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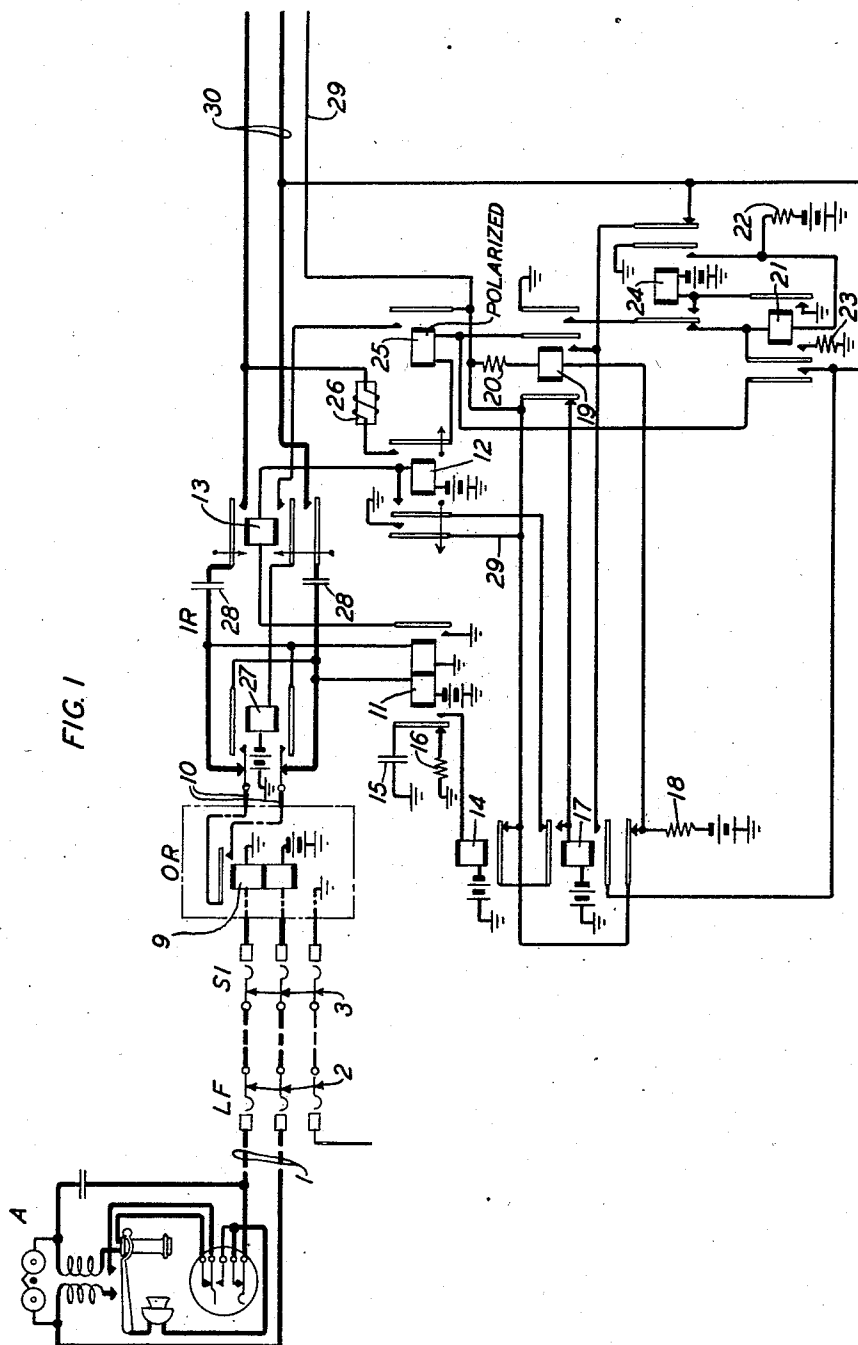
R. L. STOKELY

