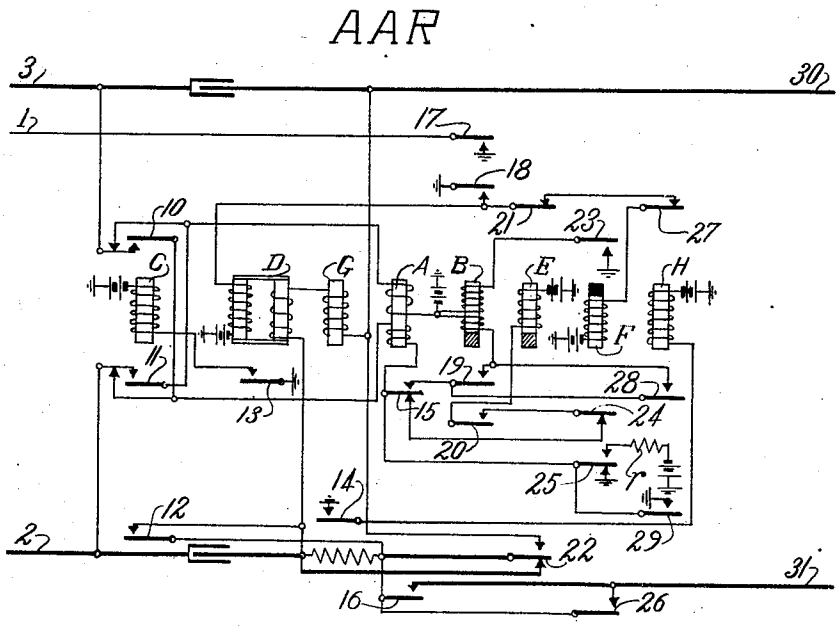
Sept. 3, 1929. J. E. OSTLINE 1,726,759

AUTOMATIC TELEPHONE SYSTEM

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Fig. 1



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Fig. 2

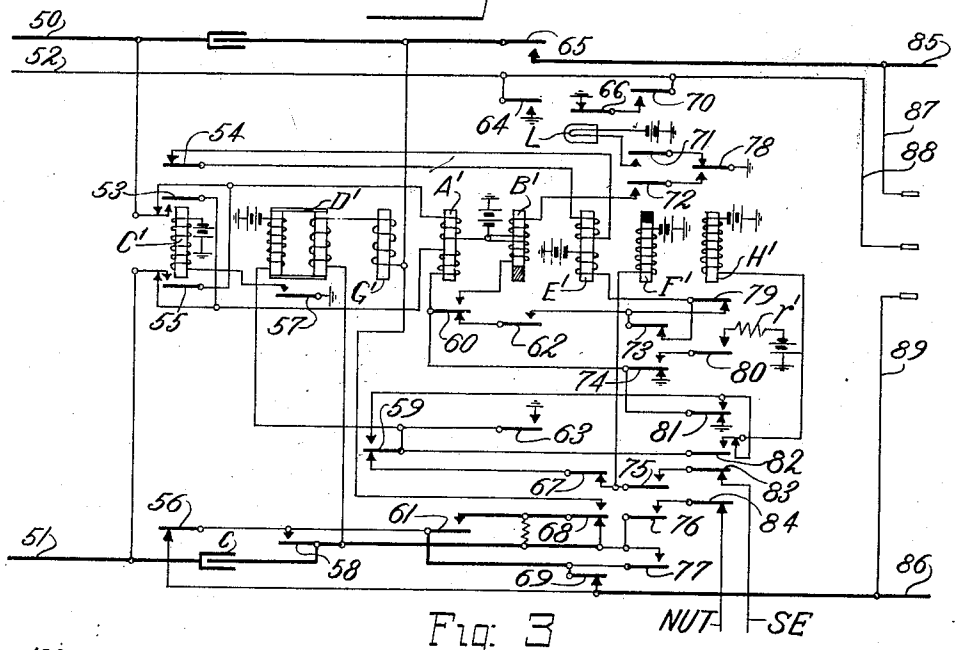
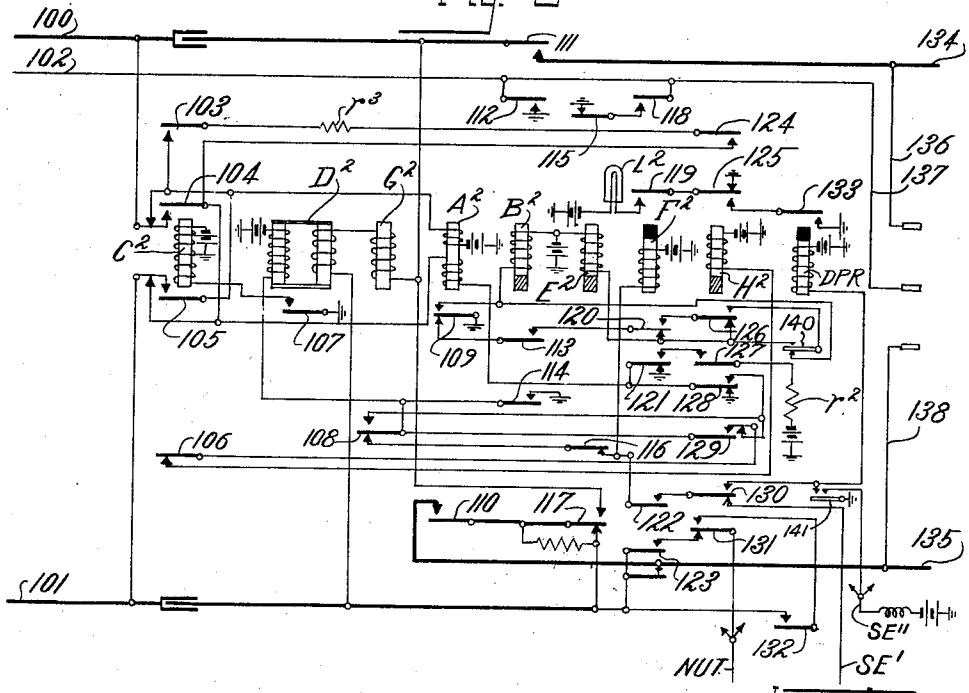


