

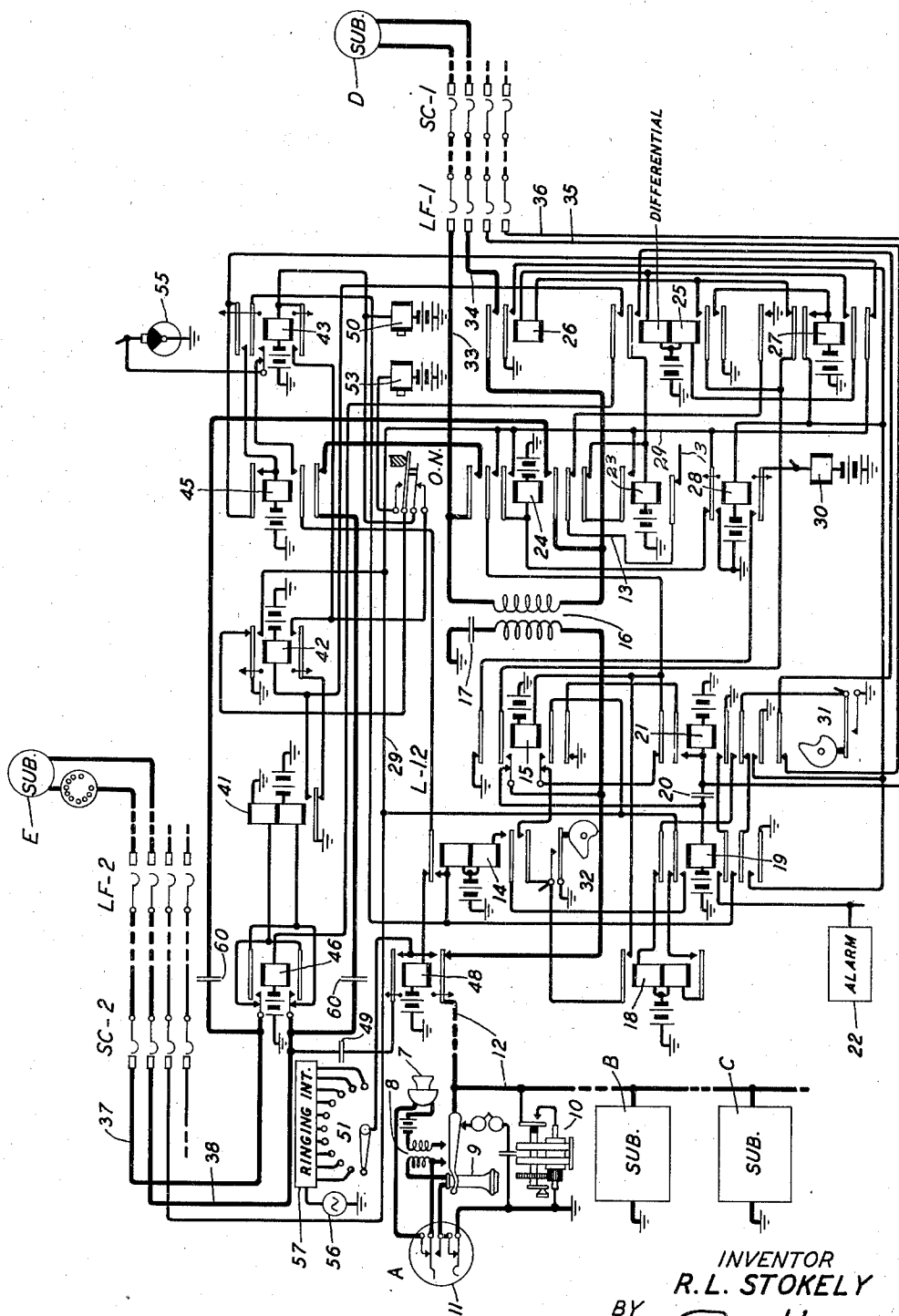
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R. L. STOKELY

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TELEPHONE SYSTEM

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INVENTOR  
R. L. STOKELY  
BY *R. M. Kenney*  
ATTORNEY

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## TELEPHONE SYSTEM

Ray L. Stokely, Floral Park, N. Y., assignor to  
Bell Telephone Laboratories, Incorporated, New  
York, N. Y., a corporation of New York

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This invention relates to telephone systems and particularly to dial telephone systems.

