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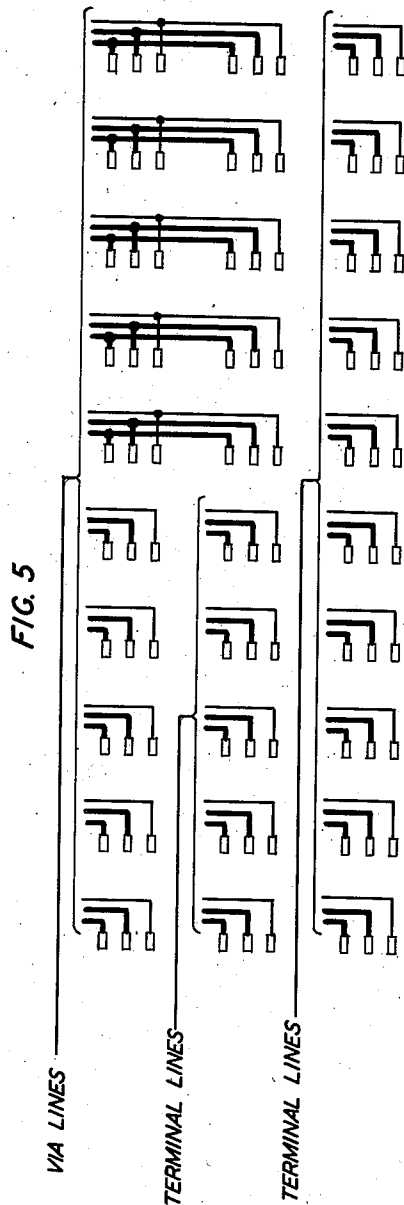
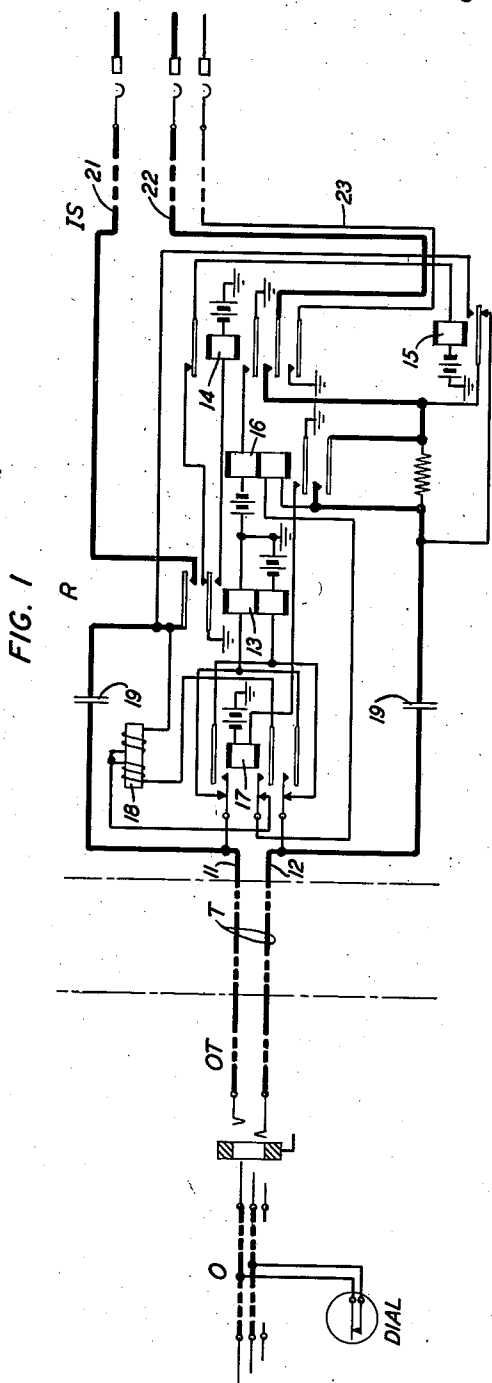
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2,097,165

TELEPHONE SYSTEM

Filed Aug. 4, 1936.

4 Sheets-Sheet 1



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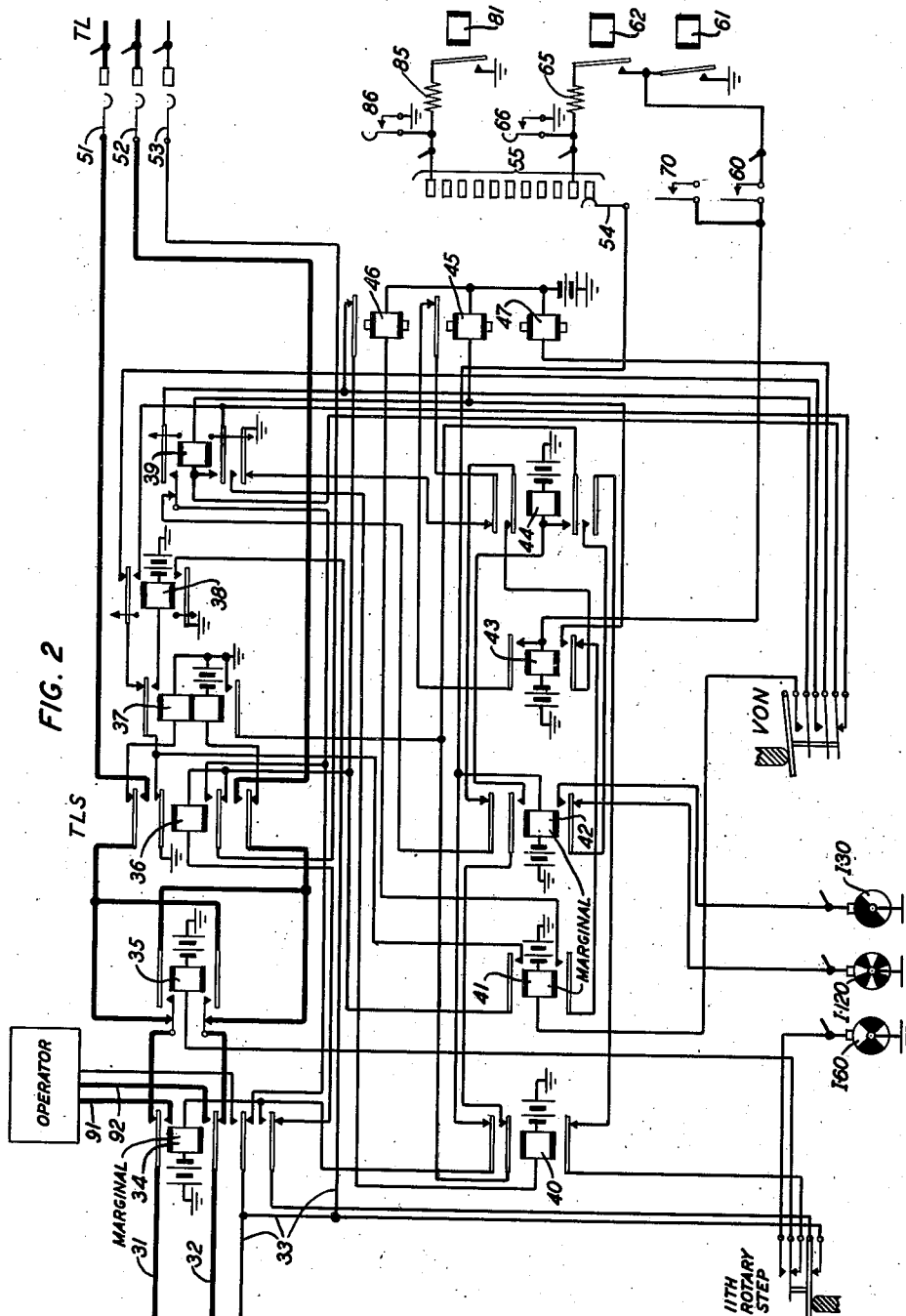
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4 Sheets-Sheet 2



