Nov. 10, 1931. C. E. STEVENS ET AL 1,831,399

REGISTER EQUIPMENT FOR AUTOMATIC TELEPHONE EXCHANGES

Filed June 5, 1930 6 Sheets-Sheet 1

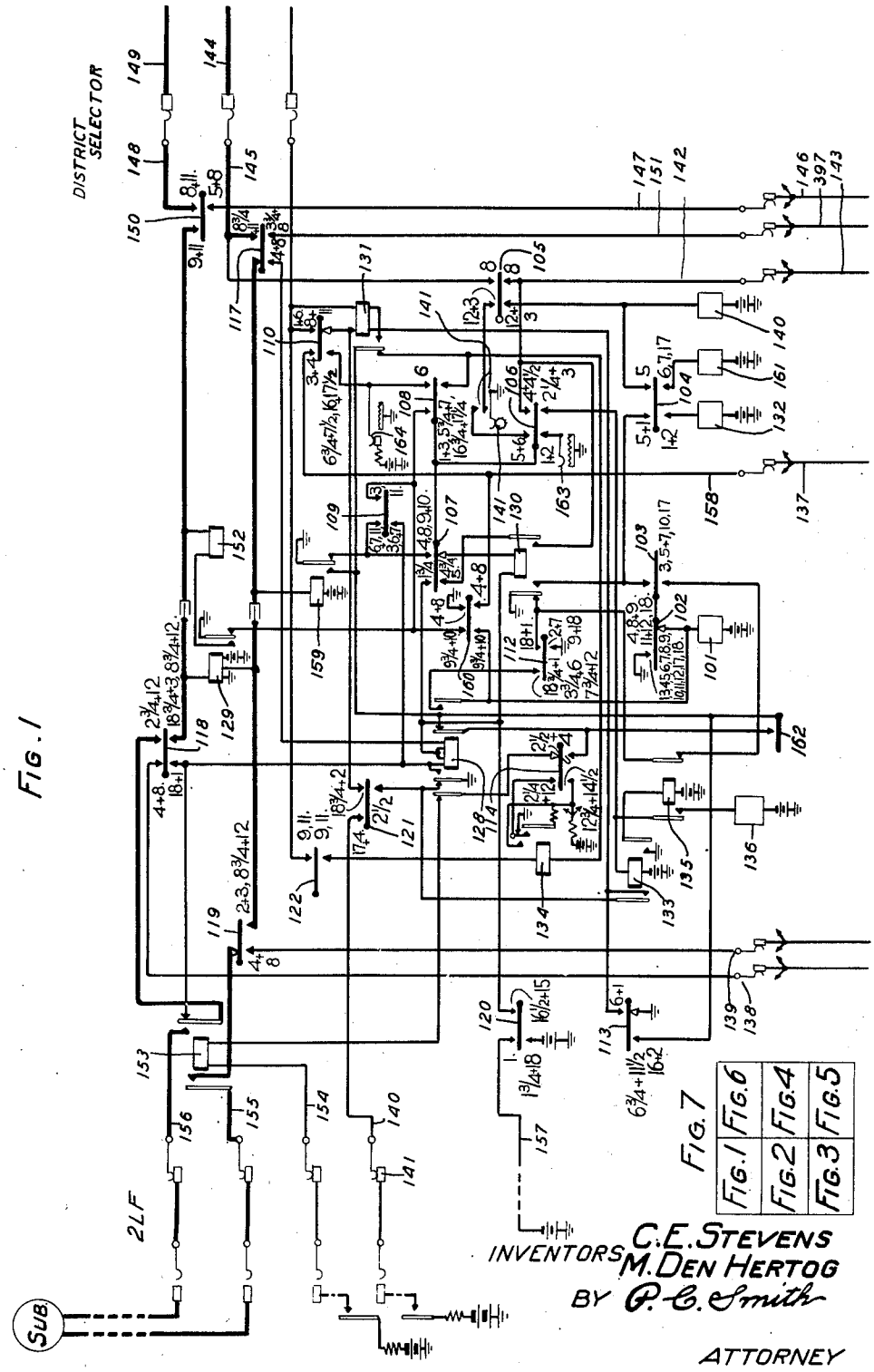


FIG. 1

FIG. 7

FIG. 1	FIG. 6	
FIG. 2	FIG. 4	
FIG. 3	FIG. 5	

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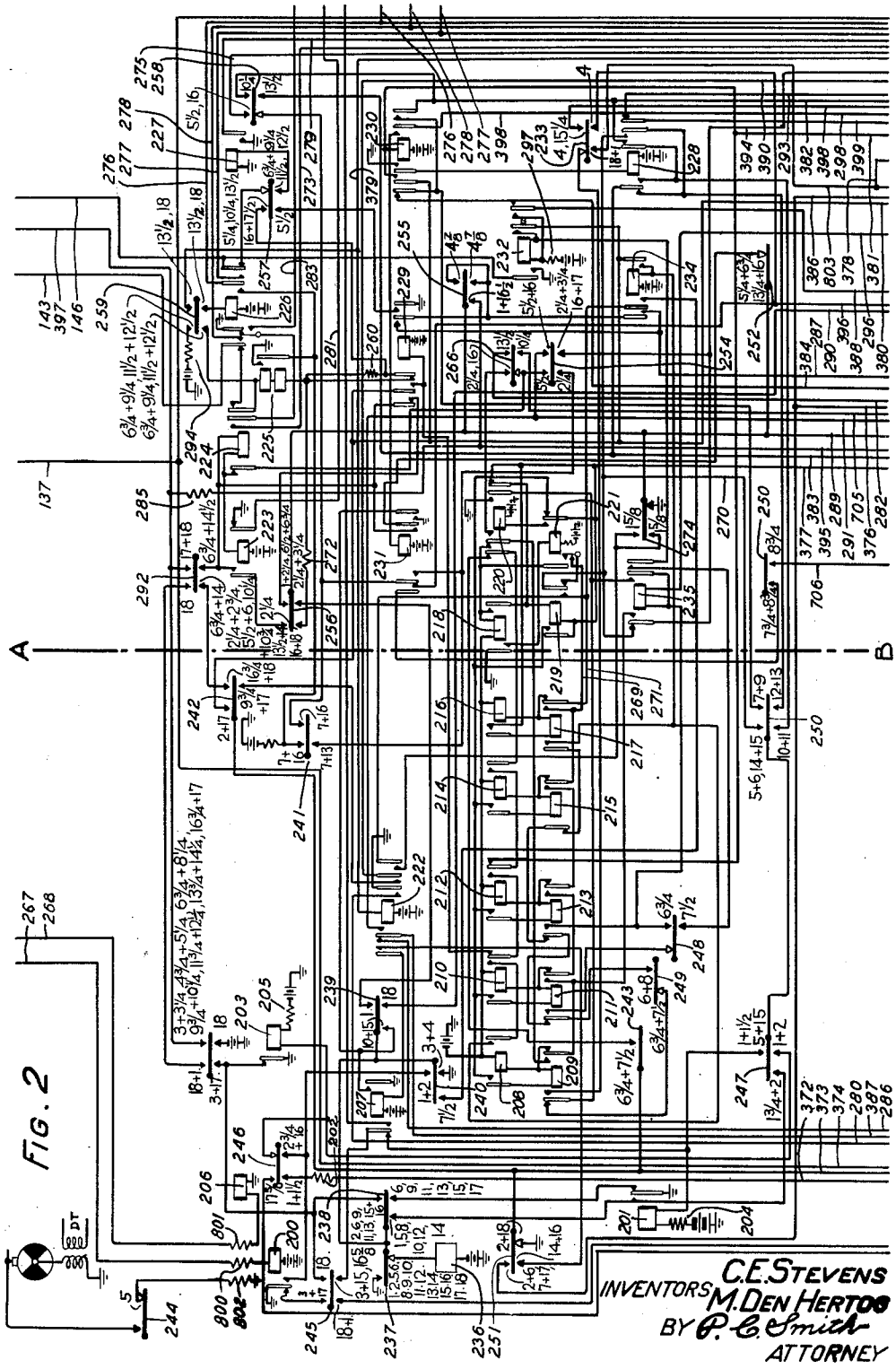


FIG. 2

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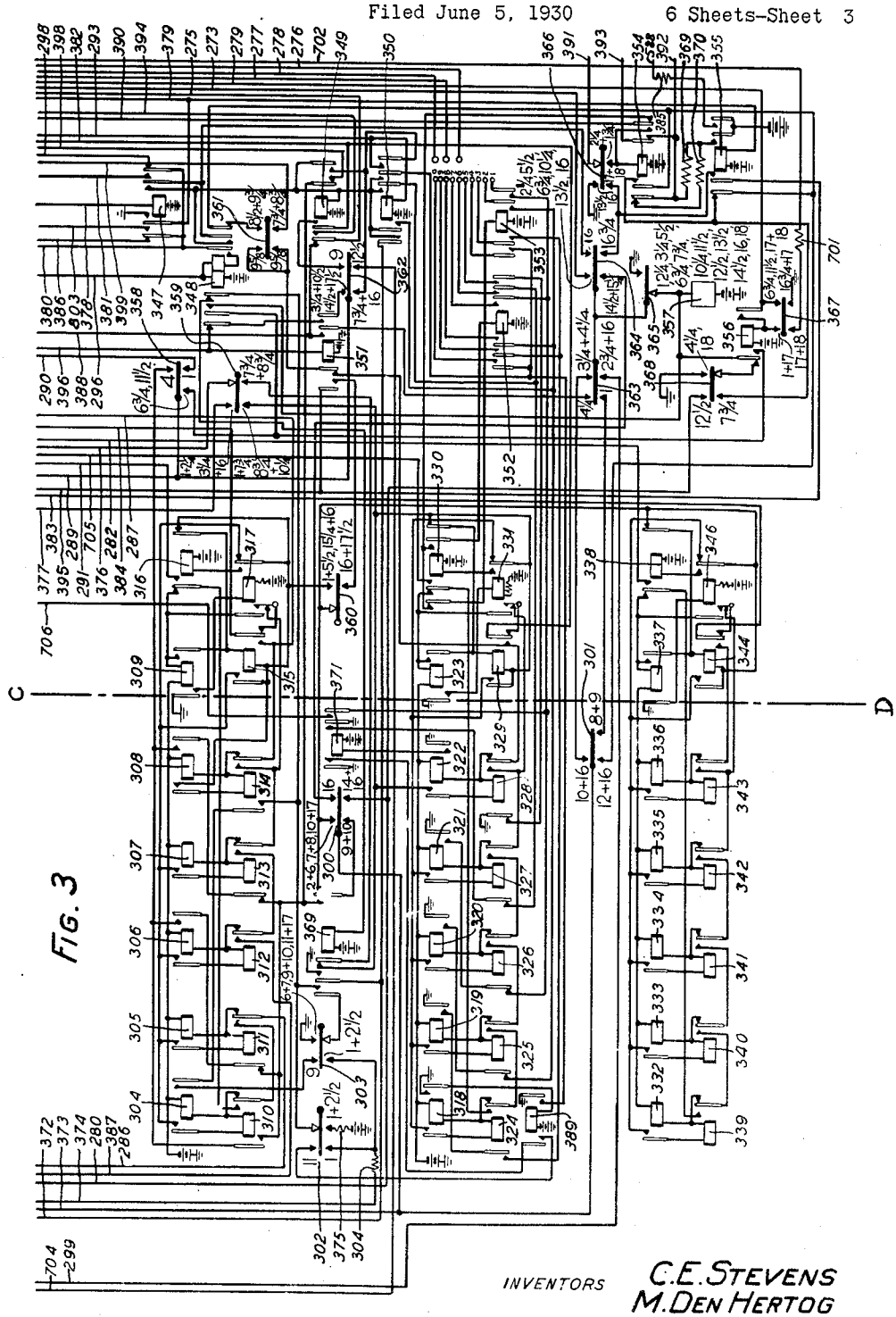


FIG. 3

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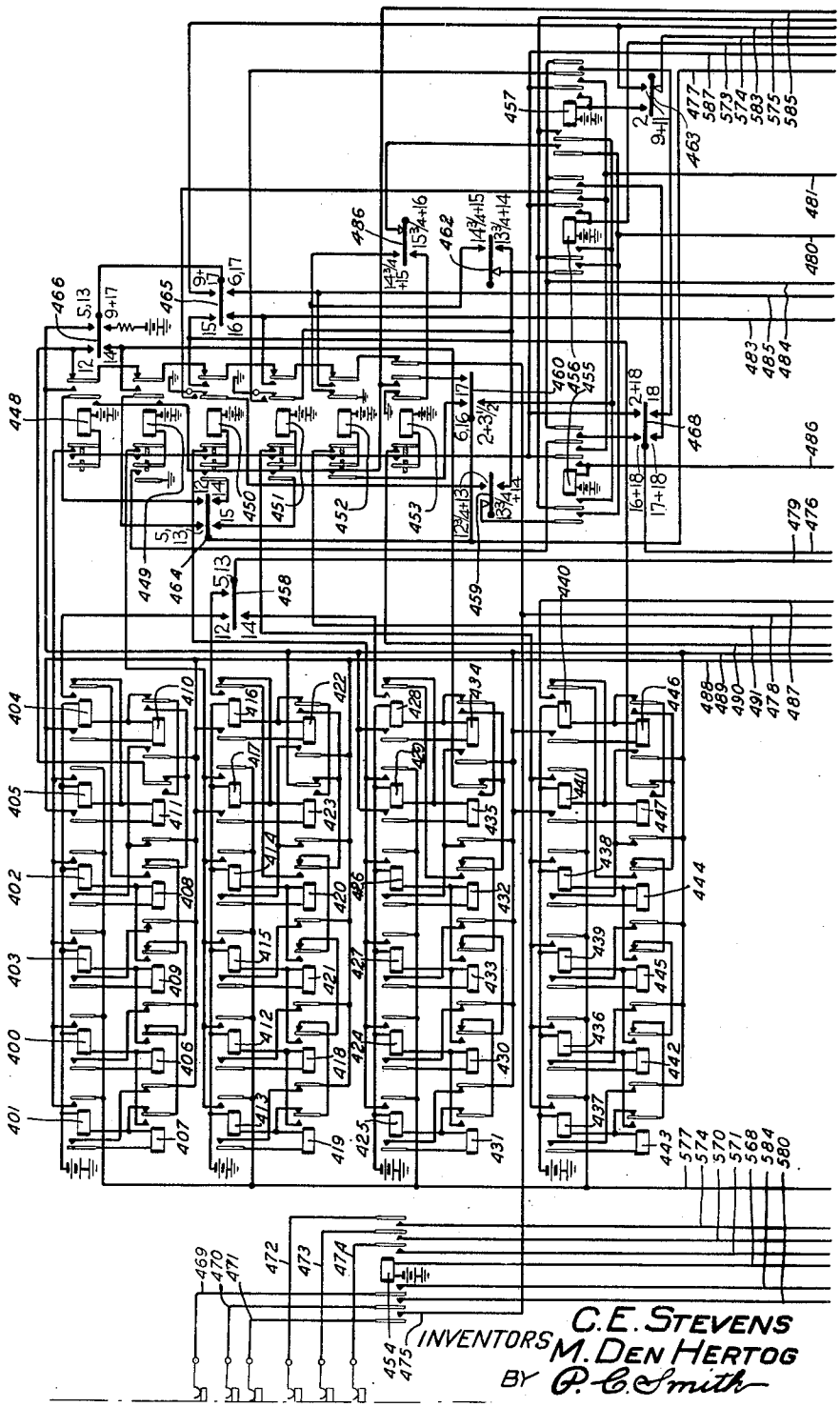


FIG. 4

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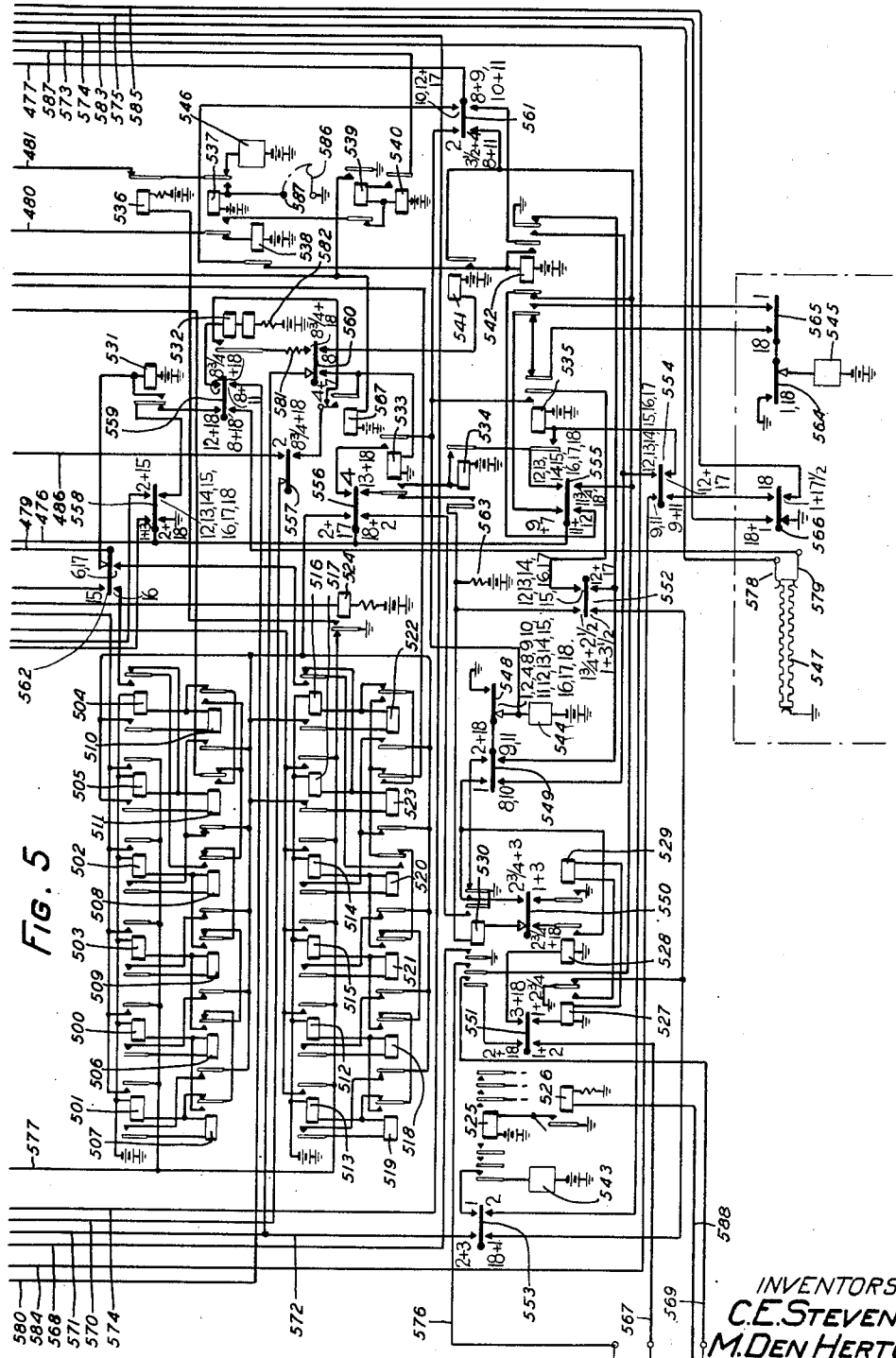


FIG. 5

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Filed June 5, 1930 6 Sheets-Sheet 6

