

Dec. 13, 1927.

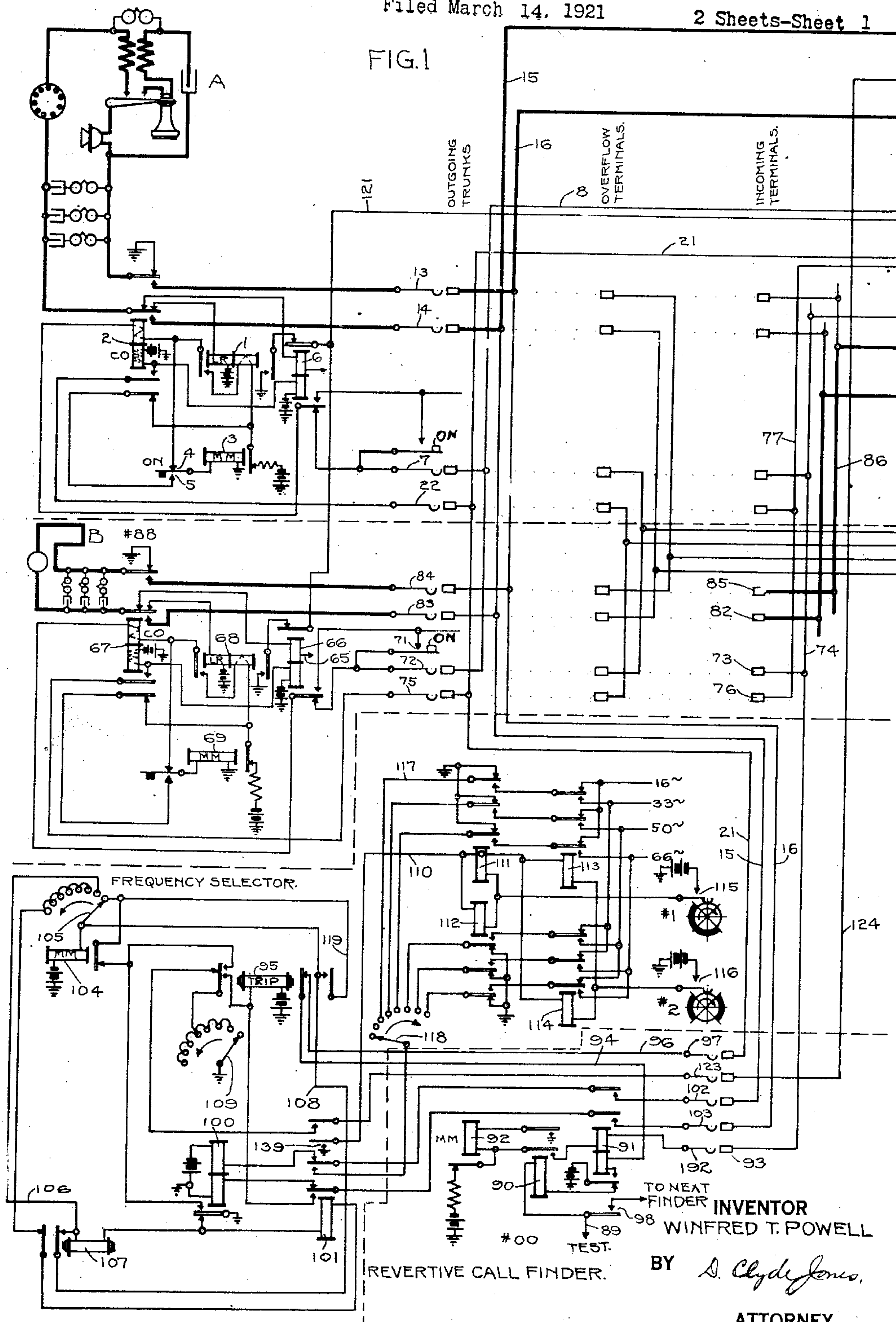
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AUTOMATIC TELEPHONE SYSTEM

Filed March 14, 1921

2 Sheets-Sheet 1



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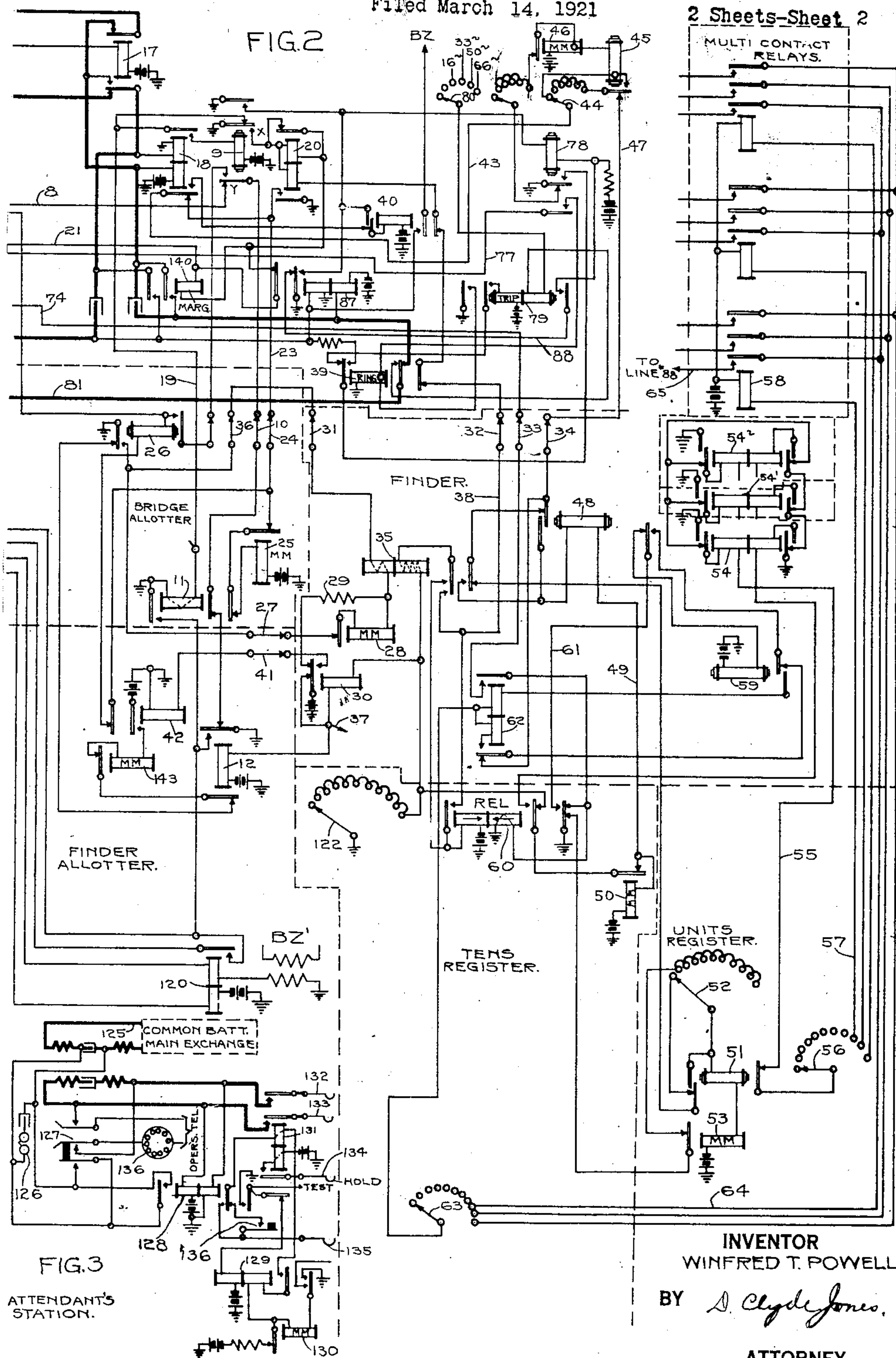
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed March 14, 1921. Serial No. 451,961.