Fig. 3



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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed December 7, 1925, Serial No. 73,557, and in Great Britain September 23, 1925.

This invention relates in general to improvements in telephone systems and in particular to novel features in repeaters which are only taken into use when a connection is extended to an intermediate exchange. Such repeaters are located in the trunks between the intermediate and wanted exchanges. One kind of repeater adapted to repeat impulses and the usual supervisory signals is used when the wanted exchange is another automatic exchange, and a simpler kind which is not required to repeat impulses is used when the wanted exchange is a manual exchange. Both types of repeaters are adapted to repeat back a busy flash signal for use if the call originates at an operator's position. Connections are provided from the repeaters to common interrupters for connecting up busy signals.

The present invention concerns an automatic-to-automatic repeater which in addition to repeating impulses repeats back busy signalling currents if the call originates at an operator's position without providing any connections to common interrupters or the like. This is effected by providing a relay which is controlled over the outgoing trunk conductors and connects battery and earth connections alternately to an incoming talking conductor.

A further feature of the invention concerns an arrangement for causing a number unobtainable tone current to be connected to the calling party's line in the event of the outgoing trunk being faulty. This is effected by a relay which is arranged to test the continuity of an outgoing trunk immediately the repeater is taken into use.

A still further feature concerns an arrangement for releasing the switches which have taken a faulty trunk into use and thereafter rendering the repeater non-selectable until the fault is cleared. The transmission of the number unobtainable tone and the rendering of the repeater non-selectable takes place should a fault occur at any stage of the connection.

In order that the invention may be clearly understood and readily carried into effect, a repeater according to the present invention will now be more fully described with reference to the annexed drawings in which:

Figure 1 shows an automatic-to-automatic repeater arranged to repeat back busy signals without any connections being made over external leads to common interrupters.

Figure 2 shows a similar repeater provided with means for transmitting the number unobtainable tone and rendering the repeater non-selectable in the event of the outgoing trunk being faulty.

Figure 3 shows a modification in which the number unobtainable tone is transmitted and the repeater rendered non-selectable in the event of the fault occurring at any stage of the connection.

A detailed description will first be given of the arrangement shown in Fig. 1, and for this purpose it will be assumed that the automatic-to-automatic repeater is taken into use by a selector switch over conductors 1, 2, and 3.

When a loop is placed across conductors 2 and 3, line relay A energizes over the following circuit: battery, upper winding of relay A, normally closed contacts controlled by armature 10 of reversing relay C, conductor 3, conductor 2, normally closed contacts controlled by armature 11, lower winding of relay A, armature 25 and its resting contact to ground. Relay A, upon energizing, connects at armature 16, the high impedance relay G and the right hand winding of polarized relay D across the outgoing trunk conductors 30 and 31, and at armature 15 prepares a circuit for slow release relay B. Relay G alone energizes at this time, battery and ground being fed to conductors 30 and 31, respectively, from the line relay of the selector in which the conductors terminate. Relay G, upon energizing, completes at armature 14 a circuit for relay H which, upon energizing, completes the following circuit for release relay B: battery, lower winding of relay B, working contact and armature 28, working contact and armature 15, armature 25 and its resting contact to ground. Relay H at armature 27 opens a point in the circuit of slow to pull up relay F and at armature 29 connects the lower winding of relay A to ground independently of relay F. Relay B, upon energizing, grounds the release trunk 1 at armature 17, at armature 18 completes a circuit for the left hand polarizing winding of relay D and at this same armature prepares a circuit for relay F, at arma-