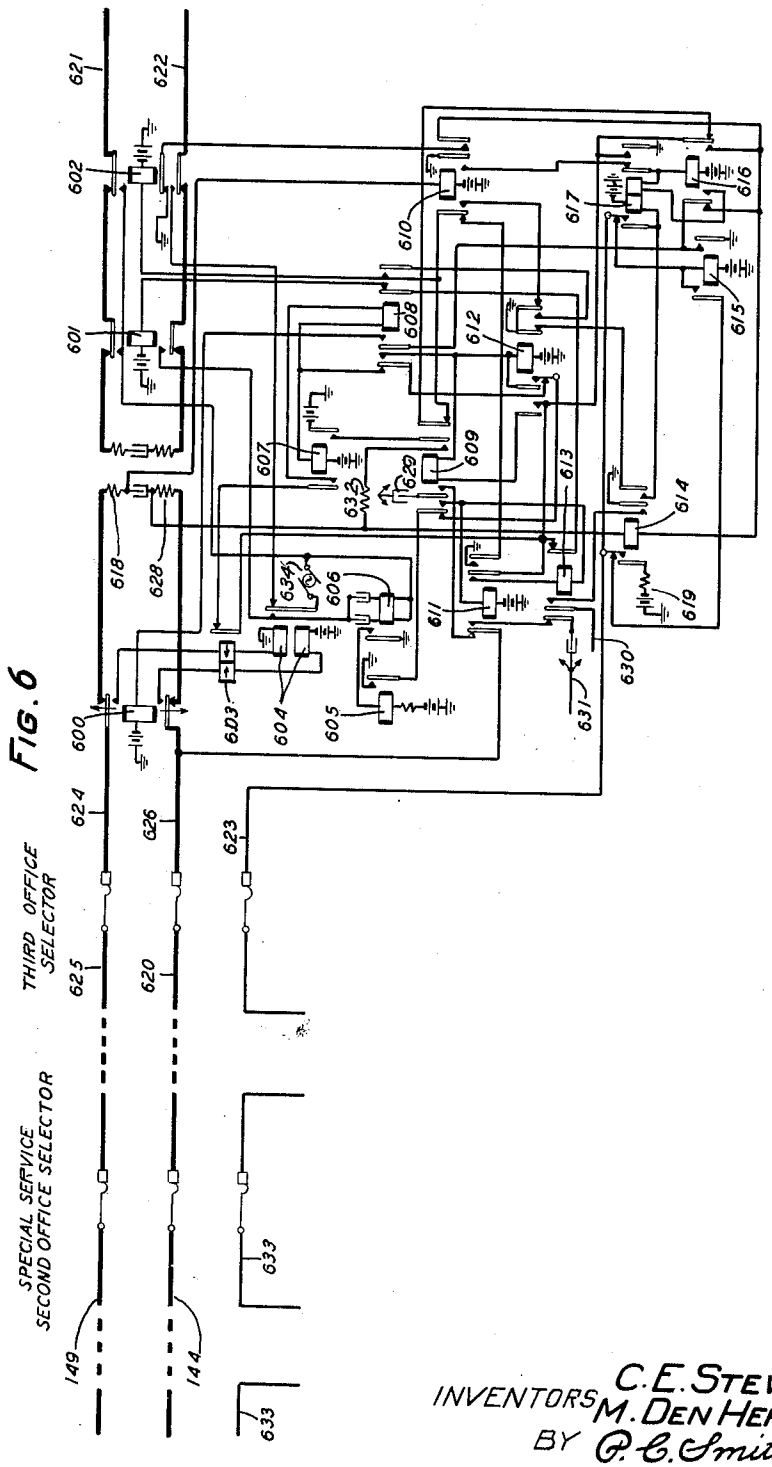


FIG. 6

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Patented Nov. 10, 1931 1,831,399

UNITED STATES PATENT OFFICE

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REGISTER EQUIPMENT FOR AUTOMATIC TELEPHONE EXCHANGES

Application filed June 5, 1930, Serial No. 459,331, and in Great Britain June 21, 1929.

This invention relates to automatic or semi-automatic telephone systems and is more particularly concerned with means for establishing calls from subscribers in an automatic office of one telephone area to subscribers located in telephone offices of different areas such as, for example, from a subscriber in one town to a subscriber in a distant town. The invention provides means for automatically completing calls to offices of different exchange areas, each of which areas may comprise a number of telephone offices governed by a numbering system involving a greater number of digits than that of the local exchange area in which the said means are provided. It includes, as well, means for automatically completing calls to offices of the local exchange area which likewise may comprise a number of telephone offices, all of which, however, are reached by one numbering system particular to the local area. More specifically, the invention has to do with means for storing in a main sender some of the digits of a wanted subscriber's number and to store the remaining digits in an auxiliary cooperating sender in such a manner that, upon the dialing of a prefix digit indicating a class of call in which the total number of digits of the wanted number exceeds the registering capacity of the main sender, the said auxiliary sender is connected to the main sender and the remaining digits are then dialed thereinto and recorded. In such cases the auxiliary sender, in cooperation with the main sender and the first selector of the various switching stages, is adapted to control the operations necessary to transfer the wanted number to the called office in the distant area and there affect the operation of automatic switches for reaching the wanted subscriber's line.

Heretofore, it has been usual to extend long distance calls, when originating in an automatic telephone office, to an operator's position and thereupon, under the control of the operator, extend the connection to another operator's position located in the office of the distant area and finally, through the automatic equipment at the distant office to the desired subscriber's line under the control of the operator in the distant office. Or, according to another method, the call is extended from the operator's position in the originating office of the home area and under her control, directly through the automatic equipment in the terminating office of the distant area.

It may be seen from the foregoing that the type of sender required on such calls in accordance with present practice, is one adapted only for registering a number whereby the connection may be extended automatically to the operator's position, which number usually consists of two or three digits. Therefore, the total registering capacity of the sender, in so far as it affects long distance calls, has been adapted to the numbering system of the home area which may, however, differ from the numbering system of any other area. The present invention, therefore, has for its principal object the provision of registering and controlling means for establishing a complete connection, without the intervention of a toll operator or operators, from an originating subscriber in an automatic office of one telephone area to a wanted subscriber in any one of a number of telephone offices or other exchange areas each of whose numbering system may be different from the numbering system of the home area. In accordance with the invention, therefore, one specific embodiment of which is described herein by way of illustration, this is accomplished in the following improved manner:

The invention contemplates the use of two senders, a main sender, a group of which is common to a number of selectors of the first switching stage, and an auxiliary sender, a group of which is common to a group of main senders. The main sender contains three principal elements, namely, an in-stepping circuit, a group of registers and an out-stepping circuit. The in-stepping circuit is adapted to be connected to the calling subscriber's line and follows the dial impulses originating at the subscriber's substation. The registers are made up of a plurality of sets of counting relays which are adapted to record, on each set, a different digit of the wanted subscriber's number and also to con-

trol the settings of the various selectors. Each digit, comprising up to ten impulses, is received on a set of these counting relays which set comprises six pairs. To reduce the total number of relays required, some of the pairs are released during receipt or delivery of impulses, by means of two additional relays provided with each set of numerical counting relays. The released pair of relays are thus employed twice during the progress of dialing or selection, but when controlling the operation of the selector stages, as more fully described hereinafter, these sets of relays are used in conjunction with a single pair of auxiliary counting relays. Further, on the selection of units digits where, in accordance with the switching mechanism used in the present embodiment of the invention, as many as twenty impulses may be required, two sets of these numerical counting relays are connected in series and finally to the single auxiliary pair if the number is such that the final selector must be advanced to the second half of the selector bank to reach the called subscriber's line. When the number is in the first half of the final connector bank and only the maximum of ten impulses are required, only one set of relays is used, in the same way as for other selections.

The out-stepping circuit is a pulsing circuit arranged in a well known manner which, in cooperation with the counting relay registers, is adapted to control by revertive impulses, the operation of either local or distant selectors in accordance with the number of impulses required for the proper setting of these selectors. The first set of counting relays is used for the registration of two digits, the first and the last digit of the total number of digits registered in the main sender. The operation of a selector stage under the control of a set of counting relay registers proceeds immediately after a digit is dialed thereinto, after which the counting relays are released. By the time the subscriber is ready to dial the second digit to be recorded on the first set of counting relays, these relays will be normal and ready to respond again to dial impulses. Each set of counting relays, therefore, performs the double function of recording the impulses comprising the digit registered thereinto and also of cooperating with the out-stepping circuit to move the various selectors to the particular levels required by the various digits dialed. The relays are used in pairs and count in a known manner; a number of them being operated and locked by the dialing impulses while the complement of the digit, translated for the required level to be reached by the selector as more fully described hereinafter, is used to control the setting of the selectors.

The auxiliary sender is functionally the same as the main sender except that it is adapted to be connected to the main sender only when the latter receives a prefix digit indicating that the total number of digits to be dialed by the calling subscriber and designating the wanted subscriber's line, will exceed the registering capacity of the main sender. A starting circuit, arranged to be closed after such a prefix designation, is operated, whereupon a group of auxiliary senders will proceed to hunt over the finder banks for the calling main sender and, as soon as one of them is connected to the calling main sender, all other auxiliary senders are returned to normal. The main sender, meanwhile, continues to receive the registration of the wanted number up to the limit of its registering capacity and the in-stepping circuit is thereafter transferred from the main to the auxiliary sender so that the registration of the remaining digits will take place in the auxiliary sender. At the same time, the auxiliary sender receives from the main sender additional information as to the total number of digits which is to comprise the wanted subscriber's number so that, after the registration of the last digit of such a number, a timing switch is operated in the auxiliary sender which delays, for a predetermined interval of time, the further functioning of the auxiliary sender in order to provide an additional period for the dialing of one or two P. B. X. suffixes. After the expiration of the said time interval, the timing switch closes circuits which cause the auxiliary sender, in cooperation with an impulse switch, the sets of counting relays in the main and auxiliary sender and the outgoing trunk, to transfer to the called office a group of impulses designating the last digit of the wanted subscriber's number; the previous digits having been transferred independent of the timing switch.

The registering means in the auxiliary sender are the same as those of the main sender except that, insofar as the outstepping circuit is concerned, the control and operation of the selectors in the terminating office of the long distance area is controlled by transmitting to those selectors, or receiving equipment controlling those selectors, a number of alternating current impulses equal to the number required to raise the selectors to the appropriate levels for reaching the wanted line. These impulses are transmitted by the outgoing trunk with which the main and auxiliary senders are adapted to cooperate.

The main sender is arranged to function with a district selector switching stage and is capable of operating with second and third office selectors which, for example, are of the kind that provide a loop after trunk hunting is completed, for which the battery and ground must be supplied from the main sender. The final selectors which function from this main sender are of the kind that have a

waiting position between tens and units selection positions from which positions they are advanced by the closure of the out-stepping circuit in the main sender.

In the present embodiment of the invention all calls, whether for a wanted subscriber in the home area or for a wanted subscriber in a distant area, may be reached over two or more of five switching stages, namely, a district selector, a local second office selector, a special service second office selector, a third office selector and a final selector as more fully described hereinafter in the description of the various types of connections. Since the same counting relay registers are used to record the dial impulses as well as to control the operation of the selector switches and since, in general, the number of impulses required to raise the selector switches involved to the required level is a complement of the number of impulses recorded in each counting relay register, the registration of the digit is modified whenever the complement of the digit dialed does not correspond to the number of impulses required to raise the selector involved to the correct trunk level. It becomes necessary, in such cases, to translate the dialed digit, that is, to operate artificially certain other pairs of counting relays of the register, or again, to release some which have been operated by the subscriber's dial impulses, in order that the number of normal counting relays corresponds to the number of steps to be taken by the selector to reach the required level.

Out going trunk circuits to long distance areas are chosen from any one of ten levels of the special service second office selector banks wherein each level of the office selector corresponds to a different direction or exchange area. This selection is effected under the control of the main sender, the direction being indicated by the calling subscriber dialing two preliminary digits which will be referred to hereinafter as direction digits. In the particular embodiment of the invention herein described the first digit used to indicate a long distance call is zero while the second digit dialed, and it may be any digit, indicates the particular distant area to which the long distance call is to be directed. After these digits are dialed the subscriber dials the fundamental number of the wanted party in the distant area without waiting for dial tone. This fundamental number comprises from four to six digits depending upon the numbering system of the called area. Two of these fundamental digits, as well as the two direction digits, are recorded on counting relay registers in the main sender and all the digits following these four are recorded in the auxiliary sender. In addition to the fundamental subscriber's number the calling subscriber may dial two suffix digits for the purpose of dialing directly into a P. B. X. connected to the distant automatic office. These suffix digits are also stored in the auxiliary sender.

Recapitulating the above, it will be observed that the minimum number of digits dialed by the calling party for a long distance call is six, namely the two direction digits and the four digits of the subscriber's number, while the maximum number of digits which may be dialed, is ten, namely two direction digits, a six digit subscriber's number and two digit suffixes for dialing to a P. B. X. Since four of these digits are registered in the main sender the maximum number of digits which can be dialed into the auxiliary sender will, therefore, be six so that six sets of counting relays have been provided in the auxiliary sender for this purpose. The auxiliary sender, in addition to recording the six digits, also takes care that the called party's number is repeated into the receiving equipment in the automatic office of the distant area.

It is assumed, in the present embodiment of the invention, that the called subscriber's number for a given distant area always comprises the same number of digits. Depending, therefore, on the second direction digit dialed, the auxiliary sender will have to control the transfer of either four, five or six digits to the selectors of the distant area, which number of digits may eventually be followed by one or two P. B. X. suffixes. In case the second direction digit indicates that the fundamental subscriber's number comprises but four digits, a particular relay device in the auxiliary sender is made to operate and this relay device will take care that after the four digits which form the fundamental subscriber's number have been received, a timing switch is brought into action which, when operated after a certain delay, will prepare to advance the district selector circuit to the "talking" position and release the registers as soon as the last digit has been transferred to the distant office. When one P. B. X. suffix is dialed the timing switch is made to release the instant the fifth digit is received and then starts to act only after the reception of the first P. B. X. suffix. When two P. B. X. suffixes have been received, so that no further digits can be expected, the timing switch is not operated again, but the district selector will be advanced immediately after all of the received digits have been transferred to the distant office.

In a similar manner when the second direction digit indicates that the fundamental subscriber's number comprises five digits, another relay device will operate in the auxiliary sender and bring the timing switch into action for the first time after the fifth digit of the fundamental subscriber's number has been received. After this, two suffix digits may be dialed after which the auxiliary

sender will function in the same manner as indicated for a four digit subscriber's number. In case the second direction digit indicates that the fundamental subscriber's number comprises six digits, yet another relay device is made to operate in the auxiliary sender and takes care that the timing switch is brought into action after the reception of the sixth digit of the fundamental subscriber's number after which two suffix digits may be dialed in the same manner as already indicated.

It will be seen from the foregoing that the auxiliary sender must transfer the first two digits of the number of the wanted line under control of two counting relay registers in the main sender. The remaining digits are transferred to the office of the distant area under the control of the counting relay registers in the auxiliary sender.

The scope and purpose of the invention will be more clearly understood by a consideration of the following detailed description taken in connection with the attached drawings in which:—

Fig. 1 shows a district selector;

Figs. 2 and 3 show a main sender;

Figs. 4 and 5 show an auxiliary sender;

Fig. 6 shows a second office selector and a third office selector connected with an outgoing trunk to a distant office of a long distance area;

Fig. 7 shows the manner in which the various figures are to be arranged with reference to each other for a complete disclosure of the present embodiment of the invention.

In the disclosure of the main sender as shown in Figs. 2 and 3, two sequence switches of the well known type are used, one of which is designated as switch 236 and the other as switch 357. Section lines A—B and C—D run vertically through the center of each figure respectively in order to separate the cams belonging to each of these two switches. The cams mentioned in this description which are located to the left of the above named division lines belong to switch 236, while those to the right of the division lines belong to switch 357.

Connection of a calling subscriber's line with an idle main sender

When a subscriber initiates a call by removing his receiver, the calling line is extended in the well-known manner over a first-line finder, to the contact banks of a second line finder switch 2LF, shown on the left-hand side of Fig. 1. A circuit is then closed from battery in the first line finder, conductor 157, upper contacts of cam 120, left winding of relay 128, lower contacts of cam 118, left winding of relay 129 to ground. A circuit, in parallel with relays 128 and 129, is also closed for relay 130 from battery on the upper contacts of cam 120, winding of relay 130, right lower contact and cam 107, cam 108 and right lower contact thereof, back contacts of relay 131, lower contacts of cam 113 to ground. Relay 128 operates, locks over its left winding and left front contacts, short-circuits relay 129 and prepares, at its right outer front contacts, a circuit to operate sequence switch magnet 101 from ground on the left back contacts of relay 130, upper contacts of cam 112, right outer front contacts of relay 128 to the winding of switch magnet 101. Since, however, relay 130 is operated, switch magnet 101 is not operated at this time. Relay 130 closes, at its left front contacts, a circuit for the power magnet 132 of the second line finder 2LF from ground on its left front contacts, left upper and lower contacts of cam 104, winding of power magnet 132 to battery. Magnet 132 now operates and drives the brushes of the line finder 2LF which are connected to conductors 140, 154, 155 and 156, over the associated contact bank in search of the calling line.

As soon as terminal 141, connected with the calling line and marked by a battery potential, is reached by the brush connected to conductor 140, relay 131 operates in the following circuit: Battery through the connecting circuit of the first line finder connected to terminal 141, conductor 140 and associated brush, upper contacts of cam 121, left winding of relay 131, right upper and lower contacts of cam 113 to ground. Relay 131 on operating opens, at its back contacts the aforementioned circuit of relay 130 which now releases, thereby opening the circuit of power magnet 132 at its left front contacts and causing the brushes of the line finder to come to rest on the terminals connected with the calling line. The left back contacts of relay 130 now close the circuit of sequence switch magnet 101 which was prepared at the right outer front contacts of relay 130 as described above. Sequence switch 101 moves out of position 1 to position 3. In passing out of position 1 relay 128 releases by the opening of its circuit at the left upper contacts of cam 120. After position 2 has been passed, relay 131 releases because its circuit is opened at the right upper contact of cam 121 and, in position 2¼, a circuit is closed for relay 133 from ground at the back contacts of relay 134, left upper and right lower contacts of cam 114, right back contacts of relay 128, back contacts of relay 131, right lower contact of cam 108, cam 106 and the right lower contact thereof, winding of relay 133 to battery. Relay 133, on operating, closes an obvious circuit for relay 135. Relay 135, in turn, closes the circuit of the sender selector magnet 136 from the aforementioned ground on relay 134 over the path described for operating relay 133. Simultaneously with the closure of the circuit for relay 133, another circuit is closed from the same ground on the contacts of relay

134, upper contacts of cam 114, left outer contacts of relay 128, winding of relay 153, conductor 154 and associated brush, to a battery circuit extending back into the first line finder. Relay 153 operates and extends the calling line conductors to the district selector.

The sender selector switch meanwhile has started to hunt for an idle main sender (Figs. 2 and 3) the idle condition of which is characterized by a battery test potential on terminal 137. This test potential of an idle main sender is provided from battery through winding of relay 369, left inner back contacts of relay 348, right upper and left lower contacts of cam 302, resistance 304, conductor 374, conductor 137 and associated terminal. A parallel circuit is also closed from battery through resistance 375 to the right lower contact of cam 302 in position 1. When an idle main sender is found, relay 131 operates again over a circuit having battery on conductor 137 and associated terminal, conductor 158 and associated brush, left upper and right lower contacts of cam 110, left winding of relay 131, left contacts of relay 133, to ground at the left inner back contacts of relay 128. Relay 131, on operating, opens the aforetraced circuit of the sender selector magnet 136 which therefore stops. Relay 133 releases also and, in turn, releases relay 135 which, at its right contacts, closes a circuit for sequence switch magnet 101 from ground at the left back contacts of relay 130, right contacts of relay 135, lower contact of cam 103, cam 102, winding of magnet 101, battery. Sequence switch 101 therefore moves to position 4. The calling subscriber's loop is now extended over the upper contacts of cam 118 and the left upper and lower contacts of cam 119, brushes 138 and 139 of the sender selector into the main sender by way of conductor 267, middle winding 800 of tone coil winding of relay 200, battery, and conductor 268, right outer winding 801 of tone coil, winding of coil 206 to ground. Relay 200 operates over this circuit. Also, as soon as the district selector circuit reaches position 4, the following circuit from the main sender is closed to operate relay 159 of the district selector: ground on cam 274, cam 255 and left lower contact thereof, resistance 285, conductor 397 and associated terminal, conductor 151 and associated brush, right lower and left upper contacts of cam 117, winding of relay 159, battery. Relay 159 operates in this circuit and prevents the district selector sequence from moving beyond position 4 by opening the circuit for relay 130 at its back contacts.

