

June 19, 1934.

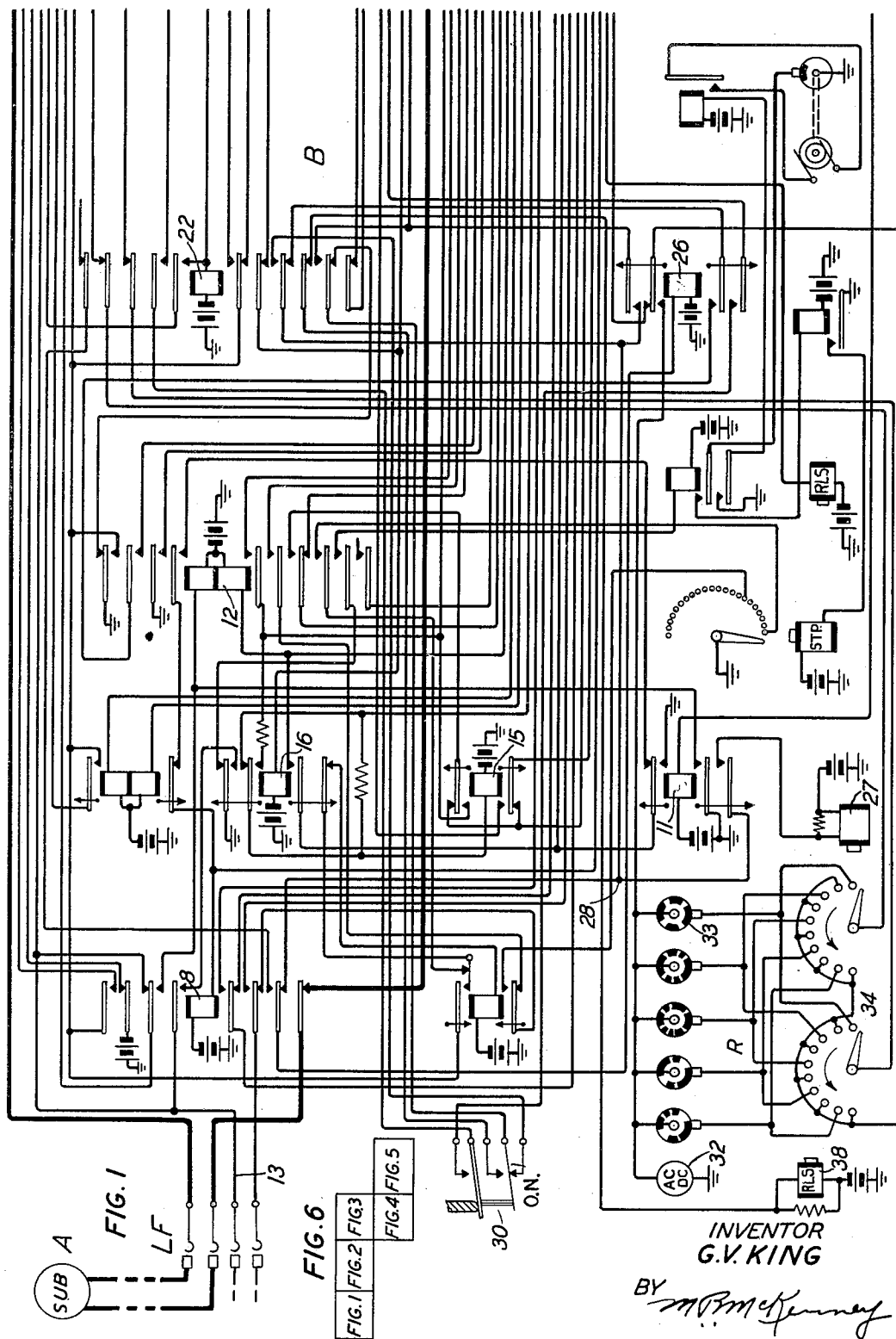
G. V. KING

1,963,747

TELEPHONE SYSTEM

Filed July 1, 1932

5 Sheets-Sheet 1



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G. V. KING

1,963,747

TELEPHONE SYSTEM

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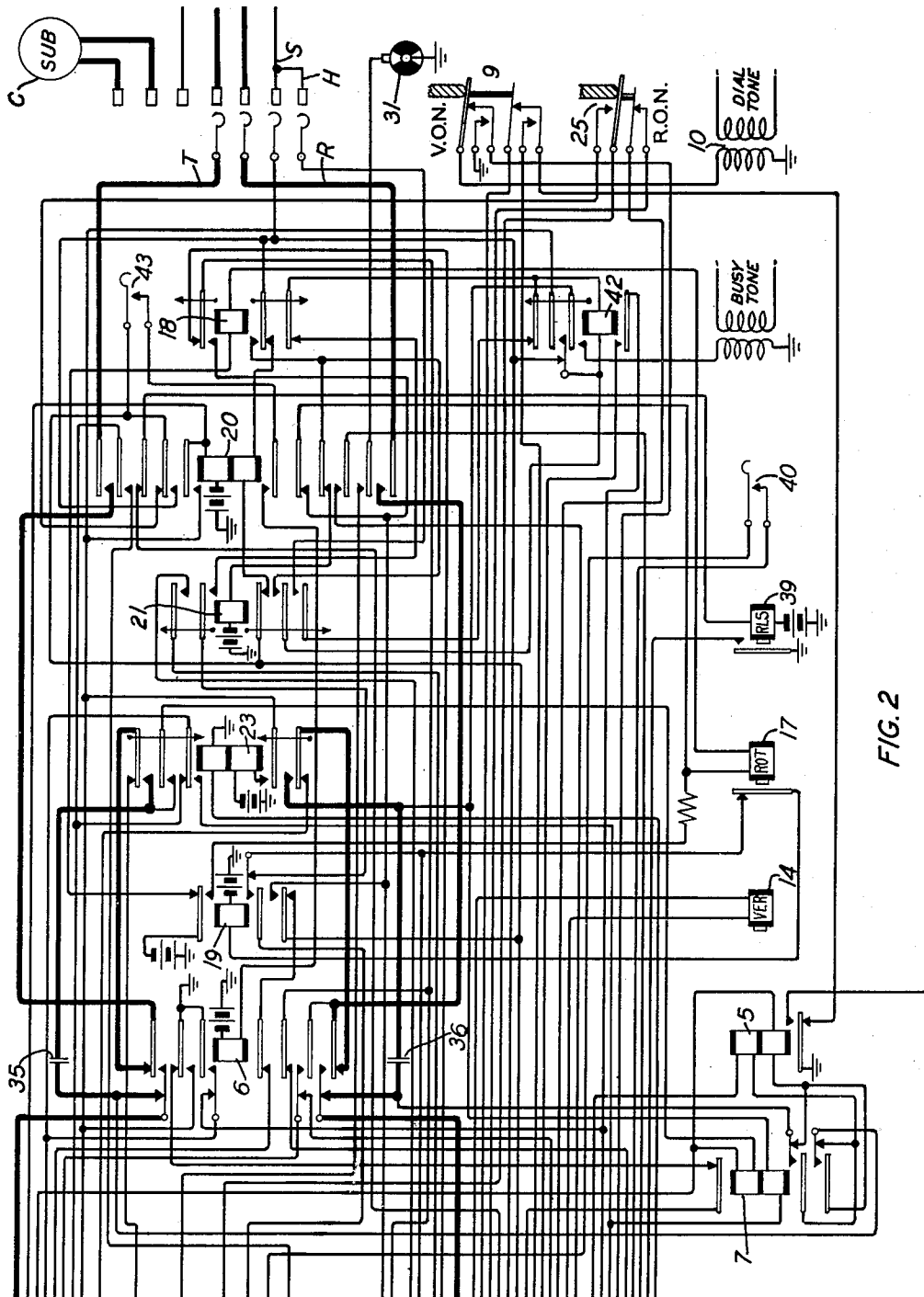


FIG. 2

INVENTOR
G. V. KING

BY *W. P. McFerry*
ATTORNEY

June 19, 1934.

