Feb. 24, 1931. R. S. BAILEY ET AL 1,793,582

TELEPHONE SYSTEM

Filed April 10, 1928 2 Sheets-Sheet 1

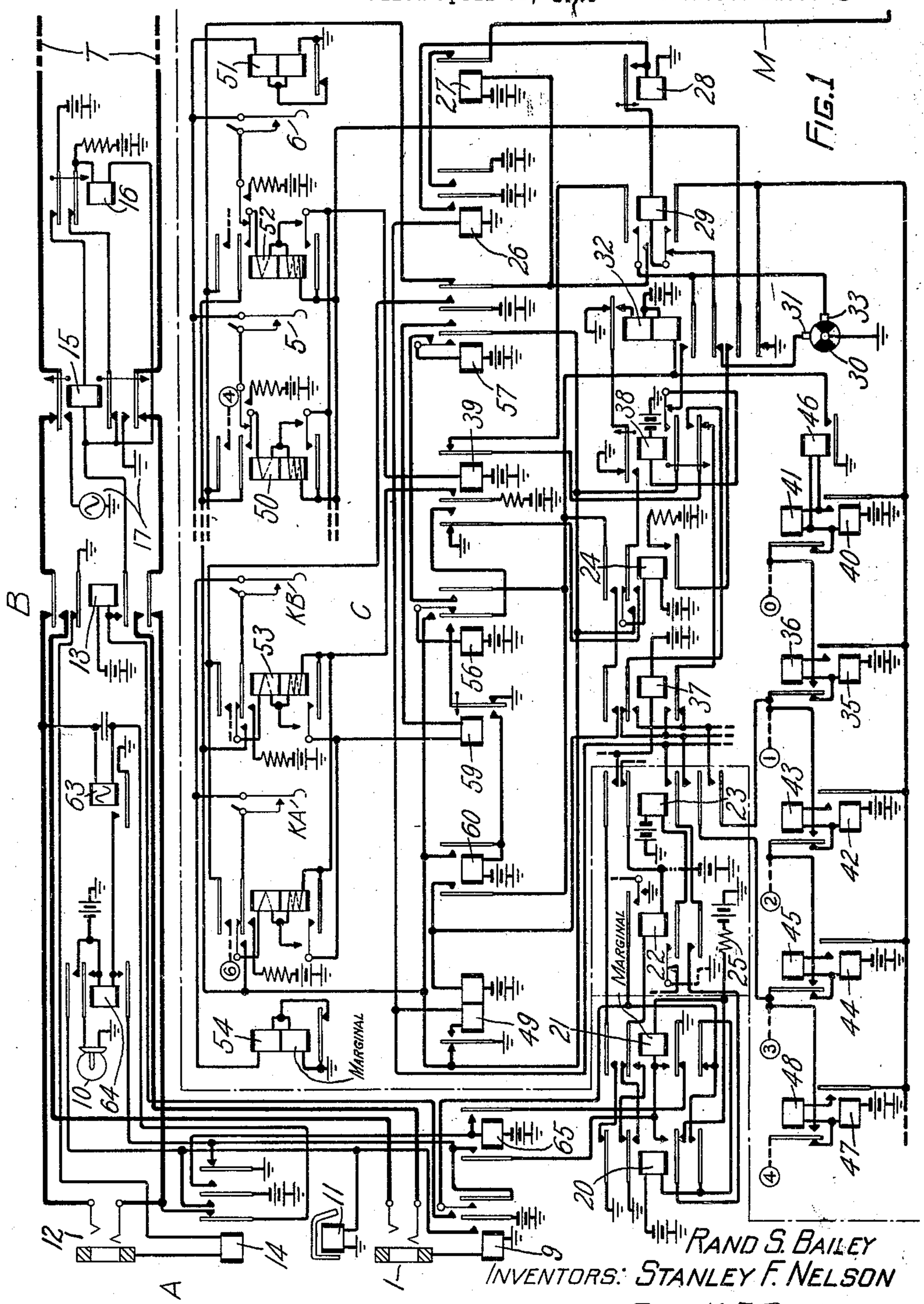

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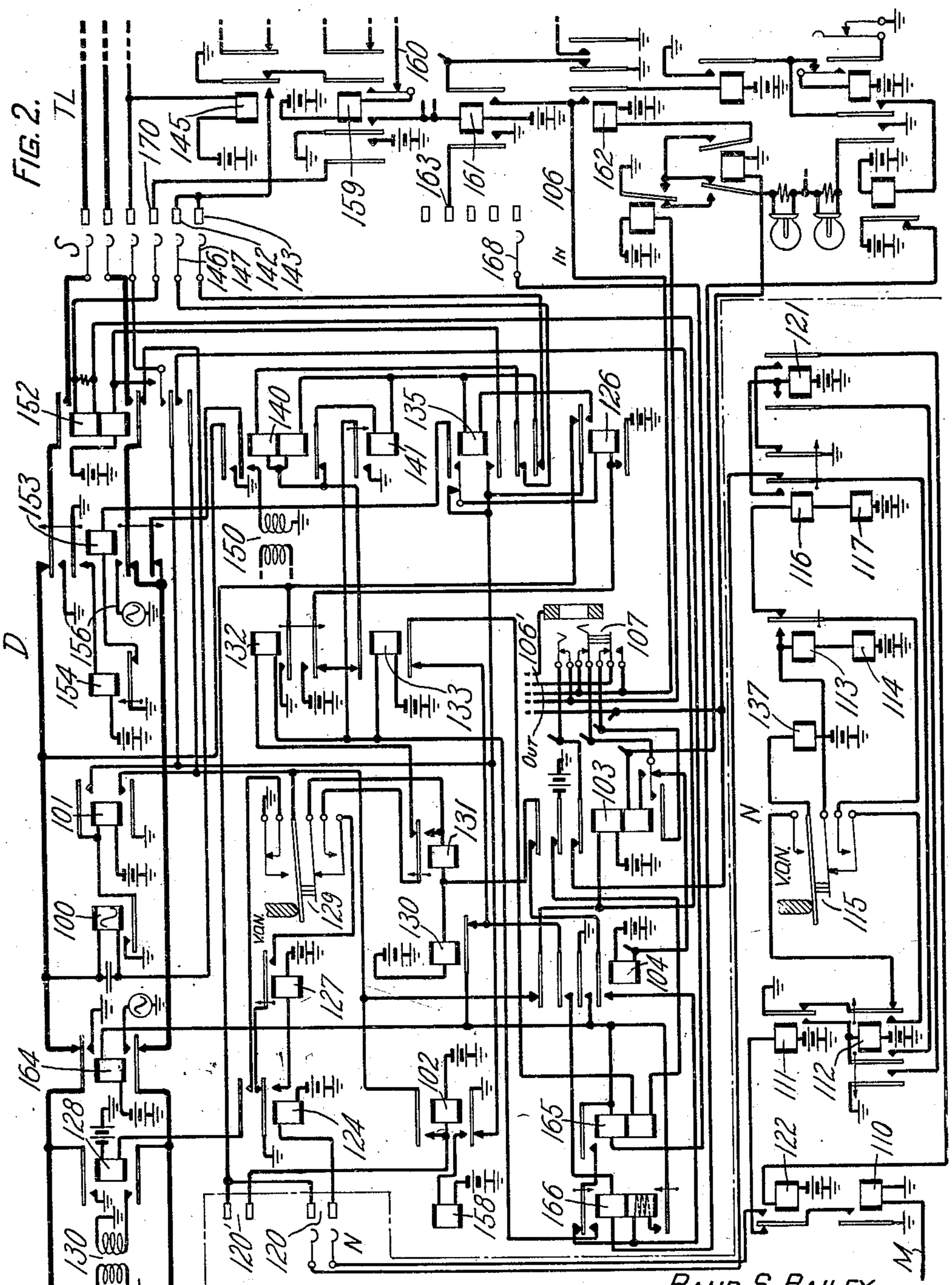
FIG. 2.



