

July 2, 1929.

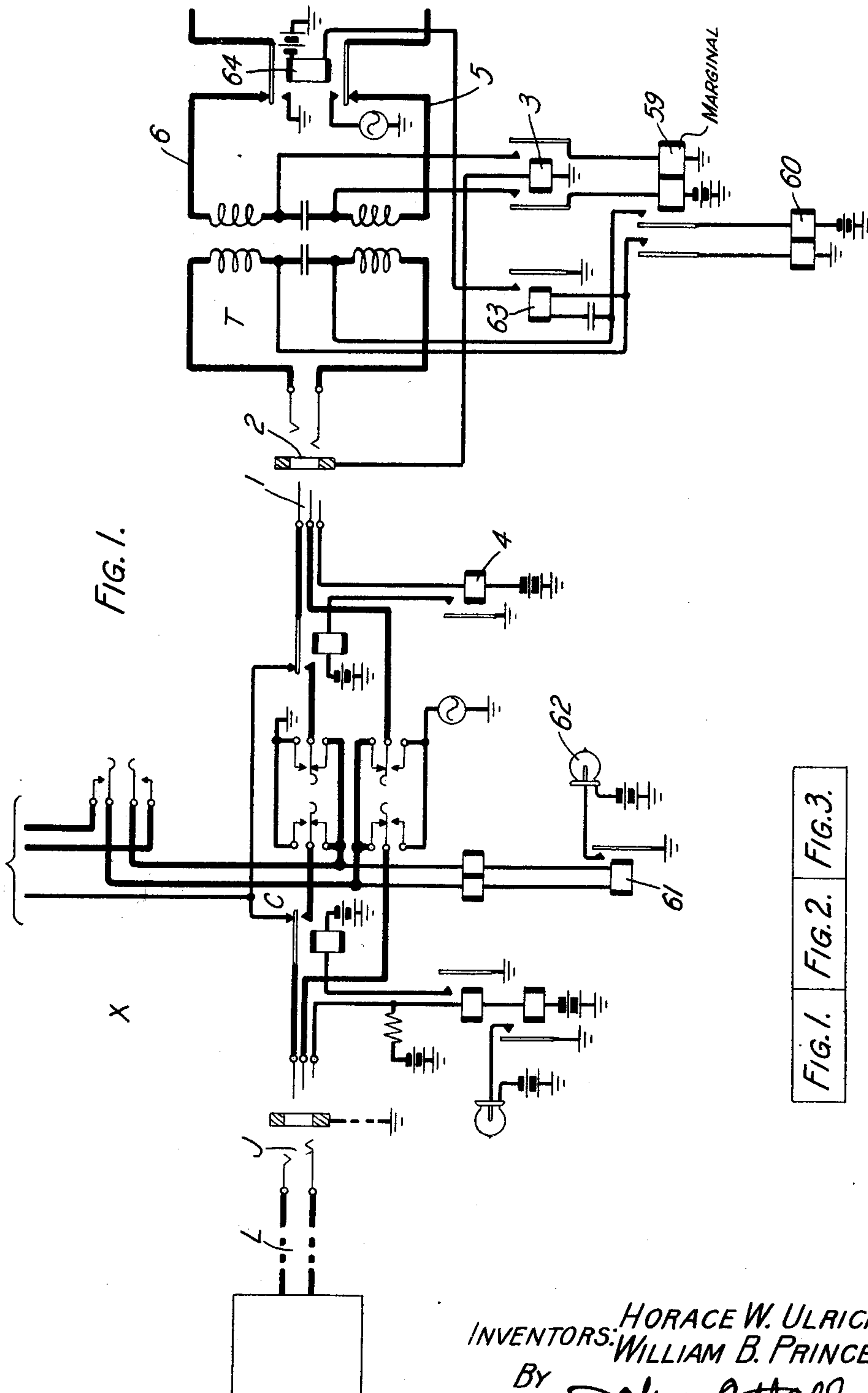
H. W. ULRICH ET AL

1,719,494

TELEPHONE EXCHANGE SYSTEM

Filed Sept. 28, 1927

3 Sheets-Sheet 1