1,861,196

TELEPHONE EXCHANGE SYSTEM

Filed Nov. 1, 1930

2 Sheets-Sheet 1



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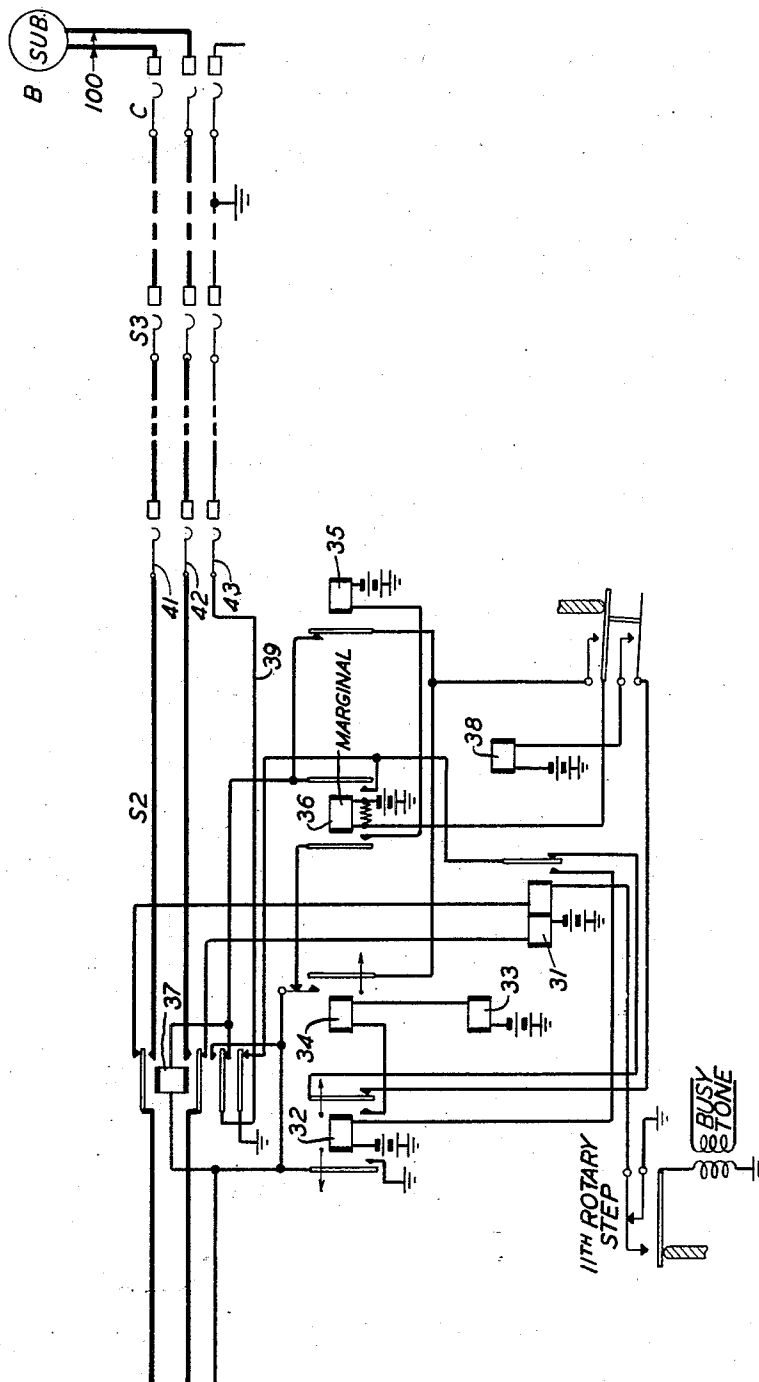
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FIG. 2



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TELEPHONE EXCHANGE SYSTEM

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This invention relates to telephone exchange systems and more particularly to repeaters for automatic and semi-automatic systems.

higher impulse frequencies materially increases the highest allowable impulse frequency over that which obtains if the open and closed periods can not be varied.

5 The object of the invention is to insure the proper operation of impulse-controlled switching apparatus, to increase the range of pulsing speed within which satisfactory switch operation may be secured, to increase the distance over which impulses may be satisfactorily transmitted, and to prevent cumulative impulse distortion when the impulses are successively repeated by several repeaters in a multi-office area.

