, 53, to relay 220; the second circuit is by way of 391, 384, 364, 63, 222 to relays 200 and 210. Relay 220 is slow to energize, and it follows that relays 200 and 210 will energize and prepare their respective locking circuits at 201 and 211 before relay 220 operates. The operation of the latter relay will close the locking circuits of relays 200 and 210 at 221 before the energizing circuits of the said relays are opened at 222.

Relay 200 prepares for the connection of the trunk conductors 41 and 42 with the right hand winding of the repeating coil R by way of 205, 285, and 202. Since the two right hand windings of the repeating coil are connected together by way of the left hand winding of the electro-polarized relay 290, 57, 333, 343, and 55, it follows that the left hand winding of relay 290 is bridged across trunk conductors 41 and 42 when the bridge is completed by closure of contact 285. Responsive to the closure of this bridge, the line relay such as 390 at exchange A operates, starts up a finder therein, and makes the trunk busy at that exchange. As a result the trunk is extended through in exchange A to the connector of a finder connector link. Similar operations will be described more in detail hereinafter in the course of the explanation of a call originating at exchange A and directed to a subscriber in exchange B. Relay 290 does not energize at this time.

Relay 210 connects the battery feed impedance 240 to the calling line by way of the upper left hand winding of repeating coil R, 231, 213, 50, 8 and 2; and at the same time connects the ground feed relay 270 to the calling line by way of 212, the lower left hand winding of repeating coil R, 234, 214, 66, 10 and 4.

At the connector switch, the calling subscriber's line is switched through to the wipers 2 and 4, upon seizure of the trunk, the switching through operation taking place a short interval after the bridge cut off relay 380 is energized over the test wiper 3. Accordingly line relay 270 of the repeater now energizes over the calling subscriber's loop.

Relay 270 closes a circuit for relay 320 by way

of 282, 272, and 60. Relay 320 locks itself to ground at 322, so that it becomes independent of ground at 282, and closes a circuit for release relay 280 at 324. Relay 280 provides a locking circuit for itself by way of 281 and 271; closes the polarizing winding of relay 290 at 281; and supplies ground to hold the preceding switches by way of 203, 283, 51, 371, 9 and 3, thus maintaining the connector and finder of the link circuit in operated position after the falling back of the line and release relays of the connector. These relays deenergize following the switching through operation. The aforementioned ground supplied by relay 280 also holds the cut off relay 380 and relays 360 and 220 of the repeater.

Outgoing calls—repeating pulses

When the calling subscriber dials the next digit of the called number, the calling loop is interrupted a number of times depending on the value of the digit, and as a result the line relay 270 is deenergized a number of times to produce a like number of interruptions in the bridge across trunk conductors 41 and 42, and thus repeat the digit over the trunk to exchange A. The circuit has two distinct functions to perform when acting as an impulse repeater; first, the reduction of the normal impedance of both the line loop and of the trunk loop; and second, the correction or regeneration of the dial pulses as received from the calling line.

The normal impedance of the line loop consists of impedance 240, line relay 270 and the left hand windings of repeating coil R. The normal impedance of the trunk at exchange A consists of the equivalent of that described last above, and at exchange B comprises the right hand windings of repeating coil R and the operating winding of polarized relay 290.

When line relay 270 deenergizes at the start of the first interruption it breaks the circuit of release relay 280 at 271; and the circuit of relay 320 at 272. Relay 280 is slow to release and remains operated during the dialling period. Relay 320 deenergizes and closes the circuit of slow to release relay 300 by way of 281, 58, and 323. Relay 300 energizes and remains operated during the transmission of the dial pulses comprising a single digit, notwithstanding the fact that relay 320 follows such pulses, as will be explained more fully hereinafter. Relay 300 reduces the impedance of the trunk loop by connecting resistance 26 across the operating winding of polarized relay 290 at 305; reduces the impedance of the line loop by connecting resistance 84 in multiple with impedance 240 at 307; provides a holding circuit for relay 350 at 303; and closes the circuit of relay 310 at 301. Relay 310 energizes and further reduces the impedance of the line loop by short circuiting the lower left hand winding of repeating coil R at 314; it still further reduces the impedance of the line loop by connecting resistance 85 in parallel with resistance 84 at 313; and opens the operating circuit to relay 330 at 311.

At the end of each series of impulses, relays 300 and 310 deenergize, thereby restoring the normal impedance of both line and loop. It will be noted that impedance 240 is reinserted in the line loop by degrees, i. e., first by the removal of shunt resistance 84, and finally by the removal of resistance 85.

Relays 330, 340, and 350, constitute a 3-relay impulse regenerator on the lock impulse principle and provide a constant open period pulse to the

outgoing trunk provided the incoming pulse characteristics and speed remain within acceptable limits.