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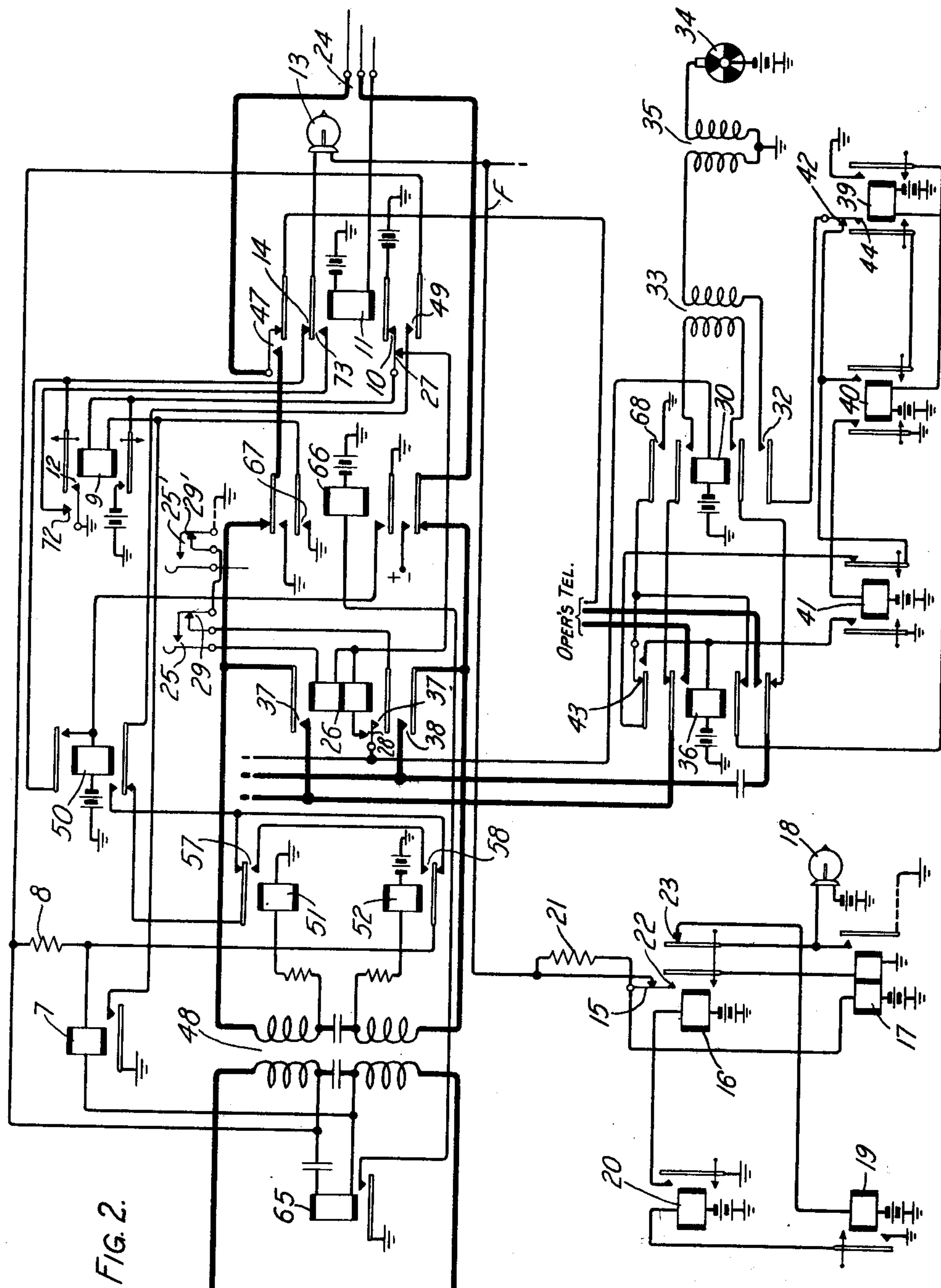
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