According to this invention, a repeater 55 for receiving incoming impulses and for repeating these impulses to a two-motion step-by-step automatic switch is arranged to vary the open and closed periods of an outgoing impulse according to the frequency with which the impulses are being transmitted. Two sets of timing relays are provided. One set is designed to measure an interval equal to the minimum open period of an outgoing impulse cycle without causing the release of the 60 change-over relay of the switch which is receiving the impulses when they are being transmitted at the lowest desirable impulse frequency. With the open period of an outgoing impulse cycle controlled by the first set of 65 timing relays, the closed period becomes shorter as the frequency with which impulses are being transmitted becomes higher; until a critical frequency is reached at which the closed period is barely sufficient to prevent the 70 release of the holding relay of the switch which is receiving the impulses. The second set of timing relays is designed to measure an interval equal to the closed period of an outgoing impulse cycle when impulses are 75 being transmitted at this critical frequency and the open period is being controlled by the first set of timing relays. At frequencies below the critical frequency, the first set of timing relays is effective to hold the outgoing pulsing loop open for the interval which they are designed to measure, the second set of timing relays being ineffective to reduce 80 this open period. But at frequencies above the critical frequency, the second set of timing relays is effective to close the outgoing loop before the interval measured by the first set of relays has elapsed, and therefore the closed period is sufficient to prevent the 85 release of the holding relay. The maximum frequency, with which impulses may be transmitted without causing the faulty operation of the switch which is receiving the impulses, is thus increased to that frequency at which the open period is equal to the minimum in- 90 95 100

10 To control automatic switches of the usual two-motion step-by-step type, having a primary stepping magnet, a secondary stepping magnet, an impulse receiving relay, a slow-to-release holding relay, and a slow-to-release change-over relay, the open period of an impulse cycle must not be less than that required for operating the primary stepping magnet and for operating and holding the change-over relay during receipt of a train of impulses at any allowable frequency; and 25 the closed period of an impulse cycle must not be less than that required for maintaining the operated position of the holding relay during receipt of a train of impulses.

30 The time required for operating the stepping magnet is independent of the impulse frequency and exceeds the time for operating the change-over relay, so that the absolute minimum open period is governed by the maximum operating time of the stepping magnet. But the length of circuit closure required for maintaining the operated position of the slow-to-release holding and change-over relays varies with the impulse frequency, so that the minimum closed and minimum open periods of an impulse cycle may be varied in like manner. Therefore, 35 if the open period is made as short as is possible without releasing the change-over relay at the lowest desirable impulse frequency, it (the open period) can be further decreased when the impulse frequency exceeds that at which the closed period is sufficient to maintain the operation of the holding relay; the 40 resulting increase in the closed period at the

terval required for operating the stepping magnet and for holding the change-over relay.

The invention will be better understood by considering the operation of a telephone system in which the features of the invention have been incorporated, one such system being represented schematically in the drawings which form a part of the following description. It is understood, however, that this embodiment of the invention is given by way of example only and that various modifications and other applications of the invention will readily occur to those skilled in the art.

The drawings, which consist of Figs. 1 and 2, represent schematically a multi-office telephone system in which automatic switches are employed for establishing connections between the subscribers.

Fig. 1 shows a calling subscriber's station A, a line-finder switch LF, a first selector switch S1, an outgoing repeater circuit OR, and an incoming repeater circuit IR.

Fig. 2 shows an incoming selector switch S2, a third selector switch S3, a connector switch C, and a called station B.

The subscribers' stations A and B are provided with the usual subscriber's set with a dial for controlling the establishment of desired connections. The line-finder switch LF is of the well known Strowger type and may be similar to that disclosed in Patent 1,711,682, issued May 7, 1929, to H. Hovland, the brushes 2 corresponding to one of the two sets of brushes shown in the Hovland patent. The selector switches S1, S2 and S3 and the connector switch C are also of the well known Strowger type and reference may be had to pages 53 to 67 inclusive of the 2nd edition of "Automatic Telephony" by Smith and Campbell for a detailed description of the operation of the circuits associated with these switches. Only those portions of the circuits of the selector and connector switches are shown as is required for a clear and complete description of this invention, the omitted portions of these circuits being represented by broken lines.

The outgoing repeater circuit OR is associated with the interoffice trunk 10 to repeat the impulses for establishing the remainder of the connection after the calling line has been extended to this repeater circuit. For a complete description of the operation of such a repeater, reference may be had to pages 70 to 72 inclusive of the aforementioned 2nd edition of "Automatic Telephony".

