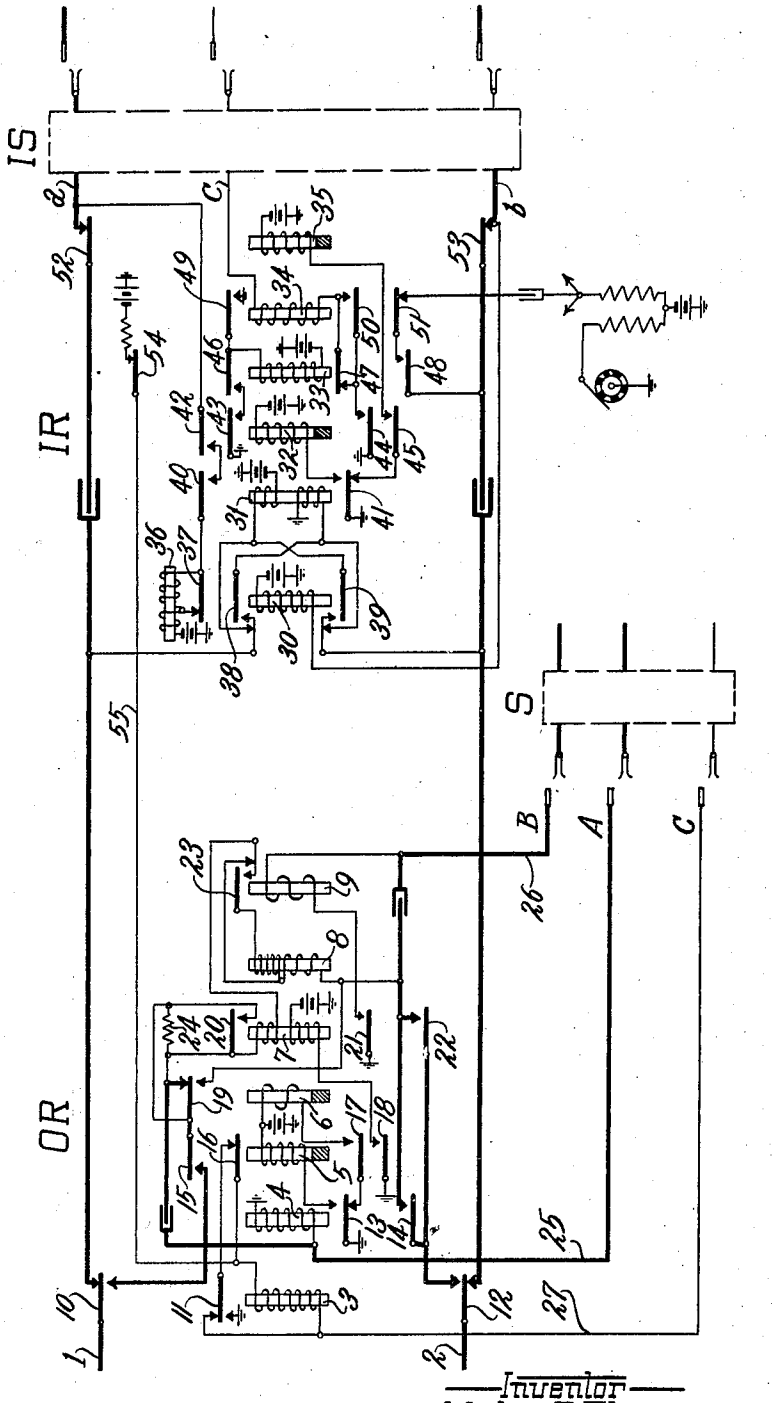
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AUTOMATIC TELEPHONE SYSTEM

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AUTOMATIC TELEPHONE SYSTEM

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The present invention relates to automatic telephone systems in general, but is concerned more particularly with multi-office automatic telephone systems in which there are two different kinds of offices or exchanges, and the principal object, stated briefly, is the provision of new and improved repeater circuits for handling calls between two different types of automatic step-by-step offices.