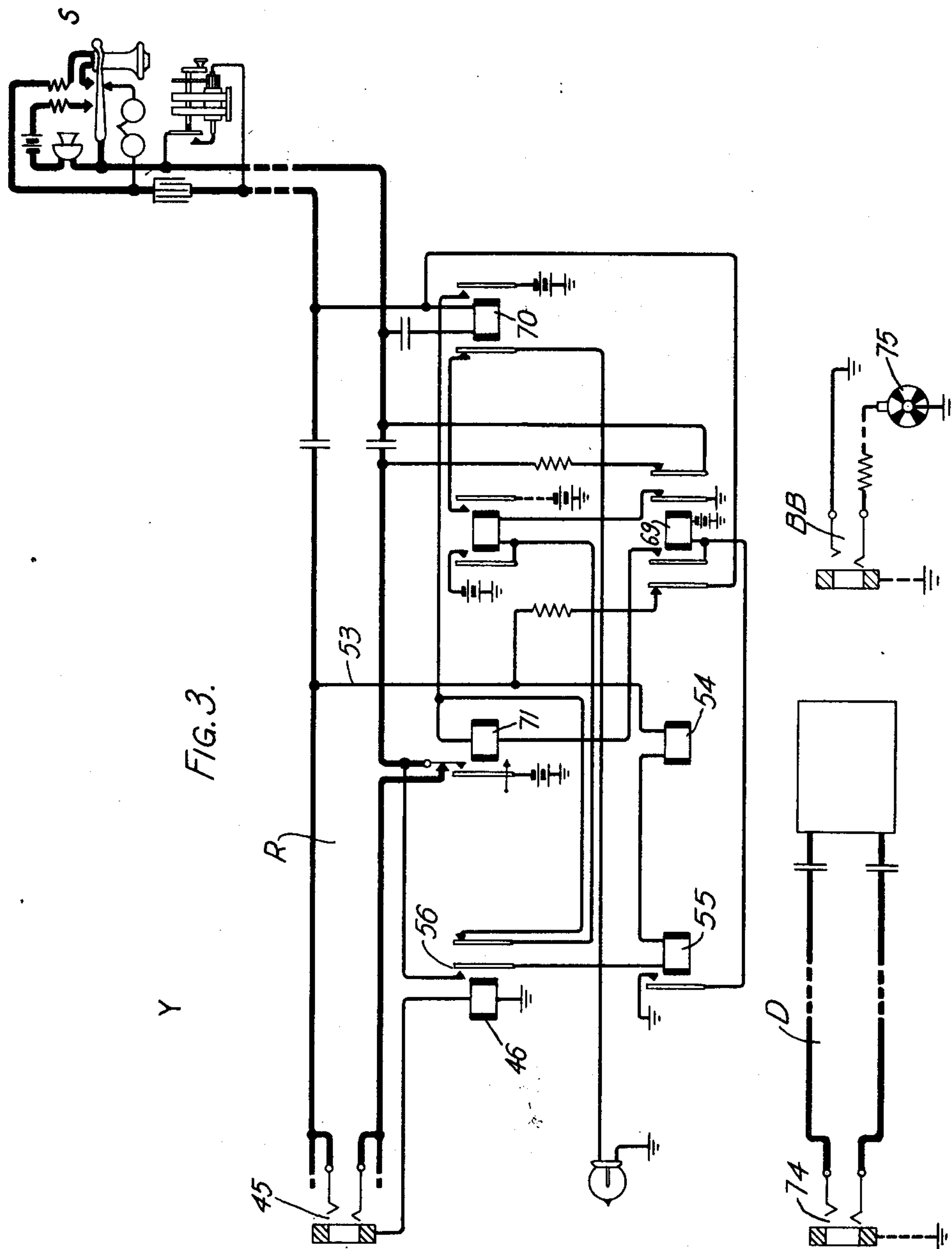
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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