Relay 369 operates in series with relay 131 over the testing circuit above traced and, in closing its front contacts, closes a circuit for relay 201 which may be traced as follows: ground on the middle inner front contacts of relay 369, conductor 372, resistance 202, left lower and right upper contacts of cam 246, right lower and upper contacts of cam 247, winding of relay 201, resistance 204, battery. Relay 203, with its low series resistance 205, is connected in parallel with relay 201 in this circuit so that the quantity of current which is passing through relay 201 rises to its full value slowly so that relay 201, after some delay, will close a ground on its front contacts to the left contact of cam 238, cam 237, to sequence switch magnet 236 and thereby move sequence switch 236 out of position 1. Relay 203 also operates in the aforetraced circuit. After position 1 has been passed, the circuit in which relay 369 was operated is opened at the left lower contact of cam 302 but relay 369 is held locked in series with resistance 304 over the following circuit: battery and winding of relay 369, left inner contacts of relay 348, outer front contacts of relay 369, lower contacts of cam 303, resistance 304, conductor 374, conductor 137 and associated contact, conductor 158 and associated brush through the right contacts of cam 160 to ground. At the same time resistance 375 to battery is connected in parallel to the above circuit through the right lower and upper contacts of cam 302 and the test potential resulting from the winding of relay 369 being in parallel with resistance 375 is maintained on conductor 137 until switch 236 has advanced beyond position 2½.

Relays 201 and 203 remain operated, therefore, in the circuit from the front contacts of relay 369 until the left lower contact of cam 246 opens after position 1½. Before this happens, however, a circuit has been closed from ground on the front contacts of relay 201 over the left lower and upper contacts of cam 247 to the winding of relay 201 so that this relay gets saturated during the time that the left lower and right upper contacts of cam 247 are closed simultaneously and will, therefore, release slowly after this circuit is opened. At the same time the ground on the front contacts of relay 201 is connected through the lower contacts of cam 247 directly to the winding of relay 203 so that this relay is maintained operated with full current flowing through its winding until relay 201 releases. When relay 201 releases, relay 203 will also release slowly and then provide a circuit for the sequence switch 236 to advance it out of position 2 from ground on its back contacts to the right upper contact of cam 238, cam 237, and winding of sequence switch magnet 236 to battery.

The above described operations in the main sender will take care that the sequence switch 236 arrives in position 3 with a sufficient delay to make certain that relay 200 is energized in series with the subscriber's loop before the back contacts of this relay are connected via the left upper contact of cam 245 to the sets of counting relays. In case, however,

that relay 200 should be energized before the sequence switch has succeeded in passing through position 2 it will provide a circuit on its front contacts to the upper contact of cam 240 to move the sequence switch without any further delay to position 3. In position 2¾ a circuit is closed for relay 203 from ground on the front contacts of relay 200 through the right lower and upper contacts of cam 246 and this relay will remain operated even while relay 200 releases during the delivery of impulses by the subscriber dialing a digit as described below. It will release only if the subscriber should make a premature release and thereby cause a very long break of the front contacts of relay 200. Sequence switch 236 is now advanced to position 5 by a ground at the right lower contact of cam 240, over the aforetraced path to cam 237.

In position 5, the primary winding 802 of the dial tone coil is excited over the upper contacts of cam 244 to tone source DT. The tone is repeated into the secondary 800 and tertiary 801 windings thereof and the subscriber receives the dialing tone in the well known manner.

In order to avoid confusion the reception of impulses will be described generally at first while the translation and modification thereof in connection with each type of call which the main sender is to handle will be considered under separate headings. It should be understood however, that the reception of impulses into the various sets of counting relays and their delivery for setting the various selectors actually takes place simultaneously.

The first digit is dialed in positions 5 and 6 of switch 236. A number of interruptions in the line, according to the digit dialed, causes relay 200 to release and to make its back contacts an equivalent number of times. When relay 200 makes its back contacts for the first time, it closes a circuit for relay 201 from ground on its back contacts, left upper and right lower contacts of cam 245, back contacts of relay 207 to the winding of relay 201. Relay 201 operates and closes an aforetraced circuit to magnet 236 thereby advancing sequence switch 236 from position 5 to position 6. Relay 201 will remain operated until the last impulse of the first digit is over and then closes an obvious circuit for switch 236 in position 6, which then advances to position 8, the switch being carried through position 7 by the grounded left upper contact of cam 237 in the well known manner. When relay 200 makes its back contacts for the first time, a circuit is also closed for the first counting relay 214 in parallel with relay 201. This circuit is traced as follows: Ground on back contacts of relay 200, left upper and right lower contacts of cam 245, back contacts of relay 207, upper contact and cam 247, cam 250 and left upper contact thereof, conductor 270, right back contacts of counting relay 219, left normally made contacts of relay 221, conductor 269, right back contacts of relay 215, winding of relay 214 to battery. Relay 214 operates and closes, on its left contacts, a holding circuit in series with relay 215. Relay 215, however, is kept short-circuited over its right back contacts and winding by the ground on the back contacts of relay 200 over the aforetraced pulsing circuit and also by ground supplied from the right lower contact of cam 251, left upper contact of cam 251, conductor 376, upper contacts of cam 359, conductor 377, right back contacts of relay 221, left contacts of relay 214 to the winding of relay 215. This short circuit is maintained until relay 200 reoperates after which relay 215 will operate, locking in series with relay 214 to ground on cam 251 over the aforetraced path and also advancing the pulsing conductor 269 connected with the back contacts of relay 200, to the next counting relay 212. In the same way, every interruption of the dial causes a pair of counting relays to operate. The fifth interruption causes relay 218 to operate over a circuit from ground on back contacts of relay 200 over the aforetraced circuit to conductor 269, the right front contacts on relays 215, 213, 211 and 209 in series, left inner back contacts of relay 220, winding of relay 218 to battery. When relay 218 operates, it operates relay 221 by closing ground on its left contacts. Relay 221, over its right front contacts, closes the aforetraced ground from cam 251 on conductor 377 to the winding of relay 220 and operates relay 220. The right back contacts of relay 221 open the holding circuit of all the counting relays locked up, other than that of relay 218 which holds from the ground on the back contacts of relay 200 now extended to the winding of relay 218 over the left front contacts of relay 221. During the period when relay 200 is on its back contacts for the fifth impulse and relay 218 is operating in consequence, relay 219 is held short-circuited by ground from cam 251 aforetraced to conductor 377 directly to one side of the winding of the said relay and by the ground from the back contacts of relay 200 through the left front contacts of relay 221, front contacts of relay 218 to the other side of the winding of the said relay. Consequently, when relay 220 operates, the short circuit around relay 219 is removed and this relay then operates in series with relay 218 from battery on the winding of relay 218, winding of both relays in series thru the right contacts of relay 218 to ground on cam 251 through conductor 377. Relays 218 and 219 are now locked over this circuit. By the operation of relay 219, the pulsing conductor 270 is transferred from conductor 269 to conductor 271 and the next impulse is directed to relay 216 and its hold-

ing ground is directly connected to conductor 377. The holding ground for the other counting relays is also to conductor 377 but this time through the left front contacts of relay 219. The counting operation then proceeds until all the impulses of the digit have been received by the set of relays.

When the dialing of the digit is terminated, relay 200 reoperates over the subscriber's loop and relay 201 releases a short interval thereafter. Relay 201 closes a ground path to the switch magnet 236 by way of cam 238 as already described and causes switch 236 to advance from position 6 to position 8. When relay 201 releases certain checks are made to see which digit has been dialed, as the first digit determines the character of the call that is in progress. Every kind of call may require a different translation depending on the relationship between trunk levels and available normal counting relays and this will be described in connection with the selections for the different classes of calls above enumerated. Postponing to a later part of this description the particular character of any call, we will describe, at the present time, the successive registration of a number in the main sender with respect to the manner in which successive digits are recorded on the various sets of counting relays.

In position 8 of switch 236, the back contact of the instepping relay 200, is connected to relay 201 and to the second set of counting relays through the following path: ground and back contacts of relay 200, left upper and right lower contacts of cam 245, back contacts of relay 207, upper contact and cam 247, cam 250 and right upper contact thereof, left outer back contacts of relay 230, conductor 384 to the right back contacts of counting relay 315. When the second digit is dialed, a certain number of the second set of counting relays are made to operate in the same manner as described for the first digit. At the same time relay 201 operates in the aforementioned circuit, advancing sequence switch 236 to position 9 and when the second digit has been dialed, relay 201 releases again and advance sequence switch 236 to position 10 over the circuit previously described.

The third digit is received in position 10 and 11 of switch 236 on the third set of counting relays 318—331 and in a similar way to that described for the first digit. The circuit from the back contacts of relay 200 may be traced as follows: ground and back contacts of relay 200, left upper and right lower contacts of cam 245, back contacts of relay 207, upper contact and cam 247, cam 250 and left lower contact thereof, right inner back contacts of relay 228, conductor 382, to right back contacts of counting relay 329.

The fourth digit is received in positions 12 and 13 of switch 236 on the fourth set of counting relays 332—346 in the following circuit: ground and back contacts of relay 200, left upper and right lower contacts of cam 245, back contacts of relay 207, upper contact and cam 247, cam 250 and right lower contact thereof, left back contacts of relay 228, conductor 383, to the left back contacts of counting relay 344.

The fifth digit is received in positions 14 and 15 of switch 236 on the first set of counting relays 208—221. As explained more fully hereinafter, by the time that the subscriber is ready to dial the fifth digit, the first set of counting relays will have already functioned to make selections controlled by the first digit recorded therein and will have released so that these relays are again available for registration and the fifth digit is recorded therein and the corresponding selection controlled by them. The circuit from the back contacts of relay 200 may be traced as follows: ground and back contacts of relay 200, left upper and right lower contacts of cam 245, back contacts of relay 207, upper contact and cam 247, cam 250 and left upper contacts thereof to the right back contacts of relay 219. At the end of the fifth digit, relay 201 releases and thereby advances sequence switch 236 to position 16 where it will wait until the selection has been completed or until the subscriber releases.

Translation and selection

The translation and selection will now be described for certain kinds of calls which the main and auxiliary senders are designed to handle.

Long distance call

A long distance call is characterized by the first digit dialed being zero, so that, when the subscriber has finished dialing the first digit, all the counting relays of the first set 208—221 are locked as well as the locally held relays 220 and 221. A path is now closed for relay 347 from ground at the front contacts of relay 220, left front contacts of relay 209 and left upper and lower contacts of cam 233 conductor 803, conductor 378, winding of relay 347 to battery. Relay 347 operates and locks over the following circuit: ground and cam 251, cam 242 and left upper contact thereof, conductor 380, left outer front contacts of relay 347, conductor 803, conductor 378 to winding of relay 347. This locking ground is also extended to conductor 381 by way of the right outer front contacts of relay 347 to the winding of relay 230 which relay also operates. Relay 230, in turn, operates relay 228 over an obvious circuit. Relay 347 operates relays 222 and 355 in parallel from its grounded inner left front contacts extending to conductor 379.

In accordance with the routes to be used and the levels to be reached by the various selectors for the completion of certain classes

of calls, a long distance call requires, in the present embodiment of the invention, three settings in the originating office, namely, one on the district selector, another on the special service second office selector and still another on the third office selector. The reason for this is the fact that the trunks towards the various distant areas are taken off the banks of the third office selector which are reached, in the present example, over level 10 of the district selector and level 3 of the special service second office selectors. This means that the main sender must be able to control three selections before any digit of the distant subscriber's number is sent out to the distant office. The first two digits which are dialed and which indicate the direction of the call must, therefore, control these three selections. Since each set of counting relays controls one selection, it is necessary to reserve one set of counting relays for the artificial selection so that provision must be made to register the second direction digit on the third set of counting relays 318—331. Likewise, provision is made to register the third digit on the fourth set of counting relays 332—346 and the fourth digit on the first of counting relays 208—221. Relays 208—221, as already explained are used twice so that by the time the subscriber is ready to dial the fourth digit of the long distance call, that is, the second digit of the wanted subscriber number, it will be registered on relays 208—221. Consequently, the operation of relays 228 and 230 take care that the back contacts of the instepping relay 200 for the second digit, is changed over from the second to the third set of counting relays 318—331. The various paths involved for the pulsing ground on the contacts of relay 200 are as follows: Second digit; ground and back contacts of relay 200, left upper and right lower contacts of cam 245, back contacts of relay 207, right upper contact and cam 247, cam 250 and right upper contact thereof, right outer front contacts of relay 230, conductor 382 to the right back contacts of counting relay 329 of the third set of counting relays. Third digit; ground and back contacts of relay 200, left upper and right lower contacts of cam 245, back contacts of relay 207, right upper contact and cam 247, cam 250 and left lower contact thereof, left front contacts of relay 228, conductor 383 to the right back contacts of relay 344 of the fourth set of counting relays. Fourth digit; ground and left back contacts of relay 200, left upper and right lower contacts of cam 245, back contacts of relay 207, right upper contact and cam 247, cam 250 and right lower contact thereof, right middle front contacts of relay 228 to the right back contacts of relay 219 of the first set of counting relays.

When relay 355 operates after the dialing of the first digit, it places a battery over two parallel resistances 369 and 370 over the two back contacts of relay 354 on conductor 393 associated with the test terminal in the auxiliary sender connecting finder banks. At the same time the starting circuit for these finders is energized over another resistance 385. Relay 526 energizes in series with resistance 385 over conductor 588 and operates the starting relays 525 which close the circuit for the power magnets 543 of all free auxiliary senders. As soon as one finder arrives on the test terminal of the calling main sender, relay 527 operates from ground on its left winding, lower contacts of cam 551, test conductor 567 and connecting brush, conductor 392 and associated terminal, left outer back contacts of relay 354, parallel resistances 369 and 370 to battery. The operation of relays 527 breaks the circuit of the finder magnet 543 at its back contacts and stops the finder switch. When relay 527 makes its front contacts, a circuit is closed through its right low resistance winding in series with the winding of relay 529. This circuit is again in parallel with the left winding of relay 527, conductor 567 and associated connecting brush. This reduces the effective resistance to the test terminal and makes it test busy for all other finders, and, due to the presence of the low resistance potential, relays 527 of other auxiliary senders will not operate on testing the terminal and will thereby cause the finders to pass by the main sender which is now connected with an auxiliary sender. Relay 529 operates in the above circuit and, in turn, closes a circuit for relay 530 from ground on contacts of relay 529, right lower and left upper contacts of cam 550, winding of relay 530, resistance 563 to battery. Relay 530, on operating, operates relay 454 over a circuit from ground on its left inner front contacts, conductor 568 to the winding of relay 454 which connects the remaining brushes of the auxiliary sender finder through to the main sender circuit. To start the auxiliary sender, sequence switch 544 is advanced from position 1 to position 2 over a circuit from ground on the right outer front contacts of relay 530, left upper contact and cam 549, cam 548, winding of magnet 544. The holding brush associated with conductor 569 is connected through the left outer front contacts of relay 530 over the left upper and right lower contacts of cam 551 in parallel with test conductor 567 so that the auxiliary sender after position 2 is held over the circuit associated with conductor 569. Relay 530 also connects a ground from its right inner front contacts to the left lower contact of cam 556. Since cams 555, 556, 558 and 468 are connected together, this ground is extended to these cams also.

While these operations have been taking place, the subscriber has been dialing the long distance number, recording the first

four digits of that number on the various sets of counting relays of the main sender and simultaneously selections have been taking place under the control of the digits previously dialed. When the fourth digit has been dialed, sequence switch 236 is advanced to position 14 and relay 207 is operated over the following circuit: ground on cam 251 and left lower contact thereof, left outer front contacts of relay 222, winding of relay 207 to battery. Relay 207, on operating, transfers the in-dialing pulsing conductor over its left front contacts directly to a conductor which is now connected to its associated terminal on the auxiliary finder bank with brush and associated conductor 471 of the connected auxiliary sender. Since the operations for connecting an auxiliary sender to the main sender were started after the reception of the first digit indicating a long distance call, an auxiliary sender is waiting and ready to receive dial impulses when the subscriber is ready to dial the fifth digit. When, therefore, relays 530 and 454 are operated, the circuit is ready to receive the various digits that the calling subscriber will dial into the auxiliary sender, since the in-dialing circuit from the back contacts of relay 200 in the main sender is now connected to the auxiliary sender over the following circuit: ground and back contacts of relay 200, left upper and right lower contacts of cam 245, left front contacts of relay 207, brush of connecting finder and associated conductor 471, left outer front contacts of relay 454, conductor 475 through the chain of outer right back contacts of relays 453, 452, 451, 450, 449 and 448 to the right back contacts of counting relay 411.

Before describing the operations which take place in the auxiliary sender, we will describe the various selections which take place as a result of the subscriber having dialed four of the digits into the main sender understanding however, that the operations of dialing and selecting take place simultaneously. After the first digit is dialed, sequence switch 357 is started from position 1 over the following circuit by sequence switch 236 arriving in position 8: ground on cam 251, conductor 373, cam 301 and right lower contact thereof, left lower contact and cam 363, cam 365, winding of magnet 357. Switch 357 stops in position 2¼ which is the first selection position for long distance calls and this selection is made under the control of the first set of counting relays 208—221. All of these relays were energized owing to the digit zero having been dialed and the tenth level of the district selector must be selected. The locking ground for the first set of counting relays is furnished over two paths in position 2¼ of switch 357, the first by way of conductor 377, upper contacts of cam 359 to ground on cam 251 as already described, and the second over conductor 376, conductor 386, left outer back contacts of relay 347, conductor 380, upper left contact and cam 242 to ground on cam 251. After the first digit is dialed and position 6 has been passed by sequence switch 236, the first holding circuit is opened at the upper left contact of cam 251. However, due to the fact that zero has been dialed and relay 347 operated in consequence, the second holding path is also opened at its left back contact. All of the counting relays 208—221 will, therefore, release and thereby make it possible for the selector whose operation is controlled by these relays to take ten steps. However, there is another pair of counting relays, used in common with all others, which also requires a pulse for their operation. This pair of relays is relay 223 and 224 and will be used, as described hereinafter, to cooperate with the first set of counting relays in the selection operation. Since all the counting relays of the first set are normal and counting relays 223 and 224 are used also, the selector would take eleven steps to satisfy the counting relay register.

It becomes necessary, therefore, that in arranging for the selection of the tenth level at the district selector bank one pair of counting relays will have to be operated artificially before selections begin. When, therefore, switch 357 advances from position 1 to position 2¼ and passes position 1⅝ a passing circuit is closed from ground on the lower right contact of cam 274, both left contacts of cam 274, right outer front contacts of relay 222, right back contacts of relay 217 to counting relay 216. When the switch leaves position 1⅝ ground is removed and counting relay 217 operates in series with relay 216 and both relays lock to ground on cam 251 over the holding circuit already described. The selection of the tenth level of the district selector bank will take place with relays 216 and 217 operated, thus insuring, as described below, the taking of ten steps by the district selector.

When sequence switch 357 arrives in position 2¼, the main sender is ready to control the operations of the district selector to select the tenth level and the out stepping or fundamental circuit is closed. This circuit is as follows: battery on the left lower and right upper contacts of cam 120, winding of relay 130, right lower contact and cam 107, cam 106 and right upper contact thereof, conductor 142 and associated brush, conductor 143 and associated terminal, left outer back contacts of relay 226, right back contacts of relay 224, winding of relay 225, resistance 272, left lower contact and cam 256, cam 274 to ground. The front contact of the out-stepping relay 225 is now connected to the first set of counting relays in the following circuit: front contacts of relay 225, left upper and lower contacts of cam 241, left and right

lower contacts of cam 254, left back contacts of relay 235 to the right back contacts of counting relay 219. Relay 130 operates in the fundamental circuit, closes a ground to magnet 101 which advances the sequence switch 101 to position 5 over an aforetraced circuit and connects the trip spindle magnet 140 to the left front contact of relay 130 by way of the upper contacts of cam 104. Trip spindle magnet 140 rotates the trip spindle and connects, at each step, a temporary ground from the spindle interrupter 141 to the fundamental circuit. This ground maintains relay 130 operated and, at the same time, short circuits the out stepping relay 225 by passing the spindle interrupter ground 141 to conductors 142 and 143 by way of cam 107 and left lower contact thereof and right front contacts of relay 130 so that relay 225 will release for every step taken by the trip spindle. It will be seen that the counting relays will now work under similar conditions when out stepping as they did when receiving the impulses from the in stepping relay 200. Since the first digit dialed is zero and all the counting relays are released except relays 216 and 217, as already described, the counting operation begins with relay 214 as in indialing. The fifth impulse is absorbed by relays 218 and 219 but relays 216 and 217 do not release with the operation of relays 220 and 221 but are locked to holding ground on cam 251 through conductor 377 as previously described. On the tenth impulse, the ground from the out stepping relay 225 is connected to the winding of relay 223 by way of the right front contacts of relay 209, left inner front contacts of relay 220, left upper and lower contacts of cam 266, left back contacts of relay 224 to the winding of relay 223. On the tenth impulse relay 223 operates. Relay 224 is maintained short circuited by ground on cam 274 through cam 256 and left upper contact thereof through the left front contacts of relay 223. When relay 225 releases, this short circuit is removed and relay 224 operates in series with relay 223 to ground on cam 274.