The two systems concerned in the present invention are commonly referred to as the Strowger type of system, that is, the two systems have automatic switches which are operated on the well known Strowger step-by-step principle. The switches of the two systems are therefore somewhat similar in mechanical construction but differ considerable in regard to switch control and supervision. The standard method of switch control in one type of system (the one used in the United States) is over a two wire metallic loop and supervision is controlled by the reversal of battery over the two talking leads. This type of system will be referred to hereinafter as a two-wire loop system. In the other type of system, switch control is over only one of the talking conductors, commonly referred to as the A or negative talking conductor, and supervision is controlled over the other talking conductor, commonly referred to as B or positive talking conductor. This latter type of system is manufactured by the Mix and Genest Telephone and Telegraph Company of Berlin, Germany, and will be referred to hereinafter as the battery pulse system or the Mix and Genest system.

The two systems are also different in regard to the method of giving the calling subscriber a busy tone when a busy line is encountered. In the two wire loop system when the connector or last switch in the train encounters a busy line, the busy relay in the connector energizes and connects up the busy machine, thereby giving the calling subscriber the busy tone. The operated switches are maintained in operated position until the calling party hangs up his receiver. In the battery pulse system when the last switch in the train encounters a busy line, all but the first of the switches automatically release responsive thereto and the busy tone is transmitted to the calling subscriber from the first switch in the switch train.

In order to provide telephone service between subscribers in the two different types of systems, as above described, a group of two-way trunk lines extends from an office of the two wire type and terminates in incoming and outgoing repeaters in an office of the so called battery pulse type.,

One of the features of the present invention relates to an incoming repeater which translates the two wire loop impulses received over the two incoming trunk conductors and transmits a corresponding number of interrupted negative battery impulses over the outgoing negative talking conductor or "A" lead; which translates the grounded switch supervision received over the outgoing positive talking conductor or "B" lead and transmits reverse battery over the two incoming talking conductors; and which connects the busy tone to the incoming trunk when the last switch of the train encounters a busy condition and all of the operated switches in the battery pulse office included in the connection release responsive to the encountered busy condition.

Another feature of the invention relates to an outgoing repeater which translates the negative battery impulses received over the incoming negative lead and transmits a corresponding number of two-wire loop impulses over the two outgoing talking conductors of the trunk, and which translates the reverse battery supervision, which is received over the two outgoing talking conductors of the trunk, to supervision over only the positive incoming talking conductor, or the B lead, by connecting ground to such conductor responsive to receiving the reverse battery supervision. These and other features of the invention not specifically mentioned at this time will be better appreciated when the following description is taken in conjunction with the accompanying drawings.

Referring now to drawings, there is shown by means of the usual circuit diagram, the

new and improved outgoing and incoming repeaters OR and IR, respectively, located in one of the offices in the so called battery pulse system, one of the trunks comprising the conductors 1 and 2 extending to a distant office of the so called two wire loop system, and the selector switches S and IS located in the battery pulse office.

The outgoing repeaters, such as OR, comprise a plurality of relays and are taken into use by calling subscribers, having lines terminating in the battery pulse office, for extending connections to called subscribers located in the distant two-wire loop offices over trunks such as the trunk comprising conductors 1 and 2. The outgoing repeaters OR are accessible to the calling subscribers by way of selectors such as S.

The incoming repeaters, such as IR, comprise a plurality of relays and are taken into use by the distant calling subscribers in the two wire loop office over trunks such as the trunk comprising conductors 1 and 2 for extending connections to called subscribers by way of the incoming selectors, such as selector IS, in the battery pulse office.

The incoming first selector switches, such as IS, are located in the battery pulse office and are vertical and rotary step-by-step switches similar in mechanical construction to the well known two-wire Strowger type of switch. The switch control circuits of which, however, are different from the Strowger switches of the well known two-wire loop type as previously described. The banks of the selectors IS are connected in multiple to the banks of the regular first selectors in the battery pulse office.

The selectors, such as S, are also located in the battery pulse office and are somewhat similar to the selectors IS. The selectors S have access to repeaters, such as OR, and may be either first, second, third or fourth selectors dependent upon the trunking layout in the battery pulse office.

The remaining switches and trunking arrangements in the two systems being well understood and forming no part of the present invention, are therefore not described or shown in the drawings.

With this general description of the drawing in mind, the operation of the repeater circuits will now be explained in detail. For this purpose, it will be assumed that a calling subscriber in the distant two-wire loop office desires to obtain a connection with a called subscriber whose line terminates in the battery pulse office. It will further be assumed that responsive to the removal of the receiver by the calling subscriber his individual line switch seizes an idle trunk leading to an idle selector repeater, such as disclosed in Patent 1,542,958 issued to A. J. Ray, and that the line switch associated with the seized selector repeater seizes an idle trunk extending to the desired office. Let us now assume that the trunk comprising the conductors 1 and 2 is the trunk seized by the line switch. Responsive to the seizure of this trunk, a closed loop circuit for energizing the line relay 31 of the incoming repeater IR may be traced over the trunk conductors 1 and 2, armatures 10 and 12 and their resting contacts, normally closed springs controlled by armatures 38 and 39, and upper and lower windings of line relay 31 to battery and ground, respectively.

