June 20, 1933. R. G. RICHARDSON ET AL 1,914,384

TELEPHONE SYSTEM

Filed Nov. 9, 1931

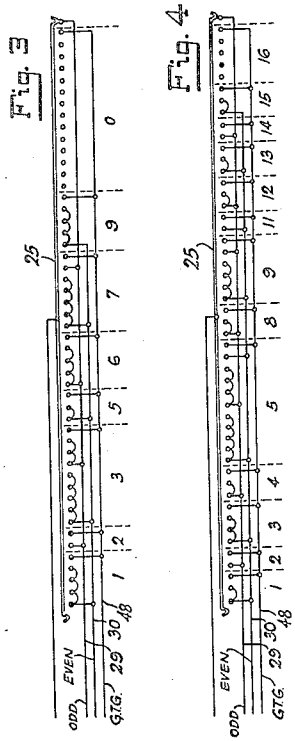

Fig. 3

Fig. 4

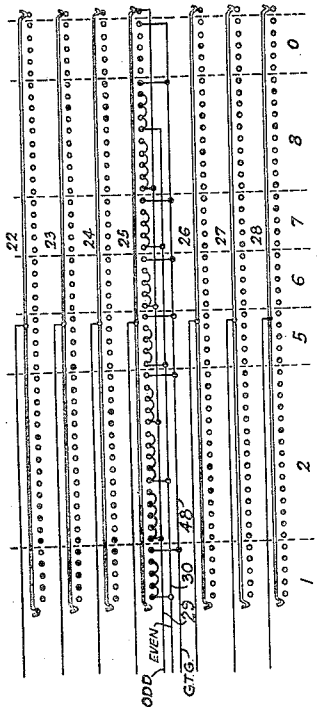

Fig. 2

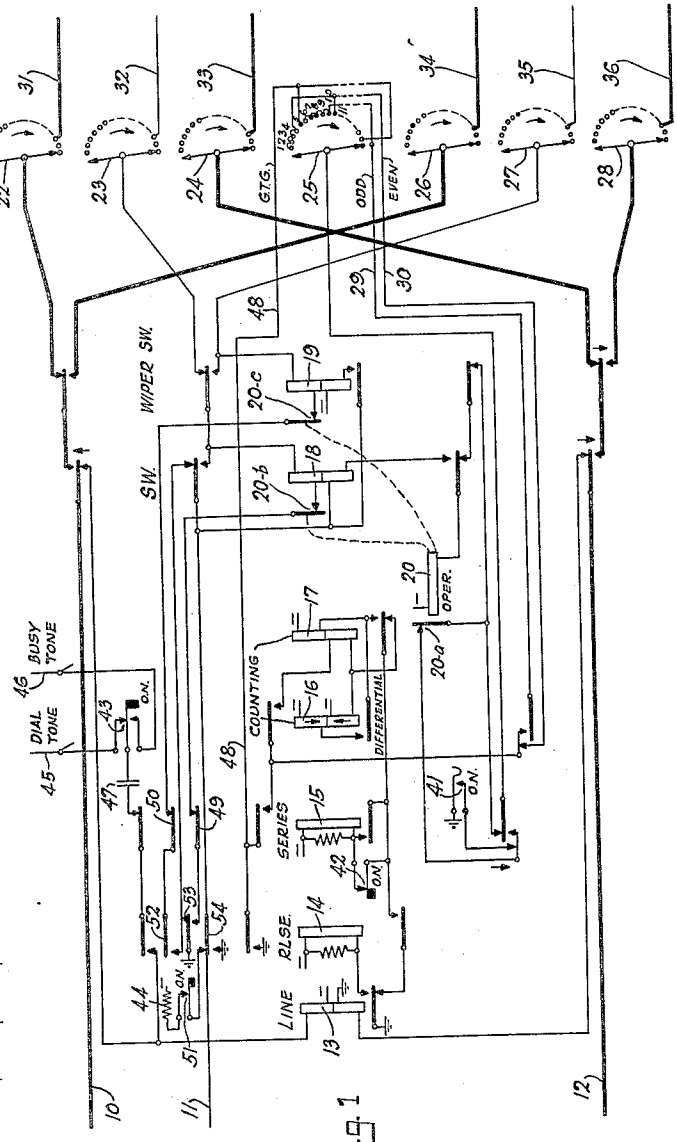

Fig. 1

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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed November 9, 1931. Serial No. 573,760.