The object of the invention is the provision of improved circuit arrangements for use in automatically completing calls to and from lines of high resistance and poor insulation.

This invention is a line circuit arrangement comprising an impulse repeater for a single-wire party line in an automatic telephone system.

According to this invention, circuit means is provided for operatively extending a subscriber's line to an individual impulse repeater in response to the origination of a call by the removal of the receiver at a station on the line. The impulse repeater comprises a sensitive impulse relay and circuit means responsive to the opening of the impulse circuit for disconnecting the winding of the impulse relay from the line to insure release of this relay.

A feature of the invention is the provision of circuit means for delaying the connection of the line to the associated impulse repeater for a predetermined short interval of time so that the calling subscriber may ascertain whether the line is in use before calling another station on the same line.

Another feature of the invention is means comprising a ring-up relay, for operation when the subscriber at one station calls another station on the line, to prevent the operative extension of the line to the associated impulse repeater.

Another feature of the invention is circuit means for restoring the ring-up relay of a line circuit upon completion of a call between two stations on the line, thereby enabling the operative extension of the line to an associated impulse repeater upon the subsequent initiation of a call from this line to a station on another line.

Another feature of the invention is circuit means comprising the ring-up relay of a magneto line for operating a permanent signal alarm in case the line becomes permanently grounded due to the removal of the receiver at a station on the line or due to a trouble condition.

These and other features of the invention will be readily understood by considering a telephone system in which the invention is embodied. One such system is illustrated schematically in the drawing which forms a part of this specification.

The invention is not limited in its application to the system shown in the drawing but may, in general, be applied to any system which includes one or more polystation lines, the subscribers' stations of which are each provided with a magneto for signaling other stations on the same line

and with a dial or other impulse sender for use in establishing talking connections with other lines in the system.

Referring to the drawing, A, B and C represent local battery subscribers' stations connected to a polystation single-wire line 12, D and E represent other subscribers' stations in the system, L-12 represents apparatus individual to the line 12 in a central office, LF-1 and LF-2 represent line-finder switches in the central office, and, SC-1 and SC-2 represent selector-connector switches in this office.

Each of the polystation-line subscribers' stations comprises a receiver 9 and transmitter 7, a dial impulse sender 11, and a magneto 10. The subscribers' stations D and E are shown as being common battery stations, the station E being equipped with a dial impulse sender for use in establishing desired connections. The line apparatus L-12 comprises a line relay 19, a ring-up relay 21, a cut-through relay 15, a cut-through delay relay 14, impulse relays 25 and 26, an auxiliary impulse relay 27, a slow-to-release relay 28, a cut-off relay 23, a release-control relay 18, a repeating coil 16, and an interrupter mechanism which is represented by the magnet 30 and two sets of contact springs 31 and 32. For use only when a station on line 12 is called from a station on some other line of the system, the line apparatus L-12 also includes an incoming-call line relay 41, slow-to-release relays 42 and 43, a cut-off relay 24, a busy-test relay 45, a reversing relay 46, a ringing-control relay 48, and a ringing-code switch which is represented by stepping magnet 50, release magnet 53 and bank 51.

The line-finder and selector-connector switches LF-1, LF-2, SC-1 and SC-2 may be of the well-known Strowger type and reference may be had to my Patent No. 1,910,972, granted May 23, 1933 and to Patent No. 1,941,085, granted to A. E. Hague et al. December 26, 1933 for a more complete description of the operation and control of the selector-connector switches. For a description of the operation and control of a Strowger type switch when used as a line-finder, reference may be had to my Patent No. 1,799,654, granted April 7, 1931. If the system includes a large number of lines, additional selector switches may be required for the establishment of desired connections and the selector-connectors SC-1 and SC-2 will in that case be replaced by a connector switch. Reference may be had to "Automatic Telephony" by Smith and Campbell, 2nd edition, pages 53 to 65, inclusive, for a de-

scription of the operation and control of a Strowger type switch when used as a connector or selector.