This invention relates to telephone systems and more particularly to telephone systems employing automatic switches in completing some part of a telephone connection.

5 The main feature of the present invention is an improved method of interconnecting telephone lines through the use of non-numerical switches only.

10 An additional feature of this invention is the provision of means for signalling party lines in such a telephone system.

15 A further feature of the invention relates to novel means for completing revertive calls, that is, calls between stations on the same telephone line.

The drawings with Figure 1 placed at the left of Figure 2 diagrammatically represent a portion of the telephone system disclosing the present invention.

20 The portion of Figure 1 appearing above the dotted line represents a telephone line having four substations thereon, as well as a non-numerical switch individual to said line, while the portion of Figure 1 between the dotted lines extending across this figure, represents a very abbreviated disclosure of a second telephone line and the non-numerical switch individual to said line, but in this instance the four substations of the line are only indicated. The portion of the drawing below this last mentioned telephone line represents a non-numerical finder switch, a numerical frequency selector and various circuits associated therewith which are employed in the case of a revertive call to intermittently and alternately signal the calling and called stations. At the upper left-hand corner of Figure 2, there is represented a talking bridge or link of which there are sufficient to care for the maximum number of simultaneous conversations. At the left-hand side of Figure 2 and set off by dotted lines there is represented a bridge or link allotter switch which, as the name signifies, operates to assign an idle bridge or link circuit for use. Near the center of Figure 2 and set off by dotted lines there appears a finder switch, of which there are sufficient to care for the maximum number of calls that are in the process of being completed. There is associated with each one of these finders, a sender which includes a tens register and a units register which appear at the lower right-hand corner of Figure 2. At the up-

per right-hand corner of Figure 2 there are 55 represented three multi-contact test relays, but it will be understood that ten such relays are provided in a system of 100 lines and that each of these relays is provided with ten distinct sets of contacts. At the lower 60 left-hand corner of this figure there appears a finder allotter which functions to assign an idle finder as well as its associated register sender for use.

Figure 3 represents an attendant operator's station and shows a portion of an individual line switch assigned to that station. A portion only of the incoming trunk and of the operator's equipment are indicated, but it will be understood that the portions 70 which have been omitted may be arranged after the manner of that now in use.

The switches which are employed in this system may be of substantially the same structure as that disclosed in the patent to 75 Clement, 1,107,153 patented August 11, 1914.

It is believed that the invention will best be understood by describing the operation of establishing a telephone connection from substation such as that indicated at "A" to 80 a called line such as that indicated at "B", which it is assumed is designated #88.

When the subscriber at "A" removes his receiver from its switch-hook, a circuit is closed from grounded battery through the 85 left-hand winding of line relay 1, inner back contact and armature of the cut-off relay 2 over the lower side of the calling line and through the calling substation circuits, over the upper side of this line and through the 90 uppermost armature and back contact of the cut-off relay 2 to ground. The line relay is energized in this circuit and closes an operating circuit for the motor magnet 3 extending from ground, winding of this mag- 95 net through the off-normal contacts 4, armature, front contact and right-hand winding of the line relay, armature and back contact of the motor magnet, resistance to grounded battery. Under the control of this circuit 100 the motor magnet advances the brushes of the line switch one step thereby opening the off-normal contacts 4 and closing the off-normal contacts 5. This completes a circuit for the motor magnet now traceable from 105 ground, winding of this magnet, off-normal contacts 5, lowermost armature and back contact of the cut-off relay 2, armature and

back contact of the motor magnet, through the resistance to grounded battery. Under the control of this last-described circuit, the motor magnet advances the brushes of the line switch until an allotted link or bridge circuit is reached, at which time the motor magnet is short-circuited by a circuit completed from grounded battery, resistance back contact and armature of the motor magnet, right-hand winding of the line relay 1, left-hand front contact and armature of this relay, upper low resistance winding of the cut-off relay 2, armature and back contact of the relay 6, test brush 7, test conductor 8, lower back contact and armature of the slow releasing relay 9, brush 10 of the bridge allotter, inner armature and back contact of relay 11, upper back contact and armature of relay 12 to ground.

This last described circuit is also effective to energize the cut-off relay 2 which disconnects the line relay 1 from the calling line and also opens the operating circuit of the motor magnet 3 at the lowermost armature and back contact of this relay. When the cut-off relay operates to extend the calling line through brushes 13 and 14 of the line switch to conductors 15 and 16 thereby completing the impulse circuit, conductor 15 extends the impulse circuit through the uppermost armature and back contact of relay 17, lower winding of relay 18 to grounded battery, while conductor 16 includes the other side of impulse circuit which extends through the lower back contact and armature of relay 17 and through the upper winding of relay 18 to ground. As a result of the closing of this circuit, relay 18 attracts its armatures and thereby closes a circuit for energizing the slow-releasing relay 9 from grounded battery, winding of this relay, upper front contact and armature of relay 18, conductor 19, low resistance winding of relay 11 to ground. Relay 11, however, is short-circuited by ground at the inner armature and back contact of a relay 9 of an idle bridge. Relay 9 thereby closes a holding circuit for the line switch extending from ground, its inner upper armature and front contact upper armature and back contact of the holding relay 20, outer back contact and armature of relay 87, conductor 21, holding brush 22 of the line switch, inner lower armature, front contact and the high resistance winding of the cut-off relay 2 to grounded battery. Relay 6 is also energized in a circuit in multiple of that just described which extends to grounded battery through the lower winding of this relay. As soon as relay 9 is actuated, it closes at its uppermost armature a circuit for energizing the relay 78. It should be noted at this point that contacts designated X on relay 9 are closed before contacts Y are opened.