The incoming repeater circuit IR and selector circuit S2 are shown in detail. The repeater circuit comprises a line relay 11 which responds to incoming impulses, a holding (or release) relay 12, an impulse relay 14, two sets of timing relays (17 and 19, and 21 and 24) for regulating the open and closed

periods of the outgoing impulses, a polarized supervisory relay 25, a cut-through relay 13, and a reversing relay 27. The selector circuit S2 comprises a line relay 31, a holding (or release) relay 32, a vertical magnet 33, a change-over relay 34, a rotary magnet 35, an interrupter relay 36, a switching relay 37, a release magnet 38, and the multiple brushes 41, 42 and 43 together with a corresponding bank of terminals. The operation of these circuits is fully set forth in the following description of a call from station A to station B.

When the receiver is removed from the receiver-hook at station A to originate a call, the line-finder LF hunts for and extends the line 1 through its multiple brushes 2 to the first selector S1. When the calling subscriber dials the first digit of the called subscriber's number, the brushes 3 of selector switch S1 are advanced to a corresponding group of terminals. The selector S1 then automatically hunts for and seizes an idle set of terminals in the selected group.

Assuming that the selected set of terminals are connected to the repeater OR and the associated out-going trunk 10, the line relay 9 of the repeater OR is energized in a circuit which includes the brushes of selector S1, the brushes of line-finder LF, and the calling subscriber's line. Relay 9 closes a bridge across the conductors of the outgoing trunk 10 and causes a holding ground to be connected through the sleeve terminal and brush of selector S1 to hold the selector and line-finder switches in their operated positions until the connection is released by the calling subscriber. Trunk 10 terminates at its distant end in an incoming repeater circuit IR; and when relay 9 closes the bridge across the conductors of trunk 10, the line relay 11 of repeater IR is operated. When the calling subscriber dials the remaining digits of the called station's number, relay 9 repeats these impulses over trunk 10 to the line relay 11 by alternately opening and closing the bridge across the conductors of trunk 10.

The aforementioned operation of relay 11 connects the winding of relay 14 to one side of condenser 15, the other side of condenser 15 being permanently connected to ground. Since condenser 15 is normally short-circuited through the back contact of relay 11, a charging current flows through the winding of relay 14 and the left-hand front contact of relay 11 to charge condenser 15. Relay 14 is thereby temporarily operated, but as soon as the charging current ceases, relay 14 releases. The operation of relay 11 also closes a circuit from battery through the winding of relay 12, in series with the winding of relay 13, to ground at the right-hand front contact of relay 11. Relay 12 operates but relay 13 is a slow-to-operate relay and does not operate at this time. With relay 12 operated,

the ground at its outer left-hand front contact is connected over conductor 29, through resistance 20, the winding of relay 19, and through resistance 18, to battery; but relay 19 does not operate since its winding is short-circuited by the lower back contact of relay 17. As soon as relay 14 releases, this ground is also connected over conductor 29, through the back contact of relay 14, the upper back contact of relay 17, and through the inner left-hand front contact of relay 12, to the winding of relay 12; relay 12 is thus locked, and the winding of relay 13 is short-circuited, under the control of relays 14 and 17. The operation of relay 12 also closes a circuit for operating relay 17, this circuit being traced from battery through the winding of relay 17, left-hand back contact of relay 19, over conductor 29, to the ground at the outer left-hand front contact of relay 12. Relay 17 locks through its upper front contact, through the back contact of relay 14, to the ground on conductor 29. When relay 17 operates, relays 13 and 19 operate since their windings are no longer short-circuited by the ground on conductor 29. When relay 19 operates, it closes a bridge across conductors 30 to cause the operation of line relay 31 of selector S2; the circuit for operating relay 31 is traced from battery through the left-hand winding of relay 31, the inner lower back contact of relay 37, over one of conductors 30, the right-hand back contact of relay 24 in parallel with the lower front contact of relay 17, the inner right-hand front contact of relay 19, winding of the polarized supervisory relay 25, right-hand front contact of relay 12, impedance coil 26, over the other of conductors 30, the upper back contact of relay 37, right-hand winding of relay 31, through the normally closed contacts of the 11th rotary-step springs, to ground. Relay 31 closes an obvious circuit for operating relay 32; and relay 32 connects a holding ground to conductor 29.