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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to systems in which toll connections are extended over automatic trunk lines.

Its object is to simplify and improve the equipment for controlling the operation of the automatic switches used to extend the trunk lines.

In the past, trunk line connections have been controlled by means of signals transmitted over separate common channels between offices to find and identify the incoming ends of trunks seized at their outgoing ends.

This invention is an improvement over systems of this type in that it provides means whereby trunks between a first and a second office terminating in automatic switches at the second office are identified and prepared for extension to desired lines in response to code impulses transmitted to the second office over a separate common channel on the seizure of said trunks at the first office and whereby said automatic switches are actuated by dialing impulses received over the common channel to connect the seized trunks with the desired lines. Said trunks are also arranged for two-way service in which the automatic switches act as selectors when connections are made over the trunks from the first office and as line finders when connections are made to the trunks at the second office. Means is further provided whereby these connections are released in response to code impulses transmitted over the common channel from the first office.

This invention has been illustrated in the accompanying drawings in which Figure 1 shows the outgoing end of a trunk at one office arranged in accordance with this invention and terminating at a toll operator's position while Fig. 2 shows the incoming end of this trunk at a second office terminating in a switch having access to trunks leading to other offices. A channel has been shown in these two figures between the first and second offices common to a plurality of such trunks. This channel is arranged to serve in the establishing of connections over said trunks in accordance with this invention and an impulse sending and receiving equipment required for this purpose which is common to a plurality of such trunks is also shown at the two offices.

Referring to the drawings the invention has been illustrated in a system whereby an operator at an office B may, by inserting the calling plug of a cord (not shown) into a calling jack 1 and by operating keys in the sender equipment C, establish a connection over trunk T and operate the switch S associated with this trunk at office D to select a group of trunks and hunt for and connect trunk T to an idle trunk, such as TL, in said group. These groups of trunks may lead to different offices, tributary to office D.

The seizure of the trunk T by the operator at A causes the sender equipment C to function to transmit a code signal over the common signaling channel M to actuate a switch N to select trunk T and prepare the associated switch S for operation by succeeding control impulses. Such impulses may be produced by operation of keys in the sender equipment C and may be transmitted over channel M. In this sender equipment two keys, 5 and 6 only, have been shown of a group of ten number keys employed in the selection of corresponding levels in the switch S where the terminals of the desired group of trunks are located. In addition, there has also been shown keys KA and KB which when operated cause the selection of corresponding groups of trunks in the level selected by the number keys. As soon as trunk T is seized by switch N dial tone is transmitted back over the trunk to the operator at A to notify her to select the desired group of trunks. The operator then sends the desired number by depressing a number key and either one of the keys KA and KB, and the switch S is accordingly operated. The tone is removed from the trunk and when the sending of impulses is completed the sender C is restored to normal for use by other operators in setting up connections over other trunks to which the sender C is common. Switch N is also restored to normal at this time and the switch S after having been advanced to the proper group of trunks proceeds to hunt for an idle trunk in

this group to extend the connection to the desired office. The trunk T is also made busy at office D against seizure by other operators and when the idle trunk is found ringing current is transmitted to the tributary office.

When the conversation over this connection is finished the operator at A removes the calling plug from jack 1 and the sender C is then again seized and acts to transmit a different code signal over channel M to actuate the switch N to again find the trunk T for the purpose of restoring the selector S, the switch N and the sender C to normal condition. The code signal in this case has been shown as the reverse of the code signal originally produced to select the trunk T at office D, although another code signal may be used.

If a connection is to be established in the opposite direction between offices D and B the seizure of a trunk such as TL at a tributary office causes the selector S or any other idle selector to be actuated as a line finder to find this trunk. When trunk TL is found an alternating current signal is transmitted over trunk T to actuate the supervisory lamp 10 at office B to notify the operator at A that a connection is being established over this trunk. A busy signal 11 is also actuated to indicate that this trunk is engaged. The operator at A will now insert the answering plug of a cord into the answering jack 12 and when conversation over this connection is finished it is released by the operator at A by the removal of the answering plug. In this case the connection is restored to normal in the same manner as when a connection originates at office B as hereinbefore described.

The switches N and S may be of the well known Strowger type having the usual up and around movements.

A description will now be made in detail of the operation of this system. If a connection is desired from office B, the toll operator at A inserts the calling plug of a cord (not shown) in jack 1. This causes the operation of relay 9 over the sleeve circuit in a manner well known in the art. Relay 9 in operating closes a circuit for busy signal 11 which indicates to other toll operators that trunk T is busy. Relay 9 in operating also closes a connection for the operation of relay 13, from battery, winding of relay 13, outer right hand armature and front contacts of relay 9, outer right hand armature and back contact of relay 14 to ground. The operation of relay 13 cuts off the tip and ring conductors of the trunk T from the answering jack 12 and connects them to the calling jack 1 and at the same time closes a circuit for relay 15 as follows: Battery, upper outer armature and back contact of relay 16, winding of relay 15, lower inner armature and front contact of relay 13 through the outer armature and front contacts of relay 9 to the ground at the right hand armature and back contact of relay 14. It should be noted that a circuit is also closed from this ground to battery through the winding of relay 16 but that this winding is short-circuited through the upper inner armature and back contact of relay 16, and lower inner armature and back contact of relay 15. Relay 16 will consequently not operate at this time.