The present invention relates to telephone systems in general, being concerned more particularly with automatic telephone systems; and the main object is the production of a new and improved trunking selector switch for use in an automatic telephone system in which the switches which respond to the controlling impulses to set up the telephone connections have only a simple rotary movement, and are positioned in accordance with the received impulses and restored to normal position by the same operating magnet.

The present invention may be considered to be an improvement on the invention disclosed in the application of Wicks et al., Serial No. 519,310, filed March 2, 1931; the improvement consisting generally in the provision of such additional circuit arrangements as are found to be desirable or necessary in actual operation, and in the provision of circuit arrangements for providing for unhampered flexibility in utilizing all the contact sets in forming any desired number of contact groups (each contact group corresponding to a different trunk group) and in apportioning the available contact sets in any desired manner amongst the various contact groups.

General Description

It may be pointed out that the system disclosed in the above-mentioned application of Wicks et al. employs rotary switch mechanisms which are described as having fifty-one sets of bank contacts, one set being used as a normal-position set. By using two sets of wipers and a suitably controlled wiper-switching relay, each of the fifty sets of contacts is sub-divided into two smaller sets, thereby giving one hundred separate contact sets, which are suitably arranged in ten groups of ten contact sets in a group, thereby following the practice which has been found to be most satisfactory in connection with the vertical-and-rotary Strowger-type automatic switches.

In multi-office telephone systems, the various groups of trunks often vary greatly in size amongst themselves. Although by using suitable grading, a trunk group can be formed which is in effect a unitary group but contains many more trunks than there are contact sets allotted to the group in the bank of any one selector, as is well understood; it is desirable, nevertheless, from the standpoint of securing the greatest possible efficiency in each individual installation, to be able to increase and decrease the number of contact sets allotted to a contact group to an extent dictated by the relative size and costs-per-trunk of the trunk groups concerned. To this end, the circuit arrangements have been modified in order to enable the size of a contact group in the bank of a selector to be expanded or contracted at will.

A feature of the invention is that the wipers of the newly developed selector are advanced over the contacts of a large group in successive stages, the selector receiving as many impulses as may be necessary to allow time for the advance over a large group to take place. Since the selector uses two sets of wipers, each step of the wipers advances them over two trunk lines; and since the selector is designed so that it will take five steps reliably in the time of the transmission of one controlling impulse thereto, the time of one impulse is sufficient to allow the advance of the wipers over a group of ten trunks; the time of two impulses is sufficient to allow the advance of the wipers of the selector over twenty trunks; etc.

A further feature of the present arrangement is that a special terminating conductor is used to mark the end of a group in the bank of the directing wiper of the selector. The provision of some additional arrangement such as this is made necessary because the arrangement employed for marking the end of a group in the hereinbefore-mentioned application of Wicks et al. cannot be used when a group contains more than ten trunks, as will be apparent upon a further perusal of the specification.

According to another feature of the invention, contacts of the release and series relays cooperate with each other and with

off-normal contacts for connecting a source of dial-tone current when the selector is taken for use (used ordinarily only in connection with a first selector) and for substituting a connection to a source of busy-tone current at the end of the directive movement of the selector; which connection persists if an idle trunk is not found, but is forthwith broken in case an idle trunk is found in the selected group.

Another feature of the invention relates to an improved circuit arrangement for preventing the application of busy tone from being interrupted and for preventing the selector from being operated further in case the calling subscriber dials another digit after a busy group has been encountered. This arrangement includes the use of a suitable circuit arrangement for preventing the series relay from reoperating after it has fallen back at the end of a series of impulses to start the trunk-hunting movement, in which case it cannot reoperate to open the busy tone connection, nor to permit further effective operation of the counting relays which direct the advance of the wipers over the groups of contacts.

Other objects and features of the invention, for the most part incidental to those herein enumerated, will become apparent upon a further perusal of the specification in connection with the accompanying drawing comprising Figs. 1–3.

Description of the drawing

Referring now to the drawing it shows by means of the usual circuit diagrams a sufficient amount of the apparatus in a telephone system embodying the features of the invention to enable the invention to be understood. Fig. 1 is a circuit drawing of the improved selector, and Figs. 2, 3, and 4 are drawings showing alternative groupings of the bank contacts into contact sets.