Application filed September 28, 1927. Serial No. 222,516.

This invention relates to telephone systems, and more particularly to signaling in connection with telephone trunking systems.

A feature of the invention is an arrangement for toll switching trunk circuits employed in completing connections to rural lines, whereby the trunk will function to transmit a signal to the distant toll operator when the trunk is connected to either a rural line having a direct current bridge connected across its talking conductors or to an "open" line, that is, a line between whose talking conductors there is no path for direct current until the called station answers, such as, for example, an interposition trunk to a trouble operator.

Another feature of the invention is an arrangement whereby the signal is effaced in response to the application of ringing current to the trunk at the toll office.

Another feature of the invention is an arrangement whereby if the trunk is connected to a rural line having a direct current bridge the application of ringing current to the trunk at the toll office will efface the signal and prevent its reactivation until the called subscriber has rung off.

A further feature is an arrangement whereby a flashing busy signal is transmitted to the toll operator in case the trunk is plugged into a "busy-back" jack, i. e. a jack having its tip spring permanently grounded and to the ring spring of which ground is intermittently connected under control of an interrupter.

A more complete understanding of the invention will be had from the following description when read in connection with the accompanying drawings which illustrates one embodiment thereof.

The drawing, Figs. 1, 2 and 3, when placed together in consecutive order represent means for establishing a connection between a line L, terminating in a jack J at a toll office, Fig. 1, and either a rural line R or an interposition trunk D outgoing from a switching office, Fig. 3.

In systems of the character described a toll completing operator as at X, Fig. 1, usually receives by means of a ticket, the number of the calling subscriber and either the name or number of the called subscriber. The completing operator may then obtain

connection of her cord circuit C with the calling subscriber's line in any approved manner well known in the art, such as over a call circuit switching trunk line L terminating in a jack J at the completing operator's position.

Assuming that the rural line subscriber S at exchange Y, Fig. 3, is the party desired, the toll completing operator will insert the calling plug 1 of her cord circuit C in jack 2 of a toll switching trunk T extending to the exchange Y, whereupon relay 3 operates in a circuit which may be traced from battery through the cord sleeve relay 4, the sleeve conductors of plug 1 and jack 2 and the winding of trunk sleeve relay 3 to ground. Relay 3 in operating connects battery and ground through the windings of relay 59, to the ring and tip conductors 5 and 6 of the trunk T, thereby operating relay 7, Fig. 2, in an obvious circuit which includes resistance 8. Relay 59 which is marginal cannot operate in series with resistance 8. Relay 7, in operating, completes a circuit to operate relay 9 which can be traced from ground, contacts of relay 7, winding of relay 9, contacts 10 of relay 11 to battery. Relay 9, in operating, locks itself up at its lower contacts under control of relay 7. Relay 9, in operating, also connects ground at its contacts 12 to light the guard and disconnect lamp 13, which circuit can be traced over contacts 14 of relay 11, lamp 13, conductor F, contacts 15 of relay 16 and the left hand winding of relay 17 to battery. Relay 17 operates in this circuit and closes an obvious circuit to light the pilot lamp 18 and to operate relay 19. Relay 19 operates relay 20 and relay 20 operates relay 16. Relay 16, in operating, opens at its contacts 15 a short circuit normally around resistance 21, thereby interposing this resistance in series with lamp 13 and causing it to darken. Relay 17 does not release at this time, thereby extinguishing lamp 18, as the closure of contacts 22 of relay 16 completes a locking circuit for relay 17 which includes both of its windings in series. When relay 16 operated it opened its contacts 23, thereby causing the sequential release of relays 19 and 20 and lastly relay 16, whereupon resistance 21 is again short circuited and lamp 13 burns at full brilliancy. This cycle of operation, which

causes lamp 13 to flash, is repeated until the plug 24 of the trunk is inserted in the jack of the called line.

The operator upon noting the flashing lamp 13, which indicates the arrival of a call, answers by operating the "talk key" 25 individual to the trunk which causes the operation of relay 26, the circuit of which may be traced from battery over lower contacts of relay 9, contacts 27 of relay 11 and the upper winding of relay 26 to ground at the contacts of key 25. Relay 26 in operating closes its contacts 28 and 31, thereby preparing a locking circuit for itself through its lower winding, which circuit is completed when key 25 is released and its contacts 29 closed.

Upon the release of key 25 and the consequent closure of contact 29, assuming that no other listening key, such as 25' of another trunk, is operated, relay 30 will be operated from ground through the contacts 29 of the listening keys, contacts 31 of relay 26 and the winding of relay 30 to battery. Relay 30 in operating closes its contacts 68, thereby completing a circuit, including the inner lower normal contacts of relay 36, for operating relay 39 which in turn causes the sequential operation of relays 40, 41 and 36. Relays 39, 40 and 41 are slow to operate for a reason which will later appear.