The aforementioned operation of relay 19 also closes a circuit from battery through resistance 22, winding of relay 21, left-hand back contact of relay 24, to ground at the outer right-hand front contact of relay 19. Relay 21 operates, thereby closing a locking circuit through its inner left-hand front contact and resistance 23. With relay 21 operated, the winding of relay 25 is connected through the outer left-hand front contact of relay 21 so that relay 25 and coil 26 are bridged across conductors 30 independent of relays 19, 17 and 24. Relay 21 also closes a circuit for operating relay 24, and relay 24 locks through its left-hand front contact to the ground at the outer right-hand front contact of relay 19. Relay 24 opens the operating circuit of relay 21, and connects ground through its right-hand front contact to resistance 22 thereby short-circuiting the

winding, and causing the release of, relay 21. The bridge for holding relay 31 of selector S2 in its operated position is now traced from the winding of relay 25, through the inner right-hand front contact of relay 19 and the lower front contact of relay 17; and no further operation takes place until the calling subscriber dials the next digit of the called station's number.

When the impulses corresponding to the second digit of the called number are repeated by relay 9 of repeater OR, relay 11 is alternately released and reoperated. Each release of relay 11 causes the discharge of condenser 15; and each reoperation of relay 11 causes the condenser to be again charged by current through the winding of relay 14. Relay 14 is thus operated and released by each impulse received by relay 11. The operation of relay 14 causes the release of relay 17; the release of relay 17 closes the short-circuit around the winding of relay 19 to cause the release of relay 19; and the release of relay 19 causes the release of relay 24. With either or both of relays 17 and 19 released, the bridge across conductors 30 is opened thereby repeating the first impulse of the series to line relay 31 of selector S2. Relay 12 is slow to release and remains operated during the receipt of each train of impulses. Relay 13 releases upon receipt of the first impulse of each series and, being slow in operating, it does not reoperate until all of the impulses of a series have been received by relay 11; the talking condensers 28 are thereby disconnected from conductors 30 during the transmission of each series of impulses to prevent interference with impulse transmission. As soon as relay 19 releases after the receipt of each impulse, the circuit for operating relay 17 is again closed; and with relay 14 in its normal position, relay 17 is again locked to the ground on conductor 29. With relay 17 reoperated, relay 19 reoperates; and with both of relays 17 and 19 reoperated, the windings of coil 26 and relay 25 are again bridged across conductors 30. Each time relay 19 reoperates, it closes the circuit for operating relay 21; relay 21 locks and closes the circuit for operating relay 24; and relay 24 locks and causes the release of relay 21. Thus relays 11, 14, 17, 19, 21 and 24 repeat their cycle of operations for each impulse received over trunk 10; and these impulses are repeated over conductors 30 to the succeeding switches.

Relays 17 and 19 are so designed that their operating and releasing will insure an opening of the bridge across conductors 30 equal to the minimum required for satisfactory stepping of the succeeding selector and connector switches when the impulse frequency is the minimum which may be 8 impulses per second. When impulses are being received by relay 11 at the rate of 8 impulses

per second the open periods of each impulse are equal to the interval between the release of relay 17 and the reoperation of relay 19, since relay 24 will have operated and relay 21 will have released prior to the release of relay 17 and since relay 21 will not have reoperated and relay 24 will not have released prior to the reoperation of relay 19. At higher impulse frequencies each impulse cycle is shorter and, if the frequency exceeds a certain value, the open periods (as measured by relays 17 and 19) constitute such a large part of each impulse cycle that it is necessary to hold the bridge closed independently of relays 17 and 19 in order that the release relay (such as relay 32) of the switch to which the impulses are being transmitted will not be released during receipt of a train of impulses. The frequency at which the closed period is barely sufficient to prevent the release of the holding relay of the switch which is receiving the impulses, when the open period is controlled by relays 17 and 19, is a critical frequency; and relays 21 and 24 are designed so that their operating and releasing will insure a closure of the bridge across conductors 30 equal to said closed period at the critical frequency. At frequencies higher than the critical frequency, which may be 11 impulses per second, the right-hand back contact of relay 24 holds the bridge across conductors 30 closed after relay 17 releases until relay 19 is also released; and the outer left-hand front contact of relay 21 holds the bridge closed whenever one impulse follows another so closely that relay 17 again releases before relay 21 has released. Although the open period of the impulse cycles is reduced below that which relays 17 and 19 were designed to measure whenever impulses are being received at a frequency greater than 11 impulses per second, the minimum allowable open period of an impulse cycle decreases as the impulse frequency increases; so that this reduction in the open period does not cause faulty operation of the switch to which the impulses are being transmitted providing the open period constitutes a sufficiently large percentage of a complete impulse cycle to prevent the release of the change-over relay (such as relay 34) of the switch during the receipt of all the impulses of a train and to insure the operation of the stepping magnet of this switch in response to each impulse transmitted.