In the usual operation of the system such

a bridge circuit as that described is in readiness to receive a call. This is due to the fact that as soon as the holding relay 20 of any bridge circuit is energized upon the location of this bridge by an allotted finder, a circuit is closed from ground, lower armature and front contact of the operated holding relay, conductor 23, brush 24 of the bridge allotter, back contact and armature of the motor magnet 25 of this allotter, outer armature and back contact of relay 11, winding of magnet 25 to grounded battery. The motor magnet 25 will thus advance the brushes of the bridge allotter as long as the brush 24 engages the terminal having a ground potential thereon due to the energization of a holding relay 20 of engaged bridge circuits. Whenever an idle bridge is reached, the motor magnet 25 will remain inert until the allotted bridge is seized by some succeeding calling line. Also when the line relay 1 is energized on the initiation of a call it closes a circuit for relay 26 including the conductor 121. With the relay 26 energized a circuit is completed from ground through its left-hand armature and front contact, brush 27 of the finder allotter, back contact, armature and winding of the motor magnet 28 of the allotted finder switch through resistance 29, back contact and armature of relay 30 to grounded battery. Under the control of this circuit the finder will advance its brushes 31, 32, 33 and 34 until its brush 31 encounters a terminal individual to the allotted bridge circuit, at which time the relay 35 is energized in a circuit extending from grounded battery, armature and back contact of relay 30, resistance 29, left-hand winding of relay 35, finder brush 31, bridge allotter brush 36, front contact and armature of relay 26 to ground. This circuit is effective to operate the relay 35 and also to short circuit the motor magnet 28 to stop the finder with its brushes in engagement with the terminals individual to the allotted bridge circuit.

When the finder reaches the allotted bridge a circuit is closed for the relay 30 from grounded battery at the armature and back contact of a relay similar to 30 of an idle finder switch, over conductor 37, winding of relay 30, right-hand winding of relay 35, inner armature and front contact of this relay, conductor 38, finder brush 32, outer back contact and armature of the ringing relay 39, outer back contact and armature of relay 40, lower winding of relay 20, inner front contact and armature of relay 9 to ground. Relays 30 and 20 are energized and relay 35 held energized in this circuit. The high resistance right-hand winding of relay 35 serves to hold it operated as long as its finder switch is in use even after the bridge allotter has advanced to some other position. The release relay 60 is energized in a

circuit in multiple of that last disclosed, and at its left-hand armature and front contact closes a locking circuit for itself independent of the control of the relay 35. With relay 60 operated an energizing circuit is closed for relay 59 from grounded battery, its winding, outer back contact and armature of relay 54, conductor 61, outer front contact and armature of relay 60 to ground. When relay 30 attracts its armature it closes a circuit from grounded battery, brush 41 of the finder allotter, winding of relay 42 to ground. This energizes relay 42 and closes a circuit for the motor magnet 143 of the finder allotter, from grounded battery, inner armature and front contact of relay 42, winding back contact and armature of this magnet, lower armature and back contact of relay 12, back contact and armature of relay 26 to ground. Under the control of this circuit the motor magnet 143 advances the brushes of the finder allotter until its brush 41 encounters the terminal individual to a finder switch that is idle, at which time relay 42 deenergizes and opens the operating circuit of the motor magnet 143.

The operations just described have been effective to connect the calling line to an idle bridge circuit and to connect an idle register sender to this link circuit through the brushes of its associated finder switch. The remaining operations have allotted another bridge circuit for the next call that it originated, and have advanced the finder allotter to assign an idle finder and its associated register sender for use in the next succeeding call.

The apparatus is now in condition to receive the impulses corresponding to the designation of the wanted line. The first series of impulses transmitted is effective to select the proper frequency for ringing the bell at the wanted station on the called line, and consists of either 2, 3, 4 or 5 impulses, depending upon whether 16, 33, 50 or 66 cycle ringing current is selected. Let it be assumed that the bell at the wanted station responds to 16 cycle ringing frequency, wherefore in order to select this frequency, the calling party operates his dial sender to transmit two impulses of current. In response to these impulses the impulse relay 18 retracts its armature twice and on each retraction closes a circuit from ground, lower armature and front contact of relay 20, lower back contact and armature of relay 18, conductor 43, brush 44 of the frequency selector in its normal position, winding of slow releasing relay 45, winding of the motor magnet 46 to grounded battery. The slow releasing relay 45 is energized in this circuit and is maintained energized during this first series of impulses, but the motor magnet 46 is operated in response to each of these impulses and advances the brushes

of the frequency selector into their second position. At the close of this series of impulses, the impulse relay 18 maintains its armatures attracted for a relatively long interval so that the circuit of the slow releasing relay 45 is broken and after a short period this relay retracts its armature to extend the impulse circuit to the register sender.

The next series of impulses, eight in number corresponds to the ten's digit of the wanted number, and in response to each of these impulses the impulse relay 18 vibrates its armatures and now closes a circuit from ground, lower armature and front contact of relay 20, lower back contact and armature of relay 18, conductor 43, brush 44 of the frequency selector switch armature and back contact of relay 45, conductor 47, brush 34, of the finder switch, continuity spring and back contact of change-over relay 48, outer armature and front contact of relay 35, winding of change-over relay 48, conductor 49, winding of the motor magnet 50 to grounded battery. The change-over relay 48 is operated in this circuit and the impulse circuit is thereby extended through the continuity spring and armature of relay 48 which renders the circuit independent of the control relay 35. In response to each impulse of the ten's series the motor magnet 50 advances the brushes of the ten's register one step, but at the close of the ten's series of impulses the change-over relay 48 of the ten's register deenergizes and the sender is in condition to receive the unit's series of impulses. As soon as the brush 122 of the ten's register is moved from its normal position, the right-hand winding of relay 35 is short circuited, and since the bridge allotter has been moved to a bridge other than that under consideration, the circuit including the left-hand winding of relay 35 is opened and it deenergizes.

The unit's impulses, which are eight in number, are repeated to the unit's register over a circuit closed from ground, armature and front contact of relay 20, back contact and armature of relay 18, conductor 43, brush 44, armature and back contact of relay 45, conductor 47, finder brush 34, continuity spring and back contact of relay 48, outer armature and back contact of relay 35, continuity spring and back contact of units change-over relay 51, the unit's register brush 52 in its first position, winding of the change-over relay 51, winding of the motor magnet 53 to grounded battery. The change-over relay 51 is energized in this circuit and extends the impulse circuit through its continuity spring and armature which renders this circuit independent of the register brush 52. In response to each of the impulses repeated over this circuit, the motor magnet 53 advances the brushes of the unit's

register one step until the close of this series of impulses when the relay 51 retracts its armatures, and if no other sender is testing any of the lines of the system, the sender under consideration tests the wanted line to determine whether it is busy or idle.