As previously explained, relay 270 follows the impulses received from the dial and when at normal opens the circuit of relay 280 at 271; the circuit of relay 320 at 272 and closes its own circuit by way of resistance 90, 284, 262, 272, 60, and relay 320. Relay 270 will not operate at this time because of the high resistance 90, the purpose of the circuit being to keep relay 270 partly energized so that it will respond more quickly during dialling. Relay 320 deenergizes and can not again energize in series with the high resistance 90; opens its own holding circuit at 322; closes the circuit of relay 300 by way of 281, 58, and 323; closes the circuit of relay 330 by way of 281, 58, 323, 311, 321 and 351. Relay 330 opens the loop to the distant exchange at 333 and closes the circuit of relay 340 at 331. Relay 340 opens a part of the incomplete loop to the distant exchange at 343, and closes the circuit of relay 350. Relay 350 opens the circuit of relay 330 at 351 and closes a holding circuit for itself by way of 281, 58, 323, 311, 321 and 351. Relay 330 now deenergizes, opens the circuit of relay 340; closes a part of the loop circuit to the distant exchange at 333; and prepares an operating circuit for relay 320 at 332. Relay 340 now deenergizes, opens the operating circuit of relay 350; and closes the loop circuit to the distant exchange at 343, thus completing the first pulse to the distant exchange.

When the line loop is again closed relay 270 will energize and reclose the circuit of relay 280 at 271; and establish a circuit for relay 320 by way of 352, 332, 59, 272, and 60. Relay 320 will lock itself up at 322, and open the locking circuit of relay 350 at 321. Relay 350 now deenergizes and opens the operating circuit to relay 320 at 352, and prepares the circuit of relay 330. When the next pulse opens the circuit of relay 270 the cyclic operation of relays 320, 330, 340, and 350 will again take place. Thus it will be seen that the duration of the repeated pulse is determined by the time interval during which relays 330 and 340 are in their operated position, and not by the character of the incoming pulse.

50 *Outgoing calls—Reversing battery to the calling line*

Continuing now with the general explanation, the digits of the called number are repeated in the manner described and result in the completion of the connection to the desired subscriber's line in exchange A. When the called subscriber answers, the connector in use reverses the direction of current flow over the trunk conductors 41 and 42 in the usual manner, causing the operation of the polarized relay 290. Relay 290 closes the circuit of reversing relay 230 at 292. The latter relay energizes to reverse the direction of current flow in the calling subscriber's line; and prepares a circuit for locking itself up by way of 65 232, 62, and 312. The later mentioned locking circuit insures that relay 230 will not deenergize in the event that the calling subscriber should operate his dial after the called party answers.

70 *Outgoing calls—Releasing*

The restoration of the receiver to the switch hook at the calling substation will open the line circuit and cause the deenergization of relay 270. Relay 270 falls away opening the circuit of relay 75 320 and the locking circuit of relay 280. Relay

320 falls away opening the circuit of relay 280; and closes the circuit to relays 300 and 310. Relay 310 causes 315 to shunt 283 so that ground may be maintained on the holding circuit after the falling away of relay 280. Relay 280 now falls away and at 285 opens the trunk loop to affect the release of the switches in the distant office; and at 281 opens the circuit to relays 300 and 310. Relay 310 next falls away and removes ground from the holding circuit at 315, thus causing the release of the preceding equipment and of relays 200, 210, 220, and 360. Relays 330, 340, and 350 will at this time run through their accustomed cycle, but without effect as the trunk loop is open at 285. The release takes place as explained, irrespective of whether or not the battery is reversed on the trunk at the time at which the calling subscriber hangs up his receiver.

If the release of the connection should take place while current is reversed on trunk conductors 41 and 42, no lock up can occur, due to the arrangement involving slow to release relays 280 and 310. The trunk loop is opened at 285 immediately upon the falling away of relay 280, but a holding circuit for the equipment at the originating exchange is maintained at 315 by relay 310. The equipment at the distant exchange will release and restore normal polarity to the trunk before relay 310 deenergizes, thereby obviating any possibility of a lock up due to opposite polarities at the ends of the trunk.

Incoming calls—Seizure

In order to complete the explanation, the operation of the repeater and line circuit of Figs. 2 and 3 will be considered in connection with a call from exchange A to exchange B.

When the trunk line is seized at exchange A, the repeater on that end of the trunk places a bridge across trunk conductors 41 and 42. Negative battery is fed to the trunk loop through impedance 240 by way of the upper left hand winding of repeating coil R, 231, 205, and 41; while positive battery is fed through relay 250 by way of 212, the lower left hand winding of repeating coil R, 234, 202 and 42.

Relay 250 operates and at 252 closes the circuit of relay 260. Relay 260 operates and at 261 prepares the locking circuit of relay 280; and at 263 closes the circuit of line relay 390. Relay 390 operates and by ground at 391 makes the trunk busy in the banks of the connectors; a circuit is also closed via 371 to relay 360. Relay 360 operates and closes a circuit via 361 and 53 to relay 220. Relay 220 operates and at 222 opens the circuit of relays 200 and 210, thus preventing their subsequent operation.

A further result of the energization of line relay 390 is the connection, at 392, of the cut off relay 380 with the test contact 12 in the bank of the finders, thus placing a test potential on this contact; and the closing of a finder start circuit at 394.