Relay 15 in operating applies ringing current to the trunk T from source 17 and opens the above mentioned short-circuit for relay 16 at its lower armature and back contact. Relay 16 is therefore now operated and thus removes the battery at the upper outer armature and back contact for relay 15 causing this relay to release. The ringing current is therefore applied to the trunk T during the operated period of relay 15 which depends on the slow to release characteristic of relay 15 and the slow to operate characteristic of relay 16. This momentary impulse of ringing current from source 17 causes the operation of the alternating current responsive relay 100. Relay 100 closes an obvious circuit for the operation of relay 101 which provides a locking circuit for itself through its upper armature and front contact to ground at the lower armature and back contact of relay 102. A connection is also established for the operation of relay 103 as follows: Battery, upper winding of relay 103, upper outer armature and back contact of relay 104, lower armature and front contact of relay 101 to ground. The operation of relay 103 makes the selector S busy and thereby prevents its operation as a line finder on calls incoming from tributary offices. This is accomplished by transferring the "in" starting lead 106 from the winding of relay 104 to the "out" starting lead 106′ at the lower armature and a front contact of relay 103, through the contacts of the key 107 and thereby prevents the selector switch S operating as a line finder but permits succeeding selectors in the group to hunt as line finders for trunks on which the calls are incoming from tributary offices. The operation of switch S as a line finder will hereinafter be described.

Referring back to Fig. 1, when relay 9 operated a circuit was also closed for the operation of the relay 20 as follows: Battery, winding of relay 20, lower outer armature and back contact of relay 21, right hand outer front contacts and armature of relay 9 to ground at the outer right hand armature and back contact of relay 14. Relays 22 and 23 constitute the usual sequence circuit employed in arrangements where common equipments are used, such as sender C common to a plurality of trunks T, for connecting the trunks in the order in which they are seized to the common equipment. These relays are individual to trunk T and it should

be understood that each trunk in the group is provided with corresponding relays. The operation of this sequence circuit is as follows: Relay 20 in operating closes a circuit for the operation of relay 22 as follows: From battery, through the upper inner armatures and back contacts of relays corresponding to relay 23 of sequence circuits associated with trunks of a higher number in the group, winding of relay 22, upper inner armature and back contact of relay 21, upper inner armature and front contact of relay 20 to ground. The operation of relay 22 closes a circuit for the operation of relay 23 as follows: Battery, winding of relay 23, inner and lower armature and front contact of relay 22 through the make before break contacts of relays corresponding to relay 22 of the lower numbered trunks in the group. The operation of both relays 22 and 23 can therefore only take place if the common equipment C is not engaged by another trunk.

When relays 22 and 23 are both operated a circuit is closed from battery through a resistance 25, winding of relay 21, lower inner armature and front contact of relay 20, lower outer armature and front contact of relay 22, lower inner armature and front contact of relay 23, to winding of relay 26 to ground. Relay 21 is marginal so that it will not operate in this circuit. Relay 26 however operates and connects battery to the common signaling channel M at its outer right hand armature and back contact and through the armature and front contact of relay 27. Relay 26 also furnishes battery for the operation of relay 28 over an obvious circuit. Relay 28 is slow to operate but prepares a circuit for the operation of relay 29. This circuit will be closed when the interrupter 30 closes a connection to ground at brush 31 with the circuit extending through the second inner armature and back contact of relay 32, make before break contacts of relay 29, the winding of this relay, the armature and front contact of relay 28, inner right hand armature and front contact of relay 26 to battery. Relay 29 in operating provides a locking circuit for itself independent of interrupter 30 from ground at the lower outer armature and back contact of relay 32. The ground at the interrupter 30 is applied alternately to brushes 31 and 33.

When relay 29 operates and the ground at the interrupter 30 is later connected to brush 33 a circuit is completed for the operation of relay 27 as follows: Battery, winding of relay 27, upper front contacts of relay 29, brush 33 to ground. Relay 27 will now therefore be alternately operated and released under control of interrupter 30 and cause the battery connection for the common signaling channel M to be correspondingly interrupted at the armature and back contact of this relay. It should be noted that the brush 33 is also connected for the operation of relay 35 over a circuit as follows: Battery, winding of relay 35, armature and back contact of relay 36, lower outer armature and front contact of relay 23, lower armature and back contact of relay 37, lower outer armature and back contact of relay 38, right hand armature and back contact of relay 39, upper armature and front contact of relay 29, brush 33, interrupter 30 to ground. Relays 35 and 36 are the second pair of relays of a counting relay system well-known in the art. A few of the other relays of this system have been shown and are designated 40 and 41, 42 and 43, 44 and 45 and 47 and 48. It should be understood that there are ten groups of such counting relays associated with the number keys in the usual manner, although only five pairs of relays have been shown for the sake of simplicity. When the ground at the interrupter 30 is removed from brush 33 for the first time relay 36 operates in series with relay 35 from battery through the windings of these two relays, armature and front contact of relay 35 to ground at the lower armature and back contact of relay 32. On the next connection of the ground at the interrupter 30, relay 40 operates through the armature and back contact of relay 41 and armature and front contact of relay 36. On the next removal of the ground at the interrupter 30, it is obvious that relays 41 and 46 operate in a parallel circuit in series with relay 40 and lock to ground at the lower outer armature and back contact of relay 32. In other words, it will require two successive connections to ground of the brush 33 to cause these counting relays and relay 46 to be operated and locked. It is also evident that relay 27 is operated twice during this period to interrupt the connection, from battery at the outer right hand armature and front contact of relay 26, for the common signal channel M. The operation of relay 46 closes an obvious circuit for the operation of relay 32 through its lower winding and this relay in operating provides a locking circuit for itself through its upper winding, upper armature and front contact, to ground at the upper armature and back contact of relay 38. The operation of relay 32 opens the locking circuit for relays 29, 35, 36, 40, 41 and 46 so that these relays will now be released. Consequently relay 29 cannot be again operated until relay 32 has released as hereinafter will be described.

Upon the next connection of ground at the interrupter 30 to brush 33 a circuit will now be closed for the operation of relay 38 as follows: Battery, winding of relay 38, make-before-break contacts of this relay, inner lower armature, armature and front contact of relay 32, brush 33, to ground at the interrupter 30. Relay 38 provides a locking circuit for itself through its inner lower arma-

ture and front contact to ground at the armature and back contact of the release relay 49. Relay 38 in operating causes the release of relay 32 as it opens the locking circuit for relay 32 at its upper armature and back contact, and closes a circuit for relay 24 as follows: Battery, winding of relay 24 and its upper inner armature and back contact, upper armature and front contact of relay 38, upper armature and back contact of relay 32, to ground. The connection from brush 31 on the next closure to ground from the interrupter 30 will now therefore be completed as before at the second lower armature and back contact of this relay for the reoperation of relay 29 which locks to the ground at the lower outer armature and back contact of relay 32. On the next closure of the ground at interrupter 30 for brush 33 relay 27 will operate as before and a circuit will also be completed for the operation of the counting relay 44 as follows: Battery, winding of relay 44, upper armature and back contact of counting relay 45, lower middle armature and front contact of relay 23, inner upper armature and back contact of relay 37, lower outer armature and front contact of relay 38, right hand armature and back contact of relay 39, upper armature and front contact of relay 29, brush 33 to ground at interrupter 30. On the subsequent interruptions of the ground connection from interrupter 30 counting relays 45, 42, 43, 35, 36, 40, 41 and 46 will operate in succession, and relay 27 will of course also be alternately operated and released in accordance with the successive connections to ground through brush 33 from interrupter 30. Thus the connection from battery for the common signal channel M will be accordingly interrupted.