Assume first that a call is originated at station A of the polystation line 12 and that station D is the called station. Upon removal of the receiver from the receiver hook at station A, a circuit is closed from ground through the impulse contacts of dial 11 through the receiver 9 and left winding of the induction coil 8, left upper contact of the receiver hook, over line 12 to the central office, through the back contact of relay 48, normally closed contacts of the upper continuity springs of relay 15, and through the winding of relay 19 to battery. Relay 19, being operated by the current in this circuit, closes a circuit for operating the slow-to-release relay 28. The operation of relay 28 connects ground potential to conductor 29, to prevent seizure of the line L—12 on an incoming call by a selector-connector SC—2, and closes a circuit for operating the start magnet 30 of an interrupter which is common to a plurality of lines. The interrupter contacts 31 and 32 are each periodically closed for a short interval, for instance .2 of a second, the interval between closures being of such a length, for instance five seconds, that a subscriber who has removed his receiver to ascertain whether or not the line is in use before operating the magneto to call another station on the same line will have replaced the receiver before an idle line-finder begins hunting for the terminals belonging to this line, as hereinafter described. Each closure of interrupter contacts 31 begins when a closure of contacts 32 ends. As soon, after relay 19 operates, as interrupter contacts 31 are closed, the cut-through delay relay 14 is operated by the current in a circuit through its upper winding, middle lower front contact of relay 19, inner lower back contact of relay 21 and the interrupter contacts 31. Relay 14 closes a locking circuit through its lower winding and lower front contact, upper front contact of relay 19, over conductor 29 to ground at the upper front contact of relay 28. When interrupter contacts 32 next close, several seconds after relay 14 operates, a circuit is closed through contacts 32, the lowermost front contact of relay 14, back contact of the lower continuity spring of relay 15, upper back contact of relay 21 and through the winding of relay 15. Relay 15, operated by the current in this circuit, locks through the front contact of its lower continuity spring over conductor 29 to ground at relay 28, opens the operating circuit for the interrupter start magnet 30, disconnects the winding of relay 19 from the line 12 and closes a circuit over line 12, through the front contact of the upper continuity spring of relay 15, upper back contact of relay 27, winding of relay 26, and through the upper winding of relay 25. Thus the operation of relay 15 causes the release of relays 19 and 14 and the operation of relays 25 and 26. Relay 26 closes a circuit for holding relay 28 operated after relay 19 releases and bridges the right winding of repeating coil 16 across conductors 33 and 34. Relay 25 closes a circuit for operating relay 27 and relay 27 locks in parallel with relay 28. Since the inner lower front contacts of relay 25 are in parallel with the upper back contacts of relay 27, the operation of relay 27 does not cause the release of relays 25 and 26. With relay 27 operated, the lower winding of relay 25 is connected in parallel with its upper winding and ground is con-

nected through the uppermost front contact of relay 27 and the inner lower back contact of relay 24 to conductor 13 to start an idle line-finder, which is represented by the finder LF—1, to establish connection with the line apparatus L—12. With relay 25 operated, the winding of cut-off relay 23 is connected through the inner upper front contact of relay 25 and the lowermost back contact of relay 21, over conductor 35, to the sleeve terminal of the set of terminals in the bank of each of the associated line-finders.