Let it be assumed that no other sender is testing any of the lines, under which assumption the relay 54 of the sender under consideration as well as the relays 54' and 54² will be inactive. Relay 54 is now operated in a circuit completed from ground, continuity spring and back contact of relay 54 through the continuity springs and back contacts of other similar relays at the other register senders, back contact and left-hand continuity spring and winding of relay 54, conductor 55, back contact and armature of relay 51, unit's register brush 56 which we will assume has been advanced to its eighth position, multi-contact relay 58 of the group of lines in which the called line is located. The relay 54 opens the energizing circuit of relay 59 but before this relay retracts its armature, a test circuit is closed from ground at the outer armature and front contact of release relay 60, conductor 61, outer armature and front contact of relay 54, continuity spring and armature of relay 59, upper winding of relay 62, ten's register brush 63 in its eighth position, conductor 64, innermost armature and front contact of relay 58 to the test wire 65 of line #88, upper winding of relay 66, upper back contact and armature of cut-off relay 67, left-hand winding of line relay 68 to grounded battery. The relay 66 attracts its armature and renders the test brush 72 ineffective to test the outgoing terminals of bridge circuits, but when this brush reaches the group of incoming terminals of the bridge circuits a contact 71 will be closed to render the test brush 72 effective. With line relay 68 energized the motor magnet 69 of the called line switch is operated to seize the bridge circuit to which the calling line is connected.

When the terminating line switch reaches the bridge circuit to which the calling line has been connected, a circuit is closed from grounded battery, resistance, contact and armature of motor magnet 69, right-hand winding of line relay 68, its front contact and armature, upper winding of cut-off relay 67, lower armature and front contact of relay 66, contact 71, test brush 72, test terminal 73, conductor 74, finder brush 33, upper front contact and armature of relay 62, left hand winding of release relay 60 to ground. The cut-off relay 67 is energized in this circuit and closes a locking circuit for itself through its lower front contact and armature, holding brush 75, test terminal 76, test conductor 77, lowermost armature and front contact of relay 78, winding of ringing relay 39 to ground. Relay 60

is differentially wound and releases because of the previously described circuit closed through its left-hand winding, and mentioned test circuit of the called line switch. With relay 60 deenergized the motor magnet 50 of the ten's register and the motor magnet 53 of the unit's register are operated to restore these registers to normal.

The ringing relay 39 is thus energized and closes a ringing circuit from the source of 16 cycle ringing current, frequency selector brush 80, right-hand winding of the trip relay 79, inner right-hand front contact and armature of relay 39 conductor 81, ring terminal 82 of the bridge circuit, line switch brush 83 through the bell of the wanted station (not shown) over the upper side of the called line, tip brush 84, tip terminal 85, conductor 86, through the resistance, left-hand front contact and armature of relay 39, inner front contact and armature of relay 78 to ground. Also when the called party responds, the trip relay 79 attracts its armature, and at its outer left-hand armature and front contact it short-circuits the ringing relay 39 which deenergizes, whereupon a locking circuit is closed for the trip relay from grounded battery, its left-hand winding front contact and armature, left-hand back contact and armature of relay 39, inner front contact and armature of relay 78 to ground as soon as this last named relay is operated. Also when the called party responds, the relay 87 is energized and closes a circuit for holding relay 78, from grounded battery, resistance, winding of this relay front contact and armature of relay 87 to ground.

Talking battery is supplied to the calling party through the windings of relay 18, while talking battery is supplied to the called party through the windings of relay 87.

In the event that the called line is engaged when the test is made of this line after the setting of the register sender, the test circuit such as 65 is open at the back contact and inner upper armature of the cut-off relay 67 so that the called line switch cannot be started to hunt for the bridged circuit to which the calling line is connected. Also there will be no circuit completed for energizing the relay 62 of the finder (Fig. 2). The relay 62 is inert and when relay 59 deenergizes after the test, a circuit is closed for the relay 40. This circuit is traceable from grounded battery, winding of relay 40, its continuity spring and contact, lower front contact and armature of relay 18, conductor 43, brush 44, armature and back contact of relay 45, conductor 47, finder brush 34, lower back contact and armature of relay 62, back contact and continuity spring of relay 59, left-hand front contact and armature of relay 54, conductor 61, outer

front contact and armature of relay 60 to ground. Relay 40 is operated in this circuit and closes a locking circuit for itself through its continuity spring and armature to ground at the uppermost front contact and armature of relay 9. With relay 40 operated a source of busy tone current is connected with the calling line to inform the subscriber there that the wanted party is busy. It will be remembered that the release relay 60 of the register sender is locked operated through its left-hand winding and a circuit controlled at the back contact of relay 42. Therefore when relay 40 energizes it opens this circuit and relay 60 deenergizes to effect the release of the registers of the sender in the manner already outlined. In the event that the calling party first terminates the call by placing his receiver on its switch-hook, the relay 18 deenergizes and shortly afterwards the slow-releasing relay 9 retracts its armature and thereby opens the holding circuit 21 of the calling line switch. This permits relays 2 and 6 to deenergize and relay 2 at its lower armature and back contact, close the operating circuit for the motor magnet 3 which restores the line switch to normal. Also when the relay 9 retracts its armatures it opens the operating circuit for the relay 78 and when this relay deenergizes it opens the holding circuit for the called line switch, which circuit includes conductor 77. This permits the cut-off relay 67 to deenergize and effect the release of the called line switch. In the event that the called party first replaces his receiver on its switch-hook, the relay 87 retracts its armature and thereby closes a circuit from ground over conductor 88 and resistance to grounded battery. This short-circuits relay 78 which opens the holding circuit of the called line switch, and effects the release in the manner described. The calling line switch, however, is not released until relay 9 deenergizes which is effected by the restoration of the calling receiver to its switch-hook. When relay 78 deenergizes it closes a self-interrupting circuit for motor magnet 46 which restores the frequency selector associated with the bridge circuit, to normal.

When a subscriber desires to call a station on his own line, he dials a series of impulses corresponding to the designation #100. In case the station #2 is calling station number 3 or station #3 is calling station #2, then it is necessary to transmit a series of two impulses. If station #2 is calling station #4 or station #4 is calling station #2, then it is necessary to send three impulses. If station #2 is calling station #5 or #5 is calling #2, it is necessary to transmit four impulses. If station #3 is calling station #4, or #4 is calling #3, then five impulses must be sent, while if station #3 is calling station #5 the dial is operated to

send six impulses; and if station #4 is calling station #5, or #5 is calling #4, seven impulses are sent. After dialing this fourth or last series of impulses the subscriber is instructed to hang up until his bell stops ringing or until he desires to abandon the call.