ture 19 closes an alternative point in the circuit of its lower winding independently of armature 28 of relay H and at armature 20 prepares a circuit for slow relay E. The above operations have all taken place responsive to the energization of relay A When impulses are transmitted over conductors 2 and 3 by interrupting the loop, relay A repeats them at armature 16 by interrupting the loop across conductors 30 and 31. Upon the first deenergization of relay A the following circuit is completed for relay E: battery E, working contact and armature 20, armature 24 and its resting contact, resting contact and armature 15, armatures 25 and 29 to ground. Relay E, upon energizing, provides at armature 22 a direct loop across conductors 30 and 31 which is independent of the impedance of relays D and G; at armature 21 opens a further point in the circuit of relay F. Further impulses are repeated by relay A at armature 16, relay E remaining energized during their transmission.

When relays A and E are energized, relay G will be short circuited and relay H will deenergize. This operation will have no effect at this time since the circuit of relay F is already opened at 21 and the circuits of relays A and B already closed at 25 and 19, respectively.

When the wanted party answers, the direction of current over conductors 30 and 31 is reversed in the well known manner and the polarized relay D energizes and completes at armature 13 a circuit for reversing relay C. Relay C, upon energizing, reverses the direction of current over conductors 2 and 3 to bring about the operation of the calling party's meter, or to bring about the operation of a manual operator's supervisory signal.

For the sake of further explanation it will now be assumed that a connection has been set up from an operator's position and that at some stage of the connection all outlets are busy. When this occurs, battery and ground alternately will be connected to conductor 30 as well as the connection of a busy tone current across conductors 30 and 31. The busy tone current would of course be audible to a calling subscriber but an operator is not always listening and a visual signal is necessary to indicate the busy condition of a connection. The alternate connection of ground and battery potentials to conductors 30 and 31 will cause relay G to deenergize and energize in unison with the ground and battery connections. Relay G, upon deenergizing, will open the circuit of relay H at armature 14, whereupon relay H will deenergize and complete at armature 27 a circuit for slow relay F. Relay F, upon energizing, completes at armature 23 a holding circuit for the upper winding of relay B and at armature 25 substitutes battery through resistance r for the ground potential normally connected to conductor 2 through the lower winding of relay A. Relay A will deenergize but release relay B will be held up by relay F to guard the release trunk. When ground potential is substituted for battery potential over conductor 30, relay G will energize and again operate relay H, whereupon the circuit of relay F will be opened at armature 27.

It will be seen that relay H connects ground to the lower winding of relay A before relay F releases. This is done in order to attain an exact correspondence and to avoid loss of time due to the flashing relay F being slow to release, and to accomplish a reasonably true reproduction and transmission of the busy signals.

Relay A at this time holds up release relay B. The operation of relays G, H and F continues during the busy period until the operator clears the connections.

It will be seen that relay F in the operated position short circuits the impulse contacts 16 of line relay A. This is provided in order to prevent relay A due to reversals from exerting a chattering effect and tending to release the connection during the busy flash period.

In this construction of repeater a certain disadvantage may result from artificially holding up the release relay B by the slow relay F, in that if the calling party should hang up while the connection is being artificially held up, a slight pause will exist which would permit the calling subscriber again seizing the trunk on making another call and again receiving the busy signal. However, when battery is fed from the first selector the calling subscriber may release the first selector so that when the release relay at the repeater deenergizes and removes ground from the release trunk, the repeater and the remaining switches of the connection are momentarily unguarded and may be seized.

Referring now to Fig. 2, this repeater while being arranged to repeat busy signal currents to a calling party in a similar manner to the repeater as shown in Fig. 1, is provided with circuit arrangements whereby when a faulty trunk is taken into use the calling party is given a number unobtainable tone, and when he replaces his receiver the preceding switches are released, the repeater then being rendered non-selectable until the fault is cleared. When this repeater is taken into use relay A′ energizes over the circuit: battery, upper winding of A′, 53, 50, 51, 55, lower winding of A′, 74 and 81 in parallel to ground. Relay A′, upon energizing, completes a circuit for slow release relay B′ at armature 60, and at armature 61 closes its impulse contacts. Relay B′,

upon energizing, grounds the release trunk conductor 52 at armature 64; at armature 65 connects the high impedance relay G′ and the right hand winding of the polarized relay D′ across the outgoing trunk conductors 85 and 86; at armature 62 prepares a circuit for the lower winding of relay E′ and at armature 63 completes a circuit for the polarized winding of D′ and prepares a circuit for relay H′.