The fundamental circuit is now opened at the right back contacts of relay 224, relay 130 releases and the trip spindle 140 stops. The front contacts of relay 224 start sequence switch 357 from position 2¼ by closing ground on the left middle back contacts of relay 226, front contacts of relay 224, conductor 273, left upper contact and cam 364, cam 365 and left lower contact thereof to magnet 357. Switch 357 advances to position 3¼ and the first set of counting relays are then released when the holding circuit for these relays is opened at the right upper contact of cam 359 after passing position 2¼.

Meanwhile the district selector, with the release of relay 130, advances the sequence switch 101 to position 8 by way of ground on the left back contacts of relay 130, right back contacts of relay 135, lower contact and cam 103, cam 102, to the winding of magnet 101. The district selector then advances to the hunting position for the selection of an idle trunk on the tenth level and eventually to the selection beyond position in the known manner; the hunting of the district selector for an idle trunk not taking place under the control of the sender.

The sequence switch 357 stops in position 3¼ until the sequence switch 236 arrives in position 9 indicating that the second or thousands digit has been received.

When the second digit is dialed, switch 236 is advanced to position 10 by the release of relay 201 at the end of the digit over a circuit previously described. Switch 357 is advanced from position 2¼ to position 5½ by ground on cam 251, conductor 373, cam 301 and left upper contact thereof, right upper contact of cam 363, cam 365 to winding of switch magnet 357. Second digit selections can now be made, the fundamental circuit being closed once more and the third level of the special service second office selector bank is selected. The second selection is controlled by the second set of counting relays of which none are energized by any digit received since, as already noted, the second digit is directed into the third set of counting relays. The third level of the special service second office selector must be selected and, in order to do this, conductor 387 from the front contact of counting relay 312 is disconnected from the armature of counting relay 311 at the left back contacts of relay 222 and is now connected via the left front contacts of relay 222 and the upper right and left contacts of cam 254 directly to relays 223 and 224. This means that after two pairs of counting relays have been energized the front contact of relay 225 is connected to relays 223 and 224 for the third impulse so that the fundamental circuit is opened after the third step of the trip spindle of the special service second office selector. The fundamental circuit path is as follows: battery through the winding of a relay in the special service second office selector similar to relay 130, conductor and terminal 144, brush and associated conductor 145, right upper and lower contacts of cam 105, conductor 142 and associated brush, conductor 143 and associated terminal, left outer back contacts of relay 226, right outer back contacts of relay 224, winding of relay 225, left inner back contacts of relay 229, upper contacts of cam 257, right back contacts of relay 226, conductor 146 and associated terminal, conductor 147 and associated brush, right lower and upper contacts of cam 150, conductor 148 and associated brush, conductor 149 and associated terminal to ground

in the special service second office selector. The front contact of the stepping relay 225 is now connected to the second set of counting relays 304—317 over the following path: ground on contacts of relay 225, upper contacts of cam 241, left lower and upper contacts of cam 258, conductor 275, left outer back contacts of relay 349, conductor 388, right outer back contacts of relay 232, conductor 384, to the right back contacts of counting relay 315. The fundamental circuit now functions and during the operation of the special service office selector counting relays 313, 307, 312 and 306 are operated. On the third impulse the ground from relay 225 is directed over the front contacts of relay 312, over a circuit previously traced to the winding of relay 223 operating this relay. When the impulse is terminated, relay 224 operates as already described in connection with the description of the first digit and the circuit from ground on the left back contacts of relay 226 to cam 364, previously described, is now closed to advance sequence switch 357 to position 6¾. The counting relays are unlocked when switch 357 passes position 5½ by the opening of the locking ground at the right upper contact of cam 360. The special service office selector now trunk hunts for an idle third office selector and when one is found and seized, a metallic loop is provided causing relay 227 to operate in the following circuit: ground and winding of relay 227, right lower and upper contacts of cam 257, right outer back contacts of relay 226, conductor 146 and associated terminal, right lower and upper contacts of cam 150, conductor 148 and associated brush, conductor 149 and associated terminal and brush, conductor 625 and associated terminal, loop within the special service second office selector circuit to conductor 620 and associated terminal, conductor 144 and associated brush and terminal, conductor 145 and associated brush, right upper and lower contacts of cam 105, conductor 142 and associated brush, conductor 143 and associated terminal, left back contact of relay 226, right back contacts of relay 224, left lower and upper contacts of cam 259, resistance 294 to battery. Relay 227 operates in this circuit and closes ground on its contacts to conductor 279, upper contacts of cam 367 to the winding of relay 356. Relay 356 operates, locks over its right front contacts to the same operating ground and, at its left front contacts, closes a circuit to the winding of magnet 357 from ground on cam 274, conductor 289, cam 358 and left lower contact thereof, left front contacts of relay 356 to the winding of magnet 357. The operation of the magnet now advances switch 357 to position 7¾. Relay 356 is released and another circuit to magnet 357 is now closed in position 7¾ from ground on cam 251, conductor 373, cam 301 and left lower contact thereof, left front contacts of relay 354, lower contacts of cam 368, left back contacts of relay 356 to the winding of magnet 357. Switch 357 advances to position 10¼.

The selections at the third office selector take place under the control of the third set of counting relays 318—331 on which, it will be recalled, the second digit is recorded. Also, the level chosen at the banks of this selector is a function of the digit dialed in respect to the fact that the counting relay setting is to be modified depending upon whether the digit dialed is zero. When switch 357 advances from position 5½ to 10¼, a check is made to determine the character of the second digit. If the digit is zero, relay 369 operates over the following circuit: battery and winding of relay 369, left inner back contacts of relay 348, upper contacts of cam 302, front contacts of relay 389, which is a relay operated from the front contacts of relay 318, to ground on the left front contact of relay 371, which is a relay operated from the front contacts of relay 322. Relay 369 locks over its outer front contact to ground on the right upper contacts of cam 303. The holding ground for the third set of counting relays is controlled directly from the left lower contact of cam 359 from position 1 to 7¾ and 8¾ to 10¼ and over the back contacts of relay 369 and right lower contact of cam 359 in position 7¾ to 8¾ and thence back to the left upper contact of cam 359 to conductor 376 which is the connecting conductor for ground on cam 251. Consequently, as switch 357 advances between positions 7¾ to 8¾ the locking circuit depends on the condition of relay 369. If this relay is operated because the digit is zero, all the counting relays of the third set will release. Otherwise, they will remain locked to the holding circuit on the left lower contact of cam 359 when position 8¾ is passed. With all the counting relays released, ten selection impulses can be received. It will be remembered, however, that the release of all counting relays furnishes eleven impulses in all, so that it is necessary to utilize but ten impulses to reach the tenth level. When switch 357 passes position 9⅝, therefore, a passing circuit is closed from ground on cam 251 over conductor 373, cam 301 and left lower contact thereof, right outer back contacts of relay 348, upper contacts of cam 361, left inner back contacts of relay 351, right back contacts of relay 328 to the winding of relay 322. Relay 322 operates and when the switch passes position 9⅝ and ground is removed, relay 328 operates and locks in series with relay 322. This operation will permit the third office selector to choose the tenth level in case the second digit dialed is zero.

Selections by the third office selector now take place in position 10¼ of switch 357, the

fundamental circuit being closed over the following path: battery to the winding of a relay similar to relay 130 in the third office selector over conductor 620 and associated terminal, conductor 144 and associated brush and terminal, conductor 145 and associated brush, right upper and lower contacts of cam 105, conductor 142 and associated brush, conductor 143 and associated terminal, left back contacts of relay 226, right outer back contacts of relay 224, winding of relay 225, left inner back contacts of relay 229, upper contacts of cam 257, right outer back contacts of relay 226, conductor 146 and associated terminal, conductor 147 and associated brush, right lower and upper contacts of cam 150, conductor 148 and associated brush, conductor 149 and associated terminal and brush, to ground, not shown, in the third office selector. The front contact of the outstepping relay 225 is directed to the third set of counting relays over the following path: ground on contacts of relay 225, upper contacts of cam 241, left lower and right upper contacts of cam 258, conductor 382, to the right back contacts of relay 329. Pulsing operations between the main sender and the third office selector now take place in the same manner as previously described for selections at the two preceding selector stages. When the number of revertive impulses necessary to satisfy the main sender have been received, the fundamental circuit is opened by the operation of relay 224 as previously described and an aforetraced circuit is closed from ground on the contacts of relay 226 to advance switch 357 to position 11½. In position 11½ the switch 357 stops during the interval that the third office selector hunts for an idle outgoing trunk to the distant office. When connection to said trunk has been made, a loop circuit is closed in the third office selector for a series circuit between relay 227 and resistance 294 as in a previous selection and operates relay 227. Relay 227 closes a ground on its front contacts to conductor 279, upper contacts of cam 367, winding of relay 356 to battery. Relay 356 operates and locks to the same operating ground and, on its left front contacts, closes a ground from cam 274, cam 358 and left lower contact thereof, left front contacts of relay 356 to the winding of magnet 357 thereby advancing switch 357 to position 12½. As the switch passes from position 11½, the circuit of relay 227 is opened at the right lower contact of cam 257 thereby causing this relay to release as likewise relay 356 will release also. When the switch reaches position 12½ a ground on the right inner front contact of relay 222 is closed on conductor 280 to the upper left and lower right contacts of cam 368, the back contacts of relay 356 to the winding of magnet 357, advancing switch 357 to position 13½. In position 13½ a circuit is closed to operate relay 226 from ground on the left inner front contacts of relay 347, conductor 379, right upper and lower contacts of cam 259, winding of relay 226 to battery. Relay 226 operates and serves to control operations from the auxiliary sender as described hereinafter.

The connection has now been extended through the district selector, the special service second office selector and a third office selector to the outgoing trunk shown in Fig. 6 which trunk extends to the automatic switches in the distant terminating office over conductors 621 and 622.

We will now describe the operations which take place in the auxiliary sender, understanding that these operations have been taking place simultaneously with those described above.

In the first place, it is necessary to indicate to the auxiliary sender how many digits will comprise the number of the wanted subscriber since all of these digits have to be repeated to the distant office. This information depends on the character of the second digit dialed. When, therefore, sequence switch 357 completes special service second office selections in position 5½ and thereafter advances to position 10¼, a check is made to determine if the digit is more than four or less than five. If the digit dialed is more than four, counting relay 330 is operated and the following circuit is closed for relay 352; battery and winding of relay 352, right inner front contacts of relay 330, right outer back contacts of relay 354, conductor 390, right middle front contacts of relay 222, right lower contact and cam 242, cam 251 to ground. On the other hand, if the digit is less than five, relay 330 will be normal and the following circuit is closed for relay 353; battery and winding of relay 353, left outer back contacts of relay 330, right outer back contacts of relay 354, conductor 390, right middle front contact of relay 222, right lower contact and cam 242, cam 251, ground. The contacts of relay 353 and those of relay 352 are wired to the counting relays 318—331 in such a manner that the relays operated in response to the number of impulses constituting the second digit will ground the correspondingly numbered terminal 1, 2 . . . 0 of the contacts of these relays. Now the wanted subscriber's number may consist of either 4, 5 or 6 digits as already described, so that these terminals are cross-connected to conductors 276, 277 and 278 in any manner suitable to the operating company in respect to the relation between the numerical value of the second digit and its corresponding interpretation in terms of the fundamental equivalent number of 4, 5 or 6 digits. Conductor 278 will be grounded if the fundamental subscriber number is to be

four digits, conductor 277 will be grounded for five digits and conductor 276 will be grounded for six digits. According, therefore, to the second digit received, a ground will be connected to one of the three conductors and associated terminals 278, or 277 or 276. Ground on conductor 278, if the fundamental number is to be a four-digit number, operates relay 455 over the following circuit: ground on conductor 278 and associated terminal on auxiliary finder bank, conductor 473 and associated brush, middle right contacts of relay 454, conductor 570, upper contacts of cam 557 conductor 486 winding of relay 455 to battery. Ground on conductor 277, if the fundamental number is to be a five-digit number, operates relay 456 over the following circuit: ground on conductor 277 and associated terminal on the auxiliary finder bank, conductor 474 and associated brush, right inner contacts of relay 454, conductor 571, conductor 572, left upper and right lower contacts of cam 553, conductor 573, winding of 456 to battery. Finally, ground on conductor 276, if the fundamental number is to be a six-digit number, operates relay 457 over the following circuit: ground on conductor 276 and associated terminal on the auxiliary sender finder bank, conductor 472 and associated brush, right outer contacts of relay 454, conductor 574, right lower and left upper contacts of cam 463, winding of relay 457 to battery. When any one of these relays operates it locks to ground on cam 558 over the right upper contact of cam 468, conductor 476 to ground on cam 558. Any one of these relays also closes the following circuit to switch magnet 544 to advance the switch from position 2 to position 4: ground through the left lower and upper contacts of cam 566 of the impulse switch 545 which is normal, conductor 575 and left inner contacts of either relay 455, 456 or 457, left lower contact and cam 460, conductor 477, cam 561 and left upper contact thereof, to the winding of magnet 544. If, for any reason, impulse switch 545 is not in the normal position, sequence switch 544 will stop in position 2 and a ground is applied from the left upper contact of cam 555 over the left outer back contacts of relay 542 and right back contacts of relay 535 to the left upper contact of cam 565 causing switch 545 to be advanced to position 1 immediately after it had arrived in position 18.

When position 2 is passed, the circuit over test brush associated with conductor 567 is opened at the left lower contact of cam 551 so that the circuit is now holding thru the circuit over conductor 569 and associated terminal from this moment. Further, while pasing thru positions 2 and 3, ground from the right outer front contacts of relay 530 is transferred to the right upper contact of cam 550 independent of relay 529. In position 3 relay 528 is connected in parallel with the test relay 527 over the right upper contacts of cam 551 and the left outer front contact of relay 530 to conductor 569 so that this relay now operates and prepares, on its front contacts, a holding circuit for relay 530 over the right outer front contacts of relay 530 and the left lower contact of cam 550. After position 2¾ is passed, relay 527 is disconnected and, when the right upper contact of cam 550 opens, the holding circuit of relay 530 is now controlled exclusively by relay 528 which, in turn, is held energized from the main sender. Relay 528 is such that it will hold in series with high resistance 369, and test brush associated with conductor 567 is now entirely insolated.

Sequence switch 544 now waits in position 4 until the main sender has completed the selections to the outgoing trunk circuit towards the distant area, as already described, and has connected the fundamental circuit from this trunk circuit through conductors 473 and 474 and their respective associated brushes. Further, when switch 544 arrives in position 3½, a passing circuit is closed from ground on the left upper and lower contacts of cam 566, conductor 575, left inner front contacts of either relay 455, 456 or 457, left lower contact and cam 460, conductor 477, cam 561 and left lower contact thereof, left middle front contacts of relay 530, conductor 576 and associated brush, conductor 391 and associated terminal, right upper and lower contacts of cam 366, winding of relay 354 to battery. Relay 354 operates and locks over its right outer front contacts, conductor 390, right middle front contacts of relay 222, right lower contacts and cam 242 to ground on cam 251. Relay 354 opens, at its right outer front contacts, the circuit of relays 352 and 353 so that the brushes connected to conductors 278, 277 and 276 are free from this moment and are available for other uses.

We will now describe how the various digits, which will be received in the auxiliary sender, are stored in the sets of counting relays of the auxiliary sender and how, thereafter, the fundamental subscriber's number is repeated to the distant office.

The counting relay registering circuit of the first digit that has to be stored in the auxiliary sender is directed from the back contacts of relay 200 over the front contact of relay 207 to conductor 471 and associated brush over the indialing pulsing circuit previously described. The impulses, when arriving, will operate relay 524 which is connected to conductor 471 and associated brush by way of conductor 478. The impulses will also be sent over the back contacts of relays 453, 452, 451, 450, 449 and 448 to the first set of counting relays 401—410 in a similar manner to that already described in connection with the storing of impulses in the various

sets of counting relays in the main sender. When the series of impulses which forms the first digit dialed in the auxiliary sender is over, relay 524 releases and completes a circuit from ground on its back contacts, conductor 577, right front contacts of one of the upper set of counting relays and left inner back contacts to the winding of relay 448. Relay 448 operates and locks over its outer left front contacts, which are made to close before the back contacts mentioned above are opened. Relay 448, by energizing, transfers the in-dialing circuit on conductor 471 and associated brush to the next set of counting relays 413—422. The second digit will now be stored on this set of relays and, at the end of the digit, relay 524, by again releasing, will close a circuit for relay 449 over conductor 577 and a counting relay in the upper set of the second set of counting relays. Relay 449 locks in the same way as described for relay 448. Relay 449, by operating, transfers the in-dialing circuit to the next set of counting relays 425—434 and, in the same manner as described, the next digit is stored on this set of counting relays.

When switch 544 arrives in position 4 as already described and the connection has been extended to the outgoing trunk shown in Figure 6, the low resistance winding of relay 533 is connected in series with relay 610 of the outgoing trunk circuit. The path is traced as follows: ground through the winding of relay 533, left lower and upper contacts of cam 560, conductor 571, inner right contacts of relay 454, conductor 474 and associated brush, conductor 277 and associated terminal, right outer front contacts of relay 226, conductor 146 and associated terminal, conductor 147 and associated brush, right lower and upper contacts of cam 150, conductor 148 and associated brush, conductor 149 and associated terminal and brush conductor 625 and associated terminal and brush, conductor 624 and associated terminal, top back contacts of relay 600, repeating coil winding 618, winding of relay 610 to battery. Relay 533 energizes in the above circuit and advances sequence switch 544 from position 4 to position 8 in a circuit from ground on cam 558, cam 556 and right upper contact thereof, right front contacts of relay 533, winding of magnet 544 to battery.

In the trunk circuit, relay 610 energizes and, in turn, energizes relay 616 from ground on its right inner front contacts through the right back contacts of relay 617 to the winding of relay 616. In the meanwhile, when the third office selector established a connection with the outgoing trunk, a ground from the third office selector was passed over conductor 623 through the normally made left contacts of relay 617 to the winding of relay 615, causing 615 to operate and lock to the same ground over its left front contacts and left normal contacts of relay 614. Relay 616 when operated, removes ground from the winding of relay 614 at its left back contacts. The third office selector, provides a battery impulse through a resistance, not shown, on conductor 620 towards the trunk circuit after relays 610 and 616 are energized and have removed ground to relay 614 so that relay 614 is prevented from energizing on this battery impulse. Relay 610, when energized, provides a ground from the right outer back contacts of relay 612 over the left front contacts of relay 610 to the winding of relay 602 which operates and connects trunk line conductors 621 and 622 over its top and bottom front contacts respectively and back contacts of relay 604 to a source of alternating current 634. The alternating current impulse which is thus sent out on the line will start the call at the distant end and cause the connection of a sender or selector or both at that end to the trunk line conductors 621 and 622. Further, relay 602 by energizing, opens a ground on its bottom inner contacts which would otherwise be connected over the right front contacts of relay 610 to the winding of relay 614 and cause relay 614 to operate over the battery impulse above mentioned.