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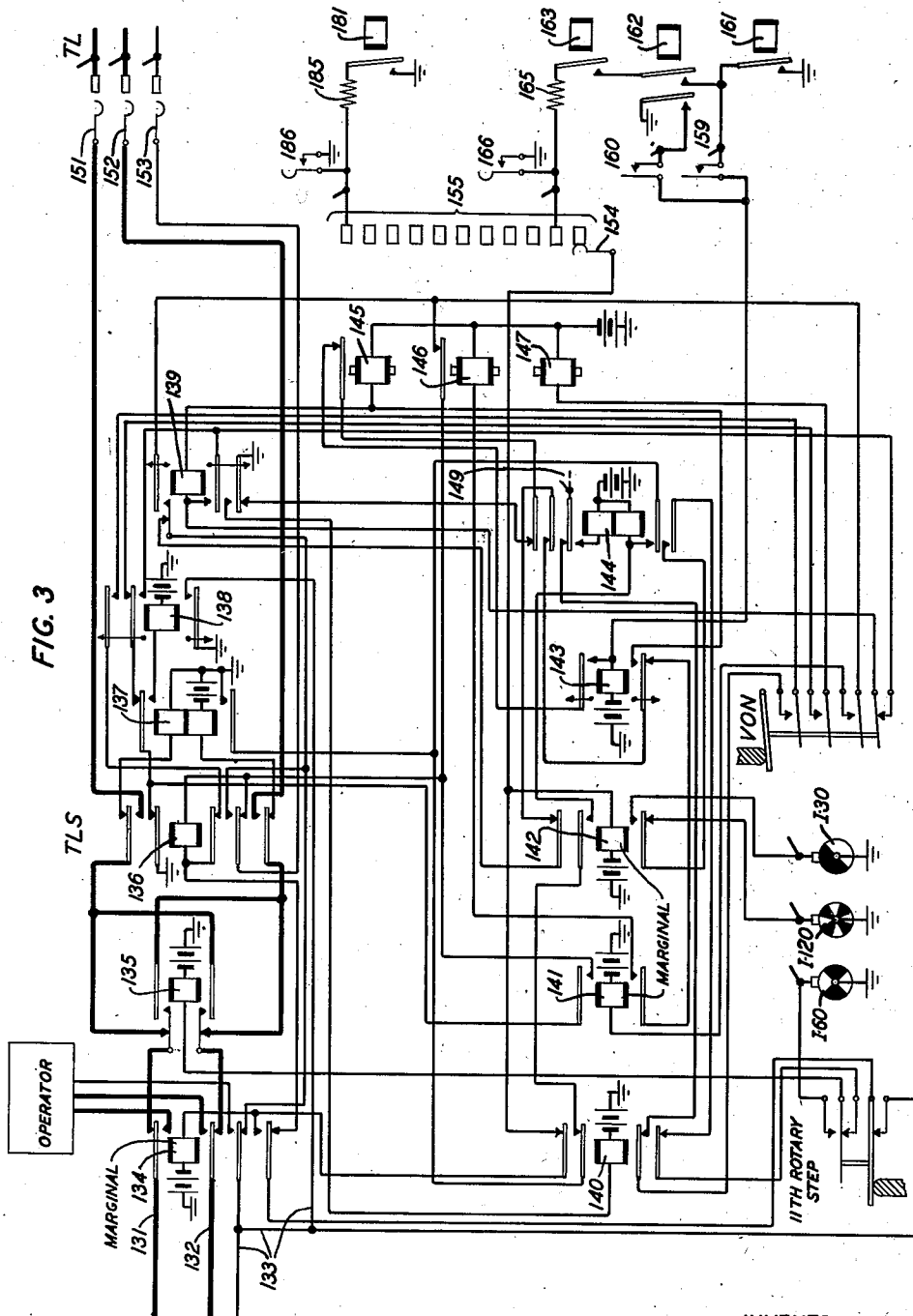
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4 Sheets-Sheet 3



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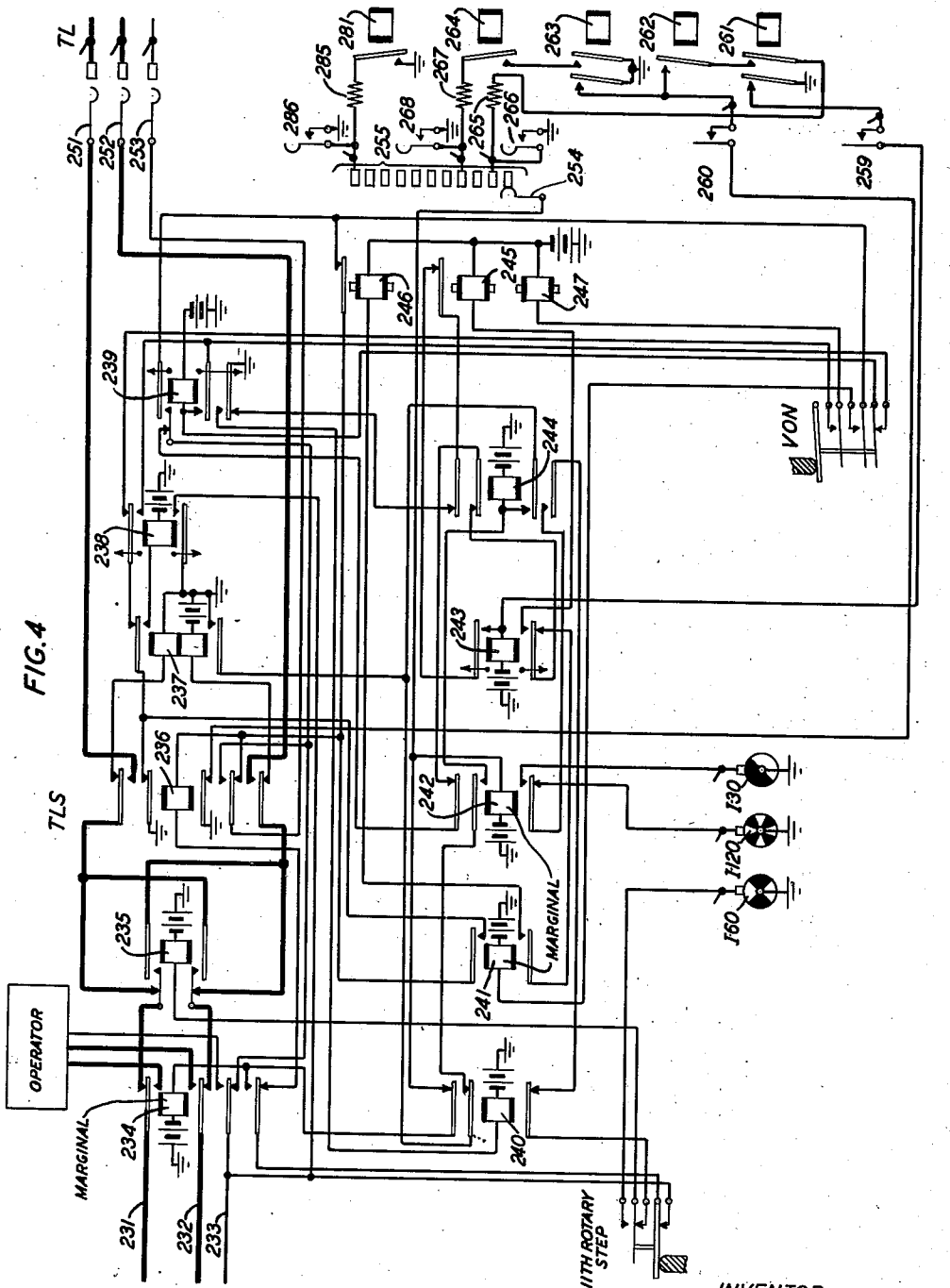
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,097,165

TELEPHONE SYSTEM

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Application August 4, 1936, Serial No. 94,168

33 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems in which automatic switching equipment is used for completing desired connections.

The invention has for its object the provision of improved switching means for selecting toll lines and for increasing the efficiency and adaptability of such equipment.