When relay 30 operated it also closed its contacts 32, thereby completing the primary circuit of transformer 33 which is supplied with an audible frequency alternating current produced by the cooperation of interrupter 34 and transformer 35. This circuit can be traced from ground, left hand secondary winding of transformer 35, right hand primary winding of transformer 33, contacts 32 of relay 30, contacts 42 of relay 39, right hand normal contacts of relay 41, contacts 43 of relay 36 and the contacts 68 of relay 30, back to ground. The operation of relay 30 also closes its inner contacts which connect the secondary of transformer 33 to the tip and ring conductors of the trunk, over normal contacts of relay 36 and contacts 37 and 38 of relay 26. The audible frequency current delivered by transformer 33 is transmitted over the trunk line to the toll cord circuit C, Fig. 1, and produces an audible tone in the toll operator's receiver. When relay 39 operates contacts 42 thereof are opened thereby interrupting the tone circuit and at the same time contacts 44 are closed and when relay 40 operates its right hand contacts complete the tone circuit a second time and when relay 41 operates, this circuit is again interrupted thereby giving the toll operator what is known as a double "zip" tone as an indication that the distant switching operator's telephone set is being connected to the trunk and that she may proceed to pass the number of the desired line.

Relays 39, 40 and 41 are made slow to operate in order to insure tone impulses of sufficient duration.

When relay 36 operates the switching operator's telephone set, indicated but not shown, is connected to the trunk. When the number of the called line is received, if it is assumed to be the rural line R, the switching operator first tests in the usual manner by touching the sleeve of jack 45 with the tip of plug 24. If the line is found to be idle, plug 24 is inserted in jack 45 which causes the operation of sleeve relay 11, the circuit for which can be traced from ground, winding of relay 46, Fig. 3, sleeve of jack 45 and plug 24 and winding of relay 11 to battery. Relay 11 in operating closes its contacts 47, thereby connecting the tip of the plug through to the repeating coil 48, opens at contacts 14 the previously traced circuit for the guard and disconnect lamp 13 thereby extinguishing it, opens at contacts 27 the previously traced holding circuit for relay 26 and, by closing contacts 49, completes a short circuit path around resistance 8 which can be traced from its upper terminal, contacts 49 of relay 11, lowermost normal contacts of relay 50 and normal contacts of relays 51 and 52 to the lower terminal of resistance 8. Also due to the direct current bridge across the rural line R which was completed by the operation of relay 46, which may be traced from the tip conductor of the line, conductor 53, inductance 54 and relay 55 in series and contacts 56 of relay 46 to the ring side of the line, relays 51 and 52 are operated when contacts 47 of relay 11 are closed. Relay 55 also operates in this circuit thereby operating relay 69. The operation of relays 51 and 52 together does not, however, affect the short circuit previously traced for resistance 8 as this circuit is still closed over contacts 57 and 58 of relays 51 and 52. The release of relay 26 disconnects the operator's telephone set from the trunk at its contacts 37 and 38 and also releases relay 30, thereby releasing at its contacts 68 relay 36.

In case a talking key such as 25' of another trunk should be operated before the plug of the first trunk is inserted in the jack of the line called, the relay 26 will be released due to the holding circuit of this relay being opened at contacts 29' of relay 25'. The release of relay 26 causes disconnection of the operator's telephone and the release of relays 30 and 36, as before described. When the second talking key is operated its associated relay corresponding to relay 26 is operated and when the key is released relays 30, 39, 40, 41 and 36 function as before described, thereby connecting the operator's set through the second trunk. This release of the operator's set from the first trunk and its connection to a second

trunk before the first trunk is plugged up is known as "overlap" operation and makes possible more rapid completion of connections during heavy load periods.

5 The short circuit around resistance 8 causes the operation, at this time, of marginal relay 59 at the toll office end of the trunk T, Fig. 1, which relay in operating connects battery and ground through the impedance coil 60 to
10 operate the bridged supervisory relay 61 of the toll cord C, thereby lighting the supervisory lamp 62 as a signal to the toll operator that the distant end of the trunk circuit has been connected with the called line and
15 that she can ring the desired subscriber.

