Feb. 1, 1927. 1,615,998

M. L. NELSON

MULTI-OFFICE TELEPHONE SYSTEM

Original Filed Aug. 17, 1921 7 Sheets-Sheet 1

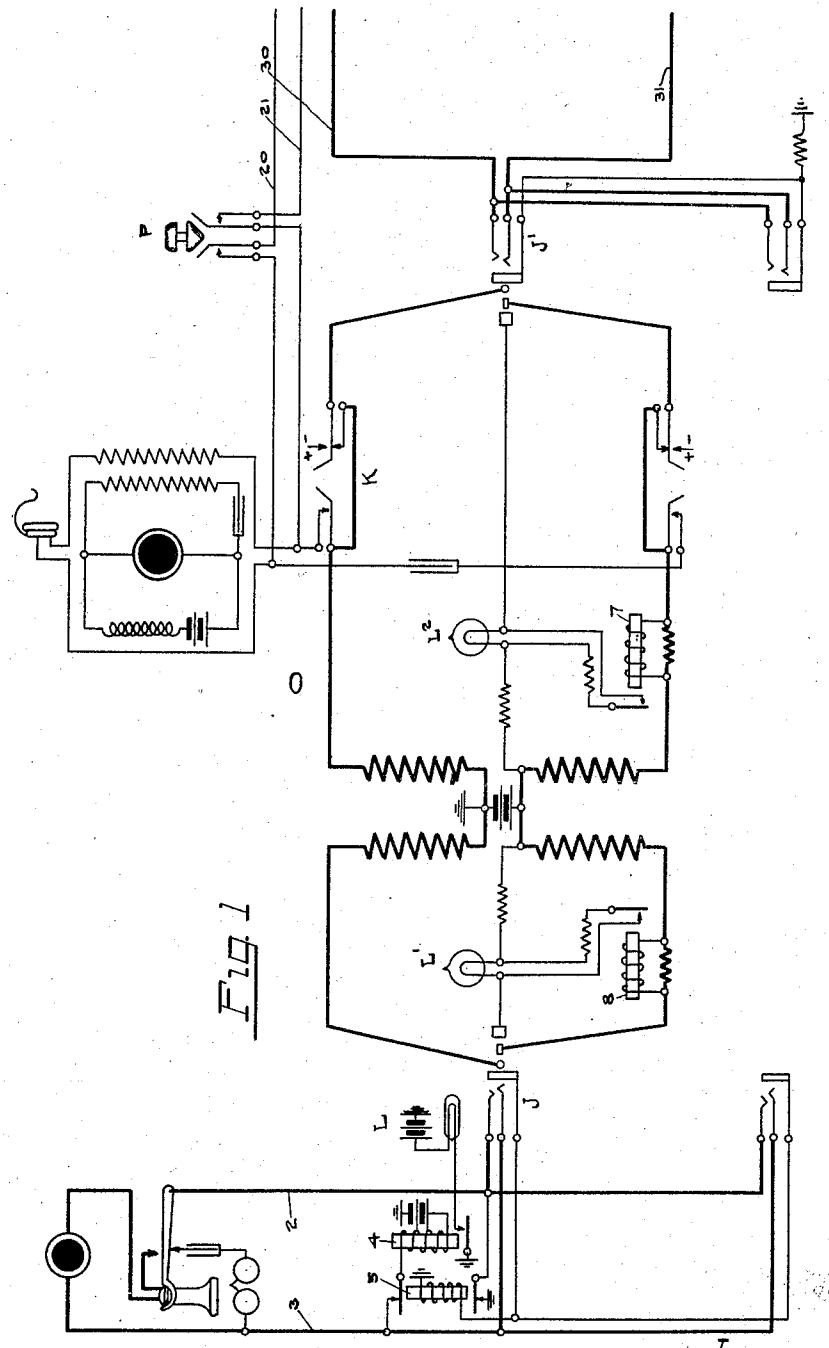

Fig. 1

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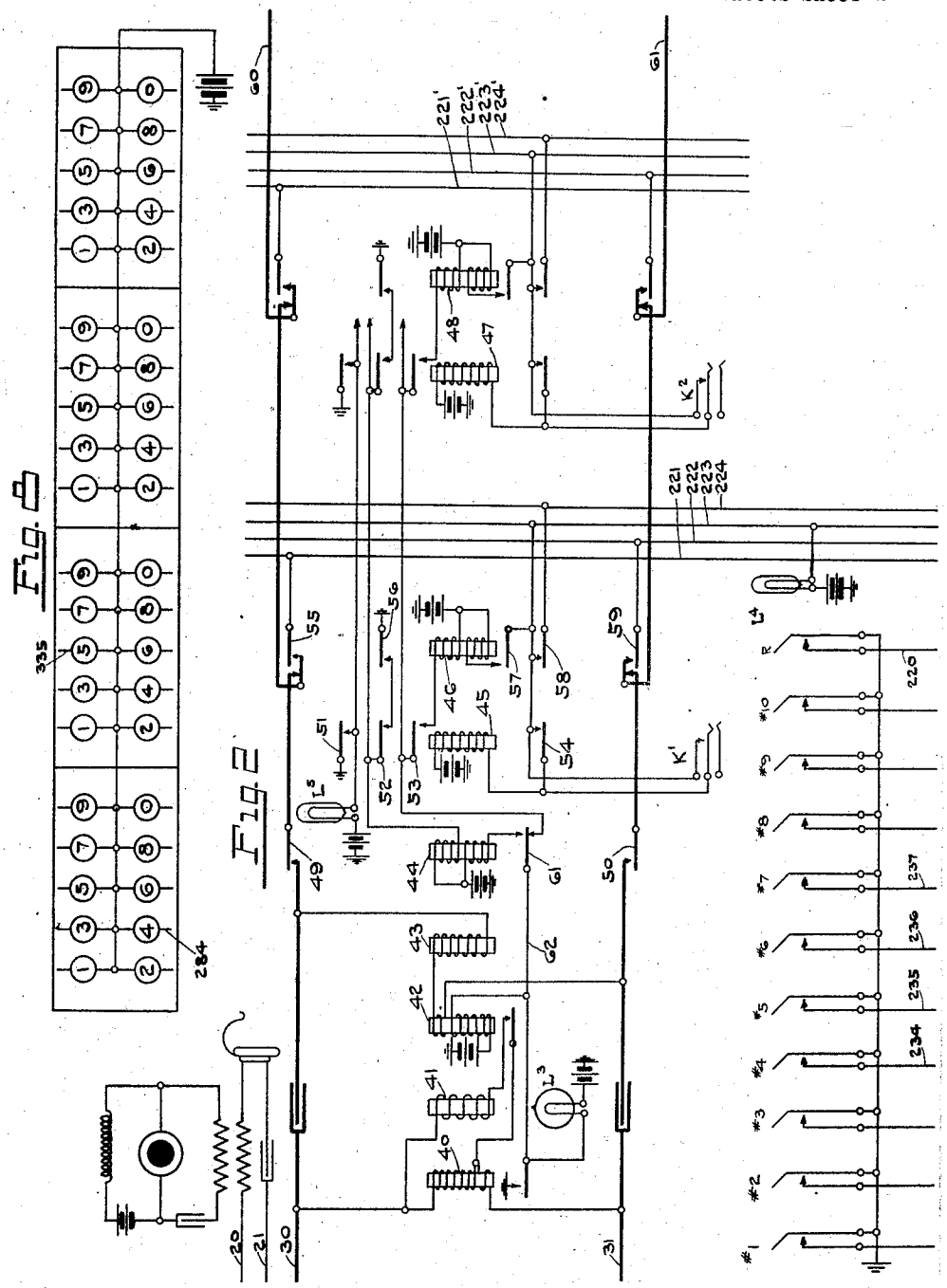
MULTI-OFFICE TELEPHONE SYSTEM