When a line-finder LF—1 finds and connects to the terminals to which the conductors 33, 34, 35 and 36 are connected, ground potential is connected through the sleeve brush of the line-finder to sleeve conductor 35, the cut-off relay 23 being thereby operated in the usual manner. Relay 23 disconnects ground from conductor 13 and connects its winding to sleeve conductor 29 so as to be held operated independent of the ground potential which caused its operation. With relay 26 held operated in series with line 12, the right winding of repeating coil 16 is connected through conductors 33 and 34 and the brushes of the line-finder LF—1 to the windings of the line relay (not shown) of selector-connector SC—1. Dial tone is thereupon transmitted from the selector-connector SC—1 to the calling station and nothing further occurs until the subscriber at station A dials the number of the station with which connection is desired. The off-normal (upper) contacts of the dial 11 are effective to open the transmitter circuit and short-circuit the receiver while each series of dial impulses is being transmitted. Relay 26 is fast in operating although the line 12 be of high resistance. The energization of the lower winding of relay 25, upon operation of relay 27, is in electromagnetic opposition to the energization of its upper winding, the resultant energization being only sufficient to hold the relay operated. The release of relay 25, each time the line circuit is opened at the dial contacts, is thereby insured, although the line insulation resistance be low. The first opening of the line circuit by the dial is, therefore, effective to cause the release of relay 25; and the release of relay 25 causes the release of relay 26, the windings of relays 25 and 26 being entirely disconnected from the line when relay 25 releases and until relay 27 releases. The release of relay 26 opens the holding circuit for relay 27 and opens the bridge across conductors 33 and 34 to cause the release of the line relay (not shown) of selector-connector SC—1. The closing of the line circuit at the end of the first dial impulse causes the reoperation of relays 25, 26 and 27 in the order named thereby again closing the bridge across conductors 33 and 34 to cause the reoperation of the line relay of the selector-connector SC—1. Relay 28 is slow-in-releasing and remains operated during dialing. Each succeeding opening and closing of the impulse contacts of the dial causes the release and reoperation of relays 25, 26 and 27 whereby the impulses are repeated by the uppermost contacts of relay 26 to control the operation of the selector-connector SC—1. Upon completion of the desired connection and answer of the called subscriber, the talking circuit includes repeating coil 16. When the subscriber at station A replaces the receiver on the receiver-hook, relays 25, 26 and 27 release. Since relay 26 does not reoperate, relay 28 releases thereby causing the release of relay 15 and

the disconnection of the busy-indicating ground potential from sleeve conductor 29.

If the subscriber at station A wishes to call another station on the same line, the receiver is removed to ascertain whether or not the line is already in use. Relay 19 is thereby operated but the receiver is replaced before relays 14 and 15 have time to be operated, the replacing of the receiver causing the release of relay 19 and the release of relay 14 if already operated. The line having been found idle, the subscriber at station A thereupon operates the magneto 10 to call the desired station. The ringing current, thus generated, is also effective to operate the ring-up relay 21 in the central office, the winding of this relay being connected through condenser 20 to line 12. Relay 19 may respond to the magneto ringing current. Relay 21 locks, through its upper front contact to ground at the lowermost back contact of relay 15 and closes a circuit for operating relay 28 to protect the line apparatus L—12 from seizure on an incoming call. When the receiver is again removed at station A to converse with the called station, relay 19 reoperates. If interrupter contacts 31 are closed when relay 21 operates, the upper winding of relay 18 will be energized; but as soon as relay 19 reoperates, relay 18 will be released. With relay 21 operated, the operation of relay 19 is ineffective to cause the operation of relay 15. When the conversation is finished, relay 19 releases and as soon thereafter as the interrupter contacts 31 are closed, the upper winding of relay 18 is energized and relay 18 operates. Relay 18 locks through its lower winding and lower front contact, through a back contact of relay 19, over conductor 29 to ground at relay 28. When the interrupter contacts 32 are next closed, a circuit is closed through the upper front contact of relay 18 for operating relay 15. The operation of relay 15 causes the release of relay 21; and the release of relay 21 causes the release of relay 28. With relays 21 and 28 released, relays 18 and 15 also release, the line apparatus then being normal ready for use on another call.