If the outgoing trunk 85, 86 is not faulty, battery potential will be connected to conductor 85 and ground potential to conductor 86 and relay G′ will energize over the circuit 85, 65, G′, right hand winding of D′, 68, 61, 69, 86. The polarized relay D′, however, will not energize at this time. Relay G′, upon energizing, completes the following circuit for relay H′; ground, 63, 59 and its working contact, normally closed contacts controlled by 82, H′, battery.

If the outgoing trunk 85, 86, is faulty, neither G′ nor H′ will operate when relay B′ energizes and instead the following circuit will be completed for slow to pull up relay F′: ground, 63, 59 and its back contact, 67, F′, battery. Relay F′, upon energizing, completes a circuit at armature 71 for the supervisory lamp L; at armature 70 grounds the release trunk 52; at armature 75 completes a locking circuit for itself over alarm conductor SE; at armature 76 connects up a number unobtainable tone to the calling party over conductor NUT, 84, 76, condenser c to trunk conductor 51. The calling party, upon hearing this tone, will replace his receiver, whereupon relays A′ and B′ deenergize. The repeater, however, will be rendered non-selectable by the ground potential connected to release trunk conductor 52 by armature 70 of relay F′. When relay A′ deenergizes upon the calling party hanging up his receiver, a momentary impulse will be transmitted to relay E′ as follows: ground 81, 60, 62, 79, lower winding of E′ to battery. Relay E′ will remove ground at armature 66 from the release trunk conductor 52 and when relay B′ falls back, the preceding switches will be released. When, however, relay E′ falls back due to the deenergization of B′, the release trunk will be guarded over the back contact of armature 66 and front contact 70 of relay F. The alarm signal operated over conductor SE will attract the exchange attendant's attention, and the lamp L will indicate the particular repeater which is faulty. When the fault is cleared, relay F′ will be released by the attendant, thereby rendering the repeater selectable again.

Assuming, however, that the trunk 85, 86 is not faulty, relay H′ energizes over the front contact of armature 59 of relay G′ following the operation of relays B′ and G′ and disconnects the alarm signal conductor SE and the number unobtainable tone conductor NUT at armatures 83 and 84, respectively; at armature 82 establishes a locking circuit for itself; at armature 80 prepares a circuit for connecting battery to the lower winding of relay A′ and at armature 78 prepares a holding circuit for the upper winding of relay B′. Relay A′ will respond to impulses received and repeat them at armature 61 over conductors 85 and 86. Upon the first deenergization of A′, the following circuit is completed for lower winding of relay E′: ground, 74, 60, 62, 79, E′. The upper winding of relay E′ being normally short circuited by contacts 54 of reversing relay C′, relay E′ will be rendered slow to release and will remain operated throughout each series of impulses. Relay E′ at armature 68 provides a direct circuit across conductors 85 and 86 for subsequent impulses which may be traced as follows: 86, 56, 61, 68, 65, 85. If no busy trunk groups are encountered subsequent impulses will be repeated in a similar manner and, when the wanted party answers, polarized relay D′ will operate and complete a circuit at 57 for reversing relay C′ which will reverse the battery and ground connection to the incoming conductors 50 and 51 for metering or supervisory purposes.

If a busy group of trunks is encountered battery and ground will be connected alternately to trunk conductor 85 by the switch encountering a busy group. Relay G′ responds to the alternate connection of battery and ground on conductor 85, and at armature 59 completes the following circuit for slow-to-pull up relay F′: ground, 63, 59 and its back contact, 67, F′ battery. At this time relays A′ and B′, F′ and H′ are operated. When relay F′ operates it will be seen that it is controlled by G′ at armature 59. Since H′ is now energized, battery will be connected over the following circuit to the incoming talking conductor 51 upon the operation of relay F′: Battery, resistance R′, working contact and armature 80 of relay H′, working contact and armature 74 of relay F′, lower winding of relay A′, normally closed contacts controlled by armature 55, trunk conductor 51. When relay G′ reenergizes, relay F′ will fall back and ground potential will be connected to conductor 51 from ground at back contact of armature 74, lower winding of A′, normally closed contacts controlled by 55, conductor 51.

During the period that battery is connected to conductor 51 through the lower winding of relay A′, the latter relay will deenergize and open the initial circuit of relay B′ but since relays H′ and F′ are energized at this time, the locking circuit for the upper winding of relay B′ will be closed and the release trunk guarded. When the calling party removes the loop from conductors 50

and 51, relay A′ will deenergize, and if this happens to be at the period at which relay F′ is in a deenergized position, relay B′ will deenergize, and remove ground from the release trunk 52 before relay G′ has operated again by battery potential on conductor 85.

Conductors 87, 88 and 89 terminate in bank contacts of local selector levels.

Referring now to Fig. 3, this repeater is similar to the repeater shown in Figure 2 except that it is modified to give the number unobtainable tone to the calling party and sound an alarm in the exchange should an open trunk be encountered after the first trunk has been taken into use. Moreover, this repeater is provided with means for reducing the annoying click in the calling party's receiver when the reversing relay operates, the means for accomplishing this also prevents the line relay from tending to release when the reversing relay operates.