Another series of impulses is therefore transmitted over this common channel to office D and in this case the number of impulses will be four, as the connection originated at the fourth group of counting relays 44 and 45. When this series of impulses has been transmitted relay 46 is operated and relay 32 is again operated. In this case relay 32 is locked by a circuit through its upper winding and upper armature and front contact, upper armature and front contact of relay 38, upper inner armature and a front contact of relay 24, to ground at the outer left-hand armature and back contact of relay 39. Relay 29 is thereby released as well as the counting relays 44, 45, 42, 43, 35, 36, 40, 41 and 46.

Two series of impulses of two and four impulses respectively have now been sent to the distant office D and these code impulses act in a manner to connect the common signaling channel M to equipments associated with the trunk T at this office and caused said equipment to apply a tone to the trunk to notify the operator that she may dial the number of the tributary office to which a connection is desired. When battery was first connected to the channel M relay 110 operated. The operation of relay 110 closes an obvious circuit for the operation of relay 111 which in turn causes the operation of relay 112. Relays 110 and 111 follow the succeeding interruptions of battery on the channel M but relay 112 being slow to release remains operated during pulsing. On the first impulse the release of relay 111 causes the operation of relay 113 and the vertical magnet 114 in series. The circuit for this magnet and relay may be traced from battery, through the magnet 114, winding of relay 113, the lower normally closed contacts of the vertical off normal contacts 115, right-hand armature and front contact of relay 112, armature and back contact of relay 111 to ground. The operation of the vertical magnet 114 operates its vertical off normal contacts 115 so that the operating path for the vertical magnet 114 and relay 113 is now transferred through the armature and front contact of relay 113 and the lower closed contacts of the vertical off normal contacts 115. Relay 113 is slow to release so that it will be held operated during the pulsing. The first series of impulses being two in number causes the vertical magnet 114 to step the brushes of switch N up to the second level of terminals on this switch.

At the end of the second impulse relay 111 remains operated until the next series of impulses is received as relay 110 will be maintained operated. This affords sufficient time for relay 113 to release and transfer the connection from the armature and back contact of relay 111 to the windings of relay 116 and rotating magnet 117 in series. The next series of impulses will now actuate the rotary magnet 117 to cause the switch N to step in a rotary direction until the fourth set of terminals in the selected level are connected to the brushes of the switch. These terminals are shown in the drawing and marked 120. Relay 116 being slow to release remains operated during the pulsing. The first operation of magnet 117 causes a circuit to be closed for relay 121 as follows: Battery, winding of relay 121, inner right-hand armature and front contact of relay 116, inner left-hand armature and front contact of relay 112, armature and front contact of relay 111 to ground. Relay 121 is locked in operated position through the circuit completed at its left-hand armature and front contact to the ground at the outer left-hand armature and front contact of relay 112. At the end of the fourth impulse relay 116 is released and provides a circuit for the operation of relay 122 as follows: Battery, winding of relay 122, right-hand armature and front contact of relay 121, to ground at the outer right-hand armature and back contact of relay 116. The

circuit connection from ground at the armature and front contact of relay 110 is now transferred from relay 111 to the lower brush of switch N and lower terminal in the fourth set marked 120 in the selected level through the winding of relay 124 to battery. Relay 111 is thereby released but it will be noted that relay 112 is maintained locked in its operated position through its inner left-hand armature and front contact, through the inner righ-hand armature and back contact of relay 116, the upper brush of the switch N and the upper terminal of the set 120, upper armature and back contact of relay 126, lower armature and back contact of relay 102, to ground.

The above mentioned circuit for relay 124 causes the relay to operate and close an obvious circuit for the operation of relay 127 and also a circuit for the operation of relay 128 which may be traced from battery, through the winding of relay 128, upper outer armature and front contact of relay 124, the upper normally closed contacts of the vertical off normal contacts 129 of switch S, to ground. Relay 128 in operating establishes a connection at its armatures and front contacts from ground and a tone source 130, to the tip and ring conductors of trunk T. As the trunk is connected through jack 1 to the cord of the operator at A, this tone is received at the operator's telephone set and notifies her that the dialing may begin. The circuit connections at office D will now remain in this condition until the dial impulses are received.

The operator at A upon receiving this tone actuates the keys for the selection of the desired tributary office. Let it now be assumed that the trunks from the desired tributary office terminate on the second half of the fifth level of the selector S. The operator at A will therefore dial the digits 5 and 6 by depressing the fifth key marked 5 and key KB. The operation of key 5 causes the switch S to step its brushes to the fifth level and the operation of key KB causes the switch to rotate its brushes on this level to the sixth set of terminals in this level, i. e., the second half of the fifth level. As hereinbefore stated the arrangement may be such that only two of this latter type of keys KA and KB are provided in the sender C on the assumption that not more than two groups of trunks leading to tributary offices are located in each level of terminals of switch S.

When key 5 is actuated the relay 50 operates over a circuit as follows: Battery at the lower armature and front contact of relay 24, third lower armature and front contact of relay 32, the two windings of relay 50 in series through an upper pair of make-before-break contacts of this relay, the contacts of key 5, the upper winding of relay 51, to ground at the armature and back contact of this relay. When relay 50 operates a circuit is closed for the operation of relay 51 which did not operate in the previously traced circuit due to the high resistance of this circuit caused by the high resistance of the lower winding of relay 50. The new circuit for relay 51 may be traced from battery through another pair of the upper make-before-break contacts of relay 50, contacts of key 5, upper winding of relay 51, to ground at the lower armature and back contact of this relay. Relay 51 will now remain operated through a circuit closed through its two windings in series. The two windings of relay 51 will prevent any relay such as, for example, 52 from operating while key 5 remains depressed in case any other key is operated, i. e., the combined resistance of these two windings in series with the high resistance of the two windings of any other relay would prevent such a relay from operating as long as key 5 remains operated in view of the comparatively lower resistance path to battery provided through the contacts of key 5 and the upper make-before-break contacts of relay 50. Relay 50 in operating provides a locking circuit for itself to ground at the armature and back contact of relay 49. This circuit may be traced from this ground, through the upper inner armature and front contact of relay 50, the upper low resistance winding of this relay and its lower front contacts, through the winding of relay 39, to battery, and through the lower front contacts of relay 50 through a resistance to battery at the lower armature and front contact of relay 24. The lower high resistance winding of relay 50 is thereby short-circuited. Consequently as long as relay 50 remains operated any other relay in this group will be prevented from operating in case the associated key is depressed, as the two windings in such a relay will be shunted by the connection to ground at the armature and back contact of relay 49 through the low resistance winding of relay 50. Relay 50 also prepares a circuit for relay 47 of the fifth group of counting relays to brush 33 and this circuit will be completed when relay 29 is operated and brush 33 is connected to interrupter 30 as will hereinafter be described.