The selector whose circuits are shown in Fig. 1 has seven wipers, 22–28, there being fifty-one contacts in the path of each wiper, as shown best in Fig. 2. These wipers stand normally on the fifty-first set of contacts, with the cam-controlled, off-normal contacts 41, 42, 43, and 51 normally in the respective open or closed positions indicated on the drawing. The operating magnet 20 is arranged to be operated in a buzzer-like manner to advance the wipers in a clockwise direction, the wipers being advanced the distance of one contact set each time the magnet is deenergized.

Fig. 2 shows all contacts and all of the seven wipers of the selector and it shows the contact sets divided into seven groups, each group giving access to ten trunks or to a multiple of ten trunks, as is shown in the following table:

Groups	Digits assigned	Number of trunks
1	1	10
2	2	30
3	5	10
4	6	10
5	7	10
6	8	20
7	0	10
		100

From this table, it will be seen that the one hundred contact sets have been allocated amongst seven groups, and that the groups are in multiples of ten.

Fig. 3 shows the one hundred contact sets in the bank of the selector divided into eight groups in accordance with the following table:

Groups	Digits assigned	Number of trunks
1	1	10
2	2	4
3	3	18
4	5	6
5	6	10
6	7	14
7	9	10
8	0	28
		100

As will be seen upon reference to Fig. 3 and to this table, the one hundred contacts of the switch are divided into eight contact groups of varying sizes, and the final group contains a large number of contact sets, eighteen of which are obtained by curtailing groups 2 to 4 and 6, so that these groups are no longer in multiples of ten.

As will appear from a further perusal of the specification, if a number of contacts which is not divisible by ten is assigned to a group, the contacts which would be required to fill up the group to make it an exact multiple of ten are, in effect, added to the final group of contacts.

Fig. 4 shows the way in which the bank of the directing wiper 25 is wired when the switch of Fig. 1 is used as an inter-office trunking switch in a system employing register translators (or directors), wherein the office-designating digits are recorded and translated into an office code. The contact sets in Fig. 4 are allocated amongst thirteen contact groups in accordance with the following table:

Groups	Digits assigned	Number of trunks
1	1	6
2	2	4
3	3	8
4	4	6
5	5	22
6	8	6
7	9	12
8	11	4
9	12	6
10	13	6
11	14	4
12	15	6
13	16	10

As will be seen upon observing this table and comparing it with Fig. 4, the contacts have been divided into groups of varying sizes which are not multiples of ten, and the final group is not a large group as in Fig. 3. This grouping is made possible because the code-digit values in the register-translator may be assigned at will. It will thus be seen that, by using the register sender to accomplish the desired translation, greater flexibility in the trunk-group sizes or contact-set sizes is attained, and that the number of groups may be increased above ten (being thirteen as illustrated).

Detailed Description

Figs. 1 and 2

The invention having been described generally, a detailed description of the operation of the apparatus shown will now be given. For this purpose it will be assumed that the selector shown in Fig. 1 has its contact bank wired as shown in Fig. 2 and that it is seized in the usual course of a telephone call by way of conductors 10, 11, and 12. It is to be noted that conductor 11 normally extends to battery by way of armature 54 of relay 14, off-normal contacts 51, and resistance 44. This battery connection is to enable the selector to be seized in case the preceding switch is of the battery-searching type.

Line relay 13 now operates over conductors 10 and 12 and through contacts of relay 18. Upon operating, line relay 13 closes a circuit for release relay 14, whereupon release relay 14 operates and grounds conductor 48 at its inner-upper armature; replaces the battery potential on conductor 11 with a ground potential at armature 54; prepares an operating circuit for series relay 15 and counting relays 16 and 17 at its lower armature; prepares test circuits for relays 19 and 18 at armatures 52 and 53; and at its upper armature completes a connection from the dial tone lead 45 to conductor 10, which connection includes off-normal spring 43, condenser 47, and contacts of relays 15 and 18. The flow of current from the source of dial tone informs the calling subscriber that he may now proceed to dial the first digit in the desired number, the selector of Fig. 1 being assumed to be a first selector.

Assuming that the first digit in the desired number is the digit 0, ten momentary interruptions are produced in the circuit of line relay 13 at the calling device on the calling line. Relay 13 is accordingly deenergized momentarily ten times. Relay 14 does not fall back during this operation because it is slow acting by virtue of the resistance element shunted around its winding. Series relay 15 responds to the first impulse in the series of impulses generated at the resting contact at the armature of relay 13. Being slow acting by virtue of the resistance element shunted around its winding, relay 15 remains operated throughout the series of impulses. Upon operating, relay 15 at its lower armature shifts the connection of the directing wiper 25 with operating magnet 20 so that it includes the interrupter contacts 20-*a*; closes a locking circuit for itself at its inner-lower armature independent of off-normal contacts 42; extends ground potential from the grounded conductor 48 at its inner-upper armature to the contacts associated with the lower armature of counting relay 16; disconnects the dial tone source at its upper armature; and at armatures 49 and 50 opens points in the test circuits of relays 18 and 19 so as to prevent a premature operation of these relays during the group selecting movement.