In systems employing automatic switches directly controlled to select a desired group of lines and automatically effective to hunt for an idle line in the group, it is known to hold the brushes of a selector switch opposite the selected group if all of the lines in the group are busy, to transmit an all-trunks-busy tone to the calling subscriber or operator, and when one or more of the lines in the group become idle to hunt for and seize an idle line. It is also known to provide selector switches in which two or more groups of terminals are combined and connected to the lines in a single line group and so arranged that hunting takes place only in a terminal group in which there is an idle line. According to this invention a selector switch, having the terminals of a plurality of terminal groups connected to the lines in a single group, is arranged to hunt for an idle line in a selected group only if there is an idle line in the group and then only in the first terminal group in which there is an idle line, to give an all-lines-busy signal to the calling station when the selector hunts in a terminal group and no idle line is found therein, to camp opposite the first group of terminals if all of the lines in the desired line group are busy, to give a camping signal to the calling station while the brushes are being held opposite a group and all lines in the group are busy, to give a different signal to the calling station when a line in the group becomes idle, and then in response to a starting signal from the calling station to hunt in the first terminal group in which there is an idle line.

According to another feature of the invention, a selector switch arranged to select an idle line in a desired group of toll lines is provided with switching means controlled by a key individual to the group to transfer a call to an operator who, on account of the heavy traffic over this group, is handling all calls thereover, the switching means becoming effective immediately upon selecting this group and irrespective of whether there is or is not an idle line in the group.

Another feature of the invention is a toll-line selector having a multi-level group comprising two grades of toll lines, terminal lines and via

lines, some of the via lines also being used for overflow from the terminal lines, the selector being arranged to camp on the terminal lines if all of the terminal and overflow via lines are busy, to camp on the via lines if all of the via lines are busy, to transmit a camping signal to the calling station, to change the signal when a line of the desired grade or one of the overflow lines becomes idle, and then in response to a starting signal from the calling station hunt for an idle line of the desired grade and if necessary for one of the overflow lines. A further feature is a group of such selectors each arranged to camp and then hunt for an idle line in response to a starting signal from the calling station, and arranged further to continue to give the calling operator the camping signal when camping on the terminal lines even though one of the overflow lines becomes idle if there is at that time another selector camping on the via lines, the signal transmitted from the last mentioned selector being changed to indicate to the calling operator that a line has become available.

These and other features of the invention will be more completely described by considering a telephone system in which the invention is embodied, one such system being illustrated schematically in the drawings which form a part of the specification. The invention is, however, not limited in its application to the system shown but is in general applicable to all systems employing automatic switches in which groups of terminals are combined to form one line group and to systems employing automatic switches for selecting toll lines.

Referring to the drawings:

Fig. 1 represents a toll office comprising an operator's position O and an outgoing trunk circuit OT and another toll office comprising the repeater R and incoming selector IS;

Fig. 2 represents a toll line selector;

Figs. 3 and 4 each represent toll line selectors which are alternative to the toll line selector of Fig. 2; and

Fig. 5 shows the terminals for a graded multiple group of toll lines in the bank of the toll line selector of Fig. 4.

The operator's position O, which is represented by a single cord and a dial may be similar to that shown in Figs. 1 and 2, and described in detail in Patent 1,859,929 granted to J. B. McKim May 24, 1932; and the trunk OT may be similar to that shown in Fig. 4 of the McKim patent. The incoming selector IS in the second and intermediate toll office may be of the well-known

two-motion step-by-step type and is represented in Fig. 1 by its brushes and a single set of terminals; for a description of the construction and operation of such a switch, reference may be had to pages 53 to 65 inclusive of the 2nd edition of "Automatic Telephony" by Smith and Campbell.

The toll-line selector TLS, in each of Figs. 2, 3 and 4, comprises a two-motion step-by-step switch with the associated relays and other control apparatus, the bank of the switch being represented in each of Figs. 2 and 3 by a single set of terminals and in Figs. 4 and 5 by a group of terminals. Each of these selector switches includes, in addition to the usual set of magnets and brushes, a vertical commutator and commutator brush. The reference characters for like elements in Figs. 2, 3 and 4 have the same tens and units digits. The three sources of ground impulses I-30, I-60 and I-120 are common to all of the toll line selectors. Source I-30 supplies 30 impulses per minute, the source I-60 supplies 60 impulses per minute, and the source I-120 supplies 120 impulses per minute.

Each of the groups of toll lines connected to the banks of the toll-line selectors TLS is assigned a route or group number which consists of one, two or more digits. If the incoming selector IS shown in Fig. 1 is omitted, the group numbers consist of a single digit; and if one or more additional selectors are included in the selecting train between the incoming selector IS and the toll line selector TLS, the numbers consist of more than two digits.

The toll line selector TSL of Fig. 2 is arranged for two groups of twenty lines each and six groups of ten lines each. The lines of one of the twenty line groups are connected to terminals in levels 1 and 2, there being two all-lines-busy relays for the group, relay 61 for the lines in level 1 and relay 62 for the lines in level 2. The lines of the other twenty line group may be connected to the terminals of any other two consecutive levels, an all-lines-busy relay being provided (but not shown) for each of the two levels. The lines of one of the ten line groups is represented by the tenth level, relay 81 being the all-lines-busy relay for this group. The level springs 60 are actuated when the brushes are on the first level, that is level one of the bank, of one twenty line group; and the level springs 70 are actuated when the brushes are on the first level, whatever level of the bank it may be, of the other twenty line group. The group keys 66 and 86 are provided for the first and last groups of lines respectively; a similar key (not shown) is provided for each of the other groups of lines. Each of the all-lines-busy relays is normally operated and is released only when all of the trunks or lines with which it is associated are busy. For a disclosure of such a group busy circuit arrangement reference may be had to Patent 1,688,617 granted to R. W. Engsborg October 23, 1928.

When an operator at position O in the one toll office wishes to establish connection with a toll line which terminates in the other of the offices represented in the drawings, which other office is reached over interoffice trunks, the plug of a cord is inserted in the jack of an outgoing trunk circuit OT and the desired toll-line group number is dialed. The dial impulses are repeated in the second toll office by the repeater R to operate the incoming selector IS and a toll line selector TLS to select the desired group of toll lines. If the group key associated with any group is operated when the group is selected, the call is diverted to

the request operator for completion in turn after all prior waiting calls to the same group have been completed. If the group key is not operated and there is an idle line in the group, the toll line selector hunts for and seizes an idle line. If the selected group of lines is a multi-level group, the selector hunts in the first level in which there is an idle line. If all of the lines in the selected group are busy and there are less than the maximum allowable number of selectors already camping on this group waiting for an idle line therein, the brushes are held opposite the selected level and a camping signal is transmitted to the calling operator. If the operator waits for an idle line, the signal is changed when a line becomes idle; and if the operator then dials the digit 1, the impulse thereby transmitted to the toll line selector is effective to start the hunting operation of the selector. If all of the lines in a selected group are busy and the maximum allowable number of other selectors are already camping on the group, waiting for a line, the selector proceeds to hunt in the first level of the group, the brushes are advanced to the eleventh rotary position, and an all-lines-busy signal is transmitted to the operator.

The establishment of a connection by the toll operator through the toll-line selector TLS of Fig. 2 will now be described in detail. When the operator at position O inserts the plug of a cord in the jack connected to trunk OT, the position dial is connected to the conductors of trunk T as described in detail in the aforementioned McKim patent, thus completing a circuit over conductors 11 and 12, through outer back contacts of relay 17 of repeater R in the intermediate toll office for operating the line relay 13 of this repeater. Relay 13 closes a circuit for operating the slow-to-release relay 14. Relay 14 connects ground potential to sleeve conductor 23 and closes a circuit through the biasing winding of relay 16. With both of relays 13 and 14 operated, a bridge is connected across the line conductors 21 and 22 of the associated incoming selector IS to cause the operation of the line relay (not shown) of this selector. The bridge is traced from conductor 21 through the outer front contact of relay 13, right winding of impedance coil 18, middle back contact of relay 17, lower winding of relay 16, back contact of relay 15, and through the middle lower front contact of relay 14 to conductor 22. The current through the lower winding of relay 16 is at this time in the non-operating direction. When the toll operator at position O dials each digit of the number of the desired toll group, relay 13 releases and reoperates in response to each dial impulse, thereby repeating the impulses over conductors 21 and 22. Being slow in releasing, relay 14 remains operated during dialing. The release of relay 13 in response to the first impulse of each digit closes a circuit for operating relay 15; and since relay 15 is slow in releasing, the intermittent closure of this circuit by relay 13 in response to each succeeding impulse of a digit is effective to hold relay 15 operated until all of the impulses in the train have been received. At its front contact, relay 15 short-circuits the impedance coil 18 and lower winding of relay 16, thereby improving the transmission of impulses over conductors 21 and 22.