If a call is originated by removing the receiver at any station of line 12, and, after extension of the line by a line-finder such as LF—1 to a selector-connector, the calling subscriber does not dial, the selector-connector operates as described in the aforementioned Patent No. 1,941,085 to connect ground potential to the fourth or control conductor of line-finder LF—1, this ground potential being extended over conductor 36 to cause the operation of relay 21. The operation of relay 21 causes the release of relay 15; and the release of relay 15 closes the locking circuit for relay 21 and reconnects relay 19 to the line 12. The reoperation of relay 19, with relay 21 operated, connects ground through the inner lower front contacts of these relays, to operate the permanent signal alarm apparatus 22. Upon termination of the permanent signal condition, the line apparatus L—12 is restored to normal as described in the preceding paragraph.

If a subscriber at some other station E calls a station on line 12, the calling line is extended by means of a line-finder LF—2 and a selector-connector SC—2 to conductors 37 and 38, thereby closing a loop circuit for operating the incoming-call relay 41. Relay 41 closes a circuit for operating relay 42 and relay 42 connects a busy-indicating ground potential to sleeve conductor 29 to prevent seizure of the line on another call, to hold the selector connector SC—2, and to

cause the operation of the auxiliary cut-off relay 24. Relay 24 locks through its inner upper front contact directly to conductor 29, closes a circuit for operating relay 15, and connects the right winding of repeating coil 16, through condensers 60, to conductors 37 and 38. Relay 15 disconnects line 12 from relays 19 and 21 and connects line 12 to relays 25 and 26, which relays are thereupon operated. Since the auxiliary cut-off relay 24 is then operated, the operation of relay 27 is ineffective to cause the starting of a line-finder.

Since the line apparatus L—12 is arranged to control the ringing of the various stations on line 12, the selector-connector SC—2 differs from that described in the above-mentioned Patent No. 1,941,085 in that it lacks the ringing-control apparatus. The dial impulses created by the dialing of the ringing-code digit are repeated by the selector-connector SC—2 to cause the alternate release and reoperation of relay 41. The first release of relay 41 closes a circuit for operating relay 43 and rotary stepping magnet 50; and the reoperation of relay 41, at the end of the first impulse, causes the release of magnet 50. The operation of magnet 50 advances the brush 51 of the ringing-code selector one step. The off-normal contacts ON are shifted when the selector is moved out of normal position, the circuit for relay 43 and magnet 50 being thereupon changed to include the lower front contact of relay 43 instead of the lower contacts of the ON springs. Each succeeding release and reoperation of relay 41 causes a corresponding operation and release of magnet 50, the brush 51 being advanced one step by each operation of magnet 50. Relay 43 is slow-in-releasing and remains operated until all of the ringing-code-digit impulses have been received. Relay 42 is also slow-in-releasing and does not release during the response of relay 41 to the dial impulses. The aforementioned operation of relay 43 also closes a circuit for operating relay 45; this circuit includes the uppermost front contact of relay 43, the lower back contact of relay 27, conductor 29 and the upper front contact of relay 42. Relay 45 locks through its upper front contact and opens the connection between the repeating coil 16 and conductor 38. The brush of ringing-control interrupter drum 55 is connected to ground during the ringing interval of all the different ringing codes; and, if relay 43 is operated during the time this brush is connected to ground, relay 14 operates. If relay 43 releases before ground is disconnected from the brush of drum 55, relay 14 is held operated through its upper front contact, the lower front contact of relay 45 and the back contact of relay 43. Relay 14 and interrupter drum 55 are thus effective, in combination with relays 43 and 45, to prevent the operation of relay 48 at any time other than at the beginning of a ringing cycle. With relay 14 released, relay 43 is operated at the beginning of the next ringing cycle to disconnect line 12 from the windings of relays 25 and 26 and connect line 12 through brush 51 and the terminal with which it is in contact, through the ringing interrupter 57 to the ringing source 56. The particular ringing code selected by brush 51 is thereby transmitted over line 12, the ringers at all of the stations on the line being operated. The brush 51 of the code selector is shown as having ten terminals; if more than ten stations are connected to line 12, a code selector with a larger number of terminals would