In addition to being delivered to series relay 15, each of the ten impulses is delivered to counting relays 16 and 17, which relays are arranged to direct the group-setting operation of the selector. As will be explained, relays 16 and 17 both operate incidental to the receipt of each odd-numbered impulse, and they both restore incidental to the receipt of each even-numbered impulse. The arrangement is such that relay 16 operates or restores, as the case may be, at the beginning of the concerned impulse, and relay 17 operates or restores, as the case may be, at the end of an impulse. The way in which relays 16 and 17 operate will now be pointed out:

When the first impulse or any odd-numbered impulse is delivered through the resting contact of armature 13 and the lower armature of relay 14, it passes through the lower armature of relay 17 to the lower winding of relay 16. Relay 16 thereupon operates and closes a circuit at its upper armature for its own lower winding in series with the lower winding of relay 17, to ground through the inner-upper armature of relays 15 and 14. No current flows through this locking circuit, however, as long as the initial circuit is intact. At the same time, the differential relay 16 connects up its upper winding in parallel with the upper winding of relay 17 at its lower armature, preparatory to the subsequent restoration of relay 16. Then, when the first impulse subsides, relay 16 remains operated in series with relay 17, and relay 17 operates. Upon operating, relay 17 disconnects the impulse conductor from the lower windings of relays 16 and 17 and connects it to the upper windings of these relays.

When the second impulse or any even-numbered impulse arrives, a holding circuit is closed for the upper winding of relay 17, and a restoring circuit for the differential relay 16 is closed through its upper winding.

The current now flowing through the upper winding of relay 16, through the inner-lower contacts of the relay, neutralizes the magnetic effect of the lower winding, permitting the relay to restore. When relay 16 restores, it opens the locking circuit for the lower windings of relays 16 and 17 at its upper contacts, while at its inner-lower armature it opens the circuit of its upper windings. Relay 17, however, remains operated through its upper winding until the impulse subsides, whereupon relay 17 restores and again transfers the impulse circuit back to the lower windings of relays 16 and 17 preparatory to reoperating the relays upon the receipt of the next impulse (any odd-numbered impulse).

The way in which the wipers 22—28 are advanced across the contact groups will now be explained. Upon reference to Figs. 1 and 2, it will be noted that the wipers 22 to 28 are standing normally on the last set of contacts in the bank (the fifty-first set). It is to be noted, moreover, that conductors 29, 30, and 48 are connected to the contacts in the banks of directing wiper 25 (as seen best in Fig. 2), so as to give a group-by-group movement to the wipers as the relay 16 is alternately operated and restored. It will be recalled that relays 15 and 16 both operate at approximately the same time at the beginning of the first impulse. With relays 15 and 16 both operated, the ground potential on conductor 48 is extended to the "odd" conductor 29, while "even" conductor 30 is disconnected, and, therefore, ungrounded. Conductor 29 is connected to the fifty-first contact in the bank of wiper 25, as well as to other contacts in the bank corresponding to different positions of wiper 25, as may be observed. Ground potential is, therefore, extended by way of conductor 29 to directing wiper 25, from whence it extends through the operated lower armature of series relay 15, interrupter contacts 20-*a*, and contacts of relays 19 and 18 to operating magnet 20. Magnet 20 operates in the usual buzzer-like manner to advance the wipers 22—28, whereupon the wipers step off the last set of bank contacts, and the other end of the wipers comes into engagement with the first set of bank contacts. The movement does not progress beyond this point for the time being because the first contact in the bank of wiper 25 is connected to conductor 30 (the "even" conductor), which is not grounded at this time.

When relay 16 restores at the beginning of the second impulse it removes ground potential from the "odd" conductor 29 and places it on the "even" conductor 30, causing the circuit of magnet 20 to be closed anew and the wipers to be driven over the first contact group and into engagement with the first set of bank contacts in the second group. It is to be noted that the final contact in the bank of wiper 25 in group 1 is connected to the group-terminating-ground conductor 48, which conductor is grounded at this time. The rotating action of the wiper, therefore, continues over this contact until wiper 25 engages the ungrounded "odd" conductor 29.