In the auxiliary sender, relay 533 is disconnected from conductor 571, conductor 474 and its associated brush after the switch passes position 7. The period between positions 4 and 8 of switch 544 is long enough to insure that the battery impulses mentioned above on conductor 620 have terminated when ground is disconnected from conductor 474 in the auxiliary sender, thus causing the release of relays 610 and 602 in the outgoing trunk. Relay 616 will then lock over its left front contacts through the right winding of relay 617 to ground on the right front contacts of relay 615. Relay 617 operates and applies a ground over its right outer front contacts and the right front contacts of relay 616 to the winding of relay 614. At the same time, the operating circuit of relay 615 is opened at its left contacts so that this relay is left locked through its left front contacts only and relay 617 is connected with its left high resistance winding to conductor 623. This circuit condition will now remain unchanged so long as the ground is left connected to conductor 623 from the third office selector. Further, relay 617 connects a ground from its right outer front contacts over the right back contacts of relays 613 and 608 to the winding of relay 601 which thereby operates and connects the alternating current relay 606 across conductors 621 and 622 of the trunk.

As soon as the impulse receiving equipment at the distant end of the trunk has been connected to the trunk line conductors 621 and 622 and is ready to receive the impulses

of the wanted subscriber's number, this condition is signalled back to the outgoing trunk in the home area by the transmission thereto of an alternating current impulse. This alternating current impulse causes the operation of relay 606 which, in turn, operates relay 605. Relay 605 operates relay 607 over a circuit from ground on the contacts of relay 605, left outer back contacts of relay 609, left inner normal contacts of relay 612, left outer back contacts of relay 608, winding of relay 607 to battery. When the alternating current impulse is terminated, relays 606 and 605 release and, by releasing, cause relay 607 to operate in series with relay 608 in the following circuit: battery, winding of relay 607, winding of relay 608, left front contacts of relay 607, back contacts of relay 603, right front contacts of relay 617 to ground. Relay 608, on operating at the end of the alternating current impulse, also opens the circuit for relay 601 at its right inner back contacts, causing it to release. It also operates relay 600 by way of its left inner front contacts to ground on the right front contacts of relay 615. Relay 600, on operating, connects the stepping relay 604 in series with both windings of the differential relay 603 to conductors 624 and 626 of the fundamental circuit towards the main and auxiliary senders. The stepping relay 604 has to control the transmission of alternating current impulses to the distant area. This relay has two windings the right winding of which is connected to conductor 624 and is in series with ground through the upper winding of relay 604, while the winding connected to conductor 626 is in series with battery through the lower winding of relay 604. As soon as the relays 604 and 603 are connected across the trunk the grounded winding of relay 604, in series with the right hand winding of relay 603, is placed in series with relay 541 of the auxiliary sender over the following circuit: ground and windings of relays 604 and 603, respectively, top front contacts of relay 600, conductor 624 and associated terminal, conductor 625 and associated brush and terminal, conductor 149 and associated brush and terminal, conductor 148 and associated brush, right contacts of cam 150, conductor 147 and associated brush, conductor 146 and associated terminal, right outer front contacts of relay 226, conductor 277 and associated terminal, conductor 474 and associated brush, right inner front contacts of relay 454, conductor 571, left upper and right lower contacts of cam 560, winding of relay 541 to battery. Relay 541 operates but its resistance is such that the stepping relay 604 and relay 603 in the outgoing trunk circuit will not operate in series with it. Relay 541 closes a circuit for relay 542 as follows: battery and winding of relay 542, front contacts of relay 541, left middle front contacts of relay 530, conductor 576 and associated brush, conductor 391 and associated terminal, upper contacts of cam 366 to ground. Relay 542 operates and, at its right outer front contacts, closes a circuit for switch magnet 544 over the right lower contact and cam 549, cam 548 to winding of magnet 544 thereby advancing switch 544 to position 9. Relay 542 is made to lock over its right inner front contacts and the lower contacts of cam 561 to the operating ground for this relay on cam 366 as already described.

When sequence switch 544 arrives in position 9 the first digit of the fundamental subscriber's number is transferred to the distant area under the control of the counting relays 332—346 in the main sender. This is accomplished as follows: When sequence switch 544 arrives in position 9 a circuit is closed from ground at cam 558, cam 555 and left upper contact thereof, left outer front contacts of relay 542, right upper contact and cam 565 of impulse switch 545, to the winding of the impulse switch magnet 545. The impulse switch 545 will start from position 1 and advance to position 18 where it will stop. When advancing over these positions the impulse drum 547 of switch 545 does two things: first, when sequence switch 544 arrives in position 8¾ a circuit is closed for relay 532 from battery through resistance 582, winding of relay 532, right upper and left lower contacts of cam 559, brush 579 of the impulse drum 547 to ground. A second ground to this relay is supplied over the right lower contact of cam 559, conductor 580, left middle contacts of relay 454, conductor 470 and associated brush, conductor 281 and associated terminal, right back contacts or relay 223 to ground. When the impulse drum 547 opens, relay 532 will not release so long as the ground at the back contact of relay 223 is maintained. When this relay operates, however, as described hereinafter, relay 532 will release every time an impulse is given to brush 579 by the impulse drum 547. Relay 532, when it operated in position 8¾, closed the loop extending from conductors 624 and 626 of the outgoing trunk to conductors 473 and 474 in the auxiliary sender over the path previously described; the loop being extended from conductor 473 to the right middle contacts of relay 454, conductor 570, left upper and right lower contacts of cam 557, the normal made contacts of relay 567, contacts of relay 532, resistance 581, upper contacts of cam 560, conductor 571, right inner contacts of relay 454 to conductor 474. Relay 604 in the outgoing trunk operates over this loop and connects relay 606 to the alternating current source 623, thereby operating it and which, in turn, operates relay 605. This latter relay, in turn, operates relay 612, over the left outer back contacts of relay 609, left normal made contacts of relay 612, left outer

front contacts of relay 608 to the winding of relay 612. As soon as this relay operates it locks over its left inner front contacts to the operating ground, independent of relay 608. Further, relay 612 will operate relay 602 by ground over its right outer front contacts and right outer front contacts of relay 608. Relay 602 then again connects the trunk line to the alternating current source 634 which is, however, interrupted at the back contacts of relay 604. It will be evident that relay 604 will now release every time relay 532 in the auxiliary sender opens its front contacts. When relay 604 releases, therefore, it closes its back contacts and connects the alternating current source 634 to conductors 621 and 622 thereby sending out an alternating current impulse to the distant office every time relay 604 releases in response to the release of relay 532. Relay 606, however, does not leave its front contacts during the stepping operations for a time long enough to cause relay 605 to release, so that the latter relay will remain operated during the period when the various digits are transmitted to the distant office. The fact that relay 605 remains on its front contacts will prevent relay 609 from energizing, as this relay is short-circuited by the front contacts of relay 605.

It will be seen that the number of impulses which are transmitted in this manner over the trunk circuit depends on how long relay 223 in the main sender remains normal, for as long as relay 223 maintains its right back contacts closed, relay 532 will remain operated over the circuit from ground on the back contacts of relay 223 even though the other circuit for relay 532 is opened by the interruption of the impulse brush 547. The winding of relay 223 is connected, in position 13½ of switch 357 over the left back contacts of relay 224, left lower and right upper contacts of cam 266, conductor 282 the left front contact of relay 338 and from thence to the front contacts in series chain of all counting relays which are energized in response to the number of pulses contained in the digit dialed. The pulsing conductor of this set of counting relays in the main sender is, in position 13½, connected to the impulse brush 578 over the following path: right armature of relay 344, conductor 383, lower contacts of cam 258, upper contacts of cam 241, right inner front contacts of relay 226, conductor 276 and associated terminal, conductor 472 and associated brush, right outer contacts of relay 454, conductor 574, right lower and upper contacts of cam 463, conductor 583, to brush 578 of impulse drum 547. The impulse drum 547, through this connecting brush 578, therefore supplies an impulse to this set of relays for every step it takes.

A number of relays of this set has been operated, as already noted, corresponding to the first digit of the fundamental subscriber's number and, when the impulse drum has taken a number of steps corresponding to the complement of this digit, relay 223 will operate by ground at the pulsing conductor already traced so that, from this moment on, the short-circuit at the back contacts of relay 223 is removed and the circuit of relay 532 is now made to depend exclusively on the circuit controlled through impulse brush 579. Therefore the number of impulses which will effect relay 532 and, in turn relay 604 in the outgoing trunk, will be equal to the number of impulses sent in by the subscriber for the first digit of the wanted party's number.

It is to be noted that after the impulse which operates relay 223 is over, relay 224 operates in series with relay 223 and, by opening its left back contacts it disconnects the impulse drum brush 578 from the windings of both relays 223 and 224. Relay 224 by operating, however, cannot advance sequence switch 357 from position 13½ since relay 226 is operated and the grounded armature over which this has taken place previously is now connected to conductor 283 and a ground will be connected to conductor 283 after the sending of the first digit has been completed. This ground is connected from the right upper contacts of cam 566 of the impulse switch 545, over the left lower and upper contacts of cam 554, conductor 584, left inner contacts of relay 454, conductor 469 and associated brush to conductor 283 and associated terminal. As soon as this occurs sequence switch 537 is moved from position 13½ to position 14½ over the front contacts of relay 224 and cam 364 over the path previously traced.

If the second digit of the fundamental subscriber's number has been dialed, switch 236 has advanced to position 16 as already described and ground on cam 300 and right upper contact thereof over conductor 373 from cam 251, is closed to the left lower contact and cam 364, cam 365 and winding of magnet 357. Switch 357 is advanced to position 16, and a circuit is now closed for relay 349 from the same ground on left lower contact of cam 364, right upper contact of cam 364, right inner front contacts of relay 347 to the winding of relay 349. Relay 349 operates to close circuits described hereinafter in connection with the transfer of the impulses of other digits to the distant office.

When switch 357 advances past position 13½, the ground at the left upper contact of cam 366 over which relay 542 is holding is opened so that relay 542 releases and a circuit from ground on its right back contacts to the right lower contact and cam 549 moves sequence switch 544 from position 9 to position 10. The left outer back contacts of relay 542 close a circuit from ground on cam 558, cam 555 and left upper contact thereof, left outer back contacts of relay 542, right outer back contacts of relay 535, left upper contact

and cam 565, to the magnet of impulse switch 545. Impulse switch 545 advances to position 1.

The auxiliary sender waits in position 10 until the second digit of the wanted subscriber's number has been dialed on the set of relays 208—221 in the main sender. When the digit is registered it is indicated by the fact that switch 357 arrives in position 16 as already described. Ground is now reconnected over the upper contacts of cam 366 to conductor 391. Relay 542 operates on this ground in the following circuit: battery, winding of relay 542, back contacts of relay 538, right upper and left lower contacts of cam 561, middle left contacts of relay 530, conductor 576 and associated brush, conductor 391 and associated terminal to ground through the upper contacts of cam 366. The operation of relay 542 causes sequence switch 544 to advance to position 11 over a circuit previously described and, at the same time, starts the impulse switch 547 from position 1 also over its previously described circuit. The operating circuit for relay 542 is opened at the right upper contacts of cam 561 but relay 542 is locked over its inner right front contacts, lower contacts of cam 561 to the operating ground.

When switch 357 reaches position 16 a ground through conductor 472 and associated brush is connected to the set of relays 208—221 over the following circuit: ground on brush 578, conductor 583, right upper and lower contacts of cam 463, conductor 574, right outer contacts of relay 454, conductor 472 and associated brush, conductor 276 and associated terminal, right inner front contacts of relay 226, upper contacts of cam 241, left lower and upper contacts of cam 258, conductor 275, left outer front contacts of relay 349, conductor 394, left back contacts of relay 235 to the right back contacts of counting relay 219. After the impulse drum 547 has taken a number of steps corresponding to the complement of the pulses of the digit which was stored on this set of relays, in the same manner as described for the first digit transferred, relay 223 will energize and remove the ground from conductor 470 which kept relay 532 continuously operated. When this circuit is opened relay 532, now exclusively under the control of the circuit from the pulsing brush 579, will release and operate an equivalent number of times corresponding to the digit dialed. In this way the impulses of the second digit are transferred to the distant area and, when the impulse drum 547 arrives in position 18, ground at the right upper contacts of cam 566 via the left lower and upper contacts of cam 554 is again connected to conductor 469 as described for the previous digit and causes sequence switch 357 to be advanced to position 18 over the front contacts of relays 226 and 224 in the manner already described. As switch 357 passes position 17 a circuit is closed for relay 356 from ground through the right lower and left upper contacts of cam 367 to the winding of relay 356. This relay operates and, in position 18, is locked through its front contacts and right upper and left lower contacts of cam 367, resistance 701, conductor 702, conductor 137 and associated terminal, conductor 158 and associated brush, right lower and upper contact of cam 160 in position 8 to ground. The operation and locking of relay 356 in position 18 under control of the district selector will prevent switch 357 from advancing to position 1, until the district selector advances beyond position 8. The ground at contacts of cam 366 is removed after position 16 and causes relay 542 to release and thereafter advance switch 544 to position 12 by a circuit over the right back contacts of relay 542. When relay 542 is released, in addition to causing the advance of switches 544 and 545, it will also connect a ground from cam 558, cam 555 and left lower contacts thereof, left inner back contacts of relay 542, middle left contacts of relay 530, conductor 576 and associated brush, conductor 391 and associated terminal, right upper and left lower contacts of cam 366, left inner front contacts of relay 355, conductor 395, resistance 285, conductor 397 and associated terminal, conductor 151 and associated brush, right lower and left upper contacts of cam 117, to the winding of relay 159 which remains operated over this circuit after the ground to resistance 285 is removed at cam 255 when switch 357 left position 16½. The ground through resistance 285 from the auxiliary sender is also connected over another path through the right lower contact of cam 555 in position 11¾ to 18 independent of relay 542 so that when this relay reenergizes in position 12 the ground on conductor 576 and the further traced circuit will not be interrupted. It will be seen that this ground is used to hold the district selector circuit in the selection beyond position under the control of the auxiliary sender after the main sender switch 357 is advanced beyond position 16½. Only by opening the ground in the auxiliary sender will it be possible to advance the district selector to the talking position.

The next digit which is to be transferred to the distant area will be handled under the control of the set of relays 401—410 in the auxiliary sender. When the third digit of the wanted party's number has been received, relay 448 is energized as already described and relay 542 operates over the previously described circuit. Relay 535 is now operated from ground on the right outer front contacts of relay 542, right upper and lower contacts of cam 554 to the winding of relay 535. Relay 535 operates and locks over its left contacts, right upper contact and cam

555 to ground on cam 558. Relay 535 performs no function at this time. As soon as the impulse drum 547 returns to position 1, after having finished transferring the second digit, that is, the digit registered on relays 208—221 and switch 544 advanced to position 12, a ground is connected from the lower contacts of cam 566 of switch 545, conductor 585, right inner front contacts of relay 448, right upper contact and cam 464, conductor 477, cam 561 and right upper contact thereof, back contacts of relay 538 to the winding of relay 542 which thereby energizes. Relay 532 is now, in addition to having energized over the right upper and left lower contacts of cam 559 to ground on impulse brush 579 of the impulse drum 547 is also connected to ground over the upper contacts of cam 559, back contacts of relay 531 to ground at the lower contacts of cam 558. Relay 531 is, in position 12, connected over cam 562 and right upper contacts thereof, conductor 479, cam 458 and left upper contacts thereof, to the right front contacts of relay 404 and will energize on the tenth impulse which is received on this set of relays. When, therefore, relay 542 again starts impulse switch 545 from position 1, a number of steps will be taken by this drum which will have no effect on relay 532 because it is in the meanwhile, being kept energized by the ground over the back contacts of relay 531. At the same time the impulse brush 578 delivers impulses to conductor 583, right upper contact and cam 465, cam 466 and left upper contact thereof to the right back contacts of relay 411 thereby causing this set of relays to step in a similar manner to that described for the previous digit. When the impulse brush 578 has, in this way, taken a number of steps corresponding to the complement of the number dialed and relays 404 and 410 operate, a circuit is closed to operate relay 531 as follows: battery and winding of relay 531, right upper contact and cam 562, conductor 479, cam 458 and left upper contact thereof, right front contacts of relay 404, right front contact of relay 408, right front contact of relay 410, right front contact of relay 411, left upper contact and cam 466, cam 465 and right upper contact thereof, conductor 583, brush 578 to ground on drum 547. Relay 531 operates and locks to the lower contacts of cam 558 so that, from this moment on, relay 532 will release for every dialing impulse that is yet to be given by the impulse brush 578. It will be seen that the number of dialing impulses supplied in this way is equal to the number of dialing impulses received from the calling subscriber's dial.

When the impulse switch 545 arrives in position 18, it will stop since the operation of relay 535 opened, at its right outer back contacts, the operating path for advancing it out of position 18. Relay 542 releases because its operating path is opened at the right lower contact of cam 566 in position 18 of the impulse switch 545 and, when the impulse switch 545 arrives in positon 18, the following circuit is closed to advance switch 544 to position 13: ground on the right outer back contacts of relay 542, right lower and upper contacts of cam 552, right inner front contacts of relay 535, to the winding of switch magnet 544. When switch 545 leaves position 12, relay 535 releases by the opening of the right upper contact of cam 555, and the switch 544 is therefore stopped in position 13. At the same time the circuit for advancing the impulse switch 545 to position 1 is completed by ground on cam 558, cam 555 and left upper contacts thereof, left outer back contacts of relay 542, right outer back contacts of relay 535, left upper contact of cam 565 to magnet of switch 545. In position 1 impulse switch 545 recloses ground on the right lower contact of cam 566 and reoperates relay 542 over the inner right front contact of relay 449 in the manner previously described for relay 448. The operation will then be repeated in a way similar to that described for the operation in position 12 except that the impulses absorded and those sent out will be controlled by the second set of counting relays 413—422.

If it is assumed that the fundamental subscriber's number comprises four digits, this fourth digit is not sent out immediately even if it has been received and relay 449 has energized. The last digit of the fundamental number is not transferred until a check has been made to determine whether or not P. B. X. digits are to follow. This check is necessary because the last digit of the fundamental number brings the final selector in the distant area to the wanted subscriber's line and ringing of the called subscriber will start immediately thereafter. If, on the other hand, P. B. X. digits are also to be transmitted to the distant office, it is necessary to delay ringing until the additional digits are disposed of. The check that no P. B. X. digits will follow is made by the timing switch 546 which energizes over a circuit closed by ground on the left outer contacts of relay 449 and the middle right front contacts of relay 455, conductor 481, back contacts of relay 536, right back contacts of relay 537 to winding of switch magnet 546 as soon as the fourth digit of the fundamental number has been received. The timing switch brush 586 will close with contact 587 after a predetermined time.

Assuming, however, that only the four digits of the wanted subscriber number have been dialed and no P. B. X. digits follow, sequence switch 544, when arriving in position 13 will close a circuit from ground on the right inner back contacts of relay 450.

which is not energized in this case, upper contacts of cam 459, left outer contacts of relay 455, conductor 480, left back contacts of relay 537 to the winding of relay 538. The operation of relay 538 opens the operating path of relay 542 thus preventing it from energizing in position 13 and thereby, in turn, prevent impulse switch 545 from commencing its next revolution so that the last digit is not transferred. From the moment the fourth digit of the fundamental subscriber number was received, the circuit previously described for timing switch 546 was closed so that sequence switch 544 will stop in position 13 with relay 542 released until brush 586 of the timing switch 546 closes with contact 587 and energizes relay 537 over an obvious circuit. This relay, on operating, disconnects the timing switch 546 from ground on conductor 481 and releases, but relay 537 locks over its right front contacts to the ground on conductor 481. Relay 537 also opens the operating circuit of relay 538 at its left back contacts so that relay 538, by releasing, completes the previously described circuit for relay 542, thru the right inner front contacts of relay 449. Relay 542, on operating, then prepares a circuit for transferring the last digit to the distant area in the manner previously described. Relay 537, on its left front contacts, operates relay 540 over the same circuit which operated relay 538 and prepares a locking circuit through the winding of relay 539 from ground on cam 558, conductor 476, cam 468 and right upper contact thereof, conductor 587 to the armature contact of relay 540. Relay 539, however, is kept short-circuited by ground over the front contacts of relay 540 just traced and also by the ground which operated relay 540. The impulse switch 545 now revolves and sends out a number of impulses over the trunk line under the control of the second set of relays 413—422 in a similar way to that described for the digit transferred in position 12. Relay 535 is again energized from the right outer front contacts of relay 542 and remains locked up after the circuit for relay 542 is opened by the impulse switch 545 opening the right lower contact of cam 566 after position 17½. A circuit is therefore prepared from ground on the right outer back contacts of relay 542, right lower and upper contacts of cam 552, right inner front contacts of relay 535, to the winding of switch magnet 544 which advances the switch 544 from position 13 to position 14. When leaving position 13 the right upper contact of cam 459, which keeps relay 539 short-circuited, is broken so that relay 539 now operates and locks in series with relay 540. Relay 539 operates relay 567 over an obvious circuit. Relay 567 closes the following circuit for relay 533 in series with the left hand winding of relay 603 and the lower winding of relay 604 in the outgoing trunk: ground and winding of relay 533, front contacts of relay 567, right lower and left upper contacts of cam 557, conductor 570, right middle front contacts of relay 454, conductor 473 and associated brush, conductor 278 and associated terminal, left outer front contacts of relay 226, conductor 143 and associated terminal, conductor 142 and associated brush, right lower and upper contacts of cam 105, conductor 145 and associated brush, conductor 144 and associated terminal and brush, conductor 620 and associated terminal and brush, conductor 626, bottom front contacts of relay 600, left winding of relay 603, lower winding of relay 604 to battery. Relay 533, differential relay 603 and relay 604 all operate in this circuit. Relay 533 closes a circuit to operate relay 534 from ground on cam 558, cam 556 and right lower contacts thereof, left front contacts of relay 533 to the winding of relay 534. Relay 534 locks to ground on cam 558, by way of the right upper contact and cam 555 to ground on cam 558.