Original Filed Aug. 17, 1921 7 Sheets-Sheet 2



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MULTI-OFFICE TELEPHONE SYSTEM

Original Filed Aug. 17. 1921 7 Sheets-Sheet 3

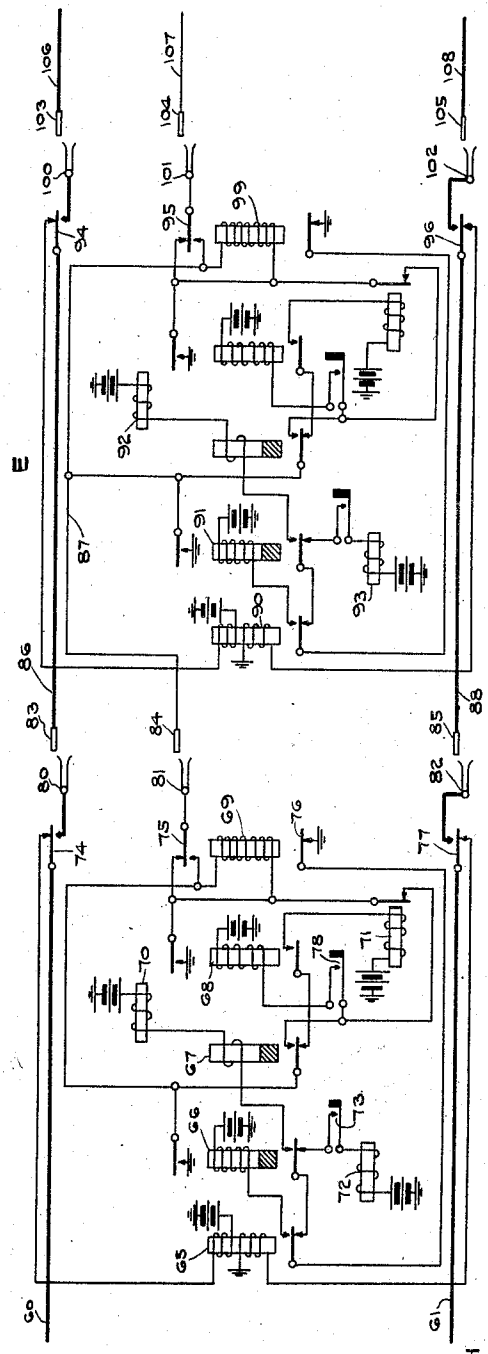

Fig. 3

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MULTI-OFFICE TELEPHONE SYSTEM