When key KB is actuated relay 53 is operated as relay 39 is operated at this time; relay 39 being operated by the circuit completed as described through the winding of this relay on the operation of relay 50. The circuit for relay 53 may be traced as follows: Battery, inner left-hand armature and front contact of relay 39, the high and low resistance windings of relay 53 in series, upper inner armature and back contact of relay 53, contacts of key KB, upper winding of relay 54 and armature and back contact of relay 54, to ground. Relay 53 in operating is locked and short-circuits its high resistance winding and also causes relay 54 to operate for the same pur-

pose and in the same manner as relay 51 was operated on the operation of relay 50. The sender C is now in condition for transmitting the two series of impulses 5 and 2 in succession.

When relay 39 is operated as described above it causes the release of relay 32 due to the opening of the connection at the outer right-hand armature and back contact of relay 39. Relay 32 in releasing completes a circuit for the operation of relay 56 as follows: Battery, winding of relay 56, inner right-hand armature and back contact of relay 56, outer left-hand armature and front contact of relay 39, upper inner armature and front contact of relay 24, upper armature and front contact of relay 38, upper armature and back contact of relay 32, to ground. Relay 56 in operating provides a locking circuit for itself through its make-before-break contacts to ground at the armature and back contact of relay 49. The purpose of the operation of relay 56 will become apparent as the description proceeds. Relay 32 in releasing permits the operation of relay 29 on the next closure of the circuit therefore through the brush 31 on interrupter 30. Relay 29 locks up as hereinbefore described and prepares a circuit for counting relay 47 which will be completed on the next closure of the connection to ground through brush 33. This circuit may now be traced as follows: Battery, winding of counting relay 47, armature and back contact of counting relay 48, the lead marked 4 from the armature of relay 48 which may be connected to the front contact also marked 4 associated with the upper outer armature of relay 50, through the outer right-hand armature and back contact of relay 57, the upper make-before-break contacts of relay 29, brush 33, to ground at the interrupter 30. On the opening of this circuit at the interrupter 30 the counting relay 48 is operated and on the succeeding interruptions of this circuit the remaining counting relays are operated and locked up in succession and thereby permit relay 27 to be alternately operated and released to interrupt the connection to battery for channel M a corresponding number of times, namely five interruptions in succession.

When relay 46 is finally operated a circuit is completed for the operation of relay 57 over a circuit as follows: Battery, winding of relay 57, its make-before-break contacts, outer right-hand armature and front contact of relay 56, armature and front contact of relay 46, to ground. Relay 57 provides a locking circuit for itself through its inner right-hand armature and front contact to ground at the armature and back contact of relay 49. Relay 32 is now again operated by the operation of relay 46 causing the release of relay 29 and the counting relays. This relay locks to ground over a circuit as follows: Battery, upper winding of relay 32, upper armature and front contact of this relay, upper armature and front contact of relay 38, upper inner armature and front contact of relay 24, outer left hand armature and front contacts of relay 39, inner right hand armature and front contact of relay 56, to ground at the armature and back contact of relay 59. The operation of relay 57 transfers at the outer right hand armature a connection from brush 33 and the counting relays through the corresponding front contact and to the upper outer armature and front contact of relay 53, and from there through lead marked 6 to the lower counting relay of the sixth group not shown. The operation of relay 57 also applies battery for the operation of relay 59 over a circuit as follows: Battery, middle right hand armature and front contact of relay 57, winding of relay 59, lower front contacts and upper winding of relay 53, upper make-before-break contacts of this relay, armature and back contact of relay 49 to ground. Relay 59 in operating opens the locking circuit for relay 32 and this relay in releasing causes the counting relays and associated circuits to function again to send the second series of impulses under control of the ground at the brush 33 of interrupter 30. Relay 32 in releasing also closes a circuit for the operation of relay 60 as follows: Battery, winding of relay 60, armature and front contact of relay 59, inner right-hand armature and front contact of relay 56, outer left-hand armature and front contact of relay 39, upper inner armature and front contact of relay 24, upper armature and front contact of relay 38, to ground at the upper armature and back contact of relay 32. Relay 60 provides a locking circuit for itself to ground at the armature and back contact of relay 49. At the end of the sixth impulse relay 46 causes the operation of relay 32 and the release of 29 as hereinbefore described. The operation of relay 46 also closes a circuit for the operation of relay 49 as follows: Battery, right-hand winding of relay 49, left-hand armature and front contact of relay 60, armature and front contact of relay 46 to ground. Relay 49 provides a locking circuit for itself to ground at its armature and front contact from battery connected through resistance 25 and winding of relay 21, inner lower armature and front contact of relay 20, lower outer armature and front contact of relay 22, lower inner armature and front contact of relay 23 and the left-hand winding of relay 49. This relay in operating causes the release of relays 60, 59, 53, 39, 50, 56, 57, 24, 38 and 32. Relay 26 is also released due to the low resistance of the left-hand winding of relay 49, and relay 26 causes the release of relay 28 and opens the circuit to battery for channel M.

The effect at office D produced by the two sets of dial impulses will now be described. It will be recalled that the code impulses place tone on the trunk T to notify the operator at A that she may dial the desired tributary office and prepare the circuits at office D for the reception of dial impulses. It will be recalled that relay 124 is operated so that the first release of relay 110, on the first interruption of the connection over channel M, causes the release of this relay and thus completes a circuit for the operation of the vertical magnet 130 and the relay 131 as follows: Battery, winding of the vertical magnet 130, winding of relay 131, lower normally made contacts of the vertical off normal contacts 129, right-hand armature and front contact of relay 127, inner armature and back contact of relay 124 to ground.