G. V. KING

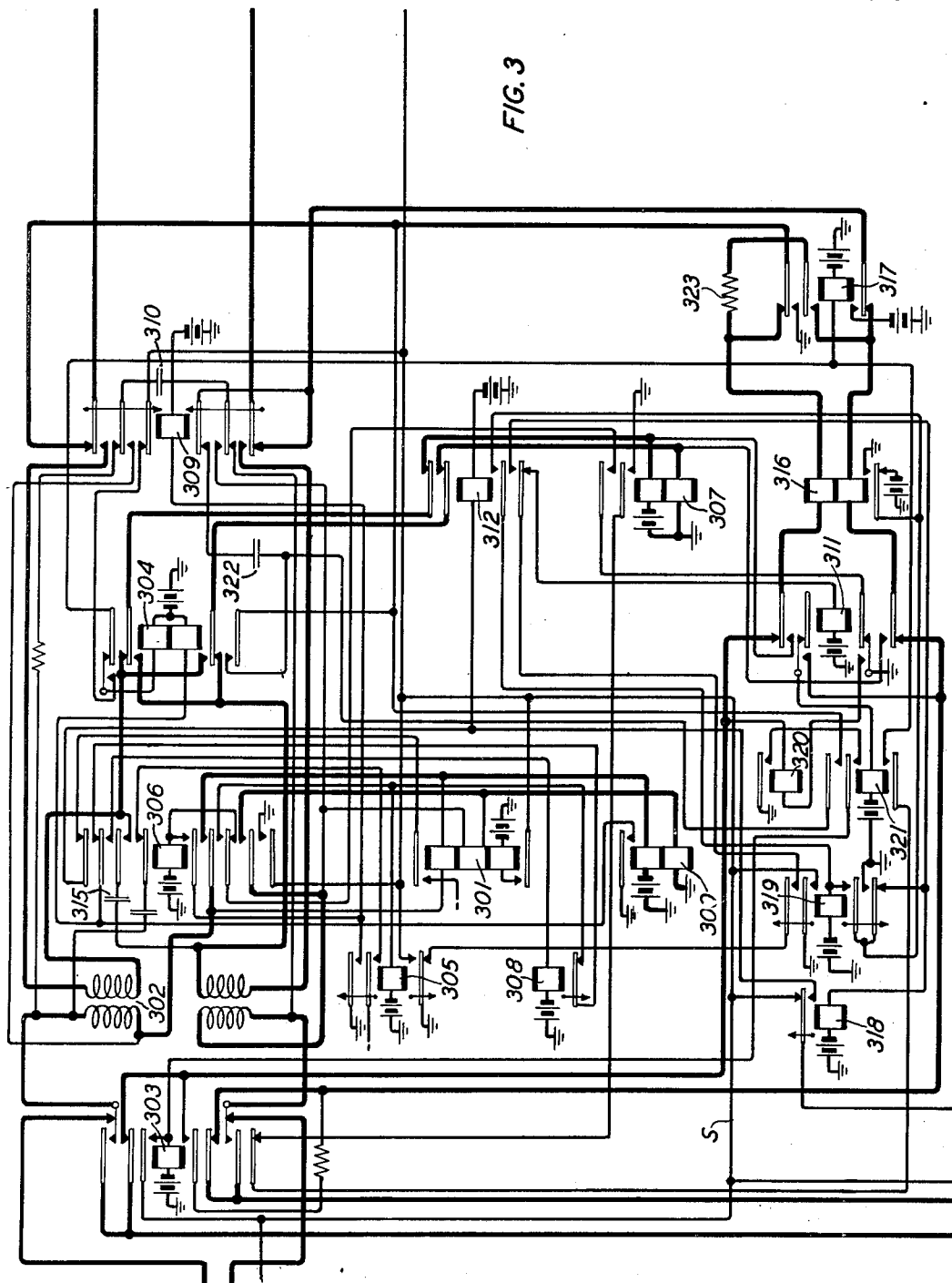
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TELEPHONE SYSTEM

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5 Sheets-Sheet 3

FIG. 3



INVENTOR
G. V. KING

BY *W. B. McHenry*
ATTORNEY

June 19, 1934.

G. V. KING

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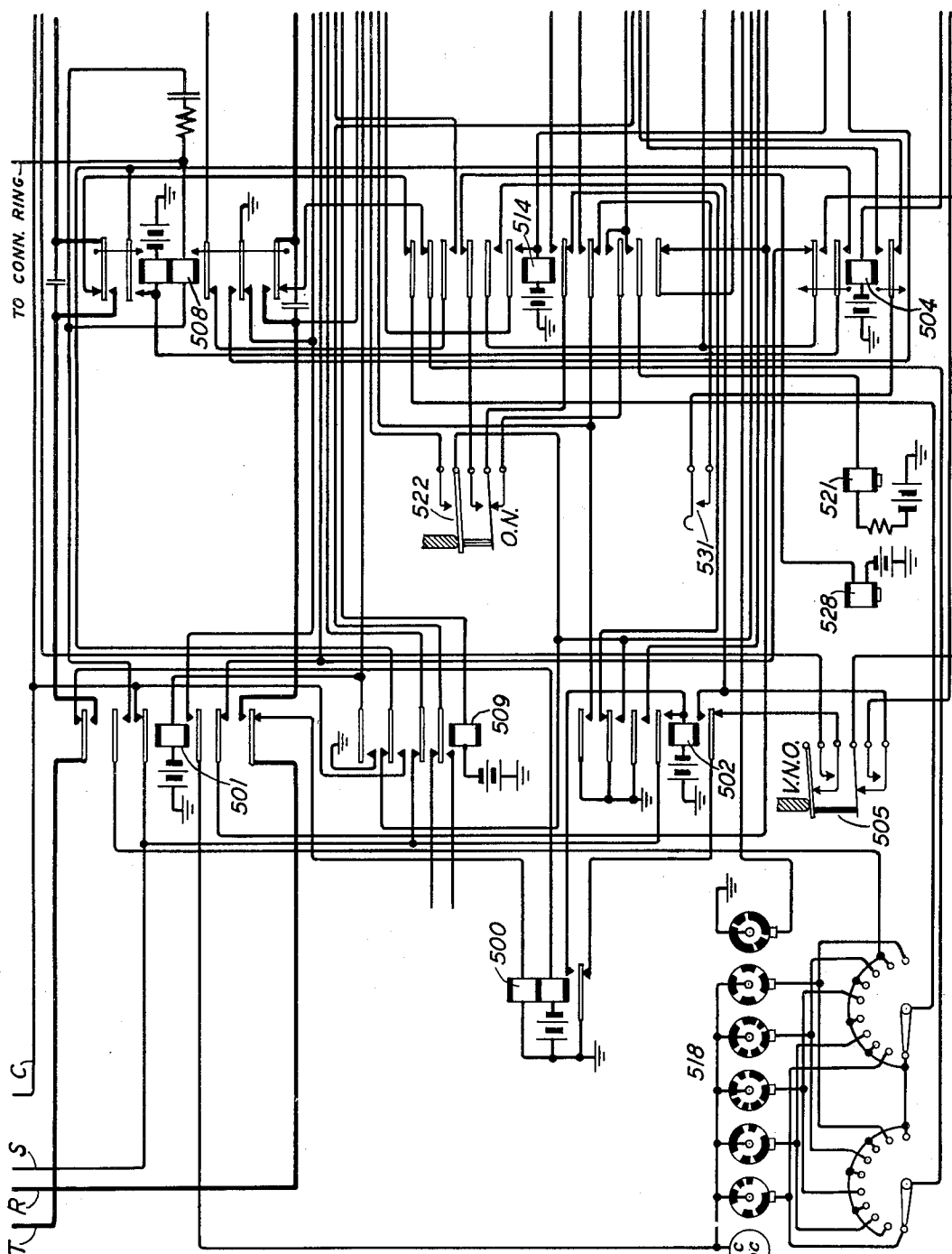


FIG. 4

INVENTOR
G.V. KING
BY
M. W. McFadden
ATTORNEY

June 19, 1934.