Line relay 31 energizes over the above traced circuit and at armature 40 prepares a circuit for repeating negative battery impulses over the "*a*" or negative conductor to the line relay in the incoming selector IS. At armature 41 relay 31 closes an energizing circuit for the slow to release relay 32. Relay 32, upon energizing, at armature 42 closes a circuit over the "*a*" conductor to the line relay in the selector IS for preparing such switch for operation; at armature 43 prepares a locking circuit for relay 33; at armature 44 closes a circuit for energizing relay 34 and for preparing a holding circuit for the selector IS; and at armature 45 prepares a circuit for energizing slow to release relay 35. The circuit for energizing relay 34 may may be traced as follows: grounded armature 44, armature 47, winding of relay 34, the "C" lead or holding conductor, to battery in the incoming selector IS. Relay 34, upon energizing, at armature 49 closes a circuit for relay 33; at armature 50 closes a locking circuit for itself; and at armature 51 disconnects the busy tone machine. Relay 33, upon energizing, at armature 54 removes the battery potential from conductors 55 and 27, thereby rendering the outgoing repeater OR busy to selectors, such as S, having access thereto; at armature 46 closes a locking circuit for itself; at armature 47 opens the initial energizing circuit of relay 34; and at armature 48 prepares a circuit for connecting the busy tone to the lower talking conductor.

Responsive to the seizure of the incoming selector IS, as above described, the line relay in such selector energizes and closes a circuit over the "C" lead or holding conductor for another relay in the incoming selector IS which prepares the selector for its vertical operation.

The calling subscriber may now dial the remaining digits in the telephone number of the called subscriber. When the calling subscriber operates his calling device in accordance with the next digit in the telephone number of the called subscriber, the circuit of the line relay 31 is interrupted a plurality of times thereby causing said relay to release a like number of times. Upon the first deenergization of line relay 31 a circuit is closed from armature 41 and its resting contact for energizing the slow to release relay 35. Relay

35 energizes and at armatures 52 and 53 opens the circuits to the talking condensers of the repeater IR. At armature 40, relay 31 interrupts or opens the switch control or impulsing circuit to the incoming first selector IS thereby causing the line relay in the selector IS to deenergize. For each interruption in the loop circuit extending over the conductors 1 and 2 the line relay 31 at armature 40 interrupts the circuit of the line relay in the incoming selector IS, thereby causing said switch to operate in the well known manner. It may well be mentioned at this time that the slow to release relay 32 is maintained energized throughout the impulsing period and that relay 35 due to its slow to release characteristics maintains its armatures attracted during each series of impulses. The interrupted negative battery impulses transmitted over the "*a*" conductor to the incoming selector IS and to subsequent selectors in the battery pulse office cause said switches to extend the connection in a well known manner to the line of the desired called subscriber.

Assuming now that the called line is busy, the operated switches in the battery pulse office automatically releases responsive to the connector or last switch in the train encountering a busy line. In the incoming selector IS, the release magnet removes battery from the "C" lead thereby opening the circuit of relay 34 which deenergizes. Relay 34, upon deenergizing, at armature 51 connects the busy tone machine to the lower talking conductor thereby transmitting the busy tone to the calling subscriber in the well known manner. The calling subscriber upon hearing the busy signal replaces his receiver and the release of the connection takes place in a manner to be described hereinafter.

We will now assume that the called line is idle. Under these conditions, the called subscriber's bell is rung in the usual manner. When the called party answers responsive thereto a relay in the last switch in the train connects ground to the lower talking conductor of such switch. This same ground extends over the intermediate switches to the "*b*" or lower talking conductor of the repeater, thereby causing the energization of the reversing relay 30. Relay 30, upon energizing, at armatures 38 and 39 reverses the direction of current flow over the conductors 1 and 2 for operating the calling subscriber's meter or for other supervisory purposes. At armature 37 relay 30 includes the high resistance winding of impedance 36 in the impulse circuit over the "*a*" lead.