The operation of the vertical magnet operates the vertical off normal contacts 129 so that the circuit for the vertical magnet 130 and relay 131 is now transferred to the armature and front contact of relay 131 and the closed lower contacts of the group 129. Relay 131 is slow in releasing so that it is held between the impulses. The first series of impulses, being six in number, causes the switch S to step its brushes to the sixth level of terminals. At the end of the sixth impulse relay 110 remains operated until the next series of impulses are received. This affords sufficient time for the relay 131 to release and transfer the pulsing connection through the windings of relay 132 and the rotary magnet 133 in series. The next series of impulses therefore causes the rotary magnet to be actuated to step the brushes of switch S to the sixth group of terminals in the fifth level, relay 132 remaining operated during this series of impulses. It should be mentioned that on the operation of the vertical off normal contacts 129 on reception of the first impulse of the first series relay 128 is released so that the tone from the source 130 is removed from the trunk T.

The original operation of relay 132 on reception of the first impulse for the rotation of the brushes on the fifth level completes a circuit for the operation of relay 126 as follows: Battery, lower outer armature and front contact of relay 132, winding of relay 126, make-before-break contacts of relay 135, lower armature and back contact of relay 102, to ground. The purpose of the operation of this relay will presently be described. The operation of relay 132 also completes at its inner lower armature a connection to ground for maintaining the relay 112 operated after relay 126 is operated to remove the original ground for maintaining this relay operated. Relay 126 in operating provides a locking circuit for itself from battery, through its lower armature and front contact, to ground at the lower armature and back contact of relay 102. This ground at the armature and back contact of relay 102 is now through the upper armature and front contact of relay 126 to the winding of relay 135 the purpose of which will become apparent in the succeeding description. At the end of the second series of dial impulses relay 132 is released and removes the ground for relay 112 so that this relay releases and causes the release of relay 121 which in turn causes the release of relay 122. The release of relay 112 closes an obvious circuit for the operation of the release magnet 137, which now returns the switch N to its normal position so as to make it available for another call. The release of relay 132 also closes a circuit for the windings of relays 140 and 141, the purpose of which will be presently described.

The terminals 142 and 143 of all the trunks of each group are strapped together except the terminal of the last trunk in each group where the terminal 142 is open and terminal 143 connected as shown. If the sixth trunk now is found busy ground will be connected to the terminals 142 and 143 due to the operation of relay 145. The windings of relay 140 are wound differentially and connected to the brushes 146 and 147 in such a manner that when ground is present on the terminals 142 and 143 relay 140 will not operate. The slow to operate relay 141, however, will operate over a circuit as follows: Battery, lower armature and front contact of relay 126, lower outer armature and back contact of relay 132, upper armature and back contact of rotary magnet 133, lower armature and back contact of relay 140, winding of relay 141, lower outer armature and back contact of relay 135, brush 147, terminal 143, inner right-hand armature and front contact of relay 145 to ground. It should be noted that the winding of relay 135 is also connected in series with relay 141 to the battery at the lower armature and front contact of relay 126, through the upper armature and front contact of relay 126 to ground at the lower armature and back contact of relay 102, but this relay will not operate at this time as the winding is short-circuited by the ground at relay 145. Relay 141 in operating provides a ground for the operation of rotary magnet 133 over an obvious circuit so that the rotary magnet 133 will step the brushes of the switch S from the terminals of the busy trunk to those of the next trunk in the group. The operation of the rotary magnet 133 opens the circuit for relay 141 at the upper armature and back contact of this magnet so that relay 141 will now release. The relay 141 in releasing causes the release of the rotary magnet 133. This action will be repeated as long as the succeeding trunks are found busy until the last trunk is reached. If the last trunk is also busy a ground will be found on

the terminal 143 but not on terminal 142. In this case relay 140 will operate, as it is faster in its operation than relay 141, over a circuit as follows: Battery, lower armature and front contact of relay 126, lower outer armature and front contact of relay 132, upper armature and back contact of rotary magnet 133, lower winding of relay 140, lower outer armature and back contact of relay 135, brush 147, terminal 143, to ground at relay 145. The operation of relay 140 thus prevents the operation of relay 141 on this ground as the circuit for this relay is opened at the lower armature and back contact of relay 140. Relay 140 places ground and a tone from the source 150 at the upper armatures and front contacts of this relay on the tip and ring conductors of trunk T to notify the operator at A in office B that all trunks to the tributary office that she has dialed are busy.

If a trunk is found idle in this group no ground will be present on the terminals 142 or 143 so that relays 140, and 135 will operate in series over a circuit as follows: Battery, lower armature and front contact of relay 126, lower outer armature and back contact of relay 132, upper armature and back contact of magnet 133, lower winding of relay 140, winding of relay 135, upper armature and front contact of relay 126, to ground at the lower armature and back contact of relay 102. Relay 135 in operating causes the operation of relay 152 over a circuit as follows: Battery, lower winding of relay 152, lower inner armature and front contact of relay 135, to ground at the lower armature and back contact of relay 102. The operation of relay 135 also opens the connections to brushes 146 and 147 and transfers the locking circuit for relay 126 from the ground at the lower armature and back contact of relay 102 to the ground, through the upper armature and front contact of relay 135 and winding of relay 153, at the armature and back contact of relay 154. Relay 153 is operated in this circuit. The operation of relay 152 connects the tip and ring conductors of the trunk T at the upper and lower inner armatures and front contacts of this relay to the tip and ring brushes of the switch S. This relay also provides a circuit for the operation of relay 145 over a circuit as follows: Battery, winding of relay 145, sleeve terminal of the selected trunk the corresponding sleeve brush of switch S the middle lower armature and front contacts of relay 152, to ground at the lower armature and back contact of relay 102. Relays 152 and 145 are thereby locked in operated position independent of the original energizing circuit for relay 152. Relay 145 in operating connects ground to the terminals 142 and 143 thus making the selected trunk busy.

Relay 153 in operating opens the connection from the tone source 150 at the lower outer armature and back contact of this relay to prevent busy tone from being transmitted to the operator at A when relay 140 operates. This relay also applies ringing current from the source 156 to the trunk leading to the tributary office, at the upper outer and inner lower armatures and front contacts of this relay, indicating to the distant tributary office operator that a connection is desired over this trunk. Relay 153 further provides an obvious circuit for the operation of relay 154. The operation of this relay causes the release of relays 153 and 126. The release of relay 153 removes the ringing current from the trunk while the release of relay 126 causes the release of relays 140 and 135. The release of relay 153 causes the release of relay 154. The circuits as now arranged remain in this condition during the talking period. That is, the conditions are such that a clear connection is established over the tip and ring conductors of trunks TL and T from the tributary office to the operator at A and conversation may begin as soon as the two operators have extended the talking connection to the calling and called subscribers in a manner well known in the art.