An idle finder is thus caused to search for the operated line, in a manner well known in this art. Assuming the finder in use is the one indicated in Fig. 3, when the test wiper 6 reaches test contact 12, the finder test relay energizes in series with cut-off relay 380 and stop the finder. Relay 380 locks itself at 384, removes the non-inductive shunt resistance at 382, and disconnects line relay 390 at 381 and 383. Relay 390 now deenergizes. Relay 380 is held energized by ground from the finder and later from the connector of the link, the circuit including the finder test wiper 75

6. These circuits are known and are fully explained in the disclosure hereinbefore referred to.

A further result of the energization of relay 250 is the closure of a circuit from 282, 254, 262, 272, and 60 through relay 320. Relay 320 operates and closes the circuit of relay 280, which in turn operates and prepares the circuit to relays 300, 330, and 350.

10 *Incoming calls—Repeating impulses*

Relay 250 follows the impulses received over the trunk and causes relay 320, the impulse regenerating relays 330, 340, 350, and relay 300 and 310 to operate as before explained to produce 15 pulses in the outgoing circuit. Due to their slow to release characteristics relays 260 and 280 remain energized until the connection is released, while relays 300 and 310 remain energized during each series of impulses. The relays in the link circuit follow the impulses received and complete 20 the desired connection.

Incoming call—Reversing battery to the trunk

25 The digits of the called number are repeated in the manner described and result in the completion of the connection to the desired subscriber's line in exchange B. When the called subscriber answers, the connector in use reverses the direction of current flow to relay 290, causing the 30 latter relay to operate and close the circuit of relay 230. Relay 230 now operates to reverse the battery over trunk conductors 41 and 42.

When the called party disconnects, the direction of current flow through relay 290 is reversed, 35 whereupon the latter relay deenergizes and opens the circuit of relay 230. Relay 230 now deenergizes and restores normal polarity to trunk conductors 41 and 42.

10 *Incoming call—Releasing*

When the calling party restores his receiver, the equipment in exchange A will release and open the trunk loop, thereby causing the deenergization of relay 250. Relay 250 opens the circuit of relay 260 at 252, and the circuit of relay 320 at 254. Relay 260 opens the line loop at 263, thus causing the release of the link circuit and of relays 360 and 220. The impulse regenerating relays operate through a complete cycle 50 but have no function to perform at this time.

While the invention has been shown as used in a trunk connecting two similar exchanges, as shown in Fig. 1C, it will be readily apparent that 55 the equipment comprising exchange B of Fig. 1C could also be used equally well in a trunk connecting with exchange A of Fig. 1B.

The invention having been described, that which is believed to be new and for which the protection of Letters Patent is desired will be 60 pointed out in the appended claims.

What is claimed is:

1. In an impulse repeater for automatic telephone systems, a first line section, a second line

section, a relay normally controlled by interruptions in said first line section, interrupter contacts on said relay for repeating such interruptions into said second line section, and means 5 for causing said relay to be controlled by interruptions in said second line section and the interrupter contacts thereon to repeat such interruptions into said first line section.

2. In an automatic telephone system, an impulse repeater comprising a line relay, an incoming circuit and an outgoing circuit, said line relay responsive to interruptions in said incoming circuit and interrupter contacts thereon for repeating such interruptions into said outgoing circuit, a first exchange, a second exchange, a 15 trunk extending between said first and second exchanges, said repeater normally inserted in said trunk with the incoming circuit connected to said first exchange and the outgoing circuit connected to said second exchange, and means 20 operated by the seizure of the said trunk from the second exchange to cause the connections of said incoming circuit to said second exchange and of said outgoing circuit to said first exchange. 25

3. In a signalling system, a first circuit, a second circuit, a repeater interposed between said first and second circuit, a relay normally controlled by interruptions in said first circuit and interrupter contacts thereon for repeating such 30 interruptions into said second circuit, and means operated by the seizure of said repeater over said second circuit to alter the connections of said relay to repeat circuit interruptions in said second circuit into said first circuit. 35

4. In an automatic telephone system, a first exchange, a second exchange, a two way trunk between said exchanges, an impulse repeater at each exchange, said repeaters normally associated 40 with said trunk for repeating impulses therefrom to one of said exchanges, and means operated by the seizure of said trunk by one of said exchanges to alter the connection of the repeater associated therewith for repeating impulses from said one exchange to said trunk. 45

5. In a signalling system, a first circuit, a second circuit, a repeater interposed between said first and second circuits, a line relay normally responsive to interruptions in said first circuit, another line relay normally ineffective, a plurality of relays common to said circuits and normally repeating into said second circuit, in response to the operations of the line relay of said first circuit, any interruptions in the first circuit, means responsive to seizure of said second 55 circuit for causing said other relay to respond to interruptions in said second circuit, for rendering the line relay of said first circuit ineffective, and for causing said plurality of relays to repeat into said first circuit, in response to the operations 60 of said other relay of said second circuit, any interruptions in the second circuit.

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