When relay 31 of selector S2 releases in response to the first impulse transmitted over conductors 30, a circuit is closed from battery through the winding of vertical magnet 33, the winding of change-over relay 34, the right-hand front contact of the release (holding) relay 32, back contact of relay 31, to ground at the back contact of the switching relay 37. Magnet 33 and relay 34 both

operate, the operation of magnet 33 being effective to raise the shaft and brushes of switch S2 one step. When relay 31 reoperates, magnet 33 releases; and each succeeding release and reoperation of relay 31, in response to impulses corresponding to the second digit of the called number, causes magnet 33 to raise the shaft and brushes an additional step. Relay 34 is slow to release and the open period of each incoming impulse cycle is sufficiently long at impulse frequencies from 8 to 14 impulses per second to hold relay 34 in its operated position until all of the impulses in the train have been received. Relay 32 is also slow to release and the closed period of each impulse cycle is sufficiently long at impulse frequencies from 8 to 14 impulses per second to prevent the release of relay 32 during receipt of all the impulses in the train. When relay 31 reoperates after the last impulse has been received, relay 34 releases. The Von springs are operated, as soon as the shaft is moved out of its normal position by the first operation of magnet 33, thereby closing a circuit from battery through the winding of interrupter relay 36, upper contact of the Von springs, front contact of relay 34, to ground at the left-hand front contact of relay 32. Relay 36 operates and locks through the interrupter contacts of rotary magnet 35 and its own right-hand front contact to ground at the outer lower back contact of relay 37. When relay 34 releases, a circuit is closed from battery through the winding of rotary magnet 35, left-hand front contact of relay 36, back contact of relay 34, to ground at relay 32. Magnet 35 operates thereby rotating the brushes of switch S2 into contact with the first set of terminals in the previously selected level. The interrupter relay 36 releases when magnet 35 operates, and magnet 35 releases when relay 36 releases. If the first set of terminals is idle, relay 37 operates in a circuit from battery through the winding of relay 36, upper contacts of the Von springs, back contact of magnet 35, winding of relay 37 to ground at relay 32; the marginal relay 36 does not operate in series with the winding of relay 37. If the first set of terminals is busy, the sleeve terminal is connected to ground; and this ground is connected through brush 43, conductor 39, and the middle lower back contact of relay 37 to short-circuit the winding of relay 37 and to cause the operation of relay 36; so that relay 36 reoperates and relay 37 remains normal. Relay 36 closes the circuit for operating magnet 35, thereby advancing the brushes to the second set of terminals in the selected level. Relay 36 and magnet 35 thus cooperate to step the brushes from one set of terminals to the next until an idle set of terminals is reached, at which time relay 37 operates. Relay 37 connects the ground

at the left-hand front contact of relay 32, through the middle lower front contact of relay 37, over conductor 39, through brush 43 to the sleeve terminal of the selected set as a test-busy condition. Relay 37 extends conductors 30 through its inner front contacts and through brushes 41 and 42 to the third selector S3, to which the selected set of terminals are connected. Relay 31 releases when relay 37 operates; and relay 31 opens the circuit through the winding of relay 32. The release of relay 32 disconnects the ground at its left-hand front contact from conductor 39, but this conductor is also connected to the ground at the outer left-hand contact of relay 12 of repeater IR.

When the calling subscriber dials the remaining digits of the called station's number, the selector S3 and the connector C are operated in the usual manner to extend the connection to line 100. When the called subscriber removes the receiver at station B in answer to the usual ringing signal, the connector circuit C operates in the usual manner to reverse the current flowing through the polarized relay 25 and coil 26 in the incoming repeater IR. Relay 25 operates when the current is reversed thereby causing the operation of the reversing relay 27. Relay 27 reverses the connections from the conductors of trunk 10 with respect to the windings of line relay 11 so that the current is reversed over the conductors of trunk 10 as a supervisory signal to the outgoing repeater circuit OR. The talking circuit extends through the outer front contacts of relay 13 and the talking condensers 28 of repeater IR.