When relay 16 is again operated to again ground conductor 29 and unground conductor 30, the wipers are advanced five steps over the first five sets of bank contacts in the second group, which group comprises thirty trunks, and, therefore, occupies fifteen sets of bank contacts, requiring fifteen steps of the wipers. Since it is assumed that the switch cannot be relied upon to take more than five steps in the time of one impulse, the circuit connections are made so that the third impulse drives the wipers over only the first five contact sets in the second group, to which the "odd" conductor 29 is connected, while the fourth impulse causes the switch to take five more steps because relay 16 restores and transfers the ground potential from the "odd" conductor 29 to the "even" conductor 30. Then, when relay 16 reoperates responsive to the fifth impulse, conductor 29 again receives ground potential in place of conductor 30 and the wipers are advanced the remaining distance over the second contact group and into engagement with the third contact group, bearing the designating digit 5.

Responsive to the sixth impulse, conductor 30 again becomes grounded and the wipers are advanced to the 6 group; responsive to the seventh impulse, conductor 29 again becomes grounded and the wipers are advanced to the 7 group; responsive to the eighth impulse, conductor 30 again becomes grounded and the wipers are advanced to the 8 group; responsive to the ninth impulse, conductor 29 again becomes grounded and the wipers are advanced over the first five contacts in the 8 group; and responsive to the tenth impulse conductor 30 again becomes grounded and the wipers are advanced to the first contact set in the 0 group.

As no further impulses are received, series relay 15 now falls back and at armatures 49 and 50 closes the test circuits through to the upper windings of relays 18 and 19, at the same time closing the busy-tone circuit at its upper armature by way of off-normal spring 43 in its alternate position, and closing the local operating circuit for magnet 20 at the normally closed contacts controlled by its lower armature. This circuit includes off-normal contacts 41, self-interrupting contacts 20-*a*, and contacts of relays 19 and 18. The closure of this circuit results in the advance of the wipers 22 to 28 over the contacts in the selected

group (group 0) unless one or the other of the two trunks now engaged by the two wiper sets is idle, in which case one or the other of the relays 18 and 19 operates immediately and interrupts the circuit of magnet 20 before magnet 20 has had time to operate. It will be assumed, however, for the purpose of the present description, that neither wiper set is in engagement with an idle trunk, in which case the magnet 20 operates in a step-by-step manner to advance the wipers over the contact sets in the selected group.

It is assumed further that the advance continues until the wipers encounter the contacts to which conductors 31 to 33 and 34 to 36 are connected. When this contact set is reached, relays 18 and 19 both operate in case both trunk lines are idle (an idle trunk line being marked by a battery potential such as the battery potential normally impressed on conductor 11 by way of resistance element 44). The circuit of magnet 20 is, therefore, interrupted at two points, preventing the further advance of the wipers. Relay 19 closes a locking circuit for its lower winding at its inner-lower armature; and at its lower armature and at its two upper armatures it disconnects wipers 22, 23, and 24 and substitutes wipers 26, 27, and 28.

Relay 18, upon opening a point in the circuit of operating magnet 20 and its inner-lower armature, closes a locking circuit for its lower winding in series with magnet 20 (magnet 20 does not operate in series with the lower winding of relay 18 because of the relatively high resistance of the said winding); opens a point in the test circuit of relay 19 and connects up wiper 27 to the incoming release-trunk conductor 11 at its inner-upper armature; and at its upper and lower armatures it disconnects conductors 10 and 12 from the windings of the line relay 13 (thereby stopping the application of busy tone to the calling line) and extends them by way of the operated upper and lower armatures of relay 19 to wipers 26 and 28.

When this occurs, the usual line and release relays in the switch connected to the distant end of conductors 34—36 operate, and the latter applies ground potential to conductor 35 to hold the selector of Fig. 1 in operated position. This ground potential is supplied, of course, before release relay 14 has had time to fall back responsive to the deenergization of the disconnected line relay 13. It is to be noted that a momentary impulse is transmitted to the lower winding of relay 16 through contacts of release relay 14 in the interval required for relay 14 to fall back after its circuit is opened by relay 13. The momentary energization of relay 16 at this time does not cause any harm to result, and relay 16 merely falls back again when relay 14 falls back.