The operation of the differential relay 603 removes, by opening its back contacts, the holding ground for relays 607 and 608 which thereby release. At the same time relay 604 is kept energized through its lower winding over the aforetraced circuit. Relay 608, on releasing, opens the circuit of relays 602 and 600. Relay 602 disconnects the trunk line conductors 621 and 622 from the back contacts of relay 604. Relay 600 disconnects relays 603 and 604 from the fundamental circuit so that these two relays release also. Owing to the fact that relay 600 is made slow to release, relay 604 will make its back contacts after relay 602 has already opened its front contacts so that no impulse can be sent out at this moment over the back contacts of relay 604 to the trunk line. Relay 600, by making its top back contacts, connects relay 610 to conductor 624 and, by making its bottom back contacts, connects relay 614 to conductor 626.

When the fundamental circuit is opened by the release of relay 600 relay 533 releases in the auxiliary sender and connects a ground from cam 558, cam 556 and right lower contact thereof, left back contacts of relay 533, left front contacts of relay 534 to the resistance 563 which is in series with relay 530. This causes relay 530 to become short-circuited and release. Relay 530 will release relay 454 in turn, and, when these two relays have released, all brushes of the connecting finder are opened and the auxiliary sender is disconnected from the main sender. Sequence switch 544 is then advanced to normal over a circuit from ground on the right outer back contacts of relay 530, cam 549 and right upper contacts thereof, cam 558 to the winding of switch magnet 548. It is seen,

therefore, that the disconnection of the auxiliary sender follows only after a check has been made that the outgoing trunk circuit has actually disconnected stepping relay 604 from the trunk and made the through connection to the trunk line.

By the release of relay 530 the ground which was connected to conductor 576 and associated brush and which held the district selector in the selection beyond position 8 is now disconnected so that relay 159 in the district selector releases. Relay 159 closes a ground on its back contacts to the winding of relay 130 by way of the right upper and lower contacts of cam 107 and causes relay 130 to operate. Relay 130 closes ground on its left front contacts, upper contact and cam 103, cam 102, to winding of magnet 101, thereby advancing switch 101 to position 9. In position 9 the in-stepping circuit is opened so that relays 200 and 203 in the main sender release. Switch 236 is advanced to position 17 by ground on the back contacts of relay 203 and to position 18 on ground on the back contacts of relay 201. Meanwhile when the district selector advanced to position 9, relay 356 was unlocked and ground through the right upper and lower contacts of cam 368, back contacts of relay 356 to winding of magnet 357 advances switch 357 to position 1. In leaving position 17 sequence switch 236 released all the energized relays by opening all contacts of cam 242 and, on arriving in position 18, a circuit from ground on cam 274, conductor 289, cam 358 and right lower contact thereof, conductor 290, right lower contact and cam 239, cam 237 to winding of magnet 236 advances switch 236 to position 1.

In case the second digit which is dialed in accordance with the wanted subscriber's number in the distant area comprises a five digit number, a ground is placed in the main sender on the terminal connected to conductor 277 which ground causes the operation of relay 456 as already described.

This relay now takes care that the timing switch 546 is brought into action only after the fifth digit has been received, by closing a circuit to the timing switch 546 from ground on the inner right front contacts of relay 450, middle right front contacts of relay 456, conductor 481, contacts of relay 536, right back contacts of relay 537 to winding of timing switch 546. It will be recalled that relay 456 operates when the fifth digit is recorded as already described and the following check for the reception of two further P. B. X. digits is then made.

In the case of a five digit number, the circuit for advancing sequence switch 544 out of position 2 is now supplied over the following path: ground and left upper contact of cam 566, conductor 575, left inner contacts of relay 456, left lower contact and cam 460, conductor 477, cam 561 and left upper contact thereof to the winding of switch magnet 544. Switch 544 advances to position 4 and there waits until the main sender connects, in position 13½ of switch 357, the fundamental circuit through to the auxiliary sender, in which case relay 533 is made to operate and switch 544 to advance to position 8 in the same way as described above for a four digit number. In position 8 switch 544 waits until the outgoing trunk circuit signals that the distant selector is prepared to receive the impulses by the connection of stepping relay 604 to the fundamental circuit whereupon relay 541 is connected in series with the grounded winding of relay 604 and 603 in the manner already described. Relay 541 then operates in this circuit and, in turn, operates relay 542 by closing the ground from the main sender on conductor 576 over its front contacts. Relay 542 locks over the bottom contacts of cam 561 to the operating ground. Relay 542 advances the sequence switch 544 to position 9 over an obvious circuit and causes the impulse switch 545 to make its first revolution. The first digit is then sent out in the manner described above under the control of counting relays 332—346 in the main sender and, when the impulse switch 545 arrives in position 18, sequence switch 357 advances to position 16 in the manner described. Relay 542 releases when ground is opened at contacts of cam 366 after position 13½ is passed and causes sequence switch 544 to advance to position 10 and the impulse switch 545 to advance to position 1 in the manner described. When switch 544 arrives in position 10 relay 542 is again energized over the circuit controlled through the back contacts of relay 538, and switch 544 is advanced to position 11. The second digit is then sent out. When this operation is finished switch 544 advances to position 12 and, in case the third digit of the fundamental number has been received, it is now transferred under the control of relays 401—410 in the auxiliary sender. Sequence switch 544 thereafter advances to position 13 and waits for the operation of relay 449 which indicates that the fourth digit of the fundamental number has been received. When this occurs the fourth digit is transferred to the distant office under the control of relays 413—422. Sequence switch 544, thereafter advances to position 14.

After the four digits have been sent a circuit is closed in position 13¼ to 14 of switch 544 from ground from the right inner back contacts of relay 451, bottom contacts of cam 462, left outer contacts of relay 456, conductor 480, left back contacts of relay 537 to the winding of relay 538, which, by energizing, prevents relay 542 from operating in position 14 and thereby holds up the transfer of the fifth digit until the timing switch 546 has operated relay 537. The timing switch 546 is energized over a front contact of relay 456

over a path previously traced. When no P. B. X. digits follow relay 537 is operated after the time taken by the timing switch brush 586 to make contact 587 and the fifth digit is then transferred owing to relay 538 releasing and relay 542 operating via the back contact of relay 538. Relay 537 also operates relay 540 as already described so that after the fifth digit has been transferred and sequence switch 544 advanced out of position 14, relay 539 is energized by the opening of the right lower contact of cam 462. Relay 539 then operates relay 567. Relay 567 operating places a ground through the winding of relay 533 on to conductors 570 and 473 of the fundamental circuit in series with the battery winding of relay 604 as already described. These relays operate and function as already described. When relay 533 releases it prepares a circuit over its left back contacts and over a front contact of relay 534 for the release of relay 530 which then causes the restoration of the auxiliary sender in the same way as described above.

In a similar manner to that described for a four digit fundamental number, P. B. X. digits may be dialed after the fifth digit and cause the circuit to operate as already described, except that relay 456 now takes care that all operations are delayed one position of the sequence switch 544 which permits an additional digit of the fundamental number to be transferred to the distant office.

For a call with a six digit fundamental number, relay 457 is made to energize over a circuit already traced and this relay controls the sender in a similar way to that described for a four and five digit number except that the timing switch 546 and all operations associated therewith are delayed for two positions of the sequence switch 544 so that this will function only on the basis of a six digit number.

When the district selector advances to position 9, relay 610 is placed in series with coil 152 to ground and relay 614 is placed in series with relay 159. All relays involved operate and the respective circuit paths are as follows: ground on contacts of relay 129, coil 152, upper contacts of cam 150, conductor 148 and associated brush, conductor 149 and associated terminal and brush, conductor 625 and associated terminal and brush, conductor 624 and associated terminal, top back contacts of relay 600, repeating coil winding 618, winding of relay 610 to battery. Battery and winding of relay 159, upper contacts of cam 117, conductor 145 and associated brush, conductor 144 and associated terminal and brush, conductor 620 and associated terminal and brush, conductor 626 and associated terminal, bottom back contacts of relay 600, repeating coil windings 628, winding of relay 614, outer right contacts of relay 610, inner lower back contacts of relay 602 to ground. Relay 614 operates and opens the circuit in which relay 615 is held to ground in the third office selector over conductor 623 and, at the same time, connects a battery through a resistance 619 to conductor 623. Relay 617 still continues to be energized over its left winding to conductor 623. The resistance of this winding, however, is such that, without the parallel resistance 619 on conductor 623, the quantity of current flowing through the series circuit with a test relay in the third office selector and the left hand winding of relay 617 would be such as to cause the test relay to release and falsely discharge the selector. Relay 615 releases and opens, at its right front contacts, the circuit in which relay 616 is held in series with the right winding of relay 617. Relay 616 will release but relay 617 is held over its left winding. By the release of relay 616 the ground on its right front contacts coming from the right front contacts of relay 617 is removed but this will happen only after relay 610 has already operated from the ground in the district selector and has placed another ground on the winding of relay 614 from the bottom inner back contacts of relay 602 as already described so that the ground to the winding of relay 614 is now exclusively under the control of relay 610 and will be removed the instant the calling subscriber releases in which case relay 129 will release and open the circuit of relay 610.

Relay 601 operated when relays 607 and 608 had released, over a circuit from battery and winding of relay 601, right back contacts of relay 608, right back contacts of relay 613 to ground on the right outer front contacts of relay 617. Relay 601 now connects the trunk line conductors 621 and 622 again to the relay 606. As soon as the called party answers an alternating current pulse will be transmitted from the distant office and cause the operation of relay 606. Relay 606 operates relay 605 which, over the left outer front contacts of relay 609, operates relay 611. As soon as the impulse is over, relays 606 and 605 release, causing relay 613 to operate in series with relay 611 to ground on the right front contacts of relay 617. Relay 611, at its left front contacts, removes the ringing tone 629 towards the calling party which, at the time the called subscriber was being rung from the distant office, induced ringing tone over the calling subscriber's line to apprise the calling party of this fact. Relay 613, at its right back contacts, opens the circuit over which relay 601 was operated so that this relay will now release and complete the talking circuit. From this moment on the conversation may commence. Relay 613 also connects a ground from the inner right front contacts of relay 614 to a timing metering device connected to conductor 630, so that

this device is started from the moment the conversation commences.

At the end of the conversation, when the calling subscriber restores, relay 129 releases which, in turn, releases relay 610. The release of relay 610 removes ground from the winding of relay 614 thereby opening the circuit of relays 159 and 614 and causing them both to release. Relay 159 closes an aforetraced circuit for relay 130 which operates and closes a circuit to advance switch 101 to position 11. From position 11 the district selector is restored to normal in the well known manner. At the same time relay 614, by releasing, removes resistance 619 from conductor 623, releasing thereby the test relay in the third office selector and permitting this circuit to move out of talking position. Relay 614 also opens the circuit for the metering device connected to conductor 630 so that the metering ceases from this moment. Relay 610, by releasing, operates relay 602 over its left back contacts to ground at the right outer front contacts of relay 611. Relay 602 again connects the trunk line conductor 621 and 622 to the source of alternating current 634 and will send over the trunk an alternating current impulse of such duration that the selectors at the distant end are caused to release. The time during which relay 602 is maintained operated is controlled by the operation of relay 617 since this relay maintains relay 611 operated as already described. Relay 617 remains locked on its high resistance winding to ground through the test relay in the third office selector and will not release until ground is removed from this circuit. This happens only after the sequence switch (not shown) of the third office selector has almost reached normal thus keeping relay 617 energized as long as possible. Relay 617 by releasing will then remove the ground to which all relays that were still energized are holding so that all relays will be released and the circuit is restored to normal.

The operations described above assume that the wanted party's line was found free and, in this case, the impulse which indicated that the subscriber had answered was only given once so that relay 613 was permitted to operate in series with relay 611. In case the wanted party is found busy, however, the distant selector will signal this condition to the outgoing end, by sending a train of alternating current pulses over the trunk line conductors 621 and 622 over which relay 606 is made to operate and release in such a manner that relay 605 does not leave its front contact. This will cause relay 611 to remain operated alone, and the short-circuit around relay 613 is preserved. Under these conditions a busy tone circuit 631 is connected through the left back contacts of relay 613 and the left front contacts of relay 611 to the calling party who, on receiving this tone, will release. The metering circuit connected to conductor 630 is not put into action as relay 613 does not operate. Relay 601 is held operated because its circuit is not interrupted at the back contact of relay 613 so that the trunk line remains connected to relay 606. When the calling party now releases, relay 610 will release and the circuit is then restored to normal in the manner already described.

Local calls

In the following classes of calls no auxiliary sender is used and the description is given to show the way in which the main sender is adapted to operate for the various selections. Local calls require four settings, that is, one on the district selector, one on the third office selector and two on the final selector. A local call is characterized by the digit 2, as the first digit dialed by the subscriber. One of the five odd levels of the district selector bank will be selected depending upon the second digit dialed in combination with the first digit 2. The operation is as follows: When the subscriber has dialed the first digit and relay 201 releases, switch 236 advances to position 8 as already described and a ground on cam 251, over conductor 373, cam 301 and right lower contact thereof, left lower contact and cam 363, cam 365, to the winding of switch 357, moves switch 357 from position 1 to position 2¼. While sequence switch 236 is advancing from position 6 to position 8 a passing ground in position 6¾ and another passing ground in position 7½ are given to check the nature of the digit recorded. If the call is a local call the first digit is 2, and relay 229 will energize on the passing ground in position 6¾ in the following circuit: battery and winding of relay 229, right back contacts of relay 210, right front contacts of relay 212 and 214, left outer back contacts of relay 220, contact and cam 243 to ground on cam 251. Relay 229 operates and locks over its left middle front contacts, left upper contact and cam 242 to ground on cam 251. In positions 1 to 2¼ of the sequence switch 357, a ground is connected from cam 274, cam 256 and right upper contact thereof, left outer front contacts of relay 229, windings of relays 224 and 223 in series. Relays 223 and 224 operate. Relay 224 opens the fundamental circuit at its right outer back contacts and prepares a ground from the middle left back contacts of relay 226 through its right front contacts, conductor 273, left upper contact and cam 364, cam 365 to winding of switch 357. Switch 357 now advances to position 3¼. The selecting position 2¼ is passed with the fundamental circuit opened so that relay 130 of the district selector does not get an opportunity to operate. Sequence switch 357 now waits in position 3¼ until the second digit has been received which is indicated by the

arrival of switch 236 in positon 10 as already described. As soon as this happens switch 357 advances from position 3¼ to position 5½ over a circuit from the aforetraced ground on cam 301 and left upper contact thereof, right upper contact and cam 363, cam 365 to winding of switch 357 and, during this advance a check is made with a view to determining whether an odd or an even second digit has been dialed. A passing impulse in position 4 on switch 357 operates relay 351 in case the second digit is even and the circuit is as follows: ground on cam 274, conductor 289, cam 358 and right upper contact thereof, the right front contact of an even counting relay of the upper set, such as for example relay 306, the left back contact of the succeeding lower counting relay in the chain, such as for example relay 311, right back contacts of relay 349, conductor 398, right upper and lower contacts of cam 233, conductor 396, to the winding of relay 351. Relay 351 locks over the left outer back contacts of relay 348, right outer front contacts of relay 351, left upper contact and cam 362, conductor 289, to ground on cam 274. Relay 351 during the passing of position 4¼ by switch 357, causes an impulse on one of its front contacts to the second set of counting relays in a circuit which is traced from ground on conductor 373, cam 301 and upper contact thereof, upper contacts of cam 363, right inner front contacts of relay 351, conductor 388, right back contacts of relay 232, conductor 384, armature of counting relay 315, front contacts of an odd counting relay as, for example relay 313, front contacts of an even counting relay as, for example relay 312, conductor 387, inner left back contact of relay 222, conductor 286, back contact of the next counting relay such as relay 311, winding of relay 305 to battery. At the termination of the impulse, that is, after switch 357 breaks the aforetraced circuit in position 4¼, relay 311 operates in series with relay 305 thereby locking up an additional pair of counting relays. If relay 229 was operated, that is, if the first digit dialed is a two, another impulse is transmitted over a front contact of this relay in position 4⅞ of switch 357 in the following circuit: ground from cam 274, cam 255 and right upper and lower contacts thereof, inner right front contacts of relay 229, conductor 287, to the armature of counting relay 314. In addition to the above described pair of impulses controlled by relays 351 and 229, relay 369 has some active part in the translation of the second set of counting relays in case the second digit dialed is zero. If this happens relay 369 will operate in position 9 of switch 236 as soon as the last counting relay has operated. The circuit path is as follows: battery and winding of relay 369, left inner back contacts of relay 348, left front contacts of relay 314, right front contacts of relay 304, upper contacts of cam 303 to ground. The operation of relay 369 has the effect that the holding ground for all counting relays operated by the second digit is opened when the sequence switch 236 advances through position 9 to position 10, so that all of these relays will release. This happens because the holding ground for the second set of counting relays, coming from cam 251 through conductor 373 to cam 300, is controlled by the left upper and left lower contacts of cam 300 in such a manner that the holding circuit is continuous between positions 9 and 10 of switch 236 if relay 369 is not operated, but an opening of 10° is given at the left upper contacts of cam 300 in case the ground at the left lower contact of cam 300 is opened by relay 369. Relay 369, when it energizes in position 9 as described, locks until sequence switch 236 moves beyond position 10. Its locking circuit is then opened at the right upper contact of cam 303. Relay 369 also closes ground to the conductor of the even counting relays which operate relay 351 so that even if the second digit dialed is zero, relay 351 will operate and lock.

Sequence switch 357, on arriving in position 5½ as above described, will close the fundamental circuit from battery on the left lower and right upper contacts of cam 120, winding of relay 130, right lower contact and cam 107, cam 106 and right upper contact thereof, conductor 142 and associated brush, conductor 143 and associated terminal, left outer back contacts of relay 226, right outer back contacts of relay 224, winding of relay 225, resistance 260, left upper and lower contacts of cam 257 to ground on the right outer front contacts of relay 229. The front contact of the outstepping relay 225 is now directed to the second set of counting relays in the following circuit: ground on the front contacts of relay 225, upper contacts of cam 241, left lower and upper contacts of cam 258, conductor 275, left outer back contacts of relay 349, conductor 388, right outer back contacts of relay 232, conductor 384, to the right back contacts of relay 315. Relay 130 in the district selector operates in the fundamental circuit, closes a ground to magnet 101 which advances sequence switch 101 to position 5, and, in this position, district selections are made as previously described.