G. V. KING

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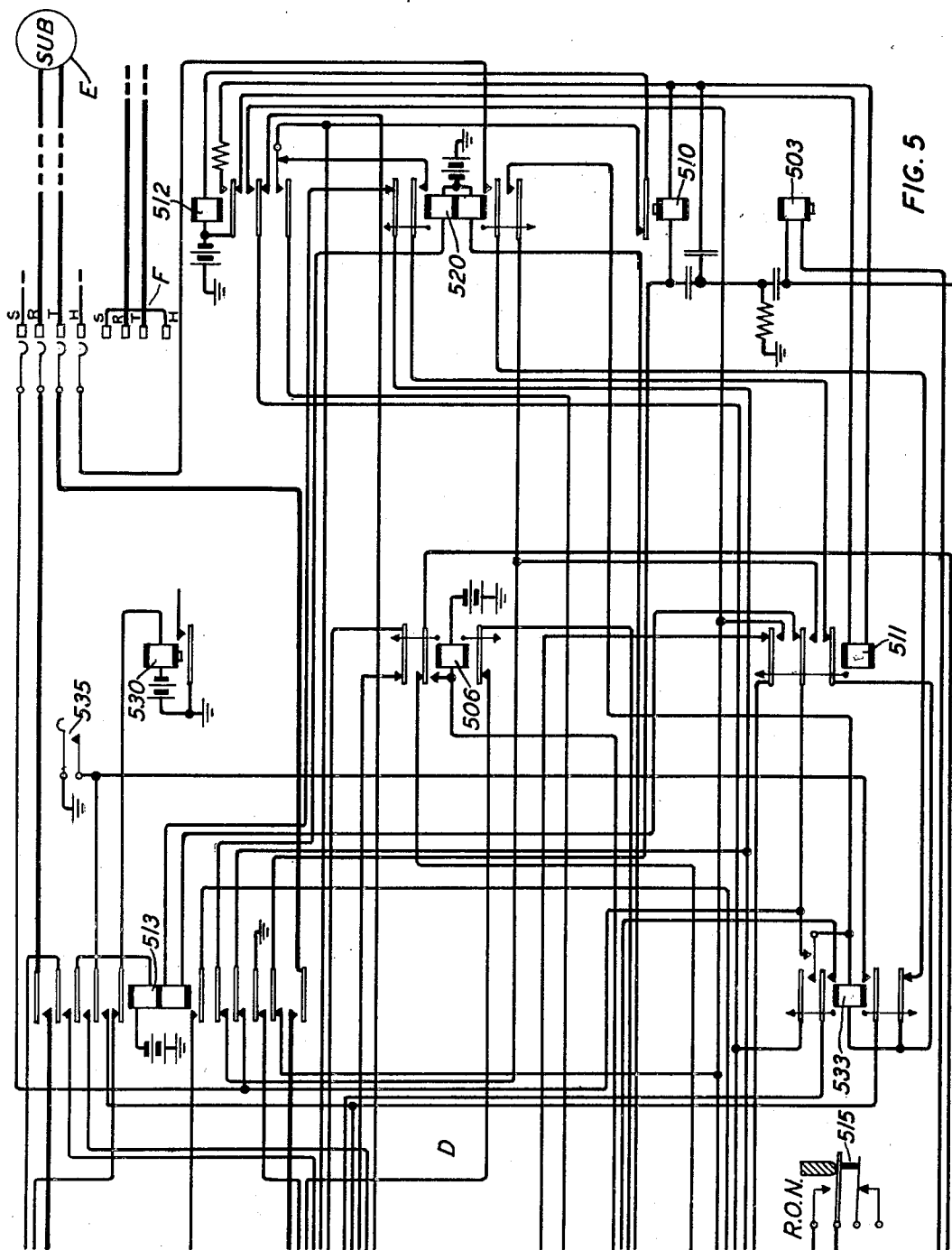


FIG. 5

INVENTOR
G.V. KING

BY

M. M. Kerney
ATTORNEY

UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Gerald V. King, Springfield, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application July 1, 1932, Serial No. 620,327

7 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to improvements in trunking circuits.

An object of this invention is to simplify and increase the utility of trunking circuits in automatic telephone systems.

Heretofore cord circuits have been used which may be converted from a battery feed circuit to circuits having no battery depending on the type of line connected thereto. Circuits have also been used in which connector circuits have batteries normally supplied from the connector circuit and in which, when the connector is seized from a local subscriber, the talking battery connections were made, while if it is seized by a trunk, the battery connection is removed and battery furnished from a repeater arrangement in the trunk.

A feature of the present invention is to prevent talking battery from being supplied from a two-way trunk incoming to an exchange under certain conditions, and to feed talking battery from the trunk under other conditions. The arrangement is such that normally the talking battery supply is not connected to the trunk for calls incoming over the trunk to the exchange. When the call is intended for local subscribers in the exchange, a relay in the trunk operates to include a talking battery connection in the trunk, while when the call is intended for a tandem trunk connection outgoing from the exchange, the trunk is maintained in its normal position without the talking battery connection being made.

Referring now to the drawings, Figs. 1 to 5 may be connected as shown in Fig. 6. Figs. 1 and 2 show a calling subscriber's line in an automatic telephone exchange and a line finder in diagrammatic form terminating in a selector connector circuit that has access to a called subscriber's line in the exchange shown in diagrammatic form and the terminals of a trunk circuit shown in Fig. 3 extending to another exchange. Figs. 4 and 5 show a selector connector extending from the trunk circuit in Fig. 3 and having access through its brushes to a called subscriber's line in the exchange, one of which has been shown in diagrammatic form and also to trunks outgoing from the exchange, one of which has been shown in diagrammatic form.

To show the embodiment of the features of this invention in these drawings, descriptions will be made of a call from a calling subscriber A, Fig. 1, through the selector connector B in Figs. 1 and 2 to a called subscriber's line at C,

Fig. 2 followed by a call from subscriber A over selector connector B and the trunk circuit in Fig. 3 to a distant exchange. In connection with Figs. 3, 4 and 5 a call will be described from a distant exchange over the trunk circuit of Fig. 3 through the selector connector D in Figs. 4 and 5 to a called subscriber E followed by a call from a distant exchange over the trunk in Fig. 3, the selector connector D in Figs. 4 and 5 to a trunk F outgoing from the exchange to another distant exchange.

Referring now to the call from subscriber A to subscriber C a connection may be established from this subscriber over line finder LF to the selector connector B and when this selector connector is seized a circuit is completed for the operation of relay 5 through the calling subscriber's loop over the tip conductor, contacts of relays 6 and 7, upper winding of relay 5, contacts of relay 8, vertical off-normal contacts 9 to ground through one winding of the repeating coil 10, the other winding of which is connected to a dial tone source, and over the ring conductor through contacts of relays 8, 6 and 7, lower winding of relay 5, contact of relay 8 to battery. Relay 5 in operating closes a circuit for relay 11. This relay in turn closes a circuit for relay 12 through the upper winding of relay 12 from ground at the lower inner armature and front contact. Relay 11 also applies this ground at the upper armature and front contact of relay 8 to the sleeve conductor 13 to the line finder LF to hold this switch operated. Relay 12 in operating prepares a pulsing path for the vertical magnet 14 and dial tone is in the meantime transmitted from the tone source through repeating coil 10 to the calling subscriber to indicate that the selector connector B is ready for the reception of the first series of impulses.