Release of the established connection

When the connection established through the selector of Fig. 1 is to be released, ground potential is disconnected from conductor 35 of the trunk seized through wipers 26—28, whereupon relays 18 and 19 fall back. All of the relays of the selector of Fig. 1 are now in the normal position as shown in the drawing, but the wipers are in an off-normal position and all of the off-normal contacts are, therefore, in an actuated position. The same circuit traced hereinbefore for operating magnet 20 in search of an idle trunk line in the selected group is now re-established through contacts of relays 18 and 19 and interrupter contacts 20-*a*, normally closed contacts controlled by the lower armature of relay 15, and off-normal contacts 41. As a result, magnet 20 operates in the usual buzzer-like manner to advance the wipers until they arrive upon the fifty-first set of bank contacts, whereupon the off-normal contacts, including off-normal contacts 41, are restored to their normal position, and the wipers stop because the restoring circuit of magnet 20 is opened at normal contacts 41. It is to be noted that neither relay 18 nor relay 19 can reoperate to interfere with the restoring operation because the test circuits of these relays are open at armatures 52 and 53 of the now-deenergized release relay 14. It is to be noted further that the idle indicating battery potential is reapplied to conductor 11 by way of off-normal contacts 51 and armature 54 when the switch again arrives in its normal or home position.

From the description hereinbefore given, it is believed that it will be understood that the trunk comprising conductors 31—33 is seized by way of wipers 22—24 in case this trunk is idle and the one comprising conductors 34—36 is busy, as in this case relay 19 does not operate to substitute wipers 26—28 for wipers 22—24. Under this condition, relay 19 cannot operate following the operation of relay 18 in case the trunk line accessible by way of wipers 26—28 becomes idle immediately, because the test circuit of relay 19 is opened at the inner-upper armature of relay 18. It will be understood further that, in case the trunk line accessible by way of wipers 22—24 is busy while the trunk line accessible by way of wipers 26 to 28 is idle, relay 18 cannot operate until after relay 19 has operated and brought relay 18 under the control of wiper 27, which connects with the idle trunk line. In this case relays 19 and 18 operate successively, while in the previously described example the two relays are operated practically simultaneously.

All-trunks busy in the selected group

When all trunks in the selected group are busy, the wipers of the selector continue to advance until they arrive upon the last contact set in the group. At this time, a new circuit for operating magnet 20 is closed by way of directing wiper 25 and the group-terminating-ground conductor 48, which circuit excludes the interrupter contacts 20—*a*, being closed through the lower armature of relay 15 and its resting contact, and contacts of relays 19 and 18. Magnet 20 operates over this circuit and remains operated, thereby preventing a further advance of the wipers of the switch, it being remembered that the wipers are advanced upon the falling back of the magnet rather than upon the operation thereof. At contacts 20—*b* and 20—*c*, operating magnet 20 opens the test circuits of relays 18 and 19, preventing these relays from energizing subsequently in case the trunks terminating in the bank contacts on which the wipers are now standing subsequently become idle.

Since the connection is not extended through to another trunk, and the incoming line remains connected to line relay 13, busy-tone current over conductor 46 continues to flow back over the calling line by way of off-normal spring 43 and condenser 47, and the calling subscriber is apprised of the busy condition of the trunk group and is expected to replace his receiver and bring about the release of the selector, which takes place when relay 14 falls back and removes ground from conductor 48. It is to be noted that further dialling on the part of the subscriber does not result in further directive operation of the wipers because magnet 20 is held operated continuously over the above-traced circuit to wiper 25, regardless of any further action on the part of counting relays 16 and 17.

It may be pointed out that the above-described all-trunks-busy condition is not sent back in case one or the other of the trunks connected to the last set of contacts in the group is idle because in this case one or the other of relays 18 and 19 operates to open the circuit of magnet 20 before magnet 20 has had time to operate.

The bank layout of Fig. 3

When the contact grouping is made as indicated in Fig. 3, the groups are not in multiples of ten, as hereinbefore explained. The operation of the switch of Fig. 1, however, is not materially affected by the different grouping, the principal differences being that it does not need to take as many as five steps responsive to certain of the impulses. For example, only two steps are required to advance the switch over the second contact group in Fig. 2, as this group contains only four trunks (two trunks for each full set of contacts).

It is to be noted that the third group has nine contact sets therein (eighteen trunks). The contacts in the bank of wiper 25 are connected up—the first five to the "even" conductor 30, the next three to the "odd" conductor 29, and the last one to the group-terminating-ground conductor 48. The switch wipers, therefore, take five steps responsive to the fourth impulse and four more responsive to the fifth impulse; three of the last four being responsive to ground potential encountered by way of conductor 29, and the fourth being responsive to ground potential encountered over conductor 48.