In order that these features may be better understood, a detailed description of the circuit will now be given. Line relay A^2 energizes when a loop is closed across conductors 100 and 101 and completes a circuit for slow release relay B^2 at 109, and at 110 closes its impulse contacts. Relay B^2, upon energizing, grounds the release trunk 102 at 112; at 111 prepares a circuit for relay G^2 in series with the right hand winding of polarized relay D^2; at 113 prepares a circuit for relay E^2 and at 114 completes a circuit for the left hand polarizing winding D^2. If the outgoing trunk 134, 135 is not faulty, battery will be received over conductor 134 and ground over 135 and the following circuit will be completed for relay G^2: battery, 134, 111, G^2, right hand winding of D^2, 117, 110. 135, ground. Relay G^2 alone energizes in this circuit and at armature 108 completes the following circuit for relay H^2: battery, H^2, 106, 129, 108, 114, ground. Relay H^2, upon energizing, completes a locking circuit for itself at armature 129; at armature 124 prepares a circuit for connecting the resistance r^3 across the winding of relay A^2 in order to minimize the click produced when C^2 operates; at 125 prepares a circuit for alarm lamp L^2; at 126 prepares a holding circuit for B^2; at 127 prepares a circuit for connecting battery through resistance r^2 to the calling line 101 in case all the lines of the group are busy; at armature 128 disconnects the lower winding of relay A^2 from ground leaving the same grounded at the back contact 121 of relay F^2, and at armature 130 prepares a locking circuit for relay F^2. Relay A^2 now responds to impulses transmitted over conductors 100 and 101 and repeats them at 110 over conductors 134 and 135. Upon the first deenergization of A^2, relay E^2 energizes and at armature 117 closes a loop across conductors 134 and 135 exclusive of the windings of G^2 and D^2; at armature 116 opens a point in the energizing circuit of relay F^2 and at 115 opens a point in the circuit for subsequently guarding the release trunk. Subsequent impulses are repeated in a similar manner and when the called party answers, current is reversed over conductors 134 and 135 to bring about the operation of polarized relay D^2 which, at armature 107 completes a circuit for reversing relay C^2 which in turn reverses the direction of current over conductors 100 and 101 in order to accomplish the operation of the calling party's meter or to effect the operation of supervisory relays.

If all the lines accessible to the switch connected to the outgoing trunk 134, 135 are busy, battery and ground will be connected alternately to conductor 134, whereupon relay G^2 will deenergize and complete the following circuit for slow to pull up relay F^2: battery, relay F^2, 116, 108, 114, ground. Relay F^2, upon energizing, connects battery over resistance r^2, 127, 121, lower winding of A^2, normally closed contacts controlled by 105, conductor 101, in order to operate a supervisory relay in the manual operator's cord circuit, assuming of course that the call was set up by an operator.

This alternate connection of battery and ground through the lower winding of relay A^2 and conductor 101 continues until the calling party abandons the connection, whereupon relay A^2 deenergizes, and if this happens to be at the period at which F^2 is in the deenergized position it opens the circuit of B^2 which in turn opens the circuit of H^2. If the call originates from a subscriber in the automatic exchange, alternate connection of battery and ground will have no effect but in addition to battery and ground being alternately connected to conductor 134 and 135 by the busy selector or connector, the usual busy tone current is superimposed on conductors 134 and 135 therefore, on conductors 100 and 101 through the talking circuit condensers.

Assuming now that the trunk conductor 134, 135 is open when taken into use, it will be apparent that under these conditions, no circuit will be completed for relay G^2 and instead of relay H^2 operating, relay F^2 will operate upon the energization of relay B^2 over the back contact 108 of G^2. With relay F^2 in energized condition and relay H^2 in deenergized condition, a locking circuit will be completed for F^2 at armature 122 in series with the alarm conductor SE′. An alarm lamp L^2 will be lighted over armature 119 and the back contact 125 of H^2; at armature 120, a circuit will be prepared for relay E^2 which includes the back contact of 126 of H^2; at armature 121 ground will be removed from the lower winding of

relay A^2. This winding, however, receives ground at the back contact 128 of H^2. At armature 123, the number unobtainable tone current is connected to conductor 101 over back contact 131 of H^2.

When the calling party receives the number unobtainable tone and removes the loop across conductors 100 and 101, relay A^2 will deenergize, opening the circuit of relay B^2, but before B^2 releases an impulse will be transmitted to relay E^2 which will remove ground at 115 from release trunk conductor 102. When relay B^2 deenergizes the release trunk conductor will be unguarded for a sufficient length of time to permit the preceding switches to release and after the interval for which E^2 is adjusted relay E^2 will release and reconnect guarding potential to the release trunk conductor, thus rendering the trunk non-selectable to other switches as long as relay F^2 remains energized. Relay F^2 cannot be released until its locking circuit is opened by an exchange attendant whose attention will be called to the fault by the alarm operated over SE', the particular repeater which is faulty being indicated by the lighting of lamp L^2.