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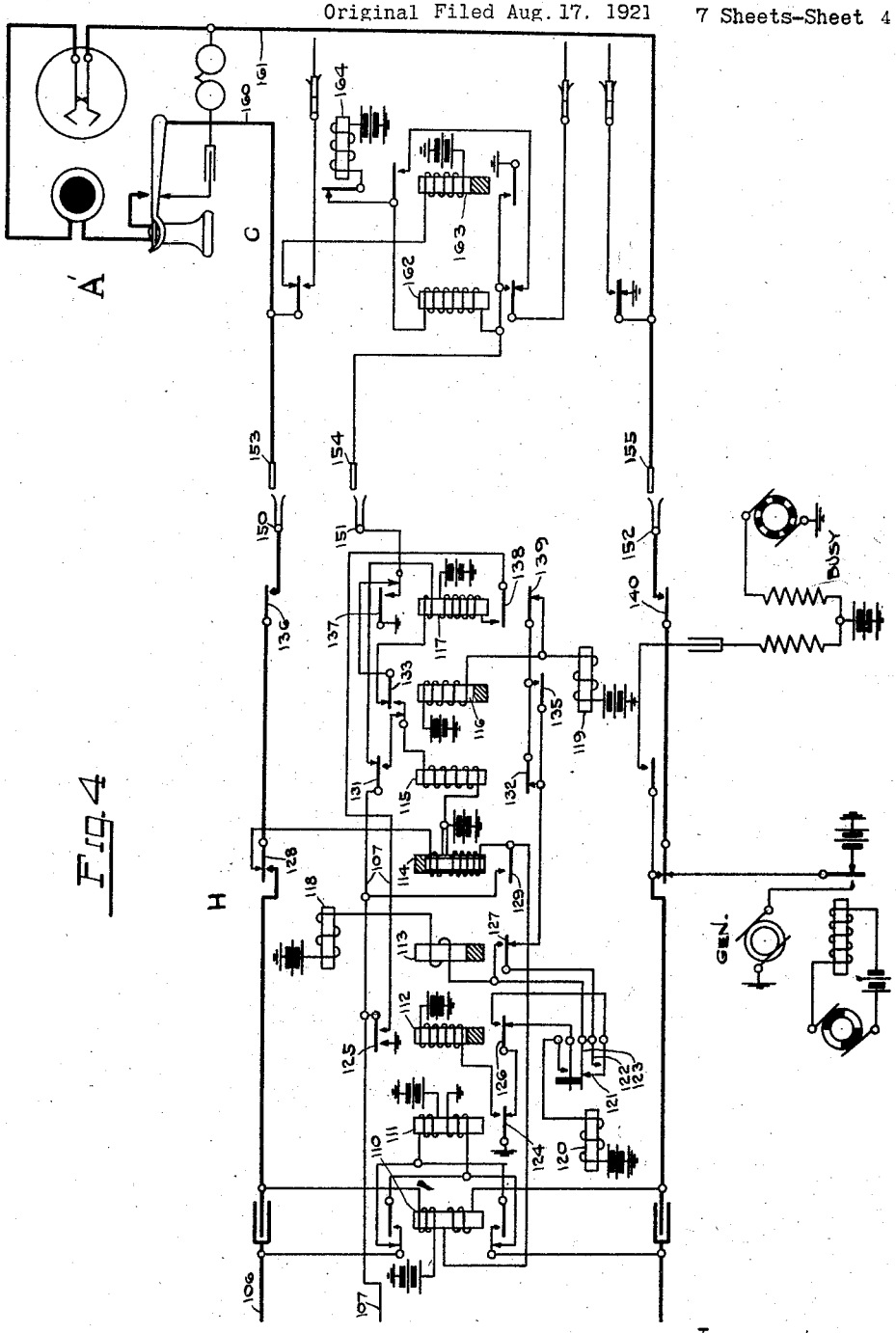

Fig. 4

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MULTI-OFFICE TELEPHONE SYSTEM