The toll operator upon receiving the ringing signal rings on the trunk T in the usual manner, causing the operation of the bridged relay 63 which connects ground to operate
20 relay 64, which relay opens the trunk circuit and applies ringing current to its outgoing side which causes the operation of the bridged relay 65 at the distant end, Fig. 2. Relay 65 in operating completes a circuit to
25 energize the ringing relay 66 which relay applies ringing current to the called line in an obvious manner. The operation of relay 66 also completes an obvious circuit to operate relay 50 which relay locks at its upper
30 contacts to ground at contacts 12 of relay 9, which relay is now operated and locked under control of relay 7.

The operation of relay 50 opens the short circuit path previously traced around resistance 8, thereby causing the release of
35 marginal relay 59, supervisory relay 61 and the retirement of supervisory lamp 62 as an indication to the toll operator that the called subscriber has been rung. Due to relay 50
40 being locked operated the short circuit path around resistance 8 is held open, thereby preventing the toll operator from receiving a second ringing signal when the relay 66 releases at the end of the ringing interval. If
45 the called subscriber does not answer, the toll operator rings a second time thereby again operating relays 63, 64, 65 and 66. Relay 66 is provided with contacts 67 which when closed provide a holding ground to
50 prevent release of relay 9 in case relay 7 releases during the ringing interval.

When the called rural subscriber replaces his receiver on the hook, he is instructed to
55 ring off by operating his hand generator, thereby operating the alternating current relay 70, which in turn, operates relay 71, the circuit for which can be traced from battery, right hand contacts of relay 70, winding of relay 71, inner left contacts of relay
60 69, which relay is now operated, to ground at the operated contacts of relay 55. The operation of relay 71 opens the ring conductor of the line between the direct current shunt and the trunk, thereby causing the
65 release of relays 51 and 52 in the trunk, Fig.

2, and reclosure of the short circuit around resistance 8 to again light the supervisory lamp in the toll cord. This short circuit path is now traced from the upper terminal of resistance 8, contacts 49 of relay 11, lower
70 alternate contacts of relay 50, upper normal contacts of relay 51 and lower normal contacts of relay 52 to the lower terminal of the resistance.

The lighting of the supervisory signal at
75 the toll office indicates to the operator that the called subscriber has rung off and she therefore challenges and, if she hears no response, disconnects.

When the plug 1 is removed from the
80 trunk jack 2, relays 3, 7 and 59 release. Relay 7, in releasing, removes the holding ground for relay 9, which relay thereupon releases and in turn removes the holding ground from relay 50 which also releases. 85

The release of relay 9 also connects ground at its contacts 72 to start lamp 13 flashing in the same manner as previously described when relay 9 operated, the only change in
90 this present circuit being that it now passes from ground over contacts 72 instead of 12 of relay 9 and contacts 73 instead of 14 of relay 11, which latter relay is still operated due to the fact that plug 24 has not as yet
95 been removed from jack 45. When the switching operator removes plug 24, sleeve relay 11 releases thereby extinguishing the flashing lamp 13 and restoring the circuit to normal.

If the call is for a station on an interpo-
100 sition trunk D, such as to a trouble operator or a supervisor, which trunk presents an open circuit to direct current when the plug 24 is plugged into the jack, such as 74, the
105 operation is the same as described when the plug was inserted in jack 45 of the rural line, except that due to the absence of a direct current bridge across the conductors of the trunk D, relays 51 and 52 do not operate
110 until the called operator connects her telephone across the line. The resistance 8 is short circuited, however, when relay 11 operates, the circuit being over normal contacts of relays 51 and 52, thereby giving the toll
115 operator a ringing signal as before.

Ringing current is connected by the toll operator as previously described which causes relays 65 and 66 to operate. Relay
120 50 also operates and locks under control of relay 9. Due to the fact that relays 51 and 52 are in normal position, the operation of relay 50 does not open the short circuit around resistance 8 and therefore the toll operator receives another ringing signal as
125 soon as relay 50 operates, unless the called operator answers immediately, in which case, relays 51 and 52 will operate and open the short circuit around resistance 8.