The bank arrangement of Fig. 4

The bank layout of Fig. 4 illustrates one grouping that may be used when the selector of Fig. 1 is used in a system employing register senders which translate digits of the office designation into a desired combination of office code digits. When the selector of Fig. 1 is used as an office selector in a system employing register senders, the contact sets of the selector may be divided into as many groups as desired with any desired apportionment of contact sets amongst the established groups, as the number of impulses in a series is not limited to ten as it is limited, in practice, in a system not using register senders. It is believed that the arrangement in Fig. 4 will be understood in view of the operation of the selector hereinbefore given and the discussion of Fig. 4 in the general description.

It will be understood, of course, that the arrangement herein disclosed of assigning the digits to the several trunk groups with due regard to the number of steps required to pass over the respective trunk groups, in accordance with their sizes, will be applicable to other rotary type selectors, including those using so-called markers, or marking switches, in place of the counting relays as herein disclosed, to direct the selector to the desired group.

What is claimed is:

1. In combination, an automatic switch having groups of lines terminating in the bank thereof, said switch being arranged to respond to a series of impulses and being of a fast-operating type so that it will move over a group of lines having not greater than a predetermined maximum number of lines therein in the time allotted to one impulse, means responsive to each impulse of a series for driving said switch into association with the next succeeding group of lines in case the group over which it is being driven is not larger than the predetermined maximum size, and means effective when the group of lines over which the switch must

be driven is a larger group for causing it to be moved over such group responsive to a plurality of impulses of the series.

2. The method of enabling the wipers of a fast-operating group-hunting automatic switch to keep up with the directing impulses of a received series of impulses indexing a group of lines, when some groups are large, which consists in causing the switch to execute more than one hunting movement in passing over a large group, and in assigning the digit values to the groups of lines so that the hunting switch has the time of more than one impulse of a series to execute the hunting movement required to advance it across a large group.

3. In an automatic switch having a free hunting movement to select any one of a plurality of groups of contacts in the bank thereof, marking means responsive to received impulses for making a plurality of group markings in the bank of said switch, means responsive to said marking means for driving said switch to a contact group depending jointly upon the effected marking and upon the previous position of said switch, means independent of said marking means for causing said switch to advance over the contacts of a selected group in search of an idle contact set, and means independent of said marking means for preventing said switch from advancing beyond a selected contact group and selecting a contact in the following group.

4. In combination, an automatic switch having wipers arranged to be driven over groups of contacts successfully by a continued single movement, means for applying a distinctive potential to the final contact of each group to mark the end of the group, means for causing said switch to restore to its normal position after it has been operated, and means for removing the distinctive potential from the final contacts of the group during the restoring operation so as to prevent the restoring operation from being interfered with.

5. In a single-motion automatic trunking switch having its contact bank divided into groups, marking conductors extending to the contact groups, marking means responsive to received impulses for energizing said marking conductors successively to cause said switch to be advanced over preceding groups and into association with a desired group of contacts, means effective upon the termination of the received series of impulses for causing said switch to search for and connect with an idle trunk in the attained contact group, and means for deenergizing all of said marking conductors during the trunk-hunting operation of said switch so as to prevent interference with the said operation.

6. In an automatic selector switch, an operating magnet and means for operating it to advance the wipers of the selector switch into association with a desired group of contacts and for additionally operating it to effect a hunting movement over the contacts in the group in search of an idle contact set, a line relay in said switch controlled over a calling line by an impulse series to cause the said operation of said magnet to drive the wipers into association with the desired group, means effective when the switch is unable to find an idle contact set in the selected group for holding the operated magnet continuously operated to set up a distinctive busy condition in the selector, and means for preventing the deenergization of said magnet responsive to said line relay being controlled by further impulses.

7. In an automatic hunting selector switch having a contact bank divided into contact groups and having two sets of wipers, each set including a test wiper, two test relays associated with said test wipers, respectively, and each having a test circuit including the associated test wiper, means for driving both of said wiper sets over a contact group at the same time with both test circuits closed, and means effective when said selector is driven over a group of contacts without finding an idle contact set in the bank of either test wiper for opening the test circuit of each of said test relays to prevent the seizure of a contact set in the succeeding group.