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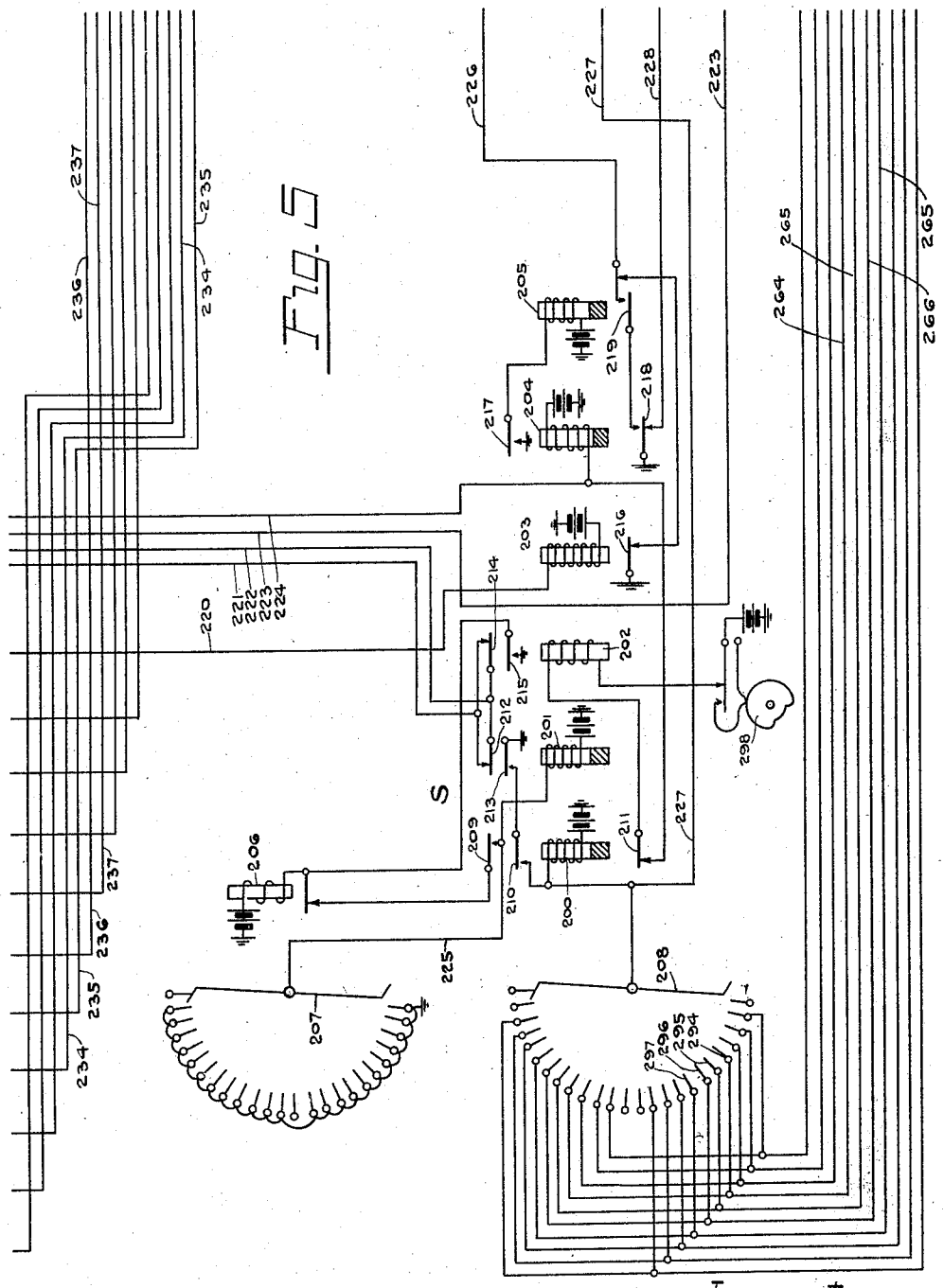

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MULTI-OFFICE TELEPHONE SYSTEM