The train of impulses, created by the dialing of the first digit of the toll group number and transmitted through repeater R over conductors 21 and 22, effects the operation of the incoming selector IS to select a group corresponding to

the digit dialed. The brushes are then automatically advanced to hunt for and seize an idle set of terminals in the selected group, which set of terminals is connected to a toll line selector TLS. When the repeater R is connected through the brushes of selector IS to a toll line selector TLS, a circuit is closed from battery through the lower winding of relay 37, lowermost back contact of relay 36, lower back contact of relay 35, inner lower back contact of relay 34, conductor 32, terminal and middle brush of selector IS, conductor 22, middle lower front contact of relay 14, back contact of relay 15, lower winding of relay 16, middle back contact of relay 17, right winding of impedance coil 18, outer front contact of relay 13, conductor 21, upper brush and terminal of selector IS, conductor 31, upper back contacts of relays 34 and 35, uppermost back contact of relay 36, and through the upper winding of relay 37 to ground. The operation of relay 37 closes a circuit for operating relay 38. At its lower front contact, relay 38 connects ground potential to the incoming sleeve conductor 33; but this is of no consequence since the ground potential at the lowermost contact of relay 14 of repeater R is connected through sleeve conductor 23 to hold the incoming selector IS and to protect the selector TLS against seizure by another incoming selector. Were the toll lines TL arranged to supply a sleeve ground for holding the connection, the repeater R could be omitted in which case the ground potential connected to sleeve conductor 33 by the lower front contact of relay 38 would be necessary to hold the incoming selector IS and guard the selector TLS against double seizure. When the operator dials the second digit of the toll route or group number, relay 37 is alternately released and re-operated as many times as there are units in the digit. Being slow in releasing, relay 38 remains operated during the response of relay 37 to dial impulses. The release of relay 37 in response to the first of the dial impulses closes a circuit from battery through the winding of the vertical stepping magnet 45, winding of relay 39, normally closed contact of the vertical off-normal springs VON, upper front contact of relay 38, and through the back contact of relay 37 to ground at the inner upper back contact of relay 36. Relay 39 and magnet 45 are operated by the current in this circuit. The operation of magnet 45 raises the brushes 51, 52, 53 and 54 one step. The VON springs are actuated as soon as the shaft moves out of normal position, the circuit through the winding of magnet 45 and relay 39 being maintained through the inner lower front contact of relay 39 after the lower contact of the VON springs is opened. The reoperation of relay 37 at the end of the first impulse causes the release of magnet 45, but relay 39 is slow in releasing and remains operated until all of the impulses in the train have been received by relay 37. At its lowermost front contact, relay 39 closes a circuit for operating relay 40 so as to prevent the operation of any one of relays 34, 35 or 44 during the advance of the brushes in response to dial impulses. Each succeeding release of relay 37 causes the reoperation of magnet 45, thereby stepping the brushes up to the level corresponding to the digit dialed.

Upon actuation of the VON springs, aforementioned, a circuit was closed, for operating relay 41, from battery through the winding of this relay, upper front contact of the VON springs, upper front contact of relay 39, middle lower

back contact of relay 34 to ground on sleeve conductor 33. When relay 39 releases, relay 41 is held operated in a circuit through the upper front contact of the VON springs, back contact of the rotary stepping magnet 46, upper front contact of relay 41 to ground at the inner upper back contact of relay 36. Assuming that the selected group comprises the terminals in only one level, that there is an idle line in the selected group, and that calls to this group of lines are not then being diverted to a request operator as hereinafter described, a circuit is closed, when relay 39 releases, from battery through the winding of magnet 46, lower front contact of relay 41, back contact of relay 43, inner back contact of relay 44, upper back contact of relay 42, upper back contact of relay 39, and middle lower back contact of relay 34, to ground on sleeve conductor 33. The operation of magnet 46 by the current in this circuit steps the brushes 51, 52 and 53 into engagement with the first set of terminals in the selected level. The operation of magnet 46 causes the release of relay 41 and the release of relay 41 causes the release of magnet 46. If this set of terminals is connected to an idle toll line, the sleeve terminal is not guarded by a ground potential and, upon the release of magnet 46, relay 36 is operated by the current in a circuit from battery through the winding of relay 41, upper front contact of the VON springs, back contact of magnet 46, winding of relay 36, lowermost back contact of relay 34, lower back contact of the "11th Rotary step" springs to ground on sleeve conductor 33. Relay 41, being marginal and in series with the winding of relay 36, does not operate. Relay 36 disconnects the windings of relay 37 from conductors 31 and 32 and extends these conductors through the brushes 51 and 52 to the toll line TL, thereby bridging the lower winding of relay 16 of repeater R across the toll line for response to any reversal of current thereover. The release of relay 37 causes the release of relay 38, relay 36 being thereafter held operated over sleeve conductors 33 and 23 to the ground at relay 14 of repeater R. If, and when, a reversal of current over line TL occurs, relay 16 of repeater R is operated and closes a circuit for operating relay 17. Relay 17 interchanges the connections between conductors 11 and 12 and the windings of relay 13, thereby reversing the current over trunk T to the operator's position. To release the connection, the operator removes the plug from the jack of trunk OT and relay 13 releases. The release of relay 13 causes the release of relay 14 and the release of relay 16, if operated. The release of relay 16 causes the release of relay 17; and the release of relay 14 disconnects the holding ground potential from sleeve conductor 23, thereby causing the release of the cut-through relay (not shown) of selector IS and the release of relay 36 of selector TLS. The selector IS is thereupon returned to normal in usual manner. At its inner upper back contact relay 36 closes the circuit for operating the release magnet 47 thereby restoring the brushes of switch TLS to normal in well known manner.

If the first set of terminals in a selected single-level group is busy, the ground potential encountered by brush 53 on the test terminal of the set is effective to prevent the operation of relay 36, since both ends of its winding are then connected to ground; and is also effective to cause the reoperation of the rotary stepping relay 41. Relay 41 again closes the circuit for operating the rotary

stepping magnet 46 and the brushes are thereby advanced to the next set of terminals. The operation of magnet 46 causes the release of relay 41 and the release of relay 41 again causes the release of magnet 46. The brushes are in this manner advanced, step-by-step; and when an unguarded set of terminals is encountered relay 36 operates as hereinbefore described. If all of the lines in the group become busy after rotary stepping has been started, the brushes are advanced to the 11th rotary position in which the "11th Rotary step" springs are actuated. At the lower contacts of these springs, the winding of relay 36 is disconnected from the ground potential on conductor 33; and, at the upper contacts, the winding of relay 35 is connected to the source of ground impulses I-60. Relay 35 is thereupon operated and released sixty times per minute to reverse the current over conductors 31 and 32 and thereby cause the alternate operation and release of relay 16 of repeated R. Relay 16 causes the alternate operation and release of relay 17; so that the current over conductors 11 and 12 to the operator's position O is reversed sixty times per minute as an all-lines-busy signal. When the operator disconnects from trunk OT, the switches are returned to normal as hereinbefore described, the release of relay 13 of repeater R being effective to cause the release of relay 37 of toll line selector TLS.