It may happen that after the repeater has been taken into use a subsequent trunk may be faulty and means must be provided to locate the fault. A slow to pull-up dash pot relay is provided for this purpose to be energized when relay F^2 and H^2 are in the operated position and the relay G^2 is in the deenergized position, the circuit being traced from ground, 114, armature 108 and its back contact of relay G^2, 116, 122, 130, dash pot relay DPR to battery. Relay G^2 deenergizes when a faulty junction is taken into use. Since the relays S^2, H^2, and G^2, are in the above condition during the busy flash period, the dash pot relay DPR is arranged not to respond during the three quarters of a second busy period. Relay DPR, however, in this instance energizes since the relay G remains deenergized due to a faulty trunk, and at armature 133 completes a holding circuit for the lamp L^2; at armature 132 connects the number unobtainable tone over armature 131 to the talking conductor 101, thereby giving the calling party the number unobtainable tone as before. When relay F^2 operates it connects battery to the lower winding of relay A^2 at the armature 121 in place of ground. Relay A^2 drops back. Prior to the operation of the dash-pot relay DPR, B^2 is maintained operated over a circuit extending from battery at the relay, through armature 140 normal, armatures 126, 120, and 113 operated, to ground at the armature 109 in its released position. When the relay DPR operates, the circuit for relay B^2 is opened, and prior to the release of that relay, the relay E^2 operates. A moment later relay B^2 will deenergize, removing guarding potential from release trunk conductor 102, and allowing the preceding switches to release. Relay E^2 subsequently reguards the trunk to prevent it being taken into use, relay F^2 being locked up over dash pot relay DPR which is also arranged to actuate an alarm SE'' to attract the exchange attendant's attention.

The conductors 136, 137 and 138 terminating in bank contacts of a level of local selectors in order to give the latter access to the junction 134, 135.

What is claimed is:

1. In a telephone system, a trunk line having two inductively connected sections, an impulse repeater associated with said trunk line, said repeater including an impulse relay for repeating current impulses from the first to the second section of said trunk line, an additional relay in said repeater, and means controlled by said last named relay and operable under predetermined conditions to transmit current impulses from the second section to the first section, said current impuses being transmitted over the winding of said first mentioned relay.

2. In a telephone system, a trunk line having inductively connected incoming and outgoing sections, a repeater associated with said trunk line, said repeater including an impulse relay for repeating current impulses from the incoming section to the outgoing section, an additional relay in said repeater, and means controlled by the said last named relay and operable upon the occurrence of predetermined conditions in the outgoing section for transmitting current impulses from the outgoing section to the incoming section, said last mentioned current impulses being transmitted over the winding of said first named relay and over one talking conductor in series.

3. In a telephone system, a trunk line having inductively connected incoming and outgoing sections, a repeater including an impulse relay for repeating current impulses from the incoming to the outgoing section, an additional relay in said repeater, and means controlled by said last named relay and operable upon the occurrence of predetermined conditions in the outgoing section for transmitting current impulses over the incoming section indicative of said conditions, said means including a slow acting relay and a quick acting relay for producing said impulses, said impulses being transmitted to the incoming section over a winding of said impulse relay.

4. In a telephone system, a trunk line having inductively connected incoming and outgoing sections, a repeater including an impulse relay for repeating current impulses from the incoming section to the outgoing section, an additional relay in said repeater,

and means controlled by said last named relay and operable under predetermined conditions under the control of the outgoing section, for transmitting current of distinctive characteristics over the incoming section indicative of said conditions, said current being given its distinctive characteristics by means in said repeater and transmitted by said first named means over a winding of the impulse relay responsive to the application of current impulses over the outgoing section.

5. In a telephone system, a trunk line having inductively connected incoming and outgoing sections, a repeater including an impulse relay for repeating current impulses from the incoming section to the outgoing section, an additional relay in said repeater for testing the continuity of the said outgoing section upon said trunk line being seized over the incoming section, and means controlled by said last named relay and operable in case the outgoing section is out of order for transmitting signalling current over the incoming section and for rendering said faulty trunk nonselectable.

6. In a telephone system, a trunk line having inductively connected incoming and outgoing sections, a repeater including an impulse relay for repeating current impulses from the incoming to the outgoing section, an additional relay in said repeater for testing the continuity of said outgoing section upon the seizure of the trunk over the incoming section, a visible and an audible signal means, and means actuated by said last named relay in case said outgoing section is out of order for transmitting signalling current over the incoming section, for rendering said faulty trunk nonselectable, and for operating said visible and said audible signals in circuits local to the trunk for indicating said faulty trunk line to an attendant.