When the connection is released by the calling subscriber relay 9 of repeater OR releases thereby opening the bridge across the conductors of trunk 10 so as to cause the release of line relay 11 of repeater IR. The release of relay 9 also disconnects the holding ground from the sleeve conductor so that the line-finder LF and first selector S1 restore to normal in the usual manner. The release of relay 11 causes the release of relay 12. Relay 12 disconnects ground from conductor 29 thereby opening the bridge across conductors 30. The connector C is restored to normal in the usual manner when relay 12 opens the bridge across conductors 30. When the holding ground at connector C is disconnected from the sleeve conductor, the selectors S3 and S2 are restored to normal. Relay 37 releases when the holding ground is disconnected from the sleeve conductor at connector C, thereby closing a circuit from battery through the winding of release magnet 38, lower contacts of the Von springs, back contacts of relays 32 and 31, to ground at the outer lower back contact of relay 37. The circuit for magnet 38 is

opened at the Von springs when the shaft of switch S2 reaches its normal position.

Since the character of the impulses transmitted over conductors 30 is independent of the character of the impulses received over trunk 10 (except that the frequency of the outgoing impulses is the same as the frequency of the incoming impulses) the repeater circuit IR is particularly adapted for use in multioffice areas where calls are routed over two or more interoffice trunks. The use of repeater IR at the incoming end of each of the interoffice trunks used in establishing such a connection prevents the cumulative distortion of the impulses transmitted to the most distant switch. The features of this invention are not limited in their application to an incoming repeater circuit but may also be incorporated in outgoing repeaters.

What is claimed is:

1. In combination, a line, a relay for receiving impulses over said line, a circuit, a bridge connected across the conductors of said circuit in consequence of the operation of said relay, means effective in consequence of the release of said relay for opening and holding said bridge open for a predetermined interval of time, and means for holding said bridge closed for a predetermined interval of time.

2. In combination, a line, a line relay for receiving impulses over said line, a circuit, an inductance, means responsive to the operation of said line relay for bridging said inductance across the conductors of said circuit, means responsive to the release of said line relay upon receipt of each impulse of a train of impulses for opening the bridge across said conductors, means for holding said bridge open for a predetermined interval of time, and means for holding said bridge closed across said conductors for a predetermined interval of time between successive openings.

3. In combination, a line, a relay for receiving impulses over said line, outgoing conductors, a bridge connected across said conductors in consequence of the operation of said relay, means effective upon the release of said relay for opening said bridge, means for measuring an interval equal to the minimum allowable opening of said bridge at the lowest desirable impulse frequency, and means for measuring an interval equal to the minimum allowable closure of said bridge between successive openings.

4. In combination, a line, a relay for receiving impulses over said line, a trunk, a bridge connected across the conductors of said trunk in consequence of the operation of said relay, means effective upon the release of said relay for opening said bridge, means effective when impulses are being received by said relay at any frequency within a certain

range of frequencies for holding said bridge open a predetermined interval, and means effective when impulses are being received by said relay at any frequency above said certain range for holding said bridge closed a predetermined interval between successive openings.

5. An impulse repeater comprising an impulse receiving relay, conductors over which incoming impulses are received, conductors over which outgoing impulses are transmitted, a first timing mechanism for measuring an interval equal to the minimum allowable open period of an outgoing impulse cycle, and a second timing mechanism for measuring an interval equal to the minimum allowable closed period of an outgoing impulse cycle, said first timing mechanism being effective to control the open period of outgoing impulse cycles at the lowest desirable impulse frequency and said second timing mechanism being effected to control the closed period of outgoing impulse cycles at the highest allowable impulse frequency.

6. In combination, a line, a relay for receiving impulses over said line, a trunk, a bridge connected across the conductors of said trunk in consequence of the operation of said relay, means effective upon the release of said relay for opening said bridge to repeat said incoming impulses to said trunk, and means for varying the open and closed portions of the impulses outgoing over said trunk depending upon the frequency with which impulses are being received.