Had all of the lines in the desired group been busy when the brushes are raised to this level, the all-lines-busy relay associated with this group has been released and a circuit is closed through the winding of relay 42. Assuming the selected level to be the tenth level and all of the lines in this group to be busy, the all-lines-busy relay 81 has been released, and the aforementioned circuit through the winding of relay 42 is traced through commutator brush 54 and commutator segment for level 10, resistor 85, to ground at the back contact of relay 81. As soon as relays 39 and 40 release, the winding of relay 34 is connected through the uppermost back contact of relay 40 in parallel with the winding of relay 42; but relay 34 is marginal and the current is limited by resistor 85 to an amount insufficient to cause the operation of relay 34. The number of selectors which are allowed to camp on a group of toll lines is limited by resistor 85 to any desired number, the drop in potential through this resistor being increased by each additional selector which selects and camps on the group. If then this maximum allowable number of selectors is already camping on the group, at the time it is selected by a selector TLS, the current through the winding of relay 42 will be insufficient to cause its operation. Although the current through the corresponding relays of the selectors already camping on the group is reduced by the parallel connection of relay 42 of the selector in question, these relays remain operated and these selectors continue to camp on the group. Assuming that less than the maximum allowable number of selectors are already camping on the group, relay 42 is operated. Relay 42 closes at its upper front contact a circuit, through the inner upper back contact of relay 49 and lower front contact of relay 37, for operating relay 44. Relay 44 locks through its inner lower front contact directly to the ground at relay 37. Relay 41 operated as hereinbefore described, remains operated; but the circuit for operating the rotary stepping magnet 46 is opened at the inner back contact of relay 44. A connection is closed by

relay 44 from the source of ground impulses I-30, through the lower front contact of relay 42, lowermost front contact of relay 44, lower back contact of relay 40, upper back contact of the "11th Rotary step" springs to the winding of relay 35. Relay 35 is then operated thirty times per minute to transmit a signal to the calling operator to indicate that all of the lines in the group are busy and that the toll line selector is camping opposite the desired group waiting for a line to become idle. When a line in the group does become idle, the all-lines-busy relay 81 re-operates, thereby causing the release of relay 42. Relay 42 transfers the winding of relay 35 from impulse source I-30 to impulse source I-120 thereby changing the signal transmitted to the calling operator to indicate that a line has become idle. If the dial at position O is then operated to transmit an additional impulse to relay 13 of repeater R, which impulse is repeated by this relay over conductors 21 and 22, relay 37 of the toll line selector is released and reoperated. The release of relay 37 causes the release of relay 44 thereby closing the circuit for operating the rotary stepping magnet 46. The brushes are advanced by the operation of magnet 46 into engagement with the first set of terminals in the level and hunting continues if necessary until the idle line is found.

Had the maximum allowable number of other toll line selectors been camping on the group connected to level 10 when the brushes of the selector whose operation is being described, are raised to level 10, the winding of relay 42 would be in parallel with the windings of the corresponding relays in the selectors already camping; and therefore the current through relay 42 is limited by resistor 85 sufficiently to prevent operation of this marginal relay. Relay 42 not being operated, relay 44 remains normal and hunting for an idle line occurs as hereinbefore described. There being no line idle in the group the "11th Rotary step" springs are actuated and the all-lines-busy signal is transmitted to the calling operator by the operation of relay 35 sixty times per minute under control of impulse source I-60 as hereinbefore described.

Assume now that the desired toll-line group is the 20 line group connected to levels 1 and 2. When the brushes are stepped up to level 1 in response to the dialing of the second digit of the group number, the level springs 60 are actuated. If all of the lines connected to terminals in level 1 are busy, relay 61 will have been released and a circuit is closed from ground through its back contact and level springs 60 for operating relay 43. If at this time there is an idle line in level 2 of the group, relay 62 will not have released and relays 42 and 44 are not operated. Relay 43 locks through its upper front contact, through the back contact of the vertical stepping magnet 45 and uppermost back contact of relay 44 to ground at the lower back contact of relay 39. Relay 43 closes a circuit for operating magnet 45; this circuit is traced from battery through magnet 45, lower front contact of relay 43, inner back contact of relay 44, upper back contacts of relays 42 and 39, and through the middle lower back contact of relay 34 to ground on sleeve conductor 33. The operation of magnet 45 raises the brushes up to level 2 and causes the release of relay 43. Relay 43, in turn, causes the release of magnet 45. The level springs 60 having been restored to normal when the brushes are moved up to level 2, relay 43 cannot reoperate. The

rotary stepping magnet 46 is then operated as hereinbefore described to advance the brushes into engagement with the first set of terminals in level 2; and, if necessary, hunting is continued until an idle line is found, at which time relay 36 operates as hereinbefore described to extend the connection to the selected toll line. In case there is an idle line in a level when the brushes are raised to this level and advanced to hunt for an idle line, but when reached each line in the level is found busy, the brushes are then advanced to the eleventh rotary position to cause the all-lines-busy signal to be transmitted to the calling operator as hereinbefore described. Had all of the lines in the entire group been busy when the brushes were raised to level 1, both of the relays 61 and 62 have been released; and a circuit is, in this case, completed through resistor 65 and commutator brush 54 for operating relay 42. Relays 42, 44 and 35 function as hereinbefore described to transmit a 30 impulse per minute camping signal to the calling operator; when a line becomes idle, the signal is changed to a 120 impulse per second; and, if the operator then dials the digit 1, relay 37 is released and reoperated to condition the selector for hunting. In case the maximum allowable number of selectors are already camping on this group when the selector brushes are raised to the first level of the group, marginal relay 42, of the selector whose operation is being described, does not operate due to the increased drop in potential through resistor 65. In this case relay 43 operates, the brushes are raised to the second level and advanced to the eleventh rotary position, and the all-lines-busy signal is transmitted to the calling operator as hereinbefore described.

If the traffic over any group of trunks to which the selector TLS has access is so heavy that calls thereover are being handled by a special operator, known as a "Request" operator, the group key associated with this group of trunks will have been operated to prevent selection of a line in the group, even if one happens temporarily to be idle, and the call is diverted to the "Request" operator. For instance, if the key 66 associated with the first 20 line group is operated and the selector brushes are raised to level 1 to select this group, ground potential is connected through the contacts of key 66, commutator segment on level 1 and commutator brush 54 to cause the operation of both of marginal relays 42 and 34. The operation of relay 34 transfers incoming conductors 31 and 32 from the line relay 37 to conductors 91 and 92 leading to the special operator. The switch is thereupon restored to normal but relay 34 is held operated through its lowermost front contact to the holding ground on conductor 33. When the calling operator releases the connection, the release of relay 14 of repeater R causes the release of relay 34.

Consider now the operation of the toll line selector TLS shown in Fig. 3 which is like that of Fig. 1 except that it is arranged to reduce the liability of two or more selectors racing for an idle line after camping. It is arranged for seven groups of ten lines each and one group of thirty lines, the thirty line group being connected to the terminals in levels 1, 2 and 3 of the bank. There are three all-lines-busy relays for the thirty-line group; relay 161 for level 1, relay 162 for level 2, and relay 163 for level 3. There are two sets of level springs, springs 159 being actuated when the brushes are raised to level 1 and springs 160

being actuated when the brushes are raised to level 2. Group keys are provided, one for each group of lines; only two of these keys are shown, key 166 for the 30 line group and key 186 for the 10 line group connected to level 10. Upon seizure of this toll line selector by an incoming selector IS, the line relay 137 is operated in turn causing the operation of relay 138. Relay 137 responds to the dial impulses corresponding to the second digit of the toll line group number dialed by the calling operator, the brushes 151, 152, 153 and 154 being thereby raised to the corresponding level. The succeeding operations of this selector are the same as that of the selector of Fig. 1 with the following described exceptions. When the thirty-line group is selected, level springs 159 are closed on level 1. If all of the lines on level 1 are engaged, as indicated by relay 161 having been released, but there is at that time an idle line in the group, relay 143 is operated through the contacts of level springs 159 to ground at the back contact of relay 161. Relay 143 causes operation of vertical stepping magnet 145 to raise the brushes to level 2. Level springs 159 are restored to normal when the brushes are raised out of level 1 and level springs 160 are closed when the brushes reach level 2. If there is at this time an idle line in level 2, hunting takes place on this level; but if all of the lines in level 2 are busy and there is an idle line in level 3, relay 143 is reoperated through the contacts of springs 160 to ground at the outer back contact of relay 162. The vertical stepping magnet 145 is thus again reoperated to raise the brushes to level 3 and hunting thereupon takes place in this level. In case all of the lines in a level become busy after hunting in that level is started, the brushes are advanced to the eleventh rotary position and a 60 impulse per minute signal transmitted to the calling operator. If all of the lines are busy when the 30 line group is selected, and less than the allowable number of selectors are camping thereon, all of the relays 161, 162 and 163 will have been released and relay 142 is operated in a circuit through commutator brush 154 and resistor 165 and the back contacts of each of the relays. Relay 142 closes a circuit through the lower winding of relay 144, upper front contact of relay 142, inner upper back contact of relay 140 to ground at the lower front contact of relay 137. Relay 144 operates and at its inner lower front contact closes a locking circuit to ground at the front contact of relay 137. At its inner upper front contact relay 144 connects its upper winding to conductor 149 which is common to all of the selectors having access to the same groups of toll lines. With relays 142 and 144 both operated, the 30 impulse per minute camping signal is transmitted to the calling operator by the operation of relay 135 under control of impulse source I-30. When a line in the group becomes idle, the circuit through the back contacts of relays 161, 162 and 163 is opened by the reoperation of one of these relays thereby causing the release of relay 142; and the signal to the operator is changed to a 120 impulse per minute line idle signal under control of impulse source I-120. The line idle signal is at the same time also transmitted to the calling operator from any other selector camping on this same group of lines. If the operator, connected to the selector whose operation is being described, dials the digit 1 relay 137 is released and reoperated. The release of relay 137 opens the holding circuit through the lower winding of relay 144 to cause