7. In a telephone system, a trunk line having inductively connected incoming and outgoing sections, a repeater including an impulse relay for repeating current impulses from the incoming to the outgoing section to progressively extend a connection from the outgoing section, an additional relay in said repeater for testing the continuity of said outgoing section upon the seizure of the trunk and for testing the continuity of said outgoing section after it has been progressively extended, and means controlled by said last named relay and actuated in case the outgoing section is out of order at any time before or after it is extended to transmit a signal over the incoming section, and to render the faulty trunk section inaccessible.

8. In a telephone system, a trunk line having inductively connected incoming and outgoing sections, a repeater including an impulse relay for repeating current impulses from the incoming section to the outgoing section to cause the progressive extension of a connection from the outgoing section, an additional relay in said repeater for testing the continuity of said outgoing section upon the seizure of the trunk and for testing the continuity of the outgoing section as it is progressively extended, and means controlled by said last named relay and actuated in case the outgoing section is out of order or has been extended to a line that is out of order for transmitting signalling current over the incoming section and for actuating an alarm indicating said faulty condition to an office attendant, said means being locked in a circuit local to the repeater and releasable only by an office attendant.

9. In combination, a pair of incoming talking conductors, a pair of outgoing talking conductors, an impulse repeater including an impulsing relay for transmitting a plurality of groups of digit impulses from an incoming to an outgoing conductor, additional relay means individual to said repeater for producing current impulses and for transmitting said impulses over an incoming talking conductor, and means in said repeater effective in case an idle trunk cannot be found upon the termination of any of the groups of impulses for operating said last named relay means.

10. In a telephone system, an impulse repeater having two incoming trunk conductors and two outgoing trunk conductors, an impulse relay for repeating groups of digit impulses received over an incoming conductor to an outgoing conductor, a testing relay, means for establishing a testing circuit to said testing relay over both outgoing conductors in series prior to the transmission of the first group of impulses and also after the transmission of each group of impulses, means at the repeater for transmitting current of distinctive characteristics over an incoming conductor if the testing relay indicates that the outgoing conductors are discontinuous, and means controlled by the testing relay for transmitting impulses from the outgoing conductors to an incoming conductor.

11. In a telephone system, an impulse repeater having two incoming trunk conductors and two outgoing trunk conductors, an impulse relay for repeating groups of digit impulses received over an incoming conductor to an outgoing conductor, a testing relay, means for establishing a testing circuit to said testing relay over both outgoing conductors in series prior to the transmission of the first group of impulses and also after the transmission of each group of impulses, means at the repeater for transmitting current of distinctive characteristics over an incoming conductor if the testing

relay indicates that the outgoing conductors are discontinuous, and means controlled by the testing relay for transmitting impulses from an outgoing conductor to an incoming conductor, said last named impulses being transmitted over a winding on said impulse relay.

12. In a telephone system, an impulse repeater having two incoming trunk conductors and two outgoing trunk conductors, an impulse relay for repeating groups of digit impulses received over the incoming conductors to the outgoing conductors, a testing relay, means for connecting the testing relay to the outgoing trunk conductors so that said relay tests the outgoing trunk conductors for two distinct conditions, means at the repeater for transmitting, over an incoming talking conductor, current of either of two distinctive characteristics dependent upon the results of said tests, and means effective under predetermined conditions in accordance with one of said tests to render the repeater non-selectable.

13. In a telephone system, an impulse repeater having two incoming trunk conductors and two outgoing trunk conductors, an impulse relay for repeating groups of digit impulses sent over the incoming conductors to the outgoing conductors, a testing relay, means for connecting the testing relay to the outgoing trunk conductors, means controlled by said testing relay for transmitting current of distinctive characteristics over the incoming conductors if the outgoing conductors are discontinuous, and means at the repeater for transmitting a current of a different and also distinctive characteristic if no connection can be obtained over the outgoing trunk conductors and said trunk conductors are not discontinuous.

14. In a telephone system, an impulse repeater having two incoming trunk conductors and two outgoing trunk conductors, an impulse relay for repeating groups of digit impulses sent over the incoming conductors to the outgoing conductors, a testing relay, means for connecting the testing relay to the outgoing trunk conductors, means controlled by said testing relay for transmitting current of distinctive characteristics over the incoming conductors if the outgoing conductors are discontinuous, and means at the repeater for transmitting a current of a different and also distinctive characteristic if no connection can be obtained over the outgoing trunk conductors and said trunk conductors are not discontinuous, the circuit for transmitting said last mentioned current extending through a winding of the impulse relay.