8. In combination, a selector switch having a release relay, a series relay, and a switching relay, off-normal contacts arranged to be closed when the selector is operated from its normal position, a line incoming to said selector, a busy-tone lead, and a circuit for applying busy-tone current from said busy-tone lead controlled jointly by said off-normal contacts, contacts of said series relay, contacts of said release relay, and contacts of said switching relay.

9. In a trunk-hunting selector having a line incoming thereto, a busy-tone lead over which busy signalling current is applied, means including off-normal contacts mechanically actuated responsive to the movement of said switch from its normal position for closing a busy-tone circuit over said incoming line from said busy-tone lead, a switching relay and means for operating it when an idle trunk is found in the selected group, and means including contacts on said switching relay for opening said busy-tone connection so as to stop the application of busy-tone current when an idle trunk line is found.

10. In combination, a bank of contacts arranged in groups, each group comprising a plurality of separate contacts, a set of

wipers arranged to be driven over said contact sets successively, an operating magnet, means for operating said magnet intermittently to drive said wipers over said contacts until a desired group of contacts has been reached, additional means for operating said magnet intermittently to drive said wipers over the contacts in the selected group to bring the wipers into association with an idle contact set, and means effective in case the wipers are driven to the last set of contacts in a selected group and the last contact set is busy for energizing said operating magnet and for maintaining it energized continuously in order to prevent the advance of the wipers beyond the last contact set in the group.

11. In combination, a selector switch having access to a group of lines, a driving circuit and means for closing it to cause said selector to be driven over said lines in search of an idle one, means for opening said driving circuit when an idle line is found, said selector having a home position, and means for restoring said opening means to reclose said driving circuit to cause said selector to be driven to its home position.

12. In an automatic-hunting group-selector having two sets of wipers positioned so that both sets hunt over a group at the same time, a test wiper and an associated test relay for each wiper set, a test circuit for each test relay including the associated test wiper, a test wiper common to both wiper sets, and means controlled by said common wiper and responsive to the end of a selected contact group being reached for separately opening each test circuit.

13. In combination, an automatic switch having its contact bank divided into separately designated groups of varying sizes, said switch being responsive to an impulse series containing a random number of impulses to advance by hunting movement into association with the corresponding group of bank contacts, there being a designation assigned to a specific large group corresponding to a given number of impulses, and a designation assigned to the next succeeding group corresponding to a number of impulses greater by more than one than said given number, while the designation assigned to any group next succeeding a small group not greater than a predetermined size corresponds to an impulse series containing only one more impulse than the series corresponding to the designation of the said small group.

14. In combination, an automatic switch having its contact bank divided into separately designed groups of varying sizes, said switch being responsive to an impulse series containing a random number of impulses to advance by a hunting movement into association with the corresponding group of bank contacts, there being a designation assigned to each group immediately following a group of not more than a given maximum size, over which the switch can advance in the time of one impulse, corresponding to only one impulse more than the number of impulses corresponding to the designation of the group which the said following group immediately follows, and a designation assigned to a group immediately following a group larger than the switch can advance over in the time of one impulse which designation corresponds to a number of impulses greater by more than one than the number of impulses corresponding to the designation of the said larger group.

15. In combination, an automatic switch having its contact bank divided into separately designated groups of varying sizes, said switch being responsive to an impulse series containing a random number of impulses to advance by a hunting movement into association with the corresponding group of bank contacts, and group-hunting-control means in said switch for operating the switch into association with any desired group responsive to a number of impulses varying directly with the number of preceding groups and with the respective sizes of such groups.

16. In combination, an automatic switch having its contact bank divided into successive groups, means responsive to impulses corresponding to group designations for causing said switch to advance in a group hunting operation until it comes into association with the designated group, and for subsequently causing it to advance in a contact-hunting operation until it comes upon an idle contact set in the group, certain of said groups being single-unit groups composed of not more contact sets than the switch can pass in a single hunting movement responsive to a single directing impulse, while other of said groups are multi-unit groups composed of two or more units of contact sets, each requiring a separate impulse to enable the switch to pass over the entire group in its group hunting operation, and means effective during the contact-hunting operation of the switch for stopping the contact hunting operation or not at the end of a unit number of contact sets, depending upon whether the contact group ends with such unit number of contacts or extends beyond.

In witness whereof, I hereunto subscribe my name this 5th day of November, 1931.

RODNEY G. RICHARDSON.

In witness whereof, I hereunto subscribe my name this 5th day of November, 1931.

JOHN I. BELLAMY.