the release of this relay unless there is, when relay 137 releases another selector in the group ready to hunt for the idle line; in which case relay 144 is held operated through its upper winding and upper front contact over conductor 149, through the inner upper back contact of the relay of the other selector which corresponds to relay 144, the inner lower back contact of the relay corresponding to relay 140, the uppermost front contact of the VON springs of the other selector, the uppermost front contact of the relay corresponding to relay 138, the inner lower back contact of the relay corresponding to relay 136, the lowermost back contact of the relay corresponding to relay 134, the lower back contact of the "11th rotary step" springs of the other selector, to ground potential on the sleeve conductor of the other selector. This arrangement prevents two waiting selectors from starting to hunt at the same time. If there is no other selector in the group ready to hunt for the idle line, the release of relay 137 causes the release of relay 144 and the selector is thereby rendered effective to hunt for the idle line in the manner hereinbefore described.

Consider now the toll line selector TLS of Fig. 4 which is like that of Fig. 2 except that it is arranged for seven groups of ten toll lines each, all of the lines in each of these groups being alike, and one group of twenty-five toll lines connected to the terminals in levels 1, 2 and 3. Fifteen of these lines are of the grade known as "terminal" lines, and ten are of the grade known as "via" lines. Two group numbers are assigned, the one having the digit 1 as its second digit and the other having the digit 3 as its second digit. As shown in Fig. 5 the terminal lines are connected to the ten sets of terminals in level 1 and to the first five sets of terminals in level 2; five of the via lines are connected to the first five sets of terminals in level 3 and the other five are connected to the last five sets of terminals in both of levels 2 and 3. Thus the two kinds of toll lines may be said to be divided into four subgroups, the first subgroup consisting of the ten terminal lines connected to level 1, the second subgroup consisting of the other five terminal lines, the third subgroup consisting of the first five via lines, and the fourth subgroup consisting of the five via lines which are multiplied to levels 2 and 3. There is an all-lines-busy relay for each of these subgroups; relay 261 for the terminal lines connected to level 1, relay 262 for the terminal lines connected to level 2, relay 263 for the five via lines connected to the first five sets of terminals in level 3, and relay 264 for the five via lines which constitute the common overflow subgroup and which are connected to the last five sets of terminals in both of levels 2 and 3. The level springs 259 are actuated when the brushes are on the first level and the level springs 260 are actuated on the third level. There are separate group keys for the terminal lines and via lines, key 266 being associated with the first level commutator segment and key 268 with the third level commutator segment. There are group keys for the other seven groups of lines; of these only key 286 for the group connected to level 10 is shown.

A similar group of lines might consist of five terminal lines connected to the first five terminals in a level and ten via lines connected to the terminals of the next level, the last five sets of terminals in the second level being multiplied to the last five sets of terminals in the first level.

When the selector of Fig. 4 is seized by an incoming selector IS, relay 237 is operated. Relay 237 closes a circuit for operating relay 238. When the second digit of the number of the desired toll line group is dialed by the calling operator, relay 237 is alternately released and reoperated in response to each impulse. The selector is thus directly operated to select the desired group and to automatically hunt for an idle line in the group in the same manner as does the selector of Fig. 2. If the number assigned to the terminal lines of the thirty-line group is dialed, the brushes are raised to the first level of the group. If, at that time, there is an idle line in this level, the selector hunts therein. If, however, all of the lines in the first level are busy, but there is either an idle terminal line on the second level or an idle via line in the overflow subgroup, then relay 243 is operated through level springs 259 and the back contact of relay 261, but the circuit for operating relay 242 is open at the contact of relay 262 or relay 263. Relay 243 locks through its upper front contact and the back contact of vertical stepping magnet 245 and closes the circuit for operating magnet 245 to step the brushes up to the second level. The circuit through the winding of relay 243 is opened when magnet 245 operates but relay 243 is slow in releasing to delay the closing of the circuit for operating the rotary stepping magnet 246. When this circuit is closed, the magnet 246 operates, advancing the brushes to the first set of terminals in level 2. If necessary, the advance is continued until an idle terminal line is found; and if none of these lines are found idle, the advance is continued to select an idle via line in the last five sets of terminals in this level. Should all of the terminals be found busy, the brushes are advanced to the eleventh rotary position and the 60 impulse per minute all-lines-busy signal is transmitted to the operator. If when the brushes select level 1, all of the terminal lines and all of the via lines which are in the overflow subgroup are busy, and less than the maximum allowable number of selectors are camping thereon, relay 242 is operated through commutator brush 254, resistor 265, and the back contacts of relays 261, 262 and 263. Relay 242 closes at its upper front contact a circuit for operating relay 244. Relay 244 locks through its inner lower front contact and at its inner upper back contact holds open the circuit for operating the rotary stepping magnet 246. The 30 impulse per minute camping signal is transmitted to the operator. When an idle terminal line or an idle via line in the overflow subgroup becomes idle, one of relays 261, 262 and 263 releases, thus causing the release of relay 242 and the 120 impulse per minute line-idle signal is then transmitted to the operator. If the operator now dials the digit 1, the release of relay 237 causes the release of relay 244, thus enabling the hunting operation of the selector.

If the number dialed by the operator is that of the via line subgroup, the brushes of the selector are raised to the third level of the bank, the selector hunts in this level if any of the lines therein are idle. If none of the lines in this level are idle, and less than the maximum allowable number of selectors are camping thereon, relay 242 is operated through resistor 267 and the back contacts of relays 264 and 263. The camping signal is transmitted and, when a line in level 3 becomes idle, the line-idle signal is transmitted.

Dialing of the digit 1 renders the selector effective to hunt for an idle line.

If one of these selectors is camping on the first level of the terminal lines and at the same time another selector of the group is camping on the level of the via lines, and the first line to become idle is a via line in the overflow subgroup, the release of the all-lines-busy relay 263 of the overflow subgroup opens the circuit through the brush 254 of the selector camping on the level of the via lines to release relay 242 of that selector and initiate trunk-hunting; but relay 242 of the selector which is camping on the first level of the terminal lines will be held operated in a circuit traced through commutator brush 254 and first level segment, resistor 265, back contacts of all-lines-busy relays 261 and 262, through the third level springs 260 of the selector which has been camping on the third level to ground at the inner lower back contact of relay 235 of this selector. By such an arrangement calls camping on the via lines are given preference over calls camping at the same time on terminal lines, in case the first line to become idle is in the overflow subgroup.

What is claimed is:

1. In a telephone system, a calling station, a two-motion selector switch, a group of lines connected to the terminals in a plurality of levels of the bank of said switch, means under the control of said station for advancing the brushes of the switch to select a level of said multi-level group, relay means effective if all of the lines in said selected level are busy for moving the brushes to a level of the group in which one or more lines are idle, electromagnetic means for advancing the brushes in any level to hunt for an idle line, electromagnetic means effective if all of the lines in the group are busy for holding the brushes of the switch opposite the first selected level, means for transmitting a distinctive signal to the calling station while the brushes are standing opposite a selected level and all of the lines in the group are busy, and means for changing the character of the signal when one of the lines in the desired group becomes idle.

2. In a telephone system, a calling station, a two-motion selector switch, groups of lines connected to the terminal bank of said switch, one or more of said groups being connected to the terminals of a plurality of levels, means under the control of said station for advancing the brushes of the switch to select any desired one of said groups, electromagnetic means for advancing the brushes in any level to hunt for an idle line, electromagnetic means effective if all of the lines in the selected group are busy for holding the brushes opposite the selected group, means for transmitting a distinctive signal to the calling station while the brushes are standing opposite a selected group and all of the lines in the group are busy, and means for changing the character of the signal when one of the lines in the group becomes idle.