When the trunk plug 24 is removed from
130 jack 74, relays 51 and 52 release, thereby

again short circuiting resistance 8 thereby giving the toll operator a disconnect signal.

In case the trunk operator tested the called line and found it busy, she would plug the trunk plug 24 into the busy-back jack BB. Fig. 3, and relay 11 would operate in the same manner as previously described. The operation of relay 11 releases relay 26, extinguishes the flashing lamp 13 and short circuits resistance 8. The operation of relay 26 disconnects the operator's telephone set from the trunk. The busy back circuit then functions by connecting intermittent ground through interrupter 75 to the ring side of the trunk, thereby intermittently operating relay 52. Relay 51 does not operate in this circuit as it is short circuited by the permanent ground on the tip spring of the busy-back jack. The intermittent operation of relay 52 opens and closes the short circuit around resistance 8, which was initially closed by the operation of relay 11, thereby flashing the toll operator's supervisory lamp at the busy back rate as determined by interrupter 75. This flashing supervisory lamp serves as an indication that the called line is busy. When this signal is received the toll operator disconnects.

What is claimed is:

1. In a telephone system, a first operator's position, a second operator's position, a line outgoing from said second position, a trunk circuit extending between said positions adapted to be connected with said line, means associated with said line responsive to connection of said trunk circuit therewith to complete a direct current bridge across said line, a link circuit at said first position connected to said trunk circuit and adapted to apply ringing current thereto, a signal associated with said link circuit, and means associated with said trunk circuit responsive to its connection with said line and the establishment of said bridge to actuate said signal.

2. In a telephone system, a first operator's position, a second operator's position, a line outgoing from said second position, a trunk circuit extending between said positions adapted to be connected with said line, means associated with said line responsive to connection of said trunk circuit therewith to complete a direct current bridge across said line, a link circuit at said first position connected to said trunk circuit and adapted to apply ringing current thereto, a signal associated with said link circuit, means associated with said trunk circuit responsive to its connection with said line and the establishment of said bridge to actuate said signal, and means responsive to the application of ringing current with said trunk circuit to efface said signal.

3. In a telephone system, a first operator's position, a second operator's position, a line

outgoing from said second position, a trunk circuit extending between said positions adapted to be connected with said line, means associated with said line responsive to connection of said trunk circuit therewith to complete a direct current bridge across said line, a link circuit at said first position connected to said trunk circuit adapted to apply ringing current thereto, a signal associated with said link circuit, means associated with said trunk circuit responsive to its connection with said line and the establishment of said bridge to actuate said signal, and self locking means responsive to the application of ringing current to said trunk circuit for effacing said signal.

4. In a telephone system, a toll operator's position, a switching operator's position, lines outgoing from said switching position, a trunk circuit extending between said positions and adapted to be connected with any of said lines, certain of said lines having associated means responsive to connection of said trunk circuit therewith to complete a direct current bridge across the talking conductors of the line, a cord circuit at said toll position connected to said trunk circuit and adapted to apply ringing current thereto, a supervisory signal associated with said cord circuit, means associated with said trunk circuit responsive to its connection to any of said outgoing lines to actuate said supervisory signal, and means responsive to application of ringing current to said trunk circuit to efface said signal.

5. In a telephone system, a toll operator's position, a switching operator's position, lines of different characteristics outgoing from said switching position, a trunk circuit extending between said positions and adapted to be connected to any of said outgoing lines, certain of said lines having associated means responsive to the connection of said trunk circuit therewith to complete a direct current bridge across the talking conductors of the line, certain other of said lines presenting an open circuit to direct current when connected to said trunk, a cord circuit at said toll position connected to said trunk and adapted to apply ringing current thereto, a supervisory signal associated with said cord circuit, means associated with said trunk circuit responsive to its connection with any of said lines to actuate said supervisory signal, and means responsive to the application of ringing current to said trunk circuit for effacing said signal.

6. In a telephone system, a first operator's position, a second operator's position, a magneto rural line outgoing from said second position, a subscriber's telephone set associated with said line and comprising means for applying ringing current thereto, other means associated with said line responsive to connection of said trunk circuit therewith

to complete a direct current bridge across said line, a link circuit at said first position connected to said trunk circuit and adapted to apply ringing current thereto, a signal associated with said link circuit, means associated with said trunk circuit responsive to its connection with said line and the establishment of said bridge to actuate said signal, means responsive to the application of ringing current to said trunk circuit for effacing said signal and maintaining said signal effaced when said ringing current is disconnected, and means responsive to the application of ringing current to said rural line at said subscriber's station for re-actuating said signal.