At each interruption of the dial on the sending of the first digit impulses, relay 5 is released and operates the vertical magnet 14 in series with relay 15, this latter relay remaining operated during the sending of these first digit impulses. The pulsing circuit may be traced from battery through the winding of relay 15, contact of relay 16, winding of vertical magnet 14, contacts of relay 12, vertical off-normal contacts 9 to ground at the armature and back contact of relay 5. After the first impulse, the vertical off-normal contacts 9 shift the pulsing circuit for the vertical magnet and relay 15 through the upper armature and front contact of relay 15 so that at the end of this series of impulses when relay 15 releases, the pulsing circuit may be shifted to the

rotary magnet 17. The shifting of the vertical off-normal contact disconnects the dial tone from the calling subscriber's line. At the end of this series of impulses relay 15 releases and the brushes of the selector connector have been advanced to the desired level in which a called subscriber's line is located.

On the next digit or series of dial impulses, relay 5 releases and operates the rotary magnet 17 and relay 18 in series. This circuit may be traced from battery, contact of relay 19, winding of relay 18, winding of the rotary magnet 17, contacts of relays 20, 22 and 6, upper armature and back contact of relay 15, contacts of relay 12, vertical off-normal contacts 9 to ground at the armature and back contact of relay 5. When relay 18 operates this circuit is shifted through the upper armature and front contact of relay 18 independent of the connection through contacts of relay 22. Relay 18 remains operated during the pulsing due to its slow release characteristics.

At the end of the second series of impulses the brushes of the selector connector B will be in connection with the terminals of the desired subscriber's line C. When this takes place and the line is idle, relay 18 releases and a circuit is thereby completed from battery over the usual cut-off relay in the line of the called subscriber over the sleeve connection through contacts of relay 18, lower winding of relay 20, contacts of relay 21 and contacts of relay 12 to ground. This circuit causes relay 20 to be partially operated to close a circuit through its upper inner armature and front contact from battery to ground at relay 12 to cause the relay 20 to be fully operated. Relay 20 in operating fully provides a ground for the sleeve circuit at its second upper armature and front contact from contacts of relay 12 directly to make the called subscriber's line busy. Relay 20 also prepares a ringing circuit for the tip and ring conductors to the called subscriber's line through the ringing trip relay 23 from a ringing source as hereinafter traced. Before tracing this circuit, however, it should be noted that on the first rotary step the rotary off-normal contacts 25 closed a circuit for the operation of relay 22 from battery, the winding of this relay, rotary off-normal contacts 25, contacts of relay 20, to ground at contacts of relay 12. Relay 22 closed a locking circuit for itself through its upper inner armature and front contact through contacts of relays 6 and 19 to ground at relay 12. Relay 22 in operating opened at its lower outer armature and back contact the original pulsing circuit for rotary magnet 17 which was shifted as hereinbefore stated to extend through contacts of relay 18. This selector connector B is arranged for party line ringing, and it functions so that regardless of whether the called party is on a single line or on a party line the calling subscriber must operate a ringing code switch R to select a suitable ringing code. This the subscriber will now proceed to do by sending a code selecting digit to relay 5. For a single line the code 1 is dialed so that relay 5 will release once. On the release of relay 5 at this time a circuit is completed for relay 26 and code switch stepping magnet 27 in parallel. The circuit for relay 26 extends from battery through the winding of this relay, contacts of relay 8 to a point 28 and the circuit for the stepping magnet 27 extends from battery through the winding of this magnet, contacts of relay 11 to point 28. From this point on the circuit may be traced

through contacts of relay 22, code switch off-normal contacts 30, contacts of relay 22, upper armature and back contact of relay 18, contacts of relay 6, upper armature and back contact of relay 15, contacts of relay 12, vertical off-normal contacts 9 to ground at the armature and back contact of relay 5. Relay 26 in operating locks itself over its upper outer armature and front contact to the ground at relay 5 independent of the off-normal contacts 30 and contacts of relay 22. A circuit is also completed for the operation of relay 19 from battery, winding of relay 19, contacts of rotary magnet 17, contacts of relay 26, off-normal contacts 30, contacts of relay 22, contacts of code switch start interrupter 31 to ground, this circuit being closed when the interrupter of code switch R is in a position to permit a full code to be transmitted as is well known in the art. Relay 19 opens at its lower outer armature and back contact the locking circuit for relay 22 which now releases, and as no further impulses are received relay 26 releases with the stepping magnet 27. This first impulse imparts a first step to the stepping magnet 27 which thereupon causes the brushes of the ringing code switch R to connect with the first terminal and thereby close the above mentioned ringing circuit through the windings of the ringing trip relay 23 for ringing of the called subscriber. This circuit may now be traced from the ringing current source 32 through the code interrupter 33, right-hand switch bank, first terminal and brush of switch R, second upper armature and back contact of relay 22, lower outer armature and back contact of relays 23 and 6, lower outer armature and front contact of relay 20 to the ring conductor over the called subscriber's loop and the ringer in the subscriber's telephone set back over the tip conductor, through the upper outer armature and front contact of relay 20, upper outer armatures and back contacts of relays 6 and 23, third upper armature and back contact of relay 22, brush and the left-hand switch bank first terminal, upper inner armature and back contact of relay 26, upper winding of relay 23 to ground. When the called subscriber B answers, relay 23 is operated sufficiently over this circuit to close its locking winding which causes this relay to operate fully. The locking circuit may be traced from battery, lower winding of relay 23 and lower inner armature and front contact to ground at contacts of relay 12. Relay 23 in operating closes at its upper and lower outer armatures and front contacts a tip and ring connection to the condensers 35 and 36 to complete the connection from the calling subscriber to the called subscriber.

This relay 23 also closes a circuit for relay 7 to cause it to operate and to close talking battery connections for the called subscriber's circuit. The talking battery for the called subscriber's line may be traced from battery through contacts of relay 8, upper winding of relay 7, contacts of relay 23, contacts of relay 6 and contacts of relay 20 through the tip conductor and the called subscriber's loop back over the ring conductor, contacts of relays 20, 6 and 23, through the lower winding of relay 7, contacts of relays 23 and 6 to ground at the upper armature and front contacts of relay 11. Relay 7 in operating reverses at the lower armatures and front contacts the connections through relay 5 for the calling subscriber's talking battery supply at contacts of relay 8 and ground at vertical off-normal contacts 9. The talking circuits for the calling

and called subscribers are now completed through the condensers 35 and 36, talking battery for both subscribers being furnished from the same source, at the third upper armature 5 and back contact of relay 8, ground for relay 5 being supplied at the vertical off-normal contacts 9 and ground for relay 7 being supplied at the upper armature and front contact of relay 11.

10 When the calling subscriber disconnects, relays 5, 11 and 12 are released in the order named. The locking circuit for relays 23 and 20 are opened by the release of relay 12 causing these relays to release. The release of relay 12 also 15 restores the code switch R by energizing its release magnet 38 over a circuit closed through the off-normal contacts 30 and the upper, outer armature and back contact of relay 12 to ground, this circuit being opened when the code switch 20 returns to normal at the off-normal contact 30. The release of relay 20 removes the ground connection from the sleeve of the called subscriber's line and opens the tip and ring connection thus releasing relay 7. Relay 20 also causes the energization of the release magnet 39 of the selector 25 connector B by closing a circuit for this magnet through its third upper armature and back contact, contacts of relay 12, vertical off-normal contacts 9 and the ground at the armature and 30 back contact of relay 5. This circuit is opened at the vertical off-normal contacts when the selector connector has returned to normal. Relay 11 in releasing removes ground from the sleeve 13 to release the line finder LF. If the called 35 subscriber disconnects prior to the calling subscriber, relay 7 releases and this, in turn, will operate the pick-up mechanism to cause release of the switches at a predetermined time interval thereafter. This is not being described as its 40 operation is immaterial as far as this invention is concerned.