3. In a telephone system according to claim 2, means under the control of said station and rendered operative when one of the lines in the group opposite which the brushes are being held becomes idle for starting the operation of the switch to hunt for an idle line.

4. In a telephone system, a calling station, a two-motion selector switch, groups of lines connected to the terminal bank of said switch, one or more of said groups being connected to the terminals of a plurality of levels, means under

the control of said station for advancing the brushes of the switch to select any desired one of said groups, electromagnetic means to advance the brushes in any level to hunt for an idle line, means for transmitting a distinctive signal to said calling station when the brushes have hunted over all of the terminals in a level without finding an idle line, electromagnetic means effective if all of the lines in the selected group are busy for holding the brushes opposite the selected group, and means for transmitting a different distinctive signal to the calling station while the brushes are standing opposite a selected group and all of the lines in this group are busy.

5. In a telephone system, a calling station, selectors each comprising a two-motion switch, groups of lines multiplied to the terminal banks of said switches, one or more of said groups being connected to the terminals of a plurality of levels in said banks, means comprising an impulse sender at the calling station for advancing the brushes of any one of said selectors to select any desired group, electromagnetic means for each switch for advancing the brushes in any level to hunt for an idle line, means for each switch effective if all of the lines in a selected group are busy to hold the brushes opposite the selected group, and means comprising resistors, one for each of said groups of lines, for preventing the holding of the brushes of more than a predetermined number of said selectors opposite the same group.

6. In a telephone system, a toll operator's position, a selector comprising a two-motion switch, groups of toll lines connected to the terminal bank of said switch, one or more of said groups being connected to the terminals of a plurality of levels in said bank, means comprising an impulse sender at said position for advancing the brushes of said switch to select any desired group, electromagnetic means for advancing the brushes in any level to hunt for an idle line, electromagnetic means effective if all of the lines in the selected group are busy to hold the brushes opposite the selected group, means for transmitting a distinctive signal to said position while the brushes are standing opposite a selected group and all of the lines in the group are busy, and means for changing the character of the signal when a line in said group becomes idle.

7. In a telephone system, a toll operator's position, a selector comprising a two-motion switch, groups of toll lines connected to the terminal bank of said switch, one or more of said groups being connected to the terminals of a plurality of levels in said bank, means comprising an impulse sender at said position for advancing the brushes of said switch to select any desired group, electromagnetic means for advancing the brushes at any level to hunt for an idle line, means for transmitting an all-lines-busy signal to the calling station if the selector hunts in a selected level and no idle line is found, electromagnetic means effective if all of the lines in the selected group are busy to hold the brushes opposite the selected group, and means for transmitting a distinctive signal to said position while the brushes are standing opposite a group and all of the lines in the group are busy.

8. In a telephone system according to claim 6, means controlled by said station and rendered operative when a line becomes idle in the group opposite which the brushes are being held for starting the hunting operation of the switch.

9. In a telephone system, a toll operator's position, a two-motion selector switch, groups of toll lines connected to the terminal bank of said switch, one or more of said groups being connected to the terminals of a plurality of levels in said bank, means comprising an impulse sender at said position for advancing the brushes of said switch to select the first level of any group, means effective if all of the lines in the selected level of a multi-level group are busy and there is an idle line in the group to step the brushes up to the first level in which there is an idle line, electromagnetic means for advancing the brushes in any level to hunt for an idle line, means effective if all of the lines in a selected group are busy for holding the brushes opposite the first level of the group, means for transmitting a distinctive signal to said position while the brushes are standing opposite a selected level and all of the lines in the group are busy, and means for changing the character of the signal being transmitted to said position when one of the lines in the group, opposite the level of which the brushes are being held, becomes idle.

10. In a telephone system according to claim 9, means controlled by said sender and rendered operative when one of the lines in the group, opposite a level of which the brushes are being held, becomes idle for starting the hunting operation of the switch in the first level in which there is an idle line.

11. In a telephone system, a calling station, a two-motion selector switch, groups of lines connected to the terminal bank of said switch, one or more of said groups being connected to the terminals of a plurality of levels, means under the control of said station for advancing the brushes of the switch to select any desired one of said groups, electromagnetic means for advancing the brushes in any level to hunt for an idle line, and electromagnetic means effective if all of the lines in the selected group are busy for holding the brushes opposite the selected group, other like selector switches, and means effective if the brushes of more than a predetermined number of said other switches are already being held opposite a group selected by said switch for preventing said brushes from being held opposite the group.

12. In a telephone system, a calling station, a two-motion selector switch, groups of lines connected to the terminal bank of said switch, one or more of said groups being connected to the terminals of a plurality of levels, means under the control of said station for advancing the brushes of the switch to select any desired one of said groups, electromagnetic means for advancing the brushes in any level to hunt for an idle line, electromagnetic means effective if all of the lines in the selected group are busy for holding the brushes opposite the selected group, means for transmitting a distinctive signal to said station while the brushes are being held opposite a selected group of trunks and all of the lines in this group are busy, other like selector switches, and means effective if the brushes of more than a predetermined number of said other switches are already being held opposite a group selected by said switch for preventing the brushes of said switch from being so held.

13. In a telephone system, a calling station, a two-motion selector switch, groups of lines connected to the terminal bank of said switch, one or more of said groups being connected to the terminals of a plurality of levels, means under the

control of said station for advancing the brushes of the switch to select the first level of any group, electromagnetic means for advancing the brushes in any level to hunt for an idle line, electromagnetic means effective if all of the lines in the selected group are busy for holding the brushes opposite the selected level, other like selector switches, and means effective if the brushes of more than a predetermined number of said other switches are already being held opposite a group selected by said switch for preventing the brushes of said switch from being so held.

14. In a telephone system, a calling station, a two-motion selector switch, groups of lines connected to the terminal bank of said selector, means under the control of said station for advancing the brushes of the selector to the terminals of any desired group, means for automatically selecting an idle line in a selected group, keys, one for each of said groups, and means rendered effective upon selection of a group and including the key individual to said group for preventing the selection of a line in that group.

15. In a telephone system, a calling station, a two-motion selector switch, groups of lines connected to the terminal bank of said selector, means under the control of said station for advancing the brushes of the selector to any desired group, means for automatically selecting an idle line in a selected group, keys, one for each of said groups of lines, an operator's position, and means rendered effective upon selection of a group and including the key individual to said group for diverting the call to said operator's position.

16. In a telephone system, a calling station, a two-motion selector switch, groups of lines connected to the terminal bank of said selector, one of said groups comprising lines preferred for use on certain calls and lines preferred for use on other calls and overflow lines for use on a call if all of the lines preferred for such a call are busy, the lines preferred for said certain calls being connected to first choice terminals in one level of said bank, the lines preferred for said other calls being connected to first choice terminals in another level and the overflow lines being multipled to the remaining terminals of both of said levels, means controlled by said station for advancing the brushes of the selector to any desired level, and means for operating the selector to hunt for an idle set of terminals in the selected level.

17. In a telephone system, a calling station, a selector comprising a two-motion switch, groups of lines connected to the terminal bank of said selector, one of said line groups comprising lines of two classes, the lines of a first class being connected to a first choice group of terminals of one level, some of the lines of the second class being connected to a first choice group of terminals of another level and the remaining lines of the second class being multipled to a second choice group of terminals in each of said levels, means controlled by said station for advancing the brushes of the selector to any desired level, means for automatically hunting for an idle line in a selected level, and means effective if all of the lines in a selected level are busy for holding the brushes of the selector opposite said level without hunting therein.

18. In a telephone system according to claim 17, means for transmitting a distinctive signal to the calling station while the brushes are being held opposite a selected level and all of the lines in said level are busy, and means for transmitting

a different signal to the calling station when one of the lines, in the level opposite which the brushes are being held, becomes idle.

19. In a telephone system according to claim 17, means for transmitting a distinctive signal to the calling station while the brushes are being held opposite a selected level and all of the lines in said level are busy, means for transmitting a different signal to the calling station when one of the lines, in the level opposite which the brushes are being held, becomes idle, and means controlled by said station and rendered operative when a line in the level, opposite which the brushes are being held, becomes idle for starting the hunting operation of said switch.