be provided, in which case the ringing code would consist of more than one digit. A ringing tone is transmitted through condenser 49 to the calling station E. The release of relay 48 at the end of the ringing interval reconnects line 12 to relays 25 and 26. Since the high resistance, high capacity and low insulation resistance of single-wire lines are such as to make it impossible to use a ringing cut-off relay in series with the line, it is necessary to reconnect the line to the sensitive impulse relays 25 and 26 at the end of each ringing cycle for operation if the receiver has been removed at the called station. Relay 48 is slow-in-releasing so as to permit discharge of the ringing condenser at the various stations before the line 12 is reconnected to relays 25 and 26, to guard against false operation of these relays. When the receiver is removed from the receiver-hook at the called station and as soon thereafter as relay 48 releases, relays 25, 26 and 27 are operated. The operation of relay 27 causes the release of relay 45 thereby preventing the reoperation of relay 48 when the brush of interrupter drum 55 is next connected to ground. The release of relay 45 also completes the talking circuit through the right winding of repeating coil 16. The operation of relay 25 closes a circuit for operating the reversing relay 46. The operation of relay 26 causes the operation of relay 28. When the connection is released by the calling subscriber, relays 41, 42 and 46 release. The release of relay 42 causes the operation of release magnet 53 thereby restoring the ringing-code selector to normal. When the receiver is replaced at the called station, relays 25, 26, 27 and 28 release. The release of relay 25 causes the release of relay 46, if operated. With both of relays 42 and 28 released, ground is disconnected from sleeve conductor 29 thereby causing the release of relays 24 and 15.

What is claimed is:

1. In a telephone system, a line, a subscriber's station, an impulse sender at said station, an impulse repeater for said line and no other, and circuit means responsive to the removal of the receiver from the receiver-hook at said station for operatively extending said line to said impulse repeater.

2. In a telephone system, a single-wire line, a subscriber's station, an impulse sender at said station, an impulse repeater for said line and no other, and circuit means responsive to the removal of the receiver from the receiver-hook at said station for operatively extending said line to said impulse repeater.

3. In a telephone system, a line, a subscriber's station, an impulse sender at said station, an impulse repeater individual to said line, circuit means effective a predetermined interval of time after the removal of the receiver from the receiver-hook at said station for operatively extending said line to said impulse repeater.

4. In a telephone system, a line, a subscriber's station, an impulse sender at said station, an impulse repeater individual to said line, a line relay for responding to the removal of the receiver from the receiver-hook at said station, a switching relay for operatively extending said line to said impulse repeater, and circuit means effective a predetermined interval of time after the operation of said line relay for operating said switching relay.

5. In a telephone system, a line, a subscriber's station, an impulse sender at said station, an impulse repeater individual to said line, a line

relay for responding to the removal of the receiver from the receiver-hook at said station, a switching relay for transferring said line from said line relay to said impulse repeater, and circuit means effective a predetermined interval of time after the operation of said line relay for operating said switching relay.

6. In a signaling system, a line, an impulse sender, an impulse relay, an auxiliary impulse relay, a signaling circuit comprising said line and sender and windings of said impulse relays in series, said impulse relay being adjusted to operate in series with a line of low conductivity and said auxiliary impulse relay being adjusted to release in series with a line of low insulation resistance, a third relay, a circuit closed by the operation of said second relay for operating said third relay, a circuit for holding said third relay operated until said impulse relay releases, a second winding of said auxiliary relay differentially energized with respect to its first winding upon operation of said third relay, and means comprising normally open contacts of said second relay for disconnecting said line from the winding of said impulse relay.

7. In a telephone system, a line, subscribers' stations connected to said line, means at each station for transmitting ringing current over the line to signal another of the stations, an impulse repeater for said line, circuit means responsive to the removal of the receiver at any one of said stations for operatively extending said line to said impulse repeater, and means comprising a relay operatively responsive to ringing current over said line for preventing said extension of the line to the impulse repeater.