Referring now to a call from subscriber A over the selector connector B and the trunk shown in Fig. 3 to a distant exchange, the calling subscriber causes operations to take place in the 45 selector connector B in the same manner as when connections are extended to other subscribers in the same exchange up to and including the vertical movement of the switch. This selector connector may be arranged to have trunks outgoing to a distant exchange in certain levels and the first digit moves the brushes of the switch to such a level. The so-called normal post springs 40 and 43 are adjusted to close on all such trunking levels. It therefore follows that when relay 15 55 releases at the end of the vertical movement the closure of springs 40 causes a circuit to be prepared for the operation of relay 18 and the rotary magnet 17 in series as follows: From battery at 60 contacts of relay 19, windings of relay 18 and rotary magnet 17 in series, contacts of relays 20, 22 and 6, lower armature and back contact of relay 15, normal post springs 40, contacts of relay 22 to ground at relay 12. This causes the 65 rotary magnet to take one step. When this step is taken this pulsing circuit is opened at contacts of relay 22 as this relay operates through a circuit closed by the rotary off-normal contacts 25 from battery, winding of relay 22, rotary off-normal contacts 25, contacts of relay 20, contacts 70 of relay 12 to ground; relay 18 being slow in releasing holds up long enough to test the sleeve terminals of the first trunk by connecting relay 21 to this sleeve terminal. If the first trunk 75 is busy, the terminals will be connected to ground

furnished from contacts of operated relays in the engaged trunk as will hereinafter be described. Relay 21 now operates due to this ground over a circuit as follows: Battery, winding of relay 21, contacts of relay 20, lower inner armature 80 and front contact of relay 18, sleeve conductor and the busy terminal S of the trunk to ground. Relay 21 operates and locks to the ground on the S terminal over a circuit independent of the connection through the lower inner armature and 85 front contact of relay 18 which now releases. This locking circuit may be traced from battery, winding of relay 21, contacts of relay 20, lower outer armature and front contact of relay 21, 90 contacts of relay 42 to ground on the S terminal. As the H and S terminals of the trunks are connected together, the release of relay 18 and the operation of relay 21 causes the ground from the S terminal to furnish an operating circuit for 95 relay 19 from battery, winding of relay 19, contacts of rotary magnet 17, contacts of relay 19, upper inner armature and front contact of relay 21, contacts of relay 18, contacts of relay 42, 100 contacts of relay 21, the H and S terminals to ground. Relay 19 closes an operating circuit for the rotary magnet 17 to cause it to take another step to the next trunk. This circuit may be traced from battery, through the upper armature and front contact of relay 19, winding of rotary magnet 17, contacts of relay 20, lower outer 105 armature and front contact of relay 19 to ground at contacts of relay 12. Relay 19 is then restored to normal by the opening of the contacts of the rotary magnet. The alternate operation and release of the rotary magnet and relay 19 are 110 not repeated until an idle trunk is reached, when relay 21 is restored to normal due to the absence of a ground on the S terminal of the idle trunk. When relay 21 releases, a circuit is completed for the lower winding of relay 20 as hereinbefore 115 described, and this relay now performs its usual function and in addition causes the operation of relay 6 over a circuit as follows: Battery, winding of relay 6, lower inner armature and front contact of relay 20, the closed off-normal springs 120 43, to ground on contacts of relay 12. Relay 6 in operating extends the tip and ring conductors directly through the trunk at its upper outer and lower outer armatures and front contacts, thus completely eliminating the transmission bridge through condensers 35 and 36 and the talking battery feed through relays 5 and 7 provided in the local call connection previously described. Relay 6 provides a locking path for relay 20 at its upper middle armature and front contact. A 130 ground connection is provided at its upper inner armature and front contact for the sleeve lead 13 of the line finder LF. It also opens the locking circuit for relay 22 at its lower inner armature and back contact. Relay 6 further opens the pulsing circuit for the code switch at the second lower armature and back contact to prevent this switch from operating when relay 5 releases. Relay 5 is disconnected by contacts opened when 140 relay 6 operated. Relays 11 and 12 now also restore, due to the release of relay 5.

With the release of relay 12 the selector connector B no longer provides ground for the S terminal, but by the connection through the calling subscriber's loop battery and ground in the trunk in Fig. 3 have caused operations to take place in a manner to be hereinafter described for the substitution of a ground for the S terminal. This ground connection now holds relay 6 operated through contacts of relay 20 and the normal 150

post springs 43. Relay 6 in turn holds relay 20 operated. With relays 6 and 20 operated the loop circuit from the calling subscriber A causes the operation of relay 300 over a circuit as follows:

5 Battery, upper winding of relay 300, upper winding of relay 301, upper left-hand winding of repeating coil 302, contacts of relay 303, over the tip conductors through the selector connector B and the subscriber's loop, back over the ring conductor, contacts of relay 303, lower left-hand winding of repeating coil 302, middle winding of relay 301, lower winding of relay 300 to ground. Relay 301 will not operate in this circuit as the two windings through which it is connected are differentially wound. Relay 300 closes an obvious circuit for the operation of relay 304 and also for the operation of relay 305. Relay 304 in operating reverses the tip and ring conductors of the trunk to prepare for the signaling of the operator at the distant exchange by reversed battery over the trunk. Relay 305, in operating, grounds the S terminal of this trunk at its lower armature and front contact, and it is this ground that holds this trunk busy to other selector connectors and maintains relay 6 in selector connector B operated. Relay 305 also closes an obvious circuit for the operation of relay 309 to complete the connection to the distant exchange from battery and ground through windings of relay 307, reversed by the operation of relay 304 so that the distant operator may now be signalled. Relay 309 disconnects the condenser 310 from bridging the left-hand windings of repeating coil 302 on the calling subscriber's side and bridges it inside the left-hand windings of the repeating coil.

When the operator at the distant exchange answers this signal a low bridge connection is made across the tip and ring conductors of the trunk at the distant exchange causing relay 307 to operate. This relay in operating causes relay 306 to operate over a circuit from battery, winding of this relay and its third lower armature and back contact, armature and front contact of relay 307 to ground at contacts of relay 311. Relay 306 locks in operated position through its lower inner armature and front contact to ground at contacts of relay 305. Relay 306 in operating transfers the control over relay 305 to the ground at the armature and front contact of relay 307 and also closes an obvious circuit for relay 308 from ground at the armature and front contact of relay 300 to open the original energizing circuit for relay 305. It also short-circuits the lower and middle windings of relay 301 for transmission reasons, and bridges the condenser 315 across the inside of the right-hand windings of repeating coil 302. The connection from the calling subscriber over the trunk to the operator at the distant exchange is now in talking condition with the battery for talking supplied in the trunk. The talking battery connection for the calling subscriber is furnished through the left-hand windings of the repeating coil 302 and the windings of relay 300, while the talking battery for the trunk and the operator is furnished through the right-hand windings of repeating coil 302, and the windings of relay 307 over the upper and lower inner armatures and front contacts of relay 304 and the upper armatures and front contacts of relay 312. Thus in this case the talking battery is furnished from the trunk, while the connection through the selector connector B is cut through without any battery connection.

75 The trunk is now held under control of both the

calling subscriber and the operator. If the receiver of the calling subscriber's set is replaced on the switchhook, relay 300 in the trunk circuit is released. This relay in turn releases relays 304 and 308. The release of relay 304 again reverses the polarity of the battery connection over the trunk in order to give the usual disconnect signal to the operator. When now the operator disconnects, relay 307 is released which in turn causes the release of relay 305. The release of relay 305 causes the release of relays 306 and 309 and removes ground from the sleeve terminal in order to release the selector connector B and the line finder LF by releasing relay 6 in the selector connector. If the operator at the distant exchange releases first, relay 307 is released causing the release of relay 305. Relay 305 releases relays 306 and 309. Relay 306 releases relay 308 and disconnects the ground from the sleeve terminal as before to release the connection beyond. Since relay 308 is slow in releasing it holds the circuit for relay 305 open until the connection beyond is released and relay 300 is thereby released, thus preventing the reoperation of relay 305 before relay 300 releases.