20. In a telephone system, a calling station, a selector comprising a two-motion switch, groups of lines connected to the terminal bank of said selector, one of said line groups comprising lines of two classes, the lines of a first class being connected to a first choice group of terminals of one level, some of the lines of the second class being connected to a first choice group of terminals of another level and the remaining lines of the second class being multiplied to a second choice group of terminals in each of said levels, means controlled by said station for advancing the brushes of the selector to any desired level, means for automatically hunting for an idle line in a selected level, means for transmitting to the calling station an all-lines-busy signal if the brushes are advanced in any level and no idle line is found therein, and means effective if all of the lines in a selected level are busy for holding the brushes of the selector opposite said level without hunting therein.

21. In a telephone system, a calling station, a selector comprising a two-motion switch, a group of toll lines comprising terminal lines and via lines, the terminals of one level of the bank of said switch being connected to via lines, the terminals in a first part of the preceding level being connected to terminal lines, and the remaining terminals of this preceding level being multiplied to the corresponding terminals of said one level, means comprising an impulse sender at the calling station for operating said selector to select the desired one of said levels, means for automatically hunting for an idle line therein, and means effective if all of the lines connected to the selected level are busy for holding the brushes of the selector opposite that level.

22. In a telephone system, a calling station, a selector comprising a two-motion switch, a group of lines comprising terminal lines connected to the terminals in the first part of a level of the bank of said switch, via lines connected to the first part of the next level, and via lines multiplied to the corresponding terminals of the remaining part of both levels, all-lines-busy relays, a first one for said terminal lines, a second one for the via lines connected to said first part of the next level, and a third one for the via lines multiplied to terminals in both levels, means comprising an impulse sender at said calling station for advancing the brushes to select the desired one of said levels, means for advancing the brushes automatically to hunt for an idle line in the selected level, and means including the all-lines-busy relay associated with the lines in the first part of the selected level and the all-lines-busy relay associated with the via lines multiplied to both of said levels for holding the brushes opposite the selected level without hunting therein when all of the lines therein are busy.

23. In a telephone system, a calling station, a selector comprising a two-motion switch, groups of toll lines connected to the terminal bank of said selector, one of said line groups comprising terminal lines connected to terminals in the first part of a level of the bank and via lines connected to the terminals of the next level of the bank, the terminals of the first level not connected to terminal lines being multiplied to the like positioned terminals of the next level, means comprising an impulse sender at the calling station for advancing the brushes of the switch to select the first level of any desired group of lines other than said one group or to the desired one of the two levels of said one group, means for advancing the brushes of the selector in any level to hunt for an idle line, means effective if all of the lines in a selected group other than said one group are busy for holding the brushes opposite the group, means effective if the level of said terminal lines is selected and all terminal lines and all of the via lines multiplied to terminals of that level are busy for holding the brushes opposite the selected level, means effective if the level of said via lines is selected and all via lines are busy for holding the brushes opposite the selected level, and means effective while the brushes are being held opposite the first level of any group and all of the lines in the group are busy or opposite either of the levels to which the terminal and via lines are connected and all the lines connected to the level opposite which the brushes are being held are busy for transmitting a distinctive signal to the calling station.

24. In a telephone system, a calling station, a selector comprising a two-motion switch, groups of toll lines connected to the terminal bank of said selector, one of said line groups comprising terminal lines connected to terminals in the first part of a level of the bank and via lines connected to the terminals of the next level of the bank, the terminals of the first level not connected to terminal lines being multiplied to the like positioned terminals of the next level, means comprising an impulse sender at the calling station for advancing the brushes of the switch to select the first level of any desired group of lines other than said one group or to the desired one of the two levels of said one group, means for advancing the brushes of the selector in any level to hunt for an idle line, means for transmitting to the calling station an all-lines-busy signal if the selector hunts in any level without finding an idle line therein, means effective if all of the lines in a selected group other than said one group are busy for holding the brushes opposite the group, means effective if the level of said terminal lines is selected and all terminal lines and all of the via lines multiplied to terminals of that level are busy for holding the brushes opposite the selected level, means effective if the level of said via lines is selected and all via lines are busy for holding the brushes opposite the selected level, and means effective while the brushes are being held opposite the first level of any group and all of the lines in the group are busy or opposite either of the levels to which the terminal and via lines are connected and all the lines connected to the level opposite which the brushes are being held are busy for transmitting a distinctive signal to the calling station.

25. In a telephone system according to claim 23, other like selectors, and means effective if the brushes of a predetermined number of said selectors are being held opposite a selected level

for preventing the brushes of another of said selectors from being held opposite this level.

26. In a telephone system according to claim 23, means for transmitting a different signal to the calling station when one of the lines over which the call may be completed becomes idle, means comprising said impulse sender for starting the hunting operation of said selector, other like selectors, and means effective, if the brushes of said selector are being held opposite the level of the via lines and the brushes of one of said other selectors are being held opposite the level of the terminal lines, and the line which becomes idle is one of the via lines which is multipled to terminals of both of said levels, to prevent the transmission of said different signal from said one of the other selectors.

27. In a telephone system, a toll operator's position, selectors each comprising a two-motion switch, groups of toll lines multipled to the terminal banks of said switches, one or more of said groups being connected to the terminals of a plurality of levels in said banks, means comprising an impulse sender at said position for advancing the brushes of one of said switches to select any desired group, means for advancing the brushes to hunt for an idle line in the selected group, electro-magnetic means for each switch effective if all of the lines in a selected group are busy to hold the brushes opposite the selected group, means in each selector for transmitting a distinctive signal to said position while the brushes are standing opposite a group and all of the lines in the group are busy, means comprising said impulse sender for starting the hunting operation if one of the lines in the group opposite which the brushes of a selector are being held becomes idle, and means effective when the hunting operation of one of two selectors, the brushes of which are being held opposite the same group of trunks, is started for preventing the hunting operation of the other of said two selectors from being started while said one selector is hunting.

28. In a telephone position, a toll operator's system, selectors each comprising a two-motion switch, groups of toll lines multipled to the terminal banks of said switches, one or more of said groups being connected to the terminals of a plurality of levels in said banks, means comprising an impulse sender at said position for advancing the brushes of one of said switches to select any desired group, means for advancing the brushes to hunt for an idle line in the selected group, electro-magnetic means for each switch effective if all of the lines in a selected group are busy to hold the brushes opposite the selected group, means in each selector for trans-

mitting a distinctive signal to said position while the brushes are standing opposite a group and all of the lines in the group are busy, and means in each selector for transmitting a different signal to said position if all of the lines in a selected group are busy and the brushes of a predetermined number of the other switches have previously been advanced to and are being held opposite this group.

29. In a telephone system, a toll operator's position, selectors each comprising a two-motion switch, groups of toll lines multipled to the terminal banks of said switches, one or more of said groups being connected to the terminals of a plurality of levels in said banks, means comprising an impulse sender at said position for advancing the brushes of one of said switches to select any desired group, means for advancing the brushes to hunt for an idle line in the selected group, electro-magnetic means for each switch effective if all of the lines in a selected group are busy to hold the brushes opposite the selected group, and means for said one switch effective if all of the lines in a selected group are busy and the brushes of more than a predetermined number of the other selectors are already being held opposite the same group for advancing the brushes of said one switch to an overflow position.

30. In a telephone system according to claim 4, means for changing the character of the last-mentioned distinctive signal when one of the lines in said selected group becomes idle.

31. In a telephone system according to claim 4, means for changing the character of the last-mentioned distinctive signal when one of the lines in said selected group becomes idle, and means under the control of said station and rendered operative when one of the lines in a group opposite which the brushes are being held becomes idle for starting the operation of the switch to hunt for an idle line.

32. In a telephone system according to claim 7, means for transmitting a different signal to said position when a line in a group opposite which the brushes are being held becomes idle.

33. In a telephone system according to claim 7, means for transmitting a different signal to said position when a line in a group opposite which the brushes are being held becomes idle, and means controlled by the operator and rendered operative when one of the lines in the group opposite which the brushes are being held becomes idle for starting the hunting operation of the switch.

GRACE MACDONALD STOKELY,
Executrix of the Estate of Ray L. Stokely,
Deceased.