7. In combination, a line, a relay for receiving impulses over said line, a trunk, a bridge connected across the conductors of said trunk in consequence of the operation of said relay, means effective upon the release of said relay for opening said bridge to repeat said incoming impulses to said trunk, and means including two timing mechanisms for varying the open and closed portions of the impulses outgoing over said trunk depending upon the frequency with which impulses are being received, one of said timing mechanisms being effective to measure an interval equal to the minimum allowable open period of an outgoing impulse cycle at the lowest desirable impulse frequency and the other of said timing mechanisms being effective to measure an interval equal to the minimum allowable closed period between the open periods of successive outgoing impulse cycles.

8. In combination, a line, a line relay for receiving impulses over said line, a trunk, an inductance, means responsive to the operation of said line relay for bridging said inductance across the conductors of said trunk, means responsive to the release of said line relay upon receipt of the first impulse of a train of impulses for opening the bridge across said conductors, means for holding

said bridge open for a predetermined interval of time, and means effective upon receipt of additional impulses for delaying the opening of said bridge to reduce the intervals during which said bridge is open.

9. In combination, a line, a relay for receiving impulses over said line, a circuit, means for closing said circuit in consequence of the operation of said relay, means effective in consequence of the release of said relay for opening and holding said circuit open for a predetermined interval of time, and means for decreasing the interval during which said circuit is open in response to successive impulses received by said relay.

10. In combination, a line, a line relay for receiving impulses over said line, a trunk, an inductance, means responsive to the operation of said relay for bridging said inductance across the conductors of said trunk, means effective upon the release of said line relay in response to each impulse for opening the bridge across said conductors, timing means for measuring the minimum allowable opening of said bridge when impulses are being received at a particular frequency, and timing means for measuring the minimum allowable closure of said bridge between successive openings.

11. In combination, a line, a line relay for receiving impulses over said line, a trunk, an inductance, means responsive to the operation of said relay for bridging said inductance across the conductors of said trunk, means effective upon the release of said line relay in response to each impulse for opening the bridge across said conductors, timing means for measuring the minimum allowable opening of said bridge at the lowest desirable impulse frequency, and timing means for measuring the minimum allowable closure of said bridge between successive openings.

12. In combination, a first circuit, a second circuit, a relay included in said first circuit, means responsive to the operation of said relay for closing said second circuit, means for interrupting said first circuit, means effective in consequence of the release of said relay in response to said interruption for opening said second circuit, means for holding said second circuit open in response to each of said interruptions of said first circuit for a predetermined interval of time, and means for holding said second circuit closed for a predetermined interval of time.

13. In a telephone system, a trunk line divided into two sections, the second section terminating in an automatic switch, a repeater joining the two sections of said trunk line, said repeater comprising a relay for receiving impulses over the first section of said trunk line, an inductive bridge across said second section, means responsive to the op-

eration of said relay for closing said bridge, means effective upon the release of said relay in response to each impulse of a train for opening said bridge, means for holding said bridge open a predetermined interval of time, and means for holding said bridge closed for a predetermined interval of time.

14. In a telephone system, a line, a repeater, and a trunk terminating in an automatic switch, said automatic switch comprising a line relay for receiving impulses, a holding relay operated in consequence of the operation of said line relay for preventing the release of said switch during receipt of a train of impulses, a primary magnet for advancing said switch in response to impulses received by said line relay, a secondary magnet, a change-over relay arranged to operate in consequence of the release of said line relay and to remain operated during the receipt of all of the impulses in the train, the release of said change-over relay being effective to close the circuit for operating said secondary magnet, said repeater comprising an impulse receiving relay for receiving impulses over said line, an inductance, means responsive to the operation of said impulse receiving relay for bridging said inductance across the conductors of said trunk to operate the line relay of said automatic switch, means effective upon the release of said impulse receiving relay in response to each impulse of a train for opening said bridge to release the line relay of said switch, means for holding said bridge open for an interval sufficient to insure the operation of the change-over relay of said switch and to prevent the release of said change-over relay until all of the impulses in the train have been received by the line relay of said switch, and means for holding said bridge closed between successive impulse openings for an interval sufficient to prevent the release of said holding relay.

45 In witness whereof, I hereunto subscribe my name this 31st day of October, 1930.

RAY L. STOKELY.

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