Referring now to a call incoming over the trunk in Fig. 3 from a distant exchange through the selector connector D and to the subscriber of line E shown in Figs. 4 and 5, the seizure of the trunk at the distant exchange by an operator causes a low bridge to be placed across the trunk conductors. This causes the operation of relay 500 from battery and ground through the windings of relay 500, contacts of relay 501, contacts of relays 303 and 311, windings of relay 316, contacts of relays 317 and 309 through the low resistance loop, over the tip and ring conductors at the distant exchange. Relay 316 also operates in this circuit and closes a circuit for the operation of relay 318 from battery, contacts of relay 319, to ground at the armature and front contacts of relay 316. Relay 318 in operating closes a connection from the C conductor of the selector connector D to the trunk circuit at its armature and front contact to battery through the winding of relay 312, the purpose of which will be apparent as the description proceeds. Relay 500 in operating closes a usual circuit for the slow-to-release relay 502. The operation of this relay prepares several holding circuits and also the pulsing circuit for the vertical magnet 503 and the selector connector is now ready to receive the selective impulses.

It should be noted that on the operation of relay 502 the connection to ground from the armature and front contact of relay 500 established through the upper inner armature and contact of relay 502 and contacts of relay 501 extends to lead C and from this lead through the armature and front contact of relay 318 through the winding of relay 312 to battery. This causes relay 312 to operate, and this relay in turn closes a circuit for relay 319 from battery, winding of relay 319, lower inner armature and front contact of relay 312 to ground at the armature and front contact of relay 316. Relay 319 is now held operated independent of ground at contacts of relay 312. Relays 312 and 319 in operating provide a holding circuit for relay 318 through the lower outer armature and front contact of relay 312, upper outer armature and front contact of relay 319 to ground at relay 305. Relay 312 opens at one point a circuit for relay 311 which is closed at another point by the operation of relay 319, to prevent this relay from operating

at this time. The operation of relay 312 also disconnects the windings of relay 307 from the trunk conductors so they may be extended through contacts of relays 304 and 306. Relay 319 connects
 5 ground to the S lead to hold the selector connector D and to make this trunk busy to selector connectors such as B. A ground extends originally from contacts of relays 500 and 502 directly to the S lead but as relay 319 operates the
 10 ground extended from the upper inner armature and front contact of this relay 319 to the S lead is independent of relay 500. This latter ground now therefore holds relay 318 operated through the S lead, contacts of relay 501, the C lead and
 15 contacts of relay 318.

The trunk circuit and the selector connector D are now in condition for dialing. During the dialing from a distant exchange for the subscriber of line E, relay 316 operates and releases
 20 while the dial is returning to normal. Each time the relay 316 is released, it short-circuits relay 319 but since this relay is slow to release it will remain operated during dialing. This short circuit may be traced from battery through the ar-
 25 mature and back contact of relay 316 to ground at the lower outer armature and front contact of relay 319. At the first interruption of the dial relay 500 is also released and causes the operation of the vertical magnet 503 in series with
 30 relay 504 over a circuit from battery, relay 504, vertical magnet 503, vertical off-normal 505, contacts of relay 502, armature and back contacts of relay 500. After the first vertical step the pulsing circuit is transferred through the
 35 vertical off-normal contact 505 to the upper outer armature and front contact of relay 504 over contacts of relays 506 and 504. Relay 504 remains operated during the pulsing as it is slow to release. Relay 504 in operating closes a cir-
 40 cuit for relay 508 from battery through the upper winding of relay 508, upper inner armature and front contact of relay 504, contacts of relay 509, contacts of relay 502 to ground. Relay 508 provides a locking circuit for itself through its upper
 45 inner armature and front contact independent of relay 504. When all the vertical impulses have been sent, relay 504 releases and transfers the pulsing circuit to the rotary magnet 510. On the next train of impulses, when relay 500 releases
 50 the rotary magnet and relay 511 are operated in series. The circuit for this relay and magnet may be traced from battery, contacts of relay 512, winding of relay 511 and winding of rotary mag-
 55 net 510, contacts of relays 513, 514, 501, 504 and 506, vertical off-normal contacts 505, contacts of relays 502 and 500 to ground. Relay 511 in operating locks itself and the rotary magnet 510 over a path through the upper outer armature and
 60 front contact of relay 511 independent of the contacts of relay 514. Relay 511 is slow in releasing and remains operated during the succeeding rotary impulses. The closure of the rotary off-normal contacts 515 when operating after
 65 the first step of the rotary movement closes a circuit for the operation of relay 514, from battery through the winding of relay 514, rotary off-normal contacts 515, contacts of relay 508, to ground. The purpose of the operation of relay 514 will
 70 become apparent hereafter. One object is to open the ringing leads from the ringing code switch 518. When the brushes of selector connector D connect with the terminals of the de-
 75 sired line E a busy test of the sleeve terminal is made through the upper winding of relay 520 and the upper middle armature and front contact of

relay 511 which being slow to release remains operated for a moment, after the rotary impulses have been delivered.

If the called line is idle relay 520 will not operate so that at the release of relay 511 an ener-
 80 gizing circuit will be closed through the lower winding of relay 513 from battery through the cut-off relay of the called subscriber's line. This circuit may be traced from battery, cut-off relay
 85 over the sleeve terminal, upper middle armature and back contact of relay 511, lower winding of relay 513, upper outer armature and back contact of relay 520, to ground at contacts of relay 502. This operates relay 513 sufficiently to close its
 90 locking circuit through the third upper armature and front contact for the upper winding of this relay to ground at relay 502, thereby causing relay 513 to operate fully. Relay 513 in operating
 95 closes the connection from the sleeve terminal directly to ground at relay 502 independent of the connection through the lower winding of relay 513. Relay 513 also connects the tip and ring conductors directly to the upper and outer
 armatures and front contacts of relay 508.

The calling subscriber at the distant exchange
 100 must now dial a code to call the subscriber of line E. This code will be the same as in the selector connector B, that is, one impulse. This causes the operation of the stepping magnet 521
 105 for the code switch 518 to take one step. This circuit may be traced from battery, winding of stepping magnet 521, contacts of relay 514, off-normal contacts of the code switch 522, contacts of relays 514, 511, 501, 504, 514 and 502 to ground at the
 110 armature and back contact of relay 500. Relay 506 also operates in parallel with the stepping magnet 521 over a circuit from battery through the winding of this relay and the circuit herein-
 115 before traced through contacts of relay 514. Relay 506 in operating opens at one point an operating path for relay 509 to ground at relay 502, closed on the operation of the off-normal contacts 522 so that this relay can not operate at this
 120 time, and it locks itself through its upper inner armature and front contact to ground at the armature and back contact of relay 500. This relay is slow in releasing so that it remains operated during the sending of the code impulses. In this case, of course, there is only one pulse so
 125 that when the pulsing ceases and relay 500 is operated relay 506 will release. In releasing this relay 506 closes the above mentioned circuit for relay 509 which now operates from battery, wind-
 130 ing of relay 509, upper outer armature and back contact of relay 506, off-normal contacts 520 to ground at contacts of relay 502. Relay 509 in operating closes a circuit for the operation of relay 501. Relay 509 transfers the locking circuit for
 135 relay 508 to lead C. Lead C is, however, due to the operation of relay 501, deprived of its ground on the sleeve lead derived from contacts of relay 319. The purpose of the removing of this ground will become apparent hereinafter. Relay 501 in
 140 operating disconnects the pulsing relay 500 from the tip and ring conductors leading to the trunk. The tip and ring conductors are now connected through to the subscriber's line at E. The connection is now held from the trunk by the ground on the sleeve lead which is derived from
 145 contacts of relay 319. Relay 500 releases but relay 502 is held by this ground on the sleeve leads. The removal of the ground from the C lead is but momentary as will hereinafter be described. This removal, however, causes the release of relay
 150 312. The release of relay 312 causes the opera-

tion of relay 311 over a circuit from battery, winding of relay 311, lower outer armature and back contact of relay 312, upper outer armature and front contact of relay 319 to ground at relay 305. Relay 312 also opens a circuit for relay 318. The removal of the battery and ground from the tip and ring conductor by the operation of relay 501 causes the release of relay 316. This release would cause the relay 319 but as this relay is slow in releasing and as relay 316 is again operated, relay 319 will remain operated. It should be noted that the operation of relay 311 now connects battery and ground through the windings of relay 307, at its upper and lower outer armatures and back contacts, windings of relay 316, contacts of relay 317, contacts of relay 309 to the trunk. Relay 311 also connects ground to the tip conductor through the winding of relay 320 and connects battery through the winding of relay 321 to the ring conductor towards the selector connector. Relay 307 now operates and relay 316 is reoperated over the trunk with relay 316 holding relay 319 operated, as mentioned above. The operation of relay 307 at this time has no effect. Relay 318 which is slow in releasing remains operated momentarily after relay 312 has released to maintain the circuit to the C lead open long enough to permit the ringing trip relay 508 in the selector connector to release due to the ground being removed, when relay 501 operated. Ground is then returned to the C lead when relay 318 has released.