When the conversation is ended and disconnection is desired the operator at A removes her plug from the jack 1 causing the release of relay 9. Relay 9 in releasing, releases the busy signal 11 and relays 13, 16 and 20. The release of relay 20 provides a ground for the operation of relay 22 over a circuit as follows: Battery, to the upper armatures and front contacts of relays in other sequence circuits corresponding to relay 23, winding of relay 22, upper inner armature and front contact of relay 21, upper inner armature and back contact of relay 20 to ground. Relay 22 causes the operation of relay 23 as hereinbefore described and the sender equipment C is thereby seized and acts as hereinbefore described to send two series of impulses over the common channel M to actuate the switch N to seize trunk T for the purpose of releasing the connection. However, the order of the digits in the code will be reversed on account of the fact that relay 37 will operate at this time over a circuit as follows: Battery, winding of relay 37, upper outer armature and front contact of relay 23, upper outer armature and front contact of relay 21, upper outer armature and back contact of relay 20, to ground. In this case, therefore, four impulses will be transmitted first followed by two impulses. The operation of relay 37 accomplishes this by switching the connection from the counting relays 35 and 44 at the upper inner armatures and lower armatures and contacts so that the fourth series of counting relays will

be connected first for controlling the sending of impulses.

The operation of relay 37 also closes a connection for the operation of relay 49 at the end of the second series of impulses. The circuit for relay 49 is as follows: Battery, right-hand winding of relay 49, upper outer armature and front contact of relay 37, upper outer armature and front contact of relay 24, to ground at the armature and front contact of relay 46. Relay 49 in operating will act as hereinbefore described to release the relays that were operated in the sender C and cause relay 21 to release by shunting it with the left-hand low resistance winding of relay 49. This shunting circuit may be traced from ground at the armature and front contact of relay 49, left-hand winding of this relay, inner lower armature and front contact of relay 23, outer lower armature and front contact of relay 22, lower inner armature and back contact of relay 20, to battery through the resistance 25. Relay 21 in releasing causes the release of relay 22 which in turn causes the release of relays 23 and 37. The circuits at office B are now therefore restored to their normal condition and the sender C available for use in the establishment of other connections.

The two series of impulses received at office D function to advance the switch N in the same manner as the previous code impulses which were sent at the time the trunk was seized except that the brushes of the switch will be advanced to the fourth level and to the second set of terminals in that level instead of to the second level and the fourth set of terminals as in the previous case. When the brushes of switch N reach these terminals, which are marked 120′, the connection to ground for the lower brush of switch N is extended through the lower terminal over an obvious circuit for the operation of relay 102. Relay 102 in operating provides a locking circuit for itself to ground at the upper closed contacts of the vertical off normal contacts 129. Relay 102 in operating opens the holding circuit for relay 112 which now releases the switch N as hereinbefore described. Relay 102 also by operating its lower armature causes the release of relays 101, 152 and 145 and provides an obvious circuit connection for the release magnet 158 which returns the switch S to normal position. The vertical off normal contacts 129 when returned to normal position causes the release of relay 102 and also the release of relay 103, which was operated as hereinbefore described to make switch S busy. The equipment at office D is now fully returned to normal condition and available for use in other connections.

If a connection is to be established in the opposite direction between offices D and B the seizure of a trunk such as trunk TL at a tributary office causes the selector S or any other idle selector to be actuated as a line finder to find this trunk. The detailed operation of the system under these circumstances will now be described. On the seizure of the trunk TL at the tributary office relay 159 will be operated over a circuit completed through lead 160, from the usual line finder circuit arrangement not shown. Relay 159 in operating provides a locking circuit for itself to ground at the inner right-hand armature and back contact of relay 145. This relay in operating also causes the operation of relay 161 over an obvious circuit. Relay 161 is common to all trunks such as TL that have terminals in a single level. Relay 161 in operating places a connection to ground on the commutator terminal 163 corresponding to the level on which these trunks terminate. For example, these trunks may terminate in the fourth level. The operation of relay 161 also establishes a circuit for the operation of relay 104 as follows: Battery, winding of relay 104, lower make-before-break contacts of relay 103, normally closed contacts of jack 107, "in" lead 106, right-hand armature and front contact of relay 161, to ground at the middle right-hand armature and back contact of relay 162, provided the switch S is idle at this time. If switch S is not idle relay 103 would already have been operated as hereinbefore described and transferred the "in" lead 106 to the "out" lead 106′ for the operation of the relay corresponding to relay 104 in the circuit of the next idle switch.

The operation of relay 104 furnishes an obvious connection for the operation of relay 164 which in operating applies ringing current to the trunk T to signal the operator at A that a connection is desired over this trunk. The operation of relay 104 also closes a circuit for the operation of relay 165 as follows: Battery, middle outer armature and back contact of relay 103, lower winding of relay 165, armature and back contact of rotary magnet 133, armature and back contact of vertical magnet 130, to ground at the second upper armature and front contact of relay 104. The operation of relay 165 closes a circuit for the operation of the vertical magnet 130 as follows: Battery, winding of vertical magnet 130, upper outer armature and back contact of relay 103, upper inner armature and front contact of relay 104, upper armature and back contact of relay 166, armature and front contact of relay 165, to ground at the second upper armature and front contact of relay 104. The vertical magnet in operating opens the circuit for relay 165 which in releasing opens the circuit for the vertical magnet. The release of the vertical magnet again closes a circuit for the relay 165 which again closes a circuit for the operation of the vertical magnet. This stepping motion continues until the switch has

been stepped up to the fourth level. When this level is reached ground on terminal 163 will be connected to brush 168 for the completion of a circuit for relay 166 as follows: Battery, second upper armature and back contact of relay 103, lower winding of relay 165, armature and back contact of rotary magnet 133, third upper armature and front contact of relay 104, upper winding of relay 166, brush 168, terminal 163 and ground at the left-hand armature and front contact of relay 161. Relay 166 in operating provides a locking circuit for itself to ground at the upper armature and front contact of relay 104, the lower high resistance winding of relay 166, the inner upper armature and front contact of relay 104, upper outer armature and back contact of relay 103, winding of the vertical magnet 130, to battery. The vertical magnet releases at this time due to the high resistance of the lower winding of relay 166 in the above mentioned circuit.

The operation of relay 166 transfers the stepping circuit from the vertical to the rotary magnet at the upper armature and front contact of this relay so that the circuit for the rotary magnet will now be traced from battery, through the winding of magnet 133, upper armature and front contact of relay 166, armature and front contact of relay 165, to ground at the second upper armature and front contact of relay 104. Relay 165 and the rotary magnet 133 will now alternately operate and release each other to step switch S in a rotary direction until battery is found on the terminal 170 associated with trunk TL, this battery being supplied at the outer left-hand armature and front contact of relay 159. When this battery connection is found the circuit will be completed for the operation of relay 152 and for preventing relay 165 from being further released and the rotary magnet from operating thus causing the switch to remain with its brushes on these terminals. This circuit may be traced as follows: Battery, outer left-hand armature and front contact of relay 159, terminal 170, the corresponding brush of switch S, upper winding of relay 152, upper winding of relay 165, to ground at the second upper armature and front contact of relay 104. Relay 152 is locked over a circuit as hereinbefore traced which is completed to the lower armature and back contact of relay 102 to ground. Relay 152 in operating closes the talking connection from trunk TL to trunk T and also causes the operation of relay 145 over a sleeve circuit under the control of the connection to ground at the relay 102.