When conversation is finished both subscribers hang up their receivers and the operated switches in the two wire loop office release in the well known manner thereby opening the circuit of line relay 31 which thereupon deenergizes. After an interval, slow to release relay 32 deenergizes and opens the locking circuits of relays 33 and 34 which thereupon deenergize. The operated switches in the battery pulse system release in the well known manner thereby rendering said switches available for use. All of the apparatus in both systems are now in normal position.

It will now be assumed that a calling subscriber in the battery pulse office desires to complete a connection with a called subscriber located in the distant two wire loop office. It will further be assumed that responsive to the removal of the receiver by the calling subscriber, the battery pulse switches are operated in the customary manner and that the selector S is operated and seizes an outgoing repeater for extending the connection to the two wire loop office. It will further be assumed that selector S seizes the outgoing repeater OR shown in the drawings. When this occurs a circuit for energizing the line relay 4 in the outgoing repeater OR may be traced as follows: from negative battery through the "A" lead of the selector S to the middle wiper of selector S, the "A" lead or conductor 25, and winding of relay 4 to ground. Relay 4, upon energizing, at armature 13 closes a circuit for energizing slow to release relay 5 and at armature 14 prepares a point in a bridge circuit for across the conductors 1 and 2. Relay 5, upon energizing, at armature 17 prepares a circuit for the slow to release series relay 6; at armature 18 closes an energizing circuit for the lower winding of electropolarized relay 7; at armature 16 removes the normally closed short circuit around relay 3, and at armature 15 prepares another point in the bridge circuit across the conductors 1 and 2. As soon as the short circuit around relay 3 is removed said relay energizes over a circuit extending from ground through the test relay in the selector S, lower wiper of the selector S, the "C" lead or conductor 27, winding of relay 3, conductor 55, armature 54, and through the associated resistance to battery. Relay 3 energizes over the above traced circuit and at armature 11 opens another point in the normal short circuit around itself and at its working contact prepares a point in the release circuit for the battery pulse switches. At armatures 10 and 12, relay 3 completes a bridge across the conductors 1 and 2 for energizing the line relay in the incoming switch in the two wire loop office. The bridge extends from trunk conductor 1 by way of armature 10 and its working contact, armature 15, armature 19 and its resting contact, upper winding of relay 7, normally closed springs controlled by armature 23, lower winding of impedance 8, armature 14, working contact of armature 12 and said armature to conductor 2. The electropolarized relay 7, although included in the bridge, is not energized because the current flow through the upper winding is in the

wrong direction. When the calling subscriber dials the remaining digits in the telephone number of the called subscriber, the circuit of line relay 4 is interrupted in the well known manner. Line relay 4 deenergizes responsive to the first impulse and at armature 13 closes an energizing circuit for the slow to release series relay 6 which thereupon energizes. At armature 14 line relay 4 opens the bridge across the trunk conductors 1 and 2 thereby causing the line relay in the incoming switch in the two wire loop office to deenergize. Series relay 6, upon energizing, at armature 19 and its working contact closes a direct current bridge across the conductors 1 and 2 in order to improve the impulsing circuit. Relay 6, however, is maintained energized only throughout each series of impulses. At the termination of the impulse, line relay 4 closes the bridge across the conductors 1 and 2 for again energizing the line relay in the distant office. The line relay 4 and the line relay in the distant office are operated in a like manner responsive to further impulses sent by the calling subscriber. At the end of each series of impulses the slow to release series relay 6 deenergizes and opens the direct current bridge thereby again substituting the bridge circuit through the electro-polarized relay 7.

The switches in the two wire loop office are operated in the well known manner to extend the connection to the called subscriber. When the called subscriber answers, the connector switch in the two wire loop office reverses the direction of current flow over the conductors 1 and 2, thereby causing the operation of the electro-polarized relay 7. Electro-polarized relay 7, upon energizing at armature 20 short circuits the high resistance 24; and at armature 21 connects ground by way of relay 9 over conductor 26 or "B" lead to selector S for controlling the switch supervision or for causing the operation of the calling subscriber's meter as the case may be.

In case the called line was busy when called, the connector in the two wire loop office would not reverse the direction of current flow but instead would connect the busy tone to the trunk and the busy tone would be transmitted to the calling subscriber over the heavy talking conductors in the well known manner.