Original Filed Aug. 17, 1921 7 Sheets-Sheet 6

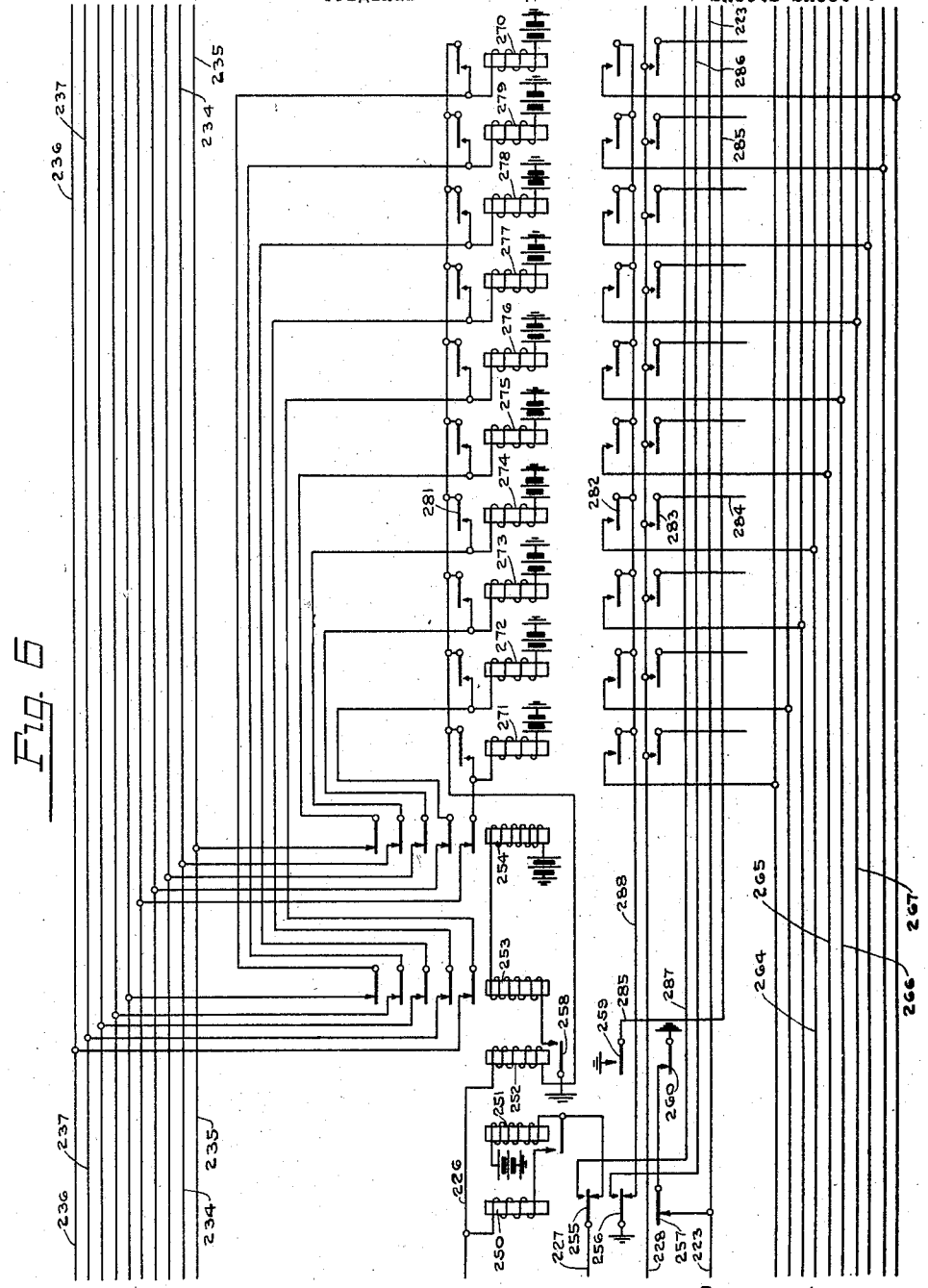

Fig. 6

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MULTI-OFFICE TELEPHONE SYSTEM

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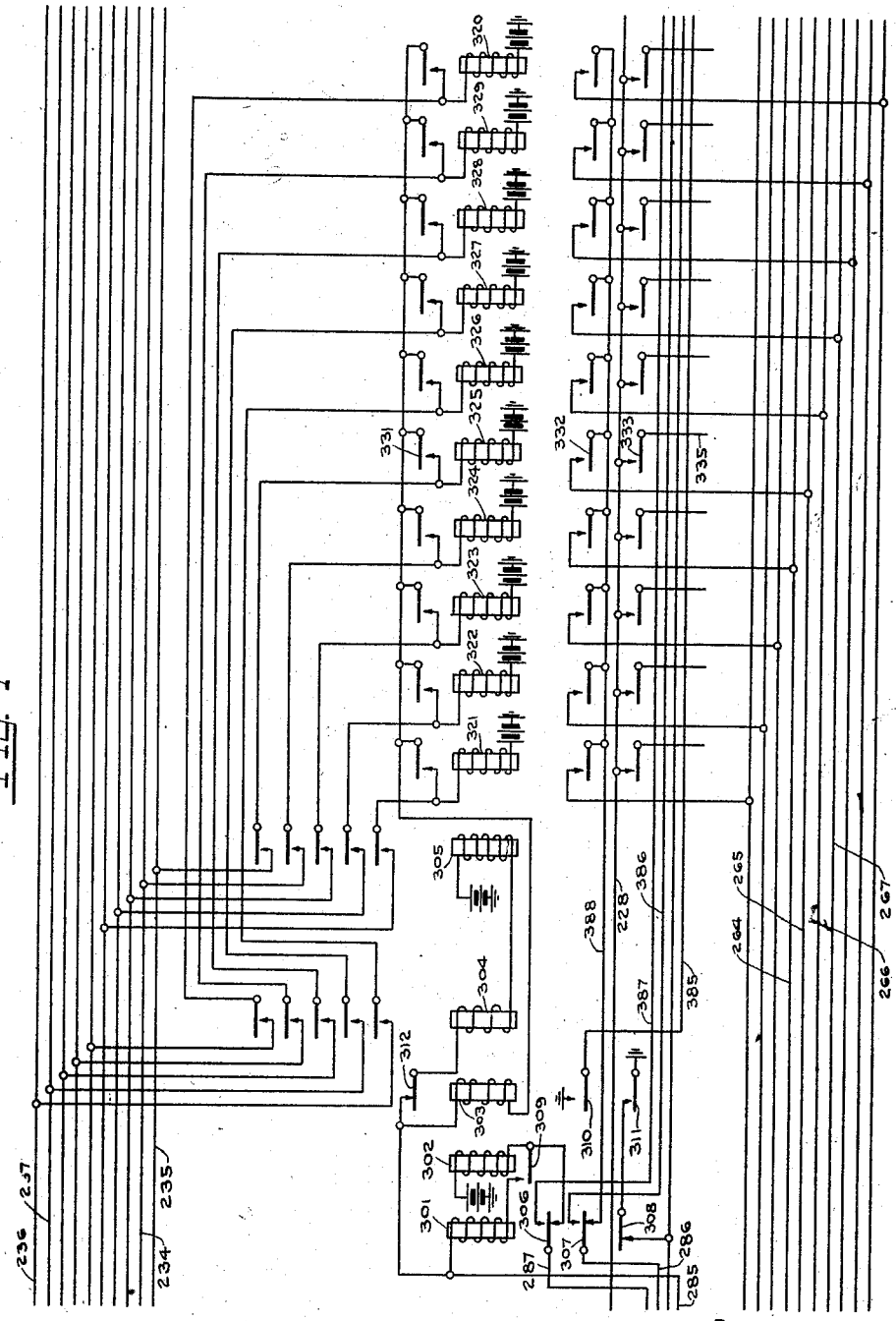
Fig. 7



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UNITED STATES PATENT OFFICE.

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MULTIOFFICE TELEPHONE SYSTEM.