7. In a telephone system, a first operator's position, a second operator's position, a line outgoing from said second position, a trunk circuit extending between said positions adapted to be connected with said line, means associated with said line responsive to the connection of said trunk circuit therewith to complete a direct current bridge across said line, a link circuit at said first position connected to said trunk circuit and adapted to apply ringing current thereto, a signal associated with said link circuit, means associated with said trunk circuit responsive to its connection with said line and the establishment of said bridge to actuate said signal, a busy-back jack and an associated source of interrupted ground potential adapted to be connected to by said trunk circuit, and means responsive to the connection of said trunk circuit to said busy-back jack to flash said signal.

8. In a telephone system, a toll operator's position, a switching operator's position, lines of different characteristics outgoing from said switching position, a trunk circuit extending between said positions and adapted to be connected with any of said outgoing lines, certain of said lines having associated means responsive to the connection of said trunk circuit therewith to complete a direct current bridge across the talking conductors of the line and other of said lines presenting an open circuit to direct current when connected to by said trunk, a cord circuit at said toll position connected to said trunk, supervisory signal means associated with said cord circuit, and means associated with said trunk responsive to its connection to any of said outgoing lines to actuate said supervisory signal means.

9. In a telephone system, an operator's position, a second operator's position, telephone lines of different characteristics outgoing from said second position, a trunk circuit extending between said positions adapted to be connected with any of said outgoing lines and so constructed and arranged as to automatically adapt itself for operation with the particular line to which

it is connected, certain of said lines having associated means responsive to the connection of said trunk circuit therewith to complete a direct current bridge across the line, a link circuit at said first position connected to said trunk circuit, signal means associated with said link circuit, and means associated with said trunk circuit responsive to its connection to any of said lines to actuate said signal means.

10. In a telephone system, a toll operator's position, a switching operator's position, lines of different characteristics outgoing from said switching position, a trunk circuit extending between said positions and adapted to be connected to any of said outgoing lines, certain of said lines having associated means responsive to the connection of said trunk circuit therewith to complete a direct current bridge across the talking conductors of the line, certain other of said lines presenting an open circuit to direct current when connected to by said trunk, a cord circuit at said toll position connected to said trunk and adapted to apply ringing current thereto, a supervisory signal associated with said cord circuit, means associated with said trunk circuit responsive to its connection to any of said lines to actuate said supervisory signal and self locking means responsive to the application of ringing current to said trunk at said toll position, when said trunk is connected to a line having a direct current bridge, for effacing said supervisory signal.

11. In a telephone system, an operator's position, a second operator's position, telephone lines outgoing from said second position, a trunk circuit extending between said position constructed and arranged to automatically adapt itself for operation with any of said lines at the second position, certain of said lines being bridged by a direct current path when connected with said trunk circuit and other lines presenting an open circuit to direct current when connected to said trunk circuit, a link circuit at said first position connected with said trunk circuit, a signal associated with said link circuit, and means associated with said trunk circuit responsive to its connection with any of said lines to actuate said signal.

12. A telephone system, an operator's position, a second operator's position, telephone lines outgoing from said second position, a trunk circuit extending between said positions constructed and arranged to automatically adapt itself for operation in any of said lines of said second position, a first one of said lines being bridged by a direct current path when connected to said trunk circuit and a second one of said lines presenting a normally open circuit to direct current when connected to said trunk circuit, a link circuit at said first position con-

nected to said trunk circuit, a signal associated with said link circuit, means associated with said trunk circuit responsive to its connection to either of said lines to actuate
5 said signal and self locking means responsive to the application of ringing current to said trunk circuit from said first operator's position, when said trunk is con-

nected to said first line, for effacing said signal.

In witness whereof, we hereunto subscribe our names this 27th day of September A. D. 1927.

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HORACE W. ULRICH.
WILLIAM B. PRINCE.