Let it be assumed that station #2 is calling station #3 on the same line: In this case when the subscriber at station #2 removes his receiver from the switch-hook, his line switch is connected to an allotted bridge circuit as in the manner previously described. Similarly an allotted finder switch connects an idle register sender to the allotted bridge circuit. The subscriber first dials one impulse in response to which motor magnet 46 of the frequency selector advances its brushes to their first position. At the close of this impulse the slow releasing relay 45 at its contact and armature, connects the impulse circuit to the ten's register. The subscriber thereupon transmits a series of ten impulses which advances the brushes of the ten's register into their tenth position in the manner previously described. Thereupon the subscriber transmits another series of ten impulses corresponding to the unit's designation which advances the unit's register brushes into their tenth position. A test circuit is then completed to start into operation an idle revertive call finder, such as is shown at the lower part of Figure 1. This test circuit extends from a multi-contact relay to conductor 89, appearing at the lower right-hand corner of Fig. 1, winding of relay 90, lower back contact and armature of relay 91 to grounded battery. Relay 90 is energized in this circuit and effects the operation of the finder by closing a circuit from grounded battery, resistance back contact, armature and winding of the magnet 92, uppermost armature and front contact of relay 90 to ground. Under the control of this circuit motor magnet 92 advances the brushes of the revertive call finder until the test brush 192 encounters the test terminal 93 of the bridge circuit to which the calling line has been connected, at which time relay 91 will be operated and will close a locking circuit for itself. This current extends from grounded battery at the inner, lower armature, front contact and lower winding of relay 91, conductor 94, inner armature and back contact of slow releasing relay 95, conductor 96, holding brush 97 to the holding conductor 21 of the selected bridge circuit. At the lowermost armature and front contact 98 of relay 91 the test circuit 89 is extended to the next revertive call finder of the series, to care for any succeeding revertive call. At the upper armatures and front contacts of relay 91 break points are closed in the signalling circuit over which the fourth series of impulses are transmitted to operate the

frequency selector associated with the rever-
 tive call finder switch. Over this circuit
 ringing current of the proper frequency
 is first applied to signal the wanted station
 on the line, and then ringing current of the
 proper frequency is applied to signal the
 calling station on this line.

This last-mentioned signalling circuit in-
 cludes both windings of relay 100 in series
 and as soon as the signalling circuit is
 closed, this relay attracts its armature there-
 by closing a circuit from ground at its front
 contact, back contact and armature of the
 motor magnet 104, brush 105 in its first po-
 sition, winding of the motor magnet 104 to
 grounded battery. As a result of the clo-
 sure of this circuit, the frequency selector
 advances its brushes into their first posi-
 tion in readiness to receive the last series of
 impulses corresponding to the wanted sta-
 tion on the party line.

The mentioned operations of the rever-
 tive call finder follow the last series of ten im-
 pulses, but before the calling subscriber
 transmits an additional series of impulses to
 select the current of the proper frequency.
 The calling subscriber now dials a series of
 two impulses corresponding to series No. 3
 on his line. These impulses are transmitted
 over the signalling circuit which extends
 from grounded battery, upper winding of
 relay 100, back contact and armature of re-
 lay 101, uppermost armature and front con-
 tact of relay 91, finder brush 102, conductor
 15, line switch brush 14 and over lower side
 of calling line through the impulse contacts
 of the calling dial and over the upper side
 of the calling line, line switch brush 13, con-
 ductor 16, finder brush 103, innermost upper
 front contact and armature of relay 91, in-
 nermost armature and back contact of relay
 101, lower winding of relay 100 to ground.
 In response to the first of these impulses a
 circuit is closed from ground, armature and
 back contact of relay 100 slow releasing re-
 lay 107, conductor 106, brush 105 in its first
 position, winding of the motor magnet 104
 to grounded battery. This circuit advances
 the frequency selector brushes into their
 second position. In response to the next
 impulse, a circuit is closed for advancing
 the frequency selector switch, extending
 from grounded battery, winding of the mo-
 tor magnet 104, conductor 108, inner arma-
 ture, front contact and winding of relay 107,
 back contact and armature of relay 100 to
 ground. The closure of this circuit is ef-
 fective to advance the frequency selector
 into its third position. Relay 107 is ener-
 gized in this circuit and remains energized
 during this series of impulses.

Since it was assumed that a series of two
 impulses is transmitted to this frequency se-
 lector, its brush 105, 109 and 118 will remain
 in their third position. In the case of a re-

vertive call, the calling party is instructed
 to hang up at the close of this series of im-
 pulses until the wanted party answers. Re-
 lay 100 deenergizes whereupon switching re-
 lay 101 will be operated to clear the signal-
 ling circuit for the application of ringing
 current, also the switching relay closes other
 circuits, the purpose of which will be de-
 scribed. The circuit for operating switch-
 ing relay 101 is from ground at the armature
 and back contact of relay 100, winding of
 relay 101, outer armature and back contact
 of relay 107, brush 105 in any of its posi-
 tions, winding of motor magnet 104 to
 grounded battery. With the relay 101 en-
 ergized a circuit is closed from ground,
 brush 109, armature and back contact of
 relay 95, uppermost front contact and ar-
 mature of relay 101, brush 123, conductor
 124, winding of relay 17 to grounded bat-
 tery. Relay 17 is energized to maintain re-
 lay 18 energized while the calling party's
 receiver is hung up during the ringing pe-
 riod. Relay 18 holds relay 9 operated to
 prevent the release of the calling line switch
 during this period. When the switching re-
 lay 101 is operated it closes its contact 139
 and armature to ground, thereby closing a
 circuit including conductor 110 and the
 winding of relays 111 and 112 through the
 contact 115 to grounded battery, whenever
 interrupter #1 has rotated to the proper
 position. Similarly the circuit including
 the conductor 110, is completed through the
 windings of relays 113 and 114, and the con-
 tact 116, whenever interrupter #2 is rotated
 into the proper position. It will be noted
 that the cam cuttings on these interrupters
 are so arranged that when interrupters 1
 and 2 rotate through an eighth of a revolu-
 tion from the position shown, they will ac-
 tuate relays 111 and 112, 113 and 114 so that
 the 33 cycle source of current is applied to
 conductor 117 and thence through brush 118
 over the conductor 15 to signal station #3
 on the calling line and back again over con-
 ductor 16 through the winding of trip relay
 95 to grounded battery. When the interrup-
 ters are rotated through another quarter of
 a revolution, then only the relays 111 and
 112 will be operated, so that the 16 cycle
 source of ringing current is then connected
 to the conductor 117, which conductor in
 this instance is also included in the ringing
 circuit just described. This alternate signal-
 ling of the calling and called subscriber's
 stations continues until one of the parties
 responds, at which time the trip relay 95 is
 energized and at its left-hand front contact
 and armature, closes a locking circuit for it-
 self through the frequency selector brush
 109 to ground. At the inner right hand ar-
 mature and back contact of relay 95 the
 holding circuit of relay 91 is interrupted to
 release the rever-
 tive call finder for use on