Application filed August 17, 1921, Serial No. 492,976. Renewed April 20, 1926.

The present invention relates to multioffice telephone systems, more especially to such systems as comprise both manual and automatic offices, or exchanges; and the object of the invention, broadly stated, is the provision of new and improved arrangements for handling those calls which originate at a manual office and which are completed in an automatic office.

More particularly, the present invention is in the nature of an improvement over copending application Serial Number 443,688, filed February 9, 1921. The particular object of the invention is to provide means whereby the time required for the B operator in the automatic exchange to set up a connection is minimized. This is accomplished by so arranging the circuits at the B operator's position that instead of having to wait for the A operator to seize the assigned trunk line the B operator only registers the desired number. Now as soon as the A operator seizes the designated trunk line the sending operations are automatically initiated.

A clearer understanding of this improvement may be obtained by considering the arrangement in the prior system which is in general similar to the present one. In this case a B operator's sending equipment is located at the automatic exchange. This apparatus includes a sending switch, and a plurality of relay storage devices, together with circuits whereby the digits, corresponding to successively actuated digit keys, are registered on the storage devices, whereby the storage devices successively control the sending switch according to the registered digits, and whereby the apparatus is automatically disassociated from the trunk line in use when the connection is completed.

In this prior system the operation is briefly as follows: The A operator at the manual exchange, upon ascertaining the desired called subscriber's number, actuates the key of her order wire extending to the proper automatic exchange and gives this number to the B operator thereat. The B operator, upon receiving this number, immediately registers it by means of push buttons provided for the purpose, and assigns an idle trunk line to the A operator. When the A operator extends the connection over this trunk line the B operator operates the starting key associated with the sending equipment in use whereby the sending apparatus starts functioning and the connection is automatically set up, the B operator having to pay no further attention to the connection. Immediately upon the completion of the sending operation the sending equipment is disassociated from the connection and may be used again. However, in the case above referred to, it is necessary that the B operator wait until the A operator extends the connection to the designated trunk line before operating her starting key. This is, of course, undesirable as it slows up the work of the B operator considerably. The present invention, as before mentioned provides means whereby as soon as the A operator seizes the designated trunk line a relay is energized which automatically starts the sending operation; thus eliminating the necessity of having the B operator actuate a key after the trunk line has been seized by the A operator. Immediately upon being started the sending operation proceeds as outlined above. This automatic starting arrangement enables the B operator to work a great deal faster as she does not have to devote as much time to each individual connection as was the case in the former system.

The above and other objects of the invention will be described in detail hereinafter reference being had to the accompanying drawings.

For an understanding of the circuits, Figs. 1, 2, 3, and 4 of the drawings should be laid out in order with corresponding lines at the ends thereof in alignment, while Figs. 5, 6, and 7 should be similarly laid out immediately below Figs. 2, 3, and 4, respectively. The drawings when thus arranged show an inter-office trunk line connecting a manual exchange with an automatic exchange, and the associated equipment required to establish a connection between two subscribers' lines such, for example, as the line of the manual substation A, Fig. 1, and the line of the automatic substation A', Fig. 4. The connection, when established, involves a manual cord circuit such as the cord circuit O, Fig. 1; an inter-office trunk line, manual to automatic, and associated trunk equipment, shown in Fig. 2; a first selector switch D, Fig. 3; a second selector

switch such as the second selector E; and a final connector switch such as the connector H, Fig. 4. The apparatus shown in Figs. 5, 6, and 7 constitutes a B operator's sender which is used to control the setting of the automatic switches, and which may be temporarily associated with the trunk line for this purpose.

The equipment shown in Fig. 1 comprising the telephone station A and the associated line equipment at the exchange, the operator's cord circuit O, and the A operator's head set, is all manual equipment of well known type and on this account will not have to be described.

The inter-office trunk line, comprising conductors 30 and 31, is one of a large group of similar trunk lines and extends from the jack J′ in the outgoing trunk multiple at the A board, in the manual exchange, by way of the B operator's position, shown in Fig. 2, to the first selector D, which is shown in Fig. 3. At the B operator's position the trunk line is normally open and is provided with a group of relays, whose circuits are shown in full, and whose operation will also be described in the course of the general explanation. According to the usual practice there is a call circuit, or order wire circuit, which terminates in the B operator's head set at the automatic exchange, and which is multipled in the call circuit keys at the A board in the manual exchange.

The first and second selectors D and E are automatic switches of the well known Strowger vertical and rotary type, such as are in common use in numerous automatic telephone exchanges throughout the country. The connector H is likewise a Strowger vertical and rotary switch and is similar in mechanical construction to the selector switches D and E. The circuits are arranged, however, for a directive control in both the vertical and rotary movements. All of these switches are operated according to the well known two wire system of control. The connector switch H has access to 100 subscribers' lines, one of which is the line extending to automatic sub-station A′. The reference character C indicates a rotary line switch of well known type which is individual to the line of substation A, and which is used by the subscriber thereat for making outgoing calls.

The B operator's sender shown herein comprises a set of digit keys, shown in the lower left-hand corner of Fig. 2, a sending switch indicated by the reference character S, and including a plurality of associated relays, all of which are shown in Fig. 5, a first digit storage device, shown in Fig. 6, a second digit storage device, shown in Fig. 7, and third and fourth digit storage devices, which are not shown but are in all respects exactly like the second digit storage device which is shown in Fig. 7. There is also a lamp indicating device, shown in Fig. 8 on the same sheet with Fig. 2.