The release of relay 508 is for the purpose of starting the ringing of the called subscriber's line. Relay 508 in releasing establishes the circuit from ground at the second lower armature and back contact for the starting of the ringing interrupter in the code switch 518, and opens the operating circuit for relay 514, at the second lower armature and front contact. Relay 514, however, remains locked under the control of relay 512 through its middle lower armature and back contact to ground at relay 502. When the pick-up lead receives a ground from the code switch the relay 512 is operated over a circuit from battery, winding of this relay, armature and back contact of rotary magnet 510, fourth upper armature and front contact of relay 514, lower inner armature and back contact of relay 508, lower inner armature and front contact of relay 513 to ground at the pick-up lead. Relay 512 in operating opens the circuit for relay 514 at the second lower armature and back contact of this relay. Relay 514 in releasing opens the circuit for relay 512 which now releases. Relay 514 in releasing also closes the ringing leads through to the called subscriber's line. The ringing circuit for the called subscriber passes from ground, lower winding of ringing relay 508, the second upper armature and front contact of relay 501, the first position of right-hand terminal bank and brush code of the switch 518, upper outer armature and back contact of relay 514, upper outer armature and back contact of relay 508, over the tip conductor through contacts of relay 513 and the called subscriber's loop back over the ring conductor through contacts of relay 513, the lower outer armature and back contact of relay 508, fifth upper armature and back contact of relay 514, the first position of the left-hand terminal bank and brush of the code switch 518 through the proper code interrupter and ringing source to ground.

When the called subscriber answers relay 508 receives sufficient current over the ringing loop

to close its locking winding to ground on the lead C through its upper armature and front contact to cause the full operation of relay 508. Relay 508 in operating opens the ringing connection and completes a talking path between the trunk and the called line. Relay 508 also opens the pick-up lead connection and causes the reoperation of relay 514 from battery, winding of this relay, rotary off-normal contacts 515, lower middle armature and front contact of relay 508 to ground so that the call originating operator may have the circuits prepared for reringing the called subscriber if he so desires.

The relays 320 and 321 are now operated over the established loop from battery through the winding of relay 321, make-before-break contact of relay 311, over the ring conductor to the selector connector and the called subscriber's loop back over the tip conductor through the winding of relay 320 to ground at the lower make-before-break contacts of relay 311. Relay 321 in operating closes an operating circuit for relay 304 from battery, upper winding of this relay and its upper outer armature and back contact, lower armature and front contact of relay 321, contacts of relay 303 to ground at the inner armature and front contact of relay 307. Relay 304 in operating reverses the ground and battery connection inside the repeating coil 302, and back to ground at relay 319. Relay 321 also bridges a condenser 322 across the trunk and across a circuit for relay 317 from battery, winding of this relay to ground at relay 307 as hereinbefore traced for relay 304. Relay 317 closes a circuit through a resistance 323 for holding relays 316 and 307 operated, reverses the battery and ground connection to the trunk to signal the operator that the called subscriber has answered. The operation of relays 320 and 321 closes a circuit for relay 303 from battery, winding of this relay, upper inner armature and front contact of relay 321, armature and front contact of relay 320 to ground. Relay 303 in operating closes a locking circuit for itself at its upper inner armature and front contact to ground on the sleeve and short-circuits the tip and ring connection towards relays 320 and 321 in order to hold them operated. It also transfers the tip and ring from the calling subscriber through the repeating coil 302 and releases relay 317. The battery and ground for the called subscriber is now supplied from the battery and ground through the windings of relay 300, the upper and middle winding of relay 301, the left-hand windings of repeating coil 302, contacts of relay 303, the tip and ring conductors, through the called subscriber's loop. Relay 300 is thereby operated over this loop and causes the operation of relay 305 which provides another path for grounding the sleeve in order to hold the selector connector and to maintain a busy condition on the trunk. Relay 305 opens the circuit for relay 311 and also closes a circuit for the operation of relay 309. Relay 311 releases relays 320 and 321. The operation of relay 309 transfers the tip and ring leads from the distant office through the right-hand windings of repeating coil 302 at its upper and lower outer armatures and front contacts and thus causes in conjunction with the release of relay 311 the release of relay 316. Relay 309 also disconnects the condenser 310 inside the repeating coil and bridges this condenser outside the repeating coil at the middle upper and lower armatures and the front contacts and opens the holding circuit through the upper winding of relay 304. Relay

304, however, is maintained operated through its lower winding by ground at relay 300. Relay 307 also remains operated over the loop to the distant exchange through its new operating path passing through the right-hand windings of the repeating coil 302 and contacts of relays 304 and 312. The release of relay 311 short-circuits relay 319 at its armatures and back contacts and relay 319 is released. Relay 311 in releasing closes the circuit for the operation of relay 306 from battery, winding of relay 306 and its third lower armature and back contact, armature and front contact of relay 307 to ground at the lower inner armature and back contact of relay 311. Relay 306 locks over a path to ground at the upper outer armature and front contact of relay 305 and transfers the control over relay 305 through the armature and front contact of relay 307 to relay 311 from control by relay 300. Relay 306 also causes the operation of relay 308. It also short-circuits the upper and middle windings of relay 301 and connects the relay 300 directly to the repeating coil 302. The circuits are now in talking condition. Thus it will be seen that in this case also the battery for talking is supplied in the trunk. The battery for the distant exchange is supplied through the windings of relay 307 and the battery for the called subscriber is supplied through the windings of relay 300.

When the called subscriber releases by hanging up the receiver on the switchhook relay 300 releases. This causes the release of relay 304 and relay 304 in releasing reverses the battery connection over the trunk to give the calling operator a disconnect signal. When the operator disconnects the relay 307 releases causing the release of relays 305, 306, 303 and 309. Ground is thereby removed from the sleeve circuit and the C lead and the selector connector B is thereby released through release of relays 513, 502, 501, 508 and 514. The release magnet 528 for the code switch is now operated from battery, winding of this magnet, third upper armature and back contact of relay 514, off-normal contacts 522, lower inner armature and back contacts of relay 514, to ground at contacts of relay 502. When the cord switch 518 is returned to normal the circuit for the release magnet 528 is opened at the off-normal contact 522. The release of relays 513 and 502 closes a circuit for the selector connector D, releases magnet 530 from battery, winding of this magnet, upper inner armature and back contact of relay 513, vertical off-normal contacts 505, lower armature and back contact of relay 502, to ground at the contacts of relay 500. When this release magnet has returned the switch to normal this circuit is opened at the vertical off-normal contacts 505.