a succeeding call. This finder is of the "stay-put" type and it remains in engagement with the bridge last used. Also the operation of the trip relay 95 closes a circuit for restoring the frequency selector to its normal position. This circuit is completed from grounded battery, winding of the motor magnet 104, conductor 108, right-hand armature and front contact of relay 95, conductor 119, armature and back contact of the motor magnet, left hand front contact and armature of relay 95, brush 109 to ground. Under the control of this circuit the motor magnet 104 advances the frequency selector until the same reaches its normal position, at which time the circuits to ground at brush 109 are opened and the trip relay deenergizes to leave the frequency selector in readiness for a succeeding call. As soon as this selector reaches its normal position, the circuit of the switching relay 101 is opened at brush 105 causing it to release. This opens the holding circuit of relay 17, Fig. 2, whereupon relay 17 releases to permit talking battery to be extended to both stations through the windings of relay 18.

In this system a so-called overflow arrangement is provided so that if all the bridge circuits become busy, a busy signal is transmitted to the calling subscriber until he releases or until a bridge circuit becomes idle.

When all the bridge circuits are in use, all the relays 9 of which there is one associated with each bridge circuit, are operated and thereby ground potential is disconnected from all the conductors such as 19. Thereupon the low resistance relay 11 is energized in the circuit now closed from ground, winding of this relay over any one of the conductors such as 19, upper armature and front contact of a relay similar to 18 and winding of a relay similar to 9 to grounded battery. Relay 11 is operated in this circuit and at its inner armature and back contact disconnects the stopping ground potential from the brush 10 and opens the bridge allotter circuit at its outer armature and back contact to prevent this allotter from continually rotating. This relay also places a ground on the overflow test terminals of the line switches, which is applied at the left-hand armature and front contact of relay 11. If a call is initiated when the above-described condition exists, the calling line switch will be advanced to the overflow trunk where relay 120 will be operated by the closed circuit of the calling line. Relay 120 establishes a holding circuit for the line switch which circuit is opened when a finder or bridge circuit becomes idle, thus causing the line switch to leave the overflow trunk and choose the bridge circuit which has become idle. As long as the line switch

remains on the overflow trunk, calling party receives a busy tone from source B Z' indicating that the bridge circuits are all busy.

If the finders are all busy, relay 12 will be operated to open the operating circuit of the finder allotter and to place a stopping potential on the test terminal of the overflow circuit so that the calling line switch will be stopped in engagement therewith. When this line switch seizes the overflow circuit, relay 120 is operated as previously described and applies a busy tone signal to the calling line until the subscriber there abandons the call or a finder becomes idle.

In Figure 3 which appears at the lower left-hand corner of Fig. 2 there is represented a two-way trunk extending from the common battery exchange to an attendant operator's position or station associated with the private automatic exchange. In the case of this attendant station there is provided an individual switch similar to that provided for each of the lines of the private system. The brushes of this individual switch are designated 132, 133, 134 and 135 and engage terminals that are in multiple with the outgoing terminals, with the overflow terminals, and with the incoming terminals appearing in the upper half of Fig. 1.

Let it first be assumed that a call from the main exchange is intended for some subscriber in the private automatic exchange. In this case the calling subscriber's line (not shown) will be extended either manually or automatically to include the conductors 125 of the trunk extending between the main exchange and the branch exchange. As soon as this connection has been completed, signal 126 will notify the operator that the call is awaiting her attention. The operator thereupon depresses her listening key 127 by which her telephone set (not shown) is connected inductively to the incoming trunk and she receives the designation of the wanted station. As soon as the listening key 127 is depressed, the relay 128 is operated in a circuit including the operator's telephone set and closes a circuit from ground, its outer front contact, armature and left-hand winding of relay 129 to grounded battery. This last named relay is operated and closes a circuit from ground, its outer front contact and armature, winding of the motor magnet 130, its armature and back contact, through the resistance to grounded battery. Under the control of this circuit the motor magnet advances the brushes 132 to 135 inclusive to select an allotted bridge circuit in the manner previously described for a subscriber's line of the private exchange. When the allotted bridge circuit is located, the relay 131 is operated in a circuit traceable from grounded battery through the resistance, back contact and armature of the motor magnet, right-hand winding, inner armature

and front contact of relay 129, armature and back contact of relay 128, off normal contacts 136 brush 135, the outgoing terminal of the allotted bridge circuit over a conductor similar to 8 of Fig. 1 to ground as previously described. This last described circuit short circuits the motor magnet 130 and stops the line switch in engagement with the allotted bridge circuit. Also when relay 131 is operated it extends the operator's telephone set through its front contacts and armatures to brushes 132 and 133 of the line switch. These brushes will thereupon extend the circuit to conductors similar to 15 and 16 of Fig. 1 to serially include both windings of a relay similar to 18 appearing at the upper left-hand corner of Fig. 2. The operation of relay 18 will energize a relay 9 as previously described to apply a holding ground to holding conductor similar to 21. The relay 131 of Fig. 3 is thereupon locked operated over a circuit completed from grounded battery, lower winding which in the case of the attendant's position is of low resistance, inner front contact and armature of this relay and holding brush 134 which is in engagement with a holding terminal associated with the seized bridge circuit and connected to the holding conductor 21.

The operator thereupon operates the dial sender 136 to set up the designation of the wanted station on the register sender. Whereupon the connection is completed in the manner that has been described in connection with calls within the private automatic exchange. After the operator has finished actuating the dial sender 136 she releases key 127 to disconnect her telephone set from the established connection.

When key 127 is restored there would be nothing to hold relays 128 and 18 operated if the following arrangement is not provided. It will be noted that the lower winding of relay 131 which is the holding winding, is of low resistance and when the called party answers thereby operating relay 87, the short circuit is removed from relay 140 and although it is marginal it operates in series with the lower winding of relay 131, and the circuit of the called line is effective to hold relays 128 and 18 operated because the condensers are short-circuited. However, in the case of calls within the exchange the relay corresponding to 131 has its lower winding of high resistance so that marginal relay 140 will not operate in the series therewith and consequently will not short circuit the condensers of the bridge circuit.