When conversation is terminated both subscribers replace their receivers. The replacement of the receiver by the calling subscriber opens the circuit of the line relay 4, whereupon said relay deenergizes. At armature 14 line relay 4 opens the bridge across the conductors 1 and 2 thereby permitting the switches in the two wire loop office to release in the well known manner. At armature 13 relay 4 opens the circuit of the slow to release relay 5 which, after an interval, releases. At armature 18 relay 5 opens the circuit of relay 7 and at armature 16 stops the current flow through relay 3 by connecting ground by way of armature 11 to relay 3 to cause said relay and the selector S to release. The deenergizing circuit for relay 3 may be traced as follows: ground by way of a working contact of armature 11 and said armature, armature 16, relay 3, conductor 27 or "C" lead, and through the test relay in the selector S to ground. Relay 3 in the outgoing repeater OR and the test relay in the selector S deenergize, thereby causing the repeater OR and the selector S to be returned to normal. The switches in the battery pulse office are released and returned to their normal position in the customary manner and may be used for extending further connections.

Having described the invention, its utility and operation, what is considered new and is desired to have protected by Letters Patent will be set forth in the appended claims.

What is claimed is:

1. In a telephone system, a first exchange, a second exchange, a repeater in said second exchange, a two conductor trunk line connecting said exchanges and terminating in said repeater, a line relay in said repeater having two windings connected to battery and ground, respectively, a closed incoming switch control circuit including the two conductors of said trunk line and the two windings of said relay in series, an automatic switch in said second exchange, a plurality of conductors outgoing from said repeater and terminating in said switch, a second switch control circuit including one pole of battery, only one of said outgoing conductors, a line relay in said switch, and the other pole of battery, means for interrupting said closed incoming switch control circuit a plurality of times to cause the operation of said line relay in the repeater, and means controlled by said line relay for interrupting said second switch control circuit a corresponding number of times to operate the line relay in said switch thereby causing said switch to extend a connection.

2. In a telephone system, two exchanges, an impulse repeater, a trunk line comprising only two conductors extending from the first exchange and terminating in said repeater in the second exchange, outgoing conductors extending from said repeater and terminating in an automatic switch in the second exchange, means in said first exchange for sending loop impulses over the two conductors of said trunk line in series to said repeater, and means in said repeater responsive to receiving said loop impulses for re-transmitting negative battery impulses out over only one of the outgoing conductors extending from said repeater to said automatic switch to extend a connection.

3. In a telephone system, two exchanges,

an impulse repeater, a trunk line comprising only two conductors extending from the first exchange and terminating in said repeater in the second exchange, outgoing conductors extending from said repeater and terminating in an automatic switch in the second exchange, other automatic switches in the second exchange, means in said first exchange for sending loop impulses over the two conductors of said trunk line in series to said repeater, means in said repeater responsive to such loop impulses for re-transmitting a like number of negative battery impulses out over only one of the outgoing conductors of the repeater to cause said switch and said other switches to extend a connection to a called subscriber's line, a source of busy signalling current in said repeater, means for automatically releasing said switch and said other switches in case the called line is busy, and means in said repeater responsive to said busy condition for automatically connecting said source to said trunk line.

4. In a telephone system, two exchanges, an impulse repeater, a trunk line comprising only two conductors extending from the first exchange and terminating in said repeater in the second exchange, outgoing conductors extending from said repeater and terminating in an automatic switch in the second exchange, other automatic switches in the second exchange, means in said first exchange for sending loop impulses over the two conductors of said trunk line in series to said repeater, means in said repeater responsive to such loop impulses for retransmitting a like number of negative battery impulses out over only one of the outgoing conductors of the repeater to cause said switch and said other switches to extend a connection to a called subscriber's line, means responsive to the called subscriber answering for grounding another outgoing conductor of said repeater, and means in said repeater controlled over said second outgoing conductor independent of the first outgoing conductor for reversing the flow of current over the conductors of said trunk line.

5. In a telephone system, two exchanges, an impulse repeater in the second exchange, a trunk line comprising only two conductors connecting said exchanges, said repeater normally disconnected from the conductors of said trunk line, incoming conductors terminating in said repeater, means for seizing said repeater over said incoming conductors, means in said repeater responsive to said seizure for connecting said trunk conductors to said repeater and for closing a bridge across the conductors of said trunk line, means for sending negative battery impulses over only one of said incoming conductors to said repeater to cause said bridge across the trunk conductors to be opened to transmit a corresponding number of loop impulses over the conductors of said trunk line, automatic switches in said first exchange operated by said loop impulses to complete a desired connection to a called subscriber's line, means responsive to the called subscriber answering for reversing the flow of current over the conductors of said trunk line, and means in said repeater responsive to said reversal for connecting ground to another of said incoming conductors for supervisory purposes.