During the selection of the appropriate trunk level at the district selector banks, the counting relays 304—317 are operated in the regular manner. If we assume, for the case of illustration, that the second digit dialed is a 2, then the seventh trunk level will be selected. Under such circumstances counting relays 313, 307, 312 and 306 have been operated and locked by the subscriber's dial impulses and relays 311, 305, 310 and 304 by the fact that the first and second digits dialed

were both 2 as described above and the stepping relay ground will therefore be directed to relay 309 in the regular manner. The seventh pulse closes the following circuit to operate relay 223: the ground from relay 225 is traced as previously described to the right front contacts of relay 310 and from there the circuit is traced to the left front contacts of relay 316, conductor 291, upper contacts of cam 254, left contacts of relay 224, to the winding of relay 223. Relay 224 is maintained short circuited by ground coming from cam 274, cam 256 and left upper contact thereof through the front contacts of relay 223. When relay 225 releases, this short circuit is removed and relay 224 operates in series with relay 223 to the aforetraced ground on cam 256.

The fundamental circuit is now opened at the right back contacts of relay 224, relay 130 in the district selector releases and the trip spindle 140 stops rotating. The front contacts of relay 224 close an aforetraced circuit which advances sequence switch 357 to position 6¾. As the switch leaves position 5½ and the right upper contact of cam 360 breaks, counting relays 304—317 are released. Relays 223 and 224 are also released when the upper contact of cam 256 opens in position 6. The district selector, meanwhile, advances to the hunting position for the selection of an idle trunk in the selected level and eventually advances to the selection beyond position 8 as already described. In the case under consideration, switch 357 is advanced immediately past position 6¾ by the fact that relays 223 and 224 are operated in series from ground on cam 251, cam 242 and right upper contact thereof, lower contacts of cam 292, winding of relay 224, winding of relay 223 to battery. The operation of relay 224 closes ground on its front contacts to the winding of switch 357. Sequence switch 357 now stops in position 7¾ until sequence switch 236 arrives in position 12, indicating thereby that the third or hundreds digit had been received. When the third digit is recorded, switch 236 advances to position 12 as already described and ground on conductor 373, cam 301 and left lower contact thereof, left back contacts of relay 355, lower contacts of cam 368, back contacts of relay 356 to the winding of magnet 357 advances switch 357 to position 10¼. While advancing to this position the following circuit is closed to operate relay 350: battery and winding of relay 350, conductor 293, right outer back contacts of relay 228, conductor 399, right lower and upper contacts of cam 361, right outer back contacts of relay 348, left lower contact of cam 301, conductor 373, to ground on cam 251. Relay 350 locks to ground on cam 274 by way of left lower contact and cam 362 and conductor 289.

After the third digit has been recorded a check is made to see whether the digit dialed is zero or even. This check is again made by means of relay 369 which, in case the third digit is zero, will operate in position 11 in the following circuit as soon as the last counting relay has been energized: battery and winding of relay 369, left inner back contacts of relay 348, upper contacts of cam 302, front contacts of relay 389 which is operated from the front contacts of relay 318, to ground at the left front and contacts of relay 371 which is operated from the front contact of relay 322. Relay 369 locks to ground at the right upper contact of cam 303. In case relay 369 operates because the third digit is zero, the holding ground for the third set of counting relays, which is controlled by the left lower contact of cam 359 will be open between positions 7¾ and 8¾ so that all of the counting relays in the third set will release in this case. If relay 369 is not operated, due to the fact that the third digit is other than zero, the relays will remain operated to ground over the left back contacts of relay 369 by way of the left upper contacts of cam 251, conductor 376 and right upper and lower contacts of cam 359. Secondly, if relay 369 is operated, or in case the digit dialed is even, relay 349 will operate in a circuit which may be traced as follows: battery and winding of relay 349, that particular set of front contacts of relay 350 which leads to the left back contacts of a subsequent odd counting relay, left back contacts of such an odd counting relay as, for example relay 325, to ground on the right front contacts of the preceding even counting relay, as for example relay 320, or front contacts of relay 369 to ground. Relay 349 will, therefore, operate for all even digits and lock through position 16 at the lower left contact of cam 362 from ground on the right lower contact of cam 274. In case relay 349 is operated, an impulse will be transmitted by switch 357 in passing position 9 from ground on cam 251, conductor 373, cam 301 and left lower contact thereof, right back contacts of relay 348, right upper and lower contacts of cam 361, conductor 399, right outer back contacts of relay 228, conductor 293, right outer front contacts of relay 350, left lower and right upper contacts of cam 362, left inner front contacts of relay 349 to the right back contacts of relay 329. The passage of switch 357 through position 9 will then cause the operation of an additional pair of counting relays. Further, in case the thousands digit is odd, relay 351 is not operated and an additional impulse will be given by switch 357 when passing position 9⅝ from the aforetraced ground on cam 301 to cam 361, left back contacts of relay 351 to the right back contacts of counting relay 328. The result of the above translations has the effect of causing an odd trunk level to be selected at the third office selector wherein the particular selection is guided by the comple-

ment of the counting relays operated by the subscriber's dial impulses and additional counting relays operated when the impulses represent an even digit. Thus, if the subscriber dials the digit two, the level selected will be 7 and if he dials digit three, the level will likewise be 7. If, on the other hand, the subscriber dials a three, no translations take place and the level selected will be 7.

Sequence switch 357, on arriving in position 10¼, will close the fundamental circuit toward the third office selector as follows: battery through the winding of a relay in the third office selector similar to relay 130 in the district selector, conductor and terminal 144, brush and associated conductor 145, right upper and lower contact of cam 105, conductor 142 and associated brush conductor 143 and associated terminal, left outer back contacts of relay 226, right outer back contacts of relay 224, winding of relay 225, resistance 260, upper contacts of cam 257, right back contacts of relay 226, conductor 146 and associated terminal, conductor 147 and associated brush, right lower and upper contacts of cam 150, conductor 148 and associated brush to ground in the third office selector. Relay 225 will now operate in series with the relay in the third office selector and will release for every step the trip spindle of the third office selector takes. The front contacts of relay 225 will now be directed to the third set of counting relays 318—331 in the following circuit: ground on contacts of relay 225, upper contacts of cam 241, left lower and right upper contacts of cam 258, conductor 382 to the right back contacts of counting relay 329. The number of steps taken by the trip spindle of the third office selector is now determined by the complement of the counting relays which have been previously operated either by the subscriber's dial impulses or by the operation of switch 357 as already described and when relays 223 and 224 are energized again at the end of the last step, the fundamental circuit is opened and the trip spindle of the third office selector is made to stop. At the same time switch 357 advances from position 10¼ to position 11½ by an aforetraced circuit closed by relay 224. In position 11½ battery through resistance 294 is closed by way of the left upper and lower contacts of cam 259, right back contacts of relay 224, left back contacts of relay 226, conductor 143 and associated terminal, conductor 142 and associated brush, right lower and upper contacts of cam 105, conductor 145 and associated brush to the third office selector and, at the same time, a ground through the winding of relay 227, right lower and upper contacts of cam 257, right outer back contacts of relay 226, conductor 146, and associated terminal, conductor 147 and associated brush, right lower and upper contacts of cam 150, conductor 148 and associated brush to the third office selector. These two circuits are joined by circuit arrangements in the third office selector as soon as an idle final selector is seized and relay 227 will operate over the loop, thereby indicating that the third office selector has successively attached itself to an idle final selector on the particular level to which the selector had been raised by the operations of the fundamental circuit. As soon as this happens, relay 227 operates relay 356 from ground on its front contacts, conductor 279, upper contacts of cam 367 to the winding of relay 356. Relay 356 operates and locks over its right front contacts to the operating ground on relay 227 while, at its left front contacts, it closes a ground from cam 274, conductor 289, cam 358 and left lower contact thereof, left front contacts of relay 356 to the winding of switch magnet 357 thereby advancing switch 357 to position 12½. When switch 357 leaves position 11½, relay 227 releases and, in turn, releases relay 356. Sequence switch 357 now awaits in position 12½ until the fourth digit is dialed. When this happens switch 236 is advanced to position 14 as already described and a ground on cam 251 through conductor 373, cam 300 and right lower contact thereof, left upper and right lower contacts of cam 368, left back contacts of relay 356 to the winding of switch 357 will advance sequence switch 357 to position 13½. Ten's selection is now made in position 13½ of sequence switch 357 under the control of counting relays 332—346 in a similar manner to that already described for previous selections. As no pairing or translation for the tenth selection is required, no further description of this selection will be given.

At the end of tens selection, relays 223 and 224 operate from the front contacts of relay 225, the circuit path being traced from ground on the contacts of relay 225 through the various operated counting relays of the third set to the left front contacts of relay 338, conductor 282, right upper and left lower contacts of cam 266, left back contacts of relay 224, to the winding of relay 223. Switch 357 is then advanced to position 14½ in the regular manner where it will wait until the units digit has been received. The registration of this digit is indicated by switch 236 being advanced to position 16. When this happens, ground on cam 251 through conductor 373, cam 300 and right upper contact thereof, left lower contact and cam 364, cam 365 to the winding of magnet 357 will advance sequence switch 357 to position 16. In this position units selections will take place in either one of two ways, depending upon whether an odd or an even hundreds digit had been dialed. In case an even hundreds digit is dialed, a number is to be selected on

the first half of the final selector arc and the selection then proceeds in a straightforward manner; the units terminal selected, in this case, depending exclusively on the units digit which is dialed. If the hundreds digit is an even number, relay 349 is operated as already described, and the grounded front contact of relay 225 is then directed over the following path to the first set of counting relays 208—221 on which the units digit has been received: ground on front contacts of relay 225, upper contacts of cam 241, left lower and upper contacts of cam 258, conductor 275, left outer front contacts of relay 349, conductor 394, left back contacts of relay 235 to the right back contacts of counting relay 219. If the hundreds digit is odd a terminal on the second half of the final selector arc is to be selected and ten additional steps must be made before the actual units selection is commenced. Under such circumstances, relay 349 is normal. The front contact of relay 225 is then directed to the second set of counting relays all of which are released by this time and the circuit path is as follows: ground on the front contacts of relay 225, upper contacts of cam 241, left lower and upper contacts of cam 258, conductor 275, left back contacts of relay 349, conductor 388, right back contacts of relay 232, conductor 384 to the right back contacts of counting relay 315. Ten impulses are now counted on the second set of counting relays and when these relays are all operated the ground from the front contacts of stepping relay 225 is directed to the first set of counting relays by way of the left front contacts of relay 316, conductor 291, right upper and lower contacts of cam 254, left back contacts of relay 235 to the right back contacts of counting relay 219. It is thus seen that, in the case of selecting a terminal on the second half of the final selector arc, the second set of counting relays is connected in series with the first set and the final selector brush carriage is made to take first ten steps before the front contact of the outstepping relay 225 is connected to the set of counting relays on which the units digit is recorded.

When the units selection is completed and relays 223 and 224 are operated in the regular manner, switch 357 is advanced to position 18 over an aforetraced circuit. As the switch leaves position 16½, ground on cam 274, cam 255 and left lower contact thereof, is removed from resistance 285, which resistance is in series with relay 159 in the district selector over a circuit previously described. The removal of this ground opens this circuit causing relay 159 to release and which, over its back contacts, will close a ground to the winding of relay 130 over the right upper and lower contacts of cam 107. Relay 130 operates and closes a circuit by way of the upper contact and cam 103 to the winding of switch magnet 101, thereby advancing switch 101 to position 10. By leaving position 8, the district selector also opens at the contacts of cams 118 and 119, the instepping circuit towards the main sender so that relay 200 is made to release. The release of relay 200 causes the release of relay 203 and this relay, by the closure of its back contacts, closes a circuit to switch magnet 236 by way of the right upper contact and cam 238 to the winding of magnet 236. Switch 236 advances to position 17. When switch 236 is past position 16⅝, relay 201 is released which, on its back contacts, closes a circuit to switch magnet 236 by way of the right lower contact and cam 238, advancing thereby switch 236 to position 18. Sequence switch 357, meanwhile, has been advanced to normal by ground on the right upper and lower contacts of cam 368 and the left back contacts of relay 356 to the winding of switch 357. Switch 357, when arriving in position 1, causes a circuit to be closed from ground on cam 274, cam 358 and right lower contact thereof, conductor 290, right lower contact and cam 239, cam 237 to switch magnet 236, advancing this switch to position 1. When both switches have restored to normal all relays are also restored and the sender is available for another call.

Selection of another exchange in the home area

These calls require five settings, namely: on the district selector, second and third office selectors and two on the final selectors. Calls outgoing to another office in the same area are characterized by the first digit being 3, 4, 5, 6 or 7.

As soon as the first digit has been received, a check is made to verify the character of the digit recorded. If either digit 3, 5 or 7 has been recorded, no auxiliary relays will be operated. If, on the other hand, either digit 4 or 6 has been recorded, relay 234 will operate in the following circuit: battery and winding of relay 234 and then either over the left front contacts of relay 217, left back contacts of relay 215, 213, 211, contacts of cam 249, left back contact of relay 209 to ground on the right inner front contacts of relay 220 or right front contacts of relay 208, 210, 212, 214, left outer back contacts of relay 220, contact and cam 243 to ground on cam 251. Relay 234 operates and locks over its right front contacts to ground on cam 251 by way of the left upper contact and cam 242 and cam 251. In case relay 234 operates, a pairing impulse is given in position 7½ of switch 236 from ground on the upper contact of cam 237, the left lower contact of cam 240, left inner front contacts of relay 234 and over to the right back contact of relay 215 to the winding of relay 214 if a six has been dialed or to relay 218 if a four has been dialed. The effect of this pairing impulse is to cause the

selection of an even level at the district selector banks by modifying an even digit to an odd digit so that the level which is a complement of the number dialed will be selected, understanding that eleven impulses in all are needed to satisfy the total of seven sets of counting relays used. Thus, if the subscriber dials a three, no pairing impulse is given by the sender and level 8 will be selected. On the other hand, if a subscriber dials a four, a pairing impulse will be given so that level 6 will be selected.

When the subscriber has dialed the first digit, switch 236 is advanced to position 8 and switch 357 will then be advanced to position 2¼ as already described in connection with previous calls. In position 2¼ the fundamental circuit is closed through the winding relay 130 in the district selector to conductor 143, as previously described for other calls, to the left outer back contact of relay 226, right outer back contact of relay 224, winding of relay 225, resistance 272, left lower contact and cam 256 to ground on cam 274. The front contact of the out-stepping relay 225 is now directed to the first set of counting relays 208—221 as follows: front contacts of relay 225, left upper and lower contacts of cam 241, lower contacts of cam 254, left back contacts of relay 235 to the right back contacts of counting relay 219. District selections will then take place according to the dialed digit and corrections therefore which have been made if the digit dialed is even. At the end of the selection, the district selector advances to the hunting position and switch 357 is advanced from position 2¼ to position 3¼ in the same manner as already described. Switch 357 now awaits in position 3¼ until the second digit has been received, which fact is indicated by the arrival of switch 236 in position 10. When this happens switch 357 is advanced to position 5½ by the aforetraced circuit closed from ground on cam 301 to cam 263 and, while advancing from position 3¼ to 5½ a check is made for verifying the character of the digit. If the digit is even, relay 351 will be energized in the same way as previously described for a local connection and, with this relay operated, a passing impulse in position 4¼ of switch 357 will operate a second pair of counting relays. This passing impulse is traced from ground on conductor 373, cam 301 and upper contact thereof, upper contacts of cam 363, right inner front contacts of relay 351, conductor 388, right outer back contacts of relay 232, conductor 384 to the right back contacts of counting relay 315. Further, in case the first digit dialed is even, relay 234 is operated as already described and a further impulse will be given over a front contact of this relay in position 4⅞ of switch 357. This impulse circuit is traced as follows: ground on cam 274, cam 255 and right upper and lower contacts thereof, left outer front contacts of relay 234, conductor 287 to the right back contacts of relay 314 or to the front contacts of the same relay to the other counting relays in the train depending upon which pair or pairs of counting relays have been energized. By a previously traced circuit through the left inner back contacts of relay 222 this path is brought to counting relay 311 and from there on to the next set of counting relays in the train, which have not been energized either by the subscriber's dial impulses or by the passing impulse in position 4¼ so that, if the first digit dialed is even and the second digit dialed was also even, two additional impulses are given to the second set of counting relays over and above the number of impulses from the subscriber's dial. In addition to this, relay 369 will energize in position 9 of switch 236 in case the second digit dialed is zero and will, when sequence switch 236 moves from position 9 to position 10, release all counting relays of the second set in the manner already described and, at the same time, operating relay 351 in the manner described for providing one impulse in case zero has been dialed. The result of the above translations is to cause the selection of an odd level at the second office selector by causing the fundamental circuit to require the complementary number of impulses to satisfy the sender over the number of impulses already recorded on the second set of counting relays.

Switch 357, on arriving in position 5½, completes a fundamental circuit in the manner previously described for selections in this position of the sequence switch except for the fact that the winding of relay 225 is now carried through the left inner back contacts of relay 229 to the left upper contact of cam 257. It will be noted, therefore, that the compensating resistance 260 which was inserted in the fundamental circuit for selections in the district selector and also for all selections in the case of a local call, is now short-circuited at the left inner back contacts of relay 229. This is due to the fact that the second and subsequent selections of a call to another office in the home area will now take place over a trunk line to a distant office. A compensating resistance is then provided at the second office selector which, with the trunk resistance itself, makes a total resistance of the same value as resistance 260. In case of selections to a local second office selector, a compensating resistance is added to that selector.

The front contact of the out-stepping relay 225 is now directed to the second set of relays and the trip spindle of the second office selector operates as many times as it is necessary to satisfy the sender in the manner described. At the end of selections, relay 224 operates and advances sequence switch

357 from position 5½ to position 6¾ while, at the same time, the second office selector advances to the hunting position in the manner described. When the second office selector finds an idle trunk, a loop is provided through the office selector through relay 227 to the battery supply through the resistance 294 through cam 259 as already described. The operation of relay 227 causes the operation of relay 356 and the consequent advance of switch 357 to position 7¾ as already described. Relays 227 and 356, therefore, indicate the completion of trunk hunting by the second office selector in the known manner and hold the sequence switch 357 in position 6¾ until the second office selector locates an idle trunk after which switch 357 is advanced to position 7¾. When the third digit has been received, switch 236 advances to position 12 and switch 357 advances to 10¼ in precisely the same way as described for a local call. Selections now proceed in the same way as for a local call and reference is made to that part of the description for further operations on the class of call now under consideration.

Calls to rural exchanges

Calls to rural exchanges are handled over one level of the district selector banks and are characterized by the first digit being 8 or 9. When sequence switch 236 advances from position 6 to position 8 during the reception of the first digit, relays 235 and 348 are energized in series in the following circuit: battery and left winding of relay 348, conductor 296, winding of relay 235, left front contacts of relay 213 if digit 8 is dialed, left back contacts of relay 211, contacts of cam 249, left back contacts of relay 209 to ground on the right inner front contacts of relay 220. Also, if digit 9 is dialed, the path is traced from the winding of relay 235, upper contacts of cam 248, left front contacts of relay 211 through the contact of cam 249, left back contacts of relay 209 to ground on the right inner front contact of relay 220. Relay 235 locks over its right inner front contacts to the same operating ground. Relay 348 locks over its right winding and right inner front contacts, conductor 380, left upper contact and cam 242 to ground on cam 251. To discriminate whether the first digit 9 has been dialed, relay 232 operates in such a case from battery through resistance 297 and winding of relay 232, right outer front contacts of relay 235, right lower and left upper contacts of cam 248, left front contacts of relay 211, contacts of cam 249, left back contacts of relay 209 to ground on the right inner front contacts of relay 220. Relay 232 locks over its right inner front contacts to ground on cam 251 by way of cam 242 and left upper contact thereof.