Supervision at the main exchange is also permitted by reason of the fact that in case of calls that originate outside of the private automatic exchange, relay 140 short-circuits the condensers which normally conductively separate two sides of each bridge circuit as has been described. With relay 140 operated

and the condensers short-circuited, the called party at the automatic exchange on hanging up his receiver will actuate a signal at the main exchange, in the case of a manual connection whereas in the case of an automatic connection he effects the deenergization of a relay to give supervision in the manner well known.

The release of the switches of the private automatic exchange in the case of a call originating at a main office is also controlled by the called party placing his receiver on the switch-hook. This will cause the relay corresponding to 87 to retract its armature and thereby short-circuit relay 78 in the manner previously described. Relay 78 on deenergizing opens the holding circuit 77 of the called line switch which thereupon releases, as has been described. This also releases relays 128 and 18 and the line switch of the Figure 3. The release of that portion of the connection completed at the main office may be effective in any well known manner.

Since the trunk as represented in Fig. 3 is of the character referred to as a two-way trunk, when a subscriber at the private automatic exchange desires to obtain a connection at the main exchange, the line switch of Fig. 3 may be operated in response to a predetermined setting of the register sender whereupon the calling subscriber can then dial impulses to set automatic switches at a distant automatic exchange, or in the case that this exchange is manual, an operator is signalled.

What is claimed is:—

1. In an automatic telephone system in combination with a plurality of telephone lines, bridge circuits, means for assigning bridge circuits for use ahead of the calls, means including a non-numerical switch for extending telephone lines to either end of an assigned bridge circuit, a plurality of senders, means for assigning senders for use, means for associating an assigned sender with an assigned bridge circuit, means for adjusting said sender from a remote point, and means operating under the control of said adjusted sender for controlling the extension of a wanted line to said assigned bridge circuit.

2. In an automatic telephone system, in combination with a plurality of telephone lines, line switches for said lines, bridge circuits, means for assigning bridge circuits for use ahead of the calls, means for causing the switch of a calling line to extend the same to an assigned bridge circuit, a plurality of senders, means for assigning senders for use, means for associating the assigned sender with an assigned bridge circuit, means for adjusting said sender from a remote point in accordance with the designation of the wanted line, and means operating under the control of said adjusted sender for causing the

line switch of a wanted line to extend the same to said assigned bridge circuit.

3. In an automatic telephone system, in combination with a plurality of telephone lines, an individual switch for each of said lines, bridge circuits each provided with two branches both terminating in each switch, means for allotting bridge circuits for use ahead of the calls, means for causing the line switch of a calling line to seize the outgoing branch of said allotted bridge circuit, a plurality of senders, means for assigning senders for use, means for associating an allotted sender with an allotted bridge circuit, means for adjusting said sender from a remote point in accordance with the designation of a wanted line, and means operating under the control of said adjusted sender for causing the individual switch of the called line to seize an incoming branch of the allotted bridge circuit.

4. In an automatic telephone system, in combination with a plurality of telephone lines, an individual switch for each telephone line, a plurality of bridge circuits each provided with incoming and outgoing branches terminating in each of said switches, a progressively movable switch for allotting bridge circuits for use ahead of the calls, means for causing the individual switch of a calling line to seize the outgoing branch of an allotted bridge circuit, a plurality of senders, means for assigning senders for use, means for associating an assigned sender with an allotted bridge circuit, means for adjusting said sender from a remote point in accordance with the designation of a wanted line, and means operating under the control of said adjusted sender for causing the individual switch of the called line to extend the same to an incoming branch of said allotted bridge circuit.

5. In an automatic telephone system, in combination with a plurality of telephone lines, a plurality of telephone stations on each of said lines, each station being provided with a signal responsive to current of certain frequency, a plurality of bridge circuits, means for allotting said circuits for use, an individual non-numerical switch for each telephone line operative on the initiation of a call on its line to extend the same to an allotted bridge circuit, sources of current of different frequencies, a frequency selector directly controlled over a calling telephone line to select a source of current of the proper frequency to signal the wanted station, a sender directly adjustable over a calling telephone line in accordance with the designation of a wanted telephone line, means responsive to the adjustment of said sender for causing the line switch of the desired line to seize the allotted bridge circuit, means responsive to said seizure to apply the selected source of current to said wanted line

and means for releasing the established connection.

6. In an automatic telephone system, in combination with a plurality of telephone lines, a plurality of stations on each of said lines, each station being provided with a signal responsive to current of a certain frequency, a plurality of bridge circuits, means for allotting said bridge circuits for use, an individual non-numerical switch for each line operative on the initiation of a call on its line to extend the same to an allotted bridge circuit, sources of current of different frequencies, a frequency selector directly controlled over a calling telephone line to select a source of current of the proper frequency to operate the signal at the wanted station, a sender directly adjustable over the calling telephone line in accordance with the designation of the called line, said sender being adjusted subsequent to the operation of said frequency selector, means responsive to the adjustment of said sender for causing the line switch of the desired line to seize the allotted bridge circuit, means responsive to said seizure to apply the selected source of current to said line and means for releasing the established connection.

7. In an automatic telephone system, in combination with a plurality of telephone lines, a plurality of stations on each of said lines, each station being provided with a signal responsive to current of a certain frequency, a plurality of bridge circuits, means for allotting said bridge circuits for use, an individual non-numerical switch for each line operative on the initiation of a call on its line to extend the same to an allotted bridge circuit, sources of current of different frequencies, means directly controlled over a calling telephone line to select a source of current of the proper frequency to operate the signal at the wanted station, a sender directly adjustable over the calling telephone line in accordance with the designation of the called line, said sender being adjusted subsequent to the operation of said frequency selector, means responsive to the adjustment of said sender for causing the line switch of the desired line to seize the allotted bridge circuit, means responsive to said seizure to apply the selected source of current to said line, means for releasing said sender for common use as soon as the individual switch of the wanted line has seized said allotted bridge circuit, and means for releasing the established connection.

8. In an automatic telephone system, in combination with a plurality of telephone lines, a plurality of stations on certain of said lines, each of said stations on a telephone line being provided with a signal responsive to current of a certain frequency, a plurality of sources of current of the

proper frequency to operate each of said signals, a frequency selector for selecting the proper frequency to operate a signal at a wanted station, a non-numerical switch responsive to control from a remote point for associating said frequency selector with a calling line, means controlled over said calling line for variably operating said selector to connect the proper source of current to a calling line to signal a wanted station thereon and means for releasing said non-numerical switch prior to the termination of the call.