15. In a telephone system, an impulse repeater having two incoming trunk conductors and two outgoing trunk conductors, an impulse relay for repeating groups of digit impulses received over the incoming conductors to the outgoing conductors, a testing relay, means for establishing a testing circuit to said testing relay over both outgoing conductors in series prior to the transmission of the first group of impulses, and also after the transmission of each group of impulses, means at the repeater for transmitting current of distinctive characteristics over the incoming conductors if the testing relay indicates that the outgoing conductors are discontinuous, and means for rendering said repeater unavailable if the first test indicates that the outgoing conductors are discontinuous.

16. A telephone system wherein an impulse repeater having a pair of incoming and a pair of outgoing conductors is arranged to repeat signals from the outgoing conductors to the incoming conductors, characterized in this, that to repeat the signals there are provided a relay the contacts of which in their alternate positions connect different potentials to an incoming conductor, and means in said repeater controlled over the outgoing conductors in series to cause said contacts to cyclically assume their alternate positions.

17. A telephone system wherein an impulse repeater having a pair of incoming and a pair of outgoing conductors is provided with a relay for repeating impulses from the incoming conductors to the outgoing conductors and is arranged to repeat signals from the outgoing conductors to the incoming conductors, characterized in this, that to repeat the signals there is provided a relay controlled over the outgoing conductors in series to alternately connect different potentials to an incoming conductor through a winding on the first named relay.

18. In a telephone system, an impulse repeater having incoming and outgoing conductors, means for repeating impulses from the incoming to the outgoing conductors, a relay in said repeater arranged to be connected to both of the outgoing conductors in series to test for the continuity of said conductors, means controlled by said relay for connecting a source of current of distinctive characteristics to the incoming conductors in case the outgoing conductors are discontinuous, and means controlled by said relay for repeating impulses from the outgoing conductors to the incoming conductors.

19. In a telephone system wherein an impulse repeater having incoming and outgoing conductors is accessible to automatic switches and when seized maintains the preceding switches operated, the combination with said repeater of means for testing for the continuity of the outgoing conductors and means controlled by said means to cause the repeater to allow the release of the preceding switches and render the repeater non-accessible to the automatic switches in the event of

the outgoing conductors being discontinuous.

20. In a telephone system, a pair of incoming talking conductors, a pair of outgoing talking conductors, an impulse repeater including an impulsing relay for transmitting a plurality of groups of digit-impulses from the incoming to the outgoing conductors, means in said repeater for testing the outgoing conductors for any of a plurality of conditions prior to the transmission of the impulses, and means for transmitting current of any of a plurality of distinctive characteristics over the incoming conductors, said means being controlled in accordance with said test, the current transmitted being indicative of the results of the test.

21. In a telephone system, a pair of incoming talking conductors, a pair of outgoing talking conductors, an impulse repeater including an impulsing relay for transmitting a plurality of groups of digit impulses from an incoming talking conductor over an outgoing talking conductor, means in said repeater for testing both of said outgoing conductors subsequent to the transmission of each of the groups of impulses, and means for transmitting signalling current from the repeater over the incoming conductors, said means being controlled in accordance with said tests.

22. In a telephone system, a pair of incoming talking conductors, a pair of outgoing talking conductors, an impulse repeater including an impulsing relay for transmitting a plurality of groups of digit impulses from an incoming talking conductor over an outgoing talking conductor, means in said repeater for testing both of said outgoing conductors subsequent to the transmission of each of the groups of impulses, means for transmitting signalling current from the repeater over the incoming trunk conductors, said means being controlled in accordance with said tests, a signal for indicating the repeater that was used, and means for operating the signal dependent upon said tests.

23. In a telephone system, a trunk line having incoming and outgoing sections, a repeater including an impulse relay for repeating current impulses from the incoming to the outgoing section to cause the extension of a connection over the outgoing section, relay means in said repeater for testing the continuity of said outgoing section, signalling means, and means actuated by the last named relay in case said outgoing conductors do not test normal for rendering said trunk line non-selectable and for operating said signal to indicate said faulty section to an attendant.

24. In an impulse repeater having incoming and outgoing sections, a line relay, a release relay controlled by said line relay for rendering said repeater busy, a third relay, means for operating said third relay responsive to impulses received over the outgoing section to repeat such impulses to the incoming section over a winding of said line relay, said line relay deenergized responsive to the repeating of said impulses, and a circuit controlled by said third relay for maintaining said release relay in energized position during the transmission of said impulses while the line relay is deenergized.

25. In an impulse repeater having incoming and outgoing sections, a line relay for controlling the maintenance of an established connection to the repeater, a second relay, means for operating said second relay responsive to impulses received over the outgoing section to repeat such impulses to the incoming section over a winding of said line relay, said line relay deenergized responsive to the repeating of said impulses, and means controlled by said second relay for maintaining such connection while the line relay is deenergized.

In witness whereof, I hereunto subscribe my name this 9th day of November, A. D. 1925.

JOHN E. OSTLINE.