6. In a telephone system, two exchanges, a trunk line comprising only two trunk conductors connecting said exchanges, two repeaters in the second exchange individual to said trunk line, outgoing conductors extending from the first of said repeaters, incoming conductors extending to the second of said repeaters, means in the first of said repeaters for receiving loop impulses over the two trunk conductors of said trunk line in series and for retransmitting negative battery impulses out over only one of said outgoing conductors of said first repeater, means in the second of said repeaters for receiving negative battery impulses over only one of said incoming conductors and for retransmitting loop impulses over the two trunk conductors of said trunk line in series, means in the first of said repeaters responsive to ground being connected to the other of said outgoing conductors of said first repeater for reversing the flow of current over the two trunk conductors of said trunk line for supervisory purposes, and means in the second of said repeaters responsive to a reversal of current over the two trunk conductors of said trunk line for connecting ground to the other of said incoming conductors of said second repeater for supervisory purposes.

7. In a telephone system, two exchanges, an impulse repeater, a two conductor trunk line extending from the first exchange and terminating in said repeater in the second exchange, a switch control circuit including both conductors of said trunk in series, an automatic switch in the second exchange, outgoing conductors from said repeater terminating in said automatic switch, a second switch control circuit including a source of battery in said repeater and only one of said outgoing conductors, and means in said repeater responsive to the closure of said first switch control circuit for closing said second switch control circuit.

8. In a telephone system, two exchanges, an impulse repeater, a two conductor trunk line extending from the first exchange and terminating in said repeater in the second exchange, a switch control circuit including both conductors of said trunk in series, an automatic switch in the second exchange, outgoing conductors from said repeater terminating in said automatic switch, a second switch control circuit including a source of battery in said repeater and only one of said

outgoing conductors, means in said repeater responsive to the closure of said first switch control circuit for closing said second switch control circuit, and means responsive to interruptions of said first switch control circuit for causing a like number of interruptions in said second switch control circuit for extending a connection by operating said switch.

9. In a telephone system, two exchanges using different switch control circuits, a two conductor trunk line connecting said exchanges, a repeater in the second exchange individual to said trunk line but normally disconnected therefrom, automatic switches in said second exchange, a plurality of conductors incoming to said repeater and accessible to said automatic switches, means responsive to the seizure of said repeater over said incoming conductors for connecting said repeater to said trunk line and for closing a bridge across the conductors of said trunk line, and means in said repeater for receiving negative battery impulses over one of said incoming conductors and for producing a like number of interruptions in said bridge.

10. In a telephone system, two exchanges using different switch control circuits, a two conductor trunk line connecting said exchanges, a repeater in the second exchange individual to said trunk line but normally disconnected therefrom, automatic switches in said second exchange, a plurality of conductors incoming to said repeater and accessible to said automatic switches, means responsive to the seizure of said repeater over said incoming conductors for connecting said repeater to said trunk line and for closing a bridge across the conductors of said trunk line, means in said repeater for receiving negative battery impulses over one of said incoming conductors and for producing a like number of interruptions in said bridge, and means responsive to the reversal of current flow over said trunk line for connecting ground to another of said incoming conductors for supervisory purposes.

11. In a telephone system, a two conductor trunk line connecting two exchanges, two repeaters in the second exchange individual to said trunk line, the first repeater being normally connected to said trunk line and the second repeater being normally disconnected therefrom, means in said first repeater for receiving loop impulses over said trunk line and for repeating a like number of negative battery impulses, means for disconnecting said first repeater from said trunk line and for connecting said second repeater thereto, and means in said second repeater for receiving negative battery impulses and for repeating a like number of loop impulses over said trunk line.

12. In a telephone system, a two way trunk line connecting two exchanges using different switch control circuits, two repeaters in the second exchange, means in one repeater for repeating impulses over said trunk line, means in the other repeater for repeating impulses received over said trunk line, and means in each repeater for translating from one system of switch control to another.

In witness whereof, I hereunto subscribe my name this 17th day of February, A. D. 1928.

VICTOR S. THARP.