Relay 103 is also operated by the operation of relay 152 over a circuit as follows: Battery, upper winding of relay 103, lower outer armature and front contact of relay 152, to ground at the upper closed contacts of the vertical off normal contacts 129. Relay 103 in operating makes switch S busy as hereinbefore described while the operation of relay 145 causes the release of relay 159 and connects terminals 142 and 143 to ground to make the trunk TL busy for calls in the opposite direction. The release of relay 159 causes the release of relay 161 and this relay in turn causes the release of relay 165, while the operation of relay 103 causes the release of relays 166 and 104. The rotary magnet is also released at this time but no further stepping occurs as the operating circuit for relay 165 is broken. Relay 104 in releasing causes the release of relay 164 to remove the ringing current from the line.

When ringing current was applied to the trunk T the alternating current responsive relay 52 at office B was operated. The operation of this relay closes an obvious circuit for the operation of relay 64 which in turn causes lamp 10 to be lighted to indicate to the operator at A that a connection over this trunk is desired. Relay 64 provides a locking circuit for itself to ground at the outer right-hand armature and back contact of relay 14. The busy signal 11 is also operated by the operation of relay 64 over an obvious circuit. When the operator A inserts an answering plug into answering jack 12 relay 14 is operated. The operation of this relay holds the busy signal 11 operated but releases relay 64 and extinguishes the lamp 10. The operation of relay 14 also opens the alternating current bridge for relay 63. An operating circuit for relay 65 is closed by the operation of relay 14 and this relay is locked by a circuit controlled by relay 21. The purpose of the operation of relay 65 will become apparent as the description proceeds. Conversation may now take place over the established connection.

When the operator removes the answering plug from jack 12 at the end of conversation relay 14 is released causing the release of the busy signal 11 and closes the alternating current bridge for relay 63. It also provides a ground connection through the left-hand armature and front contact of relay 65 for the operation of relay 21 over a circuit extending through resistance 25 to battery. Relay 21 in operating causes the release of relay 65 and causes a release signal to be sent to office D in the same manner as hereinbefore described, this release signal causing the release of switch S as hereinbefore described. When this release signal has been sent relay 21 releases and the circuits are then returned to normal condition.

It should be understood that while the invention has been described only in connection with one trunking system, it is not limited by this disclosure but may be applied to other trunking systems.

What is claimed is:

1. In a telephone system, a first office, a

second office, lines extending between said offices, automatic switches at the second office for further extending said lines, a single circuit common to said lines extending between said offices and means controllable over said circuit for actuating and releasing said switches.

2. In a telephone system, a first office, a second office, lines extending between the first and the second offices, lines outgoing from said second office, automatic switching mechanisms at said second office, means including a separate signaling channel between the first and second offices for controlling connections through said switching mechanisms between lines from the first office and lines outgoing from said second office, and means whereby said switching mechanisms serve as selectors in connections originating from the first office and as line finders in connections originating from said outgoing lines.

3. In a telephone system, a first office, a second office, lines extending between said offices, lines outgoing from said second office, automatic switches at the second office for establishing connections between lines from the first office and said outgoing lines utilized as selector switches for connections originating from the first office and as line finders for connections originating from said outgoing lines, and means including a separate signaling channel extending between the first and second offices for controlling the establishing and the release of connections of the first mentioned type and for the release of the second mentioned type of connections.

4. In a telephone system, a first office, a second office, lines extending between the first and the second offices, lines outgoing from the second office, automatic switches at the second office for establishing connections between lines from the first office and said outgoing lines, a separate signaling channel extending between the first and the second offices, means utilizing said signaling channel for controlling the establishing and the release of connections originating from the first office and for controlling the release of connections originating from said outgoing lines.

5. In a telephone system, a first office, a second office, lines between the first and the second offices, lines outgoing from the second office, automatic switches at the second office, a single circuit common to said lines between the first and second offices, means for transmitting impulses over said circuit, and means responsive to said impulses for actuating said switches to establish connections between lines from the first office and said outgoing lines and for releasing said switches.

6. In a telephone system, a first office, a second office, other offices, lines extending between the first and second offices and from the second office to said other offices, automatic switches at said second office each associated with a line from the first office, a separate signaling channel between the first and second offices, means for transmitting code impulses over said channel from said first office, means at the second office responsive to said impulses for selecting a corresponding line from the first office and the associated automatic switch, means for thereafter transmitting switch setting impulses from said first office, and means at the second office responsive to said latter impulses for actuating the selected automatic switch to establish a connection between the associated line and a line leading to a desired one of said other offices.

7. In a telephone system, a first office, a second office, lines extending between the first and second offices, lines outgoing from the second office, automatic switches at said second office each associated with a line from the first office, a separate signaling channel between the first and second offices, means for transmitting code impulses over said channel from said first office, means at the second office responsive to said impulses for selecting a corresponding line from the first office and the associated automatic switch, means for thereafter transmitting operating impulses from said first office, means at the second office responsive to said operating impulses for actuating the selected automatic switch to establish a connection between the associated line and an outgoing line, and means at the second office responsive to code impulses received from the first office for releasing the automatic switch employed in said connection.

8. In a telephone system, a first office, a second office, lines extending between said offices, automatic switches at the second office for further extending said lines, a single conductor common to said lines extending between said offices, and means controllable over said conductor for actuating and releasing said switches.

9. In a telephone system, a first office, a second office, lines extending between said offices, an automatic switch at the second office for each line, a single circuit common to said lines extending between said offices, means responsive to the seizure of a line at the first office for enabling the control of the corresponding switch at the second office over said circuit and means responsive to the release of said line at the first office for controlling said switch over said circuit to cause it to release.

10. In a telephone system, a first office, a second office, lines extending between said offices, an automatic switch at the second office for each line, a single circuit common to said lines extending between said offices, means responsive to the seizure of a line at

the first office for seizing the correspondng switch at the second office over said circuit, and means responsive to the release of said line at the first office for controlling said switch over said circuit to cause it to release.

In testimony whereof, we have signed our names to this specification this 9th day of April, 1928.

RAND S. BAILEY.
STANLEY F. NELSON.
FRANK F. SHIPLEY.