9. In an automatic telephone system, in combination with a plurality of telephone lines, a plurality of stations on certain of said lines, each of said stations on a telephone line being provided with a signal responsive to current of a certain frequency, a plurality of sources of current of the proper frequency to operate each of said signals, non-numerical switches for said telephone lines, a plurality of bridge circuits, any one of which is arranged to be seized by a non-numerical switch, a sender, means for associating said sender with a selected bridge circuit, means for variably operating said sender over a calling line and bridge circuit in series, a frequency selector, a non-numerical switch associated therewith, means operated in response to a pre-determined setting of said sender for causing said non-numerical switch to associate said frequency selector with a calling line, means controlled over said calling line for directly operating said frequency selector to apply a source of current of the proper frequency to signal the wanted station on the calling line, and means for releasing said established connection.

10. In an automatic telephone system in combination with a plurality of telephone lines, non-numerical switches for the use of said lines, a plurality of bridge circuits each having incoming and outgoing branches terminating in each of said switches, a test brush for each non-numerical switch, means for rendering said test brush effective to test outgoing branches of said bridge circuits when its telephone line is calling, and means for rendering said test brush effective to test only incoming branches of said bridge circuits when its telephone line is being called.

11. In an automatic telephone system in combination with a main exchange, a branch exchange, telephone lines terminating at said branch exchange, an operator's position at said branch exchange, a trunk circuit extending between said main exchange and said operator's position, non-numerical switching means associated with said operator's position for automatically extending a call from said trunk circuit to a wanted telephone line and from a telephone line to said trunk, and means controlled over said

telephone line for disestablishing a portion of the connection.

12. In an automatic telephone system, in combination with a main exchange, a branch exchange, telephone lines terminating at said branch exchange, an attendant operator's position at said branch exchange, a two-way trunk circuit extending between said main exchange and said operator's position, means including a non-numerical switch for automatically extending any one of said telephone lines as a calling line over said trunk circuit to the main exchange, means including said non-numerical switch associated with said operator's position for extending a call from said trunk circuit to a wanted telephone line, and means controlled over said wanted telephone line for disestablishing a portion of a connection.

13. In an automatic telephone system, in combination with a telephone line, a plurality of stations on said telephone line, each of said stations being provided with a signal responsive to current of different character from that to which the other stations are responsive, a plurality of bridge or link circuits, a non-numerical switch for extending said telephone line to a bridge circuit, sources of current of different character for actuating said signal, a numerical switch, means for associating said last-mentioned switch with said bridge circuit and means for operating the same over said telephone line, means responsive to the setting of said numerical switch for applying the proper source of current to said telephone line to signal the calling and wanted stations thereon, and means for releasing said numerical switch before termination of the conversation.

14. In an automatic telephone system, in combination with a telephone line, a plurality of stations on said telephone line, each of said stations being provided with a signal responsive to current of different frequency from that to which the other stations are responsive, a plurality of bridge circuits, a non-numerical switch for extending said telephone line to a bridge circuit, sources of current of different frequency for actuating said signal, a numerical switch, means for associating said last-mentioned switch with said bridge circuit and means for operating the same over said telephone line, means responsive to the setting of said numerical switch for alternately applying the proper sources of current to said telephone line to signal the calling and wanted stations thereon, and means for releasing said numerical switch before the termination of the conversation.

15. In an automatic telephone system, in combination with a telephone line, a plurality of stations on said telephone line, each of said stations being provided with a sig-

nal responsive to current of different character from the other stations, a bridge circuit, a source of talking current connected to each bridge circuit, a non-numerical switch having terminals in which said telephone line and bridge circuit terminate, a numerical switch connectible to said bridge circuit and responsive to directive control over said telephone line, means responsive to the setting of said numerical switch for selecting sources of current of the proper frequency to signal the calling and wanted stations on said wanted telephone line, and a conversational circuit including said telephone line and bridge circuit but having only one automatic switch therein.

16. In an automatic telephone system, a plurality of telephone lines, a plurality of non-numerical switches, a plurality of bridge circuits, means for causing a non-numerical switch to extend a calling telephone line to an assigned bridge circuit, a plurality of senders, means for assigning senders for use, means for associating the assigned sender with an assigned bridge circuit, means for adjusting said assigned sender from a remote point in accordance with the designation of the wanted telephone line, and means operative under the control of said adjusted sender for causing a non-numerical switch to extend a called line to said assigned bridge circuit.

17. In an automatic telephone system, a plurality of telephone lines, a plurality of telephone stations on each of said telephone lines, each of said stations being provided with a signal responsive to current of a certain characteristic, a plurality of bridge circuits, a plurality of non-numerical switches, means including at least one of said non-numerical switches for extending a calling telephone line to a bridge circuit on the initiation of a call, sources of current of different characteristics, means controlled over the calling telephone line and bridge circuits for causing a non-numerical switch to extend a called telephone line to said selected bridge circuit and means directly controlled for connecting current of the proper characteristic to signal the wanted station on the called telephone line.

18. In an automatic telephone system, a plurality of telephone lines, a plurality of stations on each of said lines, each of said stations being provided with a signal responsive to current of a certain characteristic, a plurality of bridge circuits, a plu-

ality of non-numerical switches, means including a non-numerical switch for extending a calling telephone line to a bridge circuit, sources of current of different characteristics to actuate said signals, a frequency selector directly controlled over a calling telephone line to select a source of current of the proper character to actuate the signal at the wanted station, a sender directly adjustable over the calling telephone line in accordance with the designation of the called line, said sender being adjusted subsequent to the operation of said frequency selector, means responsive to the adjustment of said sender for causing a non-numerical switch to extend the wanted telephone line to the selected bridge circuit, means responsive to said extension to apply the selected source of current to said telephone line, and means for releasing the established connection.

19. In a telephone system, a plurality of telephone lines, a plurality of bridge circuits, an over-flow circuit, a plurality of non-numerical switches, means including a non-numerical switch extending a calling telephone line to a bridge circuit on the initiation of a call, and means directly controlled for causing a non-numerical switch to extend the wanted telephone line to the bridge circuit to which the calling line is connected, means for rendering the bridge circuit busy when it is seized by a non-numerical switch, and means operative when all of said bridge circuits are busy for causing said non-numerical switch to extend a calling telephone line to said over-flow circuit.

20. In an automatic telephone system, a main exchange, a local exchange, an operator's position at said local exchange, a plurality of telephone lines terminating at said local exchange, means including a plurality of automatic switches for interconnecting said telephone lines, means including a trunk circuit for extending a call from said main exchange to said operator's position, a non-numerical switch associated with said trunk circuit, and means including a non-numerical switch and certain of said automatic switches for extending said trunk to any of said telephone lines and for extending any of said telephone lines to said trunk.

In witness whereof, I hereunto subscribe my name this 9th day of March, A. D. 1921.

WINFRED T. POWELL.