8. In a telephone system according to claim 7, means responsive to the replacing of the receivers at the calling and called stations on a call between two stations on said line for causing the release of said relay to render said circuit means operative for use on a succeeding call originating at one of said stations.

9. In a telephone system, a line, subscribers' stations connected to said line, a magneto at each station for transmitting ringing current over the line to signal any other station on the line, a relay for responding to ringing current over said line, an automatic switch for use in completing a call originating over said line, circuit means responsive to the removal of the receiver at any of said stations for operatively extending said line to said switch, alarm signal means, and circuit means including said relay for disconnecting said line from said switch and for operating said alarm signal means.

10. In a signaling system, a line, an impulse sender, an impulse relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said impulse relay being adjusted weak and said auxiliary relay being adjusted stiff, a third relay, and circuit means comprising said second and third relays effective in response to the opening of said signaling circuit for disconnecting the winding of said impulse relay from the line.

11. In a signaling system, a line, an impulse sender, an impulse relay, a signaling circuit comprising said line and sender and the winding of said relay, and circuit means comprising another relay operatively responsive to the opening of said circuit for disconnecting the winding of said impulse relay from said line.

12. In a telephone system, a line, a subscriber's station connected to said line, an impulse re-

peater permanently connected to said line, circuit means responsive to the removal of the receiver from the receiver-hook at said station for operatively associating said line and impulse repeater, and a dial at said station for creating signal impulses transmitted over said line to said impulse repeater.

13. In a telephone system, lines, a plurality of subscribers' stations connected to one of said lines, a magneto at each station for use in signaling the other stations on the line, an impulse repeater for use in establishing a connection between any one of said stations and any other of said lines, a relay connected to said line and operatively responsive to signaling current from any one of said magnetos for preventing the extension of said line to said impulse repeater, and circuit means for disconnecting said relay and for operatively extending said line to the impulse repeater.

14. In a telephone system, a line, subscribers' stations connected to said line, each station comprising a magneto and an impulse sender, an impulse repeater individual to said line, circuit means responsive to the removal of the receiver at any one of the stations for operatively extending said line to the impulse repeater, and a relay operatively responsive to ringing current created by the operation of the magneto at any of said stations for preventing the extension of said line to said impulse repeater.

15. In a telephone system, a line, subscribers' stations connected to said line, each station comprising a magneto and an impulse sender, an impulse repeater individual to said line, circuit means responsive to the removal of the receiver at any of said stations to originate a call for operatively extending said line to the impulse repeater, a relay operatively responsive to ringing current created by the operation of the magneto at any of said stations for preventing the extension of said line to said impulse repeater, and circuit means rendered effective by the return of the receiver to normal position for causing

ing the release of said relay to enable extension of said line to said repeater on a subsequent call.

16. In a telephone system, lines, one of said lines being a party line, a magneto at each of the stations of said party line for use in calling the stations on the line, an impulse sender at each of said stations for use in calling stations connected to other lines, an impulse repeater for use in completing calls from any one of said party line stations to stations connected to other lines, a line relay responsive to the removal of the receiver at any one of said party line stations, a ring-up relay responsive to current created by the operation of the magneto at any of said party line stations, circuit means effective a predetermined interval of time after the operation of said line relay for disconnecting said ring-up relay from the line and for operatively connecting said line to said impulse repeater, circuit means rendered effective by the operation of said ring-up relay for preventing the extension of said line to said impulse repeater, circuit means for holding said ring-up relay operated during conversation between stations of said party line, and circuit means effective a predetermined interval of time after the return of the receivers to normal at the calling and called stations of said party line for causing the release of said ring-up relay.

17. In a telephone system, lines including a line having a plurality of magneto stations permanently connected thereto, an impulse sender at each of said stations, means comprising impulse controlled switches for use in connecting said line to a desired one of the other lines, an impulse repeating relay for repeating impulses from said sender to said switches, said impulse relay being individual to but normally disconnected from said line, and means comprising a line relay normally connected to said line and responsive to removal of the receiver at any of said stations for connecting said line to said impulse repeating relay.

RAY L. STOKELY.