The digit keys, Nos. 1 to 0, inclusive, are ordinary self restoring keys, or push buttons, located in a single row in front of the B operator and control the setting of the storage devices. There is also a release key R and a lamp L^4 located in the same row with the digit keys. The sending switch S, in Fig. 5, is a simple rotary switch having two horizontal rows of bank contacts and the two wipers 207 and 208 associated therewith. These wipers are adapted to be driven by any suitable form of ratchet mechanism in a forward direction only by means of the stepping magnet 206. The cam 298 is mounted on a constantly rotating shaft which is driven by a small motor, or other suitable means, at a speed of about ten revolutions per second. This is the impulse sending cam and may be common to a number of different senders.

The first digit storage device, shown in Fig. 6, comprises the digit relays 271–270, inclusive, and the five relays 250–254, inclusive. The other storage devices are very similar to the first digit storage device, and all of them will be described in full hereinafter.

A little further description of the apparatus at the B operator's position may now be advisable before proceeding with the operation of the system. In addition to the inter-office trunk line, shown in Fig. 2, there may be perhaps fifty or more other trunk lines, all extending through the position by way of their respective associated relay equipments to first-selector switches. In addition to the operator's sender which is shown in the drawings, there are two or three other senders, making perhaps four altogether, and each sender terminates in a four conductor trunk line which is multipled at the relay equipments of all of the inter-office trunk lines. Thus, any sender may be connected with any inter-office trunk line. The local trunk line associated with the sender shown in the drawings, comprises conductors 221–224, inclusive, which conductors are connected in multiple to contacts of relays, such as the relay 46, associated with the several inter-office trunk lines. Although none of the other senders are shown, the local trunk line associated with the second sender is shown in the drawing at the right of Fig. 2, and comprises conductors 221′ and 224′, inclusive. The local trunk lines associated with the other two senders are similar to the one shown and, therefore, it is believed that the arrangements will be readily understood without further explanation.

The lamp indicating device, shown in Fig. 8, is individual to the sender illustrated, and

there is a similar indicating device for each of the other senders. This indicating device comprises a plurality of banks of switchboard lamps, there being a lamp in each bank for each of the ten digits. The number of different banks of lamps will, of course, depend upon the number of digits in the telephone numbers; for four digit numbers four banks of lamps will, of course, be required as illustrated in the drawing. The digits to which the lamp corresponds are printed on a semi-transparent screen behind which the lamps are located, and these numbers are ordinarily scarcely discernible. When the lamps immediately behind any series of digits are lighted, however, these digits will stand out clearly and may be read by the operator with great facility. The manner in which the lamps are connected is exceedingly simple, and on this account the wiring has not been drawn out in detail. It may be explained, however, that one side of all of the lamps is connected to the exchange battery while individual conductors run from the other side of each lamp to contact springs on the digit relays of the several storage devices. Thus, the individual conductors, such as conductor 284, which come from the ten lamps in the first digit bank are connected to springs of relays 271–270, inclusive; the conductors, such as conductor 335, coming from the lamps of the second digit bank are connected to contacts of relays 321–320, inclusive, of the second digit storage device, while the conductors coming from the lamps in the third and fourth digit banks are similarly connected to the contacts of the digit relays in the third and fourth storage devices, respectively.

The operation of the system in establishing a telephone connection will now be explained, it being assumed for this purpose that the subscriber at substation A in the manual exchange desires to obtain connection with the subscriber at substation A′ in the automatic exchange. The telephone number at substation A′ will be assumed as No. 4567. When the receiver is removed at substation A, a circuit is completed over the line conductors 2 and 3 for the line relay 4, which is accordingly energized and lights the line lamp L. This notifies the A operator, at whose position the answering jack J appears, that a call has been received and she will respond by inserting the answering plug of an idle cord circuit, the cord circuit O for example, in the jack J. Upon the insertion of the plug, a circuit is completed over the sleeve conductor thereof which includes the cut off relay 5 of the calling line, and the supervisory lamp L′ in the cord circuit in series. The cut off relay 5 is accordingly energized and disconnects the line relay 4. The supervisory lamp L′ would be lighted at the same time were it not for the fact that the receiver is off at substation A, whose transmitter is now supplied with current from the cord circuit. As a result, the supervisory relay 8 in the ring side of the cord circuit is energized and shunts out the lamp L′ to prevent it from being lighted.