Referring now to a call incoming over the trunk shown in Fig. 3 and selector connector D to an outgoing trunk such as F for tandem calls the selector connector is directed to a group of trunks leading to a distant exchange and are operated to select an idle trunk to this exchange. The selection of a trunk group is established in the same manner as the selecting of a desired local subscriber's line if the trunks or distant exchanges are arranged in more than one group in a level, in which case two digits will be used, one for the vertical movement of the switch and the other for selecting of a group of trunks in the desired level and then the switch will be actuated as a selector to hunt for an idle trunk. In case there is only one group in a level, for

example, the uppermost level, the selection of this group requires but a single digit. In this latter case the normal post springs 531 and 535 will start the rotary hunting movement to select an idle trunk. As this invention is primarily concerned with the method of furnishing talking for the sake of brevity the selection of a trunk in the uppermost level of the selector connector D will be described. In this case but a single digit will be employed. The vertical movement of the switch will be the same as hereinbefore described to advance the brushes of the selector connector to the uppermost level. When this level is reached, normal post springs 531 will be closed. Now when the vertical movement of the switch has ceased and relay 504 is released, the closing of a connection between these springs 531 will establish a circuit for the operation of the rotary magnet 510 and relay 511 as follows: From battery, contacts of relay 512, windings of relay 511 and rotary magnet 510 in series, contacts of relays 513, 514, 501, 506, 504, normal post springs 531, contacts of relay 514 to ground at the contacts of relay 502. This circuit is only closed momentarily as on the first rotary step, the rotary off-normal contacts 515 close to operate relay 514 to open the circuit for magnet 510 and relay 511. Relay 511 is operated long enough to test the sleeve terminal by connecting relay 520 to the sleeve lead for testing. The H and S terminals of all the trunks are connected together except on the corresponding terminals of the last trunk. If, therefore, the first trunk is busy the switch will pass on to the terminals of the next trunk. Should this be the case relay 520 will operate before relay 511 releases over a circuit from battery, upper winding of relay 520, contacts of relay 513, upper middle armature and front contact of relay 511, the sleeve terminal S to the busy ground of this trunk. Relay 520 locks to this busy ground independent of relay 511. Upon the release of relay 511 the ground connection is carried from the S terminal through the winding of relay 512 to energize this relay over a circuit from battery, winding of relay 512, armature and back contact of rotary magnet 510, make-before-break contacts of relay 512, contacts of relay 520, contacts of relays 511 and 533, contacts of relay 520 over the H terminal to the S terminal to the busy ground. Relay 512 then operates and locks over a local circuit through its lower inner armature and front contact to ground at relay 502. Relay 512 closes a circuit for the rotary magnet 510 as follows: Battery, contacts of relay 512, winding of rotary magnet 510, contacts of relays 513 and 512 to ground at relay 502. When the rotary magnet operates the circuit for relay 512 is opened and causes the release of the rotary magnet 510. The alternate operation and release of the rotary magnet 510 and relay 512 continues until an idle trunk is found. When the selector connector reaches an idle trunk relay 520 is restored to normal and thereby permits the operation of relay 513 as hereinbefore described. This relay closes the tip and ring connections due to the ringing trip relay 508. In this case, however, on the operation of relay 513, relay 501 is immediately operated over a circuit from battery, winding of this relay, second upper armature and front contact of relay 513, off-normal post springs 535 to ground. Relay 501 now extends the tip and ring connection from the originating trunk to the called trunk and disconnects the pulsing relay 500. The release of relay 500

at this time prevents it from preparing the code switch for operation as in this case no ringing is required. Since code switch 510 remains in normal position relay 509 cannot operate over the off-normal contacts 522 of the code switch and consequently relay 508 remains operated in this circuit, the locking circuit controlled by relay 502. With relay 509 remaining in normal position a circuit closed through contacts of relays 509 and 513 serves to keep lead C connected to lead S in spite of the operation of relay 501. This connection may be traced from lead C, fourth upper armature and front contact of relay 513, second upper armature and back contact of relay 509 to the sleeve lead S. As the connection to ground for the C lead is not opened no change will take place in the trunk shown in Fig. 3 at this time, the relay 312 remaining operated to maintain ground on the sleeve. This ground on the sleeve lead indicates that a tandem connection is being made and consequently the pulsing connection from the calling exchange is now completed through the tip and ring conductors of the trunk from the distant office and trunk F. In this case, therefore, there is no battery fed from the trunk in Fig. 3. The operator at the distant exchange may now send impulses directly over the trunk F, or if this trunk is connected to an operator's position she may talk over the connection with battery furnished from said exchange.

When the operator at the call originating exchange disconnects relay 316 releases and short-circuits relay 319 which then releases to remove the ground on the sleeve lead S. This causes relay 502 to release causing the return of the selector connector to normal as hereinbefore described. The called trunk releases when the subscriber restores the ground supplied over the sleeve brush by relay 502. Relay 319 in releasing, releases relay 318 which in turn releases relay 312, thus restoring the trunk circuit to normal.

What is claimed is:

1. In a telephone system, a two way trunk, a talking battery connection in said two way trunk, subscribers' lines, extension trunks, means for connecting said two way trunk to a subscriber's line or to an extension trunk, and means for establishing the talking battery connection in said trunk responsive only on the establishing of a connection to a subscriber's line.

2. In a telephone system, a trunk, a talking battery connection in said trunk, a switch associated with said trunk, subscribers' lines accessible from said switch, extension trunks accessible from said switch, means operative when a connection to a subscriber's line is established for connecting said talking battery connection to the said first trunk, and means responsive to the establishing of a connection to an extension trunk for preventing said battery connection from being made.

3. In a telephone system, a two-way trunk, means at one end of said trunk for establishing connections to said trunk, means at the same end of the trunk for establishing two different types of connections from said trunk, means for feeding talking battery from said trunk in response to the establishing of connections to said trunk and in response to the establishing of one of said two types of connections from said trunk.

4. In a telephone system, a two-way trunk, a talking battery connection in said trunk, means at one end of said trunk for establishing connections to said trunk, subscribers' lines, extension trunks, means at the same end of said trunk for establishing connections to subscribers' lines or to said extension trunks, means for maintaining a connection for said talking battery in response to the establishing of a connection to said trunk, means for establishing connections from said talking battery to said trunk in response to the establishing of connections to subscribers' lines, and means for preventing talking battery connection from being made to said trunk in response to the establishing of connections to said extension trunks.

5. In a telephone system, a trunk, a talking battery connection in said trunk, means at one end of said trunk for establishing connections to said trunk, subscribers' lines, extension trunks, means responsive to the establishing of connections to said end of said trunk for maintaining a connection for said talking battery in said trunk, a switch associated with said trunk, a by-pass connection from the opposite end of said trunk to said switch excluding the talking battery connection, means responsive to an incoming call from said opposite end of the trunk for actuating said switch for establishing a connection to a subscriber's line or to an extension trunk, and means operative only if the connection is established to a subscriber's line for opening said by-pass connection and to include the talking battery in the connection established to said subscriber's line.

6. In a telephone system, a trunk, a talking battery connection in said trunk, means at one end of said trunk for establishing a connection to said trunk for outgoing calls, subscribers' lines, extension trunks, means at the same end of said trunk for establishing connections to a subscriber's line or to an extension trunk for incoming calls, a first relay in said trunk, a second relay in said trunk, means operative on the establishment of an outgoing call for including the talking battery in the outgoing call connection, including the maintaining of the first relay, deenergizing and energizing the second relay, means operative on the establishing of an incoming call to a subscriber's line for including the talking battery in the incoming call connection including the energization of both relays, said means operative on the establishing of an incoming call to an extension trunk for excluding the talking battery from the incoming call connection including the maintaining of both relays deenergized.

7. In a telephone system, a two-way trunk, a talking battery in said trunk, means at one end of said trunk for establishing connections to said trunk and for including the talking battery in said connection, means at the same end of the trunk for establishing two types of connections from the trunk in response to calls incoming over the trunk, and means for including said talking battery in one type of connection when established and for excluding the talking battery in the other type of connection when established.

GERALD V. KING.