After the first digit has been dialed and sequence switch 236 is advanced to position 8, switch 357 is advanced to position 2¼ in the manner described and will close the fundamental circuit in the same way as for a call to another office. The front contact of the out-stepping relay 225, however, is now connected to the first set of counting relays over the following path: front contacts of relay 225, left upper and lower contacts of cam 241, lower contacts of cam 254, left front contacts of relay 235 and, if digit 8 is dialed, the right back contact of relay 209 to the winding of counting relay 208 or, if digit 9 has been dialed, the left inner front contacts of relay 220, left upper and lower contacts of cam 266, left back contacts of relay 224 to the winding of relay 223. This has the effect that, after the trip spindle 140 has taken two steps, relays 223 and 224 are operated and open the fundamental circuit since, for a rural call, relay 220 is already operated by the calling subscriber dialing digit 8 or 9. After the first selection, the first set of counting relays is made to release in the usual manner and relay 235 releases also since its locking circuit is opened by the release of relay 220. The release of relay 235 restores the front contact of relay 225 back to the armature of relay 219 so that, for the last digit, the operation of the first set of counting relays will again take place in the ordinary manner. Relay 348, however, remains locked and will prevent any translation of remaining digits dialed so that the rural sender will receive the complement of the number of impulses which have been received for each digit dialed. Relay 348 prevents translation by the fact that it opens the circuit for relay 351 so that no translating impulse can be given to the second set of counting relays in position 4¼ of switch 357. It also opens the circuit for relay 369 so that this relay is prevented from operating both in positions 9 and 11 of switch 236 and cannot, therefore, release the second or third set of counting relays in case the digits dialed therein should be zero as described for other calls. It also opens the circuit which supplies a ground to the right upper and lower contacts of cam 361 in positions 8½ to 9¾ so that relay 350 is prevented from energizing in position 8½ to 8¾ and thereby prevent an impulse from being given by means of relay 349 to the hundreds counting relays in position 9 of switch 357. It also prevents a translating impulse from being given in position 9⅝ of switch 357 to the hundreds relays via the left inner back contacts of relay 351. After district selections have been completed and the district selector is connected to an idle trunk extending to the rural exchange a ground is extended from the left front contacts of relay 232, conductor 146 and associated terminal, conductor 147 and associated brush, right lower and upper contacts of cam 150, conductor 148 and associated brush to the outgoing trunk to the rural ex-

change. As soon as a rural sender is connected to the trunk, a check is made for this ground, which check indicates to the rural sender that digit 8 was the first digit dialed by the subscriber. The rural sender then completes the fundamental circuit for selections controlled by the second digit and which take place in position 5½ of switch 357 as previously described for other connections. The front contact of the out-stepping relay 225 will now be directed to the second set of counting relays over the following circuit: ground on contacts of relay 225, upper contacts of cam 241, left lower and upper contacts of cam 258, conductor 275, left outer back contacts of relay 349, conductor 388, right outer front contacts of relay 232, resistance 297 to battery. This causes relay 232 to release so that the ground extended over its left contact of the rural sender by way of conductor 146 is now opened and, with the release of this relay, the front contact of relay 225 is restored to the second set of relays 304—317. The selections will then take place in the usual manner.

Special service calls

Special service calls require two selections, namely, one on the district selector and one on the special service second office selector. These special service calls are characterized by the fact that the first digit dialed is one and they are handled, in the present embodiment of the invention, over lever 10 of the district selector. After the reception of the first digit, sequence switch 236 advances to position 8, but while passing position 6¾, the following circuit is closed to operate relay 230: battery and winding of relay 230, right back contacts of relay 212, right front contacts of relay 214, left outer back contacts of relay 220, contact and cam 243 to ground on cam 251. Relay 230 locks to ground over its left middle front contacts, left upper contact and cam 242 to ground on cam 251. Relay 230 on operating closes ground on its left inner front contacts to the winding of relay 228 thereby causing this relay to operate. A path is also closed for operating relay 231 as follows: battery and winding of relay 231, right inner front contacts of relay 230, conductor 298, right outer back contacts of relay 247, conductor 380, left upper contact and cam 242 to ground on cam 251. The immediate result of the operation of relay 230 is that the in-stepping circuit for the second digit is transferred in positions 8 and 9 of switch 236 from the second set of counting relays 304—317 to the third set of counting relays 318—331 so that the impulses of the second digit of the special service call will be stored on the third set of counting relays. When the second digit has been received and sequence switch 236 is advanced to position 10, a ground is supplied from the right outer front contacts of relay 231 to the left lower contact and cam 239, cam 237 to the winding of magnet 236 causing switch 236 to be advanced to position 16. Switch 236 will now wait in position 16 until all selections are finished. As soon as the first digit has been received, switch 357 is advanced to position 2¼ where the first selection takes place in the manner described and, owing to the fact that only one pair of counting relays, namely, 214 and 215 are operated, the tenth level on the district selector will be chosen. At the end of selections, switch 357 advances to position 3¼ and there awaits until the second digit has been received and when this happens, it is advanced to position 5½ over a circuit controlled from ground on cam 301 as already described. Before the fundamental circuit can be reclosed in this position, however, relays 223 and 224 will energize in series over a circuit from ground on cam 274, cam 252 and contact thereof, right inner front contacts of relay 231, winding of relay 224, winding of relay 223 to battery. The operation of relay 224 advances sequence switch 357 past position 5½ in the manner described while the fundamental circuit is maintained opened at the right outer back contacts of relay 224. The circuit for relays 223 and 224 is maintained beyond position 6¾ so that sequence switch 357 is advanced to 7¾ in the same manner. By this time sequence switch 236 has been advanced beyond position 12 over the circuit closed by relay 231 so that, when switch 357 arrives in position 7¾, the aforetraced circuit for advancing switch 357 beyond 7¾ is closed at the left lower contact of cam 368 and switch 357 is advanced to position 10¼ where the second selection will take place on the third set of counting relays. While passing position 8½ to 8¾, relay 350 cannot operate since this circuit is opened at the right outer back contacts of relay 228. In consequence, no translating impulse will be given to the third set of relays in position 9 of switch 357. A translating impulse, however, will be given for the second digit in position 9⅝ of switch 357 from a ground on cam 301 and left lower contact thereof, right outer back contacts of relay 348, right upper and left contacts of cam 361, left inner back contacts of relay 351 to the right armature of counting relay 328. In case, also, the second digit dialed is zero, relay 369 is operated in position 11 of switch 357 over the following circuit: battery and winding of relay 369, left inner back contacts of relay 348, upper contacts of cam 302, left front contact of relay 389 to ground on left front contacts of relay 371. When switch 357 passes position 7½ to 8½ all the counting relays of the third set will, therefore, be released in the manner previously described. When switch 357, therefore, arrives in position 10¼ a number of counting relays will

be operated and a level will be selected by the special service second office selector in accordance with the second digit dialed and the translating impulse given in position 9⅝, switch 357. As soon as the special service trunk has been selected at the special service second office selector banks, the fundamental circuit controlled over conductor 148 is opened at the second office selector so that relay 227 is released as already described and causes the release of relay 356. This advances switch 357 from position 12½ to position 13½ since switch 236 is already in position 16 as described above. In position 13½ relays 223 and 224 are again operated in series over the circuit controlled by the right inner front contacts of relay 231, cam 252 and contact thereof to ground on cam 274. Switch 357 advances to beyond position 16 under the control of relay 224 so that switch 357 runs past positions 13½ and 16 with the fundamental circuit opened at the back contacts of relay 224.

After position 16½, the ground which held district in selection beyond position through resistance 285 and conductor 397 is open at the left lower contact of cam 255 so that the district selector may then advance and will arrive in position 9 only after the special service second office selector has had the opportunity to close the fundamental circuit towards the special service trunk so that the supervisory relay 159 of the district selector may operate in position 8¾ to ground supplied from the special service trunk and thus stop the district selector in position 9. The sender is then made to release as already described for local calls.

What is claimed is:

1. In a telephone system, a calling line, a main sender, an auxiliary sender, means for extending said calling line to said main sender, means for operatively connecting said main sender to said auxiliary sender, a called line, and means in said auxiliary sender, cooperating with means in said main sender for extending said calling line to said called line.

2. In a telephone system, a calling line equipped with a dial, a main sender, an auxiliary sender, means for extending said calling line to said main sender, means in said main sender for registering dial impulses from said calling line, means in said main sender for operatively connecting said main sender to said auxiliary sender, means for extending said calling line to said auxiliary sender, and means in said auxiliary sender for registering further subscribers' dial pulses.

3. In a telephone system, an originating office, a calling line equipped with dial in said originating office, a main sender in said originating office, registers in said main sender for registering dial pulses from said calling line, an auxiliary sender in said originating office, registers in said auxiliary sender for registering dial pulses from said calling line, a terminating office, means for extending said calling line to said registers in said main sender, means for operatively connecting said main sender to said auxiliary sender, means for extending said calling line to said registers in said auxiliary sender, means under control of said registers in said main sender for extending said calling line to said terminating office, and means in said main sender and said auxiliary sender for transferring to said terminating office the dial impulses registered on said registers in said main sender and said auxiliary sender designating said called line.

4. In a telephone system, a calling line equipped with a dial, a main sender, an auxiliary sender, registers in said main sender for registering digit impulses from said calling line, means for extending said calling line to said registers in said main sender, means responsive to a digit recorded in one of said registers for operatively connecting said main sender to said auxiliary sender, registers in said auxiliary sender for registering digit pulses from said calling line, means for extending said calling line to said registers of said auxiliary sender, and means for registering on said registers in said auxiliary sender further digit impulses from said calling line.

5. In a telephone system, a plurality of exchange areas each having a plurality of central offices and controlled by a distinct numbering system, an originating office in one of said areas, a calling line equipped with a dial in said originating office, a main sender in said originating office, an auxiliary sender in said originating office, a terminating office in another of said areas, means for extending said calling line to said main sender, means in said main sender for registering digit impulses from said calling line, said digit impulses being a part of number designating a called line, means for extending said calling line to said auxiliary sender, means in said auxiliary sender for registering digit impulses from said calling line, said digit impulses being the remaining part of number designating a called line, an office selector, means under control of said main sender for extending said calling line to said terminating office over said office selector, and means in said office selector under control of said main sender and said auxiliary sender for transferring said digit pulses comprising number of said called line to said terminating office.

6. In a telephone system, a plurality of main senders, a plurality of auxiliary senders, said auxiliary senders being common to said plurality of main senders and means in each of said main senders for operatively

taking into use one of said auxiliary senders of said plurality of auxiliary senders.

7. In a telephone system, a calling line equipped with dial, a main sender, an auxiliary sender, means for extending said calling line to said main sender, registers in said main sender, means for extending said calling line to said registers, means for recording on said registers digit pulses from said calling line, said digit impulses comprising a part of the number designating said wanted line, means for operatively connecting said main sender to said auxiliary sender, registers in said auxiliary sender for registering dial impulses from said calling line, means for extending said calling line to said registers in said auxiliary sender and means in said auxiliary sender for registering digit impulses from said calling line of the remainder of said digit impulses designating a wanted line.

8. In a telephone system, a calling line equipped with a dial, a main sender, an auxiliary sender, registers in said main sender for registering digit pulses from said calling line, means for extending said calling line to said registers and means responsive to the first digit dialed on one of said registers for operatively connecting said main sender to said auxiliary sender.

9. In a telephone system, a main sender, an auxiliary sender, registers in said main sender, means for operating said registers, a relay in said main sender operative responsive to the operation of one of said registers and means responsive to the operation of said relay for operatively connecting said main sender to said auxiliary sender.

10. In a telephone system, a calling line equipped with dial, a main sender, an auxiliary sender, registers in said main sender for registering digit impulses from said calling line, registers in said auxiliary sender for registering digit impulses from said calling line, means for extending said calling line to said registers in said main sender, a relay in said main sender responsive to the operation of said registers in said main sender, means for operatively connecting said main sender to said auxiliary sender and means for extending said calling line to said registers in said auxiliary sender over the contacts of said operated relay.

11. In a telephone system, a calling line equipped with dial, a sender, a group of registers in said sender for registering digit impulses from said calling lines, a first trunk selector equipped with contact banks, a second trunk selector extending from said contact banks, means for extending said calling line to each of said registers in succession, means responsive to a distinct number of impulses dialed in said first register of said group of registers for skipping said second register and extending said calling line to said third register of said group of registers, means in said sender for simulating dial impulses, means under control of said first register for operating said second register by said simulating means, means in said sender under control of said first register for controlling said first trunk selector, and means in said sender under control of said second register for controlling said second trunk selector.

12. In a telephone system, an originating office, a calling line equipped with dial in said originating office, a main sender in said originating office, an auxiliary sender in said originating office, registers in said main sender for registering digit impulses from said calling line, registers in said auxiliary sender for registering digit impulses from said calling line, a terminating office, an outgoing trunk extending from said originating office to said terminating office, means for extending said calling line to said registers in said main sender, means for recording on said registers in said main sender the digit impulses of part of the number designating a wanted line in said terminating office, means for extending said calling line to said registers in said auxiliary sender, means for recording on said registers in said auxiliary sender the digit impulses of the remaining part of the number designating a wanted line in said terminating office, means for connecting said main sender and said auxiliary sender to said outgoing trunk, means in said outgoing trunk under control of said operated registers in said main sender and said operated registers in said auxiliary sender for transmitting impulses designating said wanted line in said terminating office.

13. In a telephone system, an originating office, a calling line equipped with dial in said originating office, a main sender in said originating office, an auxiliary sender in said originating office, a terminating office, an outgoing trunk extending from said originating office to said terminating office, registers in said main sender for registering digit impulses from said calling line, registers in said auxiliary sender for registering digit impulses from said calling line, means in said main sender for registering on two of said registers the digit impulses of two digits designating said terminating office, means for registering on other said registers in said main sender the digit impulses of a part of the number designating a wanted line, means for extending said calling line to said registers in said auxiliary sender, means for registering on said registers in said auxiliary sender the digit impulses of the remaining part of said number designating said wanted line, means responsive to said registers in said main sender on which is registered said two digits for extending said main sender and said auxiliary sender to said outgoing

trunk, a relay in said main sender responsive to said extension, means in said outgoing trunk for transmitting impulses to said terminating office under control of means in said auxiliary sender and means in said auxiliary sender responsive to said operated relay in said main sender for operating said impulsing means in said outgoing trunk for transmitting to said terminating office a number of impulses designating the number of said wanted line.

14. In an auxiliary sender having registers for recording dial pulses, a stepping relay and an impulse switch, said switch capable of producing a definite number of impulses and means for intermittently operating said relay under control of said registers and said impulse switch.

15. In a telephone system, a main sender, registers in said main sender for registering dial impulses, registers in said auxiliary sender for registering dial impulses, a stepping relay in said auxiliary sender, an impulse switch in said auxiliary sender, means in said main sender for operatively connecting said main sender to said auxiliary sender, and means for intermittently operating said stepping relay under control of said registers in said main sender and said impulse switch and also under control of said registers in said auxiliary sender and said impulse switch.

16. In a telephone system, a main sender, an auxiliary sender, means for connecting said main sender to said auxiliary sender, registers in said main sender each capable of registering a variable number of impulses up to a certain number, registers in said auxiliary sender each capable of registering a variable number of pulses up to the same said number, a relay in said main sender, a relay in said auxiliary sender, an impulse switch in said auxiliary sender, means for operating said impulse switch, means in said impulse switch for producing the same number of impulses as can be registered in each of said registers, means for operatively connecting said impulse means of said impulse switch to any of said registers in said main sender after said register is operated, means for operatively connecting said impulse producing means of said impulse switch to any of said registers in said auxiliary sender after said register is operated, means for registering in a register of said main sender when said impulse producing means of said impulse switch is connected thereto, impulses produced by said impulse switch equal in number to the difference between said variable number of pulses registered in said register and total said number of pulses which can be registered in said register, means for registering in a register of said auxiliary sender when said impulse producing means of said impulse switch is connected thereto impulses produced by said impulse switch equal in number to the difference between said variable number of impulses registered in said register and total said number of impulses which can be registered by said register, a stepping relay in said auxiliary sender operatively responsive to said impulse producing means of said impulse switch when said switch is connected to any of said registers, means under the control of said relay in said main sender for keeping said stepping relay permanently operated while said impulse switch is producing impulses to be registered in any of said registers in said main sender, and means under control of said relay in said auxiliary sender for keeping said stepping relay permanently operated while said impulse switch is producing impulses to be registered in any of said registers in said auxiliary sender.

17. In a telephone system, a calling line equipped with dial, a main sender, an auxiliary sender, registers in said main sender each capable of registering a group of impulses, means for extending said calling line to said registers in said main sender, means in said main sender responsive to the registration of a definite number of impulses in one of said registers for operatively connecting said main sender to said auxiliary sender, said distinct number of impulses also designating the total number of digits to be dialed by said calling line and designating a wanted line, means in said main sender responsive to the registration of said definite number of impulses for indicating said total number of digits, and means in said auxiliary sender, responsive to said last mentioned means in said main sender, for recording a similar indication in said auxiliary sender.

18. In a telephone system, a calling line equipped with dial, a main sender, an auxiliary sender, registers in said main sender each capable of registering a number of impulses, means for extending said calling line to said registers in said main sender, means for operatively connecting said main sender to said auxiliary sender, two relays in said main sender, means in said main sender responsive to the registration of a definite number of impulses in one of said registers for operating one of said relays, means in said main sender responsive to the registration of either one of two definite number of impulses in one of said registers for operating either one or the other of said relays, circuits in said auxiliary sender controlled by said two relays and responsive to said pulse registration in said register in said main sender, and means in said auxiliary sender responsive to any of said circuits for further controlling the operation of said auxiliary sender.

19. In a telephone system, a calling line equipped with a dial, a main sender, an auxiliary sender, registers in said main sender

each capable of registering a number of impulses from said calling line, registers in said auxiliary sender each capable of registering a number of impulses from said calling line, means for extending said calling line to said registers in said main sender, means for operatively connecting said main sender to said auxiliary sender, means for extending said calling line to said registers in said auxiliary sender, two relays in said main sender each responsive to the registration of one of two definite number of impulses in one of said registers in said main sender, circuits in said auxiliary sender controlled by either of said two relays and responsive to registration of said definite number of impulses, each of said circuits also indicating the total number of digits to be dialed by said calling line on said registers in said auxiliary sender, a timing switch in said auxiliary sender operatively controlled by any of said circuits and said register in said auxiliary sender containing the registration of the last digit impulses, and means responsive to the operation of said timing switch for further controlling the operation of said auxiliary sender.

20. In a telephone system, an auxiliary sender comprising registers each capable of registering dial pulses, a timing switch, a relay adapted to control the operating circuit of said timing switch, means responsive to the operation of a number of registers for operating the said timing switch, and means for operating said relay upon the operation of a further register for releasing said timing switch.

21. In a telephone system, an originating office, a calling line in said originating office, equipped with dial, a main sender in said originating office, an auxiliary sender in said originating office, registers in said main sender for registering digit impulses from said calling line, means for extending said calling line to said registers in said main sender, registers in said auxiliary sender for registering digit impulses from said calling line, means for extending said calling line to said registers in said auxiliary sender, a terminating office, a plurality of trunk selectors in said originating office, an outgoing trunk extending from said originating office to said terminating office, a relay device in said outgoing trunk controlling a source of alternating current, means under control of said registers in said main sender for connecting said main sender and said auxiliary sender to said outgoing trunk over said plurality of trunk selectors, means in said auxiliary sender under control of registers in said main sender and registers in said auxiliary sender for operating said relay device as many times as there are impulses dialed into each of said registers, and means in said outgoing trunk controlled by said relay device for sending alternating current impulses from said alternating current source to operate automatic switches in said terminating office.

22. In a telephone system, an originating office, a calling line in said originating office equipped with dial, a main sender in said originating office, an auxiliary sender in said originating office, registers in said main sender for registering digit pulses from said calling line, means for extending said calling line to said registers in said main sender, registers in said auxiliary sender for registering digit impulses from said calling line, means for extending said calling line to said registers in said auxiliary sender, a terminating office, a plurality of trunk selectors in said originating office, an outgoing trunk extending from said originating office to said terminating office, a relay device in said outgoing trunk controlling a source of alternating current, means under control of said registers in said main sender for connecting said main sender and said auxiliary sender to said outgoing trunk over said plurality of trunk selectors, means in said auxiliary sender under control of registers in said main sender and registers in said auxiliary sender for operating said relay device as many times as there are impulses dialed into each of said registers, means in said outgoing trunk controlled by said relay device for sending alternating current impulses from said alternating current source to operate automatic switches, and means in said outgoing trunk responsive to a signal from said main sender and said auxiliary sender for removing said relay device and said alternating current source from said outgoing trunk when all of said impulses have been sent.

In witness whereof, we hereunto subscribe our names this 13 day of May, 1930.

CHARLES E. STEVENS.
MARTINUS DEN HERTOG.