The A operator will now throw her key K to listening position in order to obtain from the calling subscriber the number of the party with whom he desires to converse. Having ascertained that the desired number is the No. 4567 in the automatic office, the operator will restore her listening key and will depress the proper call circuit button in order to connect her head set with the call circuit extending to the desired office, or exchange. The call circuit button at this particular A operator's position, which is associated with the particular automatic exchange in question, is the button P, and when this is depressed the A operator's head set is connected directly with the B operator's head set in the automatic office. The A operator now repeats the No. 4567 to the B operator; and this number is registered by the latter operator by means of the digit keys associated with one of her senders as soon as it is received, it being understood, of course, that in the present case the sender which is shown in the drawing is the one which will be used. In registering the number, the B operator will depress the digit keys 4, 5, 6, 7, and the starting key K′ in rapid succession and the entire number is completely registered and the sending apparatus prepared for operation practically as soon as the A operator has finished transmitting the number. The key K′ is associated with the trunk line in use and also with the sender upon which the desired number has been registered in order to connect this sender with the trunk line. As soon as the A operator is through talking the B operator will reply with the number of an idle interoffice trunk line. The A operator now inserts the calling plug of the cord circuit in use in the designated jack in the outgoing trunk multiple. Assuming that the trunk line comprising conductors 30 and 31 is the trunk line assigned, the plug will be inserted in the jack J′ and a circuit is immediately completed over the two sides of the trunk line in series for the bridged relay 40 at the B operator's position. Relay 40 is energized by current flowing from the cord circuit at the A board and closes a circuit for the busy lamp L^3. This signal notifies the B operator that the A operator has taken the trunk. The sending switch S, Fig. 5, is now operated under the control of the several storage devices in succession and four series of impulses are transmitted over the trunk line, comprising conductors 60 and 61, connecting Figs. 5 and 3, whereby

the first selector D, a second selector, such as the selector E, and a connector, such as the connector H, are operated in order to complete connection to the desired subscriber's line. The B operator, having actuated the various digit keys and the starting or trunk key K′, has done all that is required of her toward the establishment of the connection and need pay no further attention to it. The sender, upon which the number has been registered, controls the automatic switches without any further attention, and when the last switch has been operated the sender is automatically disassociated from the trunk line and is ready for use in registering another called number.

We will return now to the point where the B operator begins to register the number transmitted to her by the A operator in order to go into the subsequent circuit operations more in detail. The ten digit relays of the first digit storage device are normally connected to the ten leads, or conductors, coming from the ten digit keys, and when the operator depresses the No. 4 digit key a circuit is completed over conductor 234 for the fourth digit relay 274. Upon energizing, relay 274 prepares a locking circuit for itself at armature 281; connects the grounded conductor 228 to conductor 284 which extends to the No. 4 lamp in the first digit bank of the lamp indicating device, and causes the digit 4 to be immediately displayed; and connects the grounded conductor 288 with the conductor 264 which extends to the lower bank of the impulse sending switch S and there terminates in bank contact 294. The operator depresses the digit key only for an instant and when it is released, relay 274 is held up over a locking circuit which includes relay 252 and the grounded conductor 226. Relay 252 is accordingly energized in series with relay 274 and at its armature 258 closes a circuit for relays 253 and 254 in series, which, upon energizing, disconnect all of the digit relays 271–270, inclusive, from the conductors coming from the digit keys. Relay 274, of course, remains energized over its locking circuit. Relay 252 also connects ground to the holding conductor 223 at armature 260, and at armature 259 connects ground to conductor 285 extending to the second digit storage device Fig. 7, thus completing a circuit for relays 304 and 305 in series. Upon energizing, these relays connect the ten digit relays 321 to 320, inclusive, to the ten conductors coming from the digit keys. In this manner the second digit storage device is prepared for registering the second digit.

It will be clear now that when the No. 5 digit key is depressed, a circuit will be closed over conductor 235 for the fifth digit relay 325 of the second digit storage device. Upon energizing relay 325 prepares a locking circuit for itself at its armature 331, connects the grounded conductor 228 to the lamp conductor 335 at armature 333, thereby displaying the No. 5 digit in the second digit bank of the lamp indicating device, and connects conductor 388 to conductor 265 at armature 332. The latter conductor extends to the lower bank of the sending switch S and terminates there in bank contact 295. When the No. 5 digit key is released, ground is removed from conductor 235 and relay 325 becomes locked in series with relay 303 over conductor 285. Relay 303 is accordingly energized in series with relay 325 and at its armature 312 breaks the circuit of relays 304 and 305, whereupon these relays fall back and disconnect the digit relays 321–320, inclusive, from the conductors coming from the digit keys. Relay 303 also grounds the holding conductor 223 at its armature 311, and at its armature 310 grounds the conductor 385 which extends to the third digit storage device, thereby completing a circuit for the relays, corresponding to relays 304 and 305, which connect the ten digit relays of the third digit storage device with the conductors coming from the digit keys.

When the operator depresses the No. 6 digit key, a circuit is completed over conductor 236 for the sixth digit relay in the third digit storage device and this relay is energized with a result similar to that described in the case of the two previously energized digit relays, and it follows that the digit 6 is displayed in the third digit bank of the lamp indicating device, and a circuit is prepared for grounding conductor 266 which extends to the lower bank of the sending switch S and terminates there in bank contact 296. When the operator releases the No. 6 digit key, the sixth digit relay in the third digit storage device becomes locked in series with the associated relay, corresponding to relay 303 of the second digit storage device, and this relay, upon energizing, breaks the circuit of the relays through the medium of which the digit relays were connected to the conductors coming from the digit keys, whereby these digit relays are again disconnected. Ground is also placed upon the holding conductor 223 in the third digit storage device and at the same time ground is placed upon the conductor, corresponding to conductor 385, which extends to the fourth digit storage device, whereupon a circuit is completed for a pair of relays in said device, corresponding to the relays 304 and 305 of the second digit storage device, these relays having the function of connecting up the ten digit relays of the fourth digit storage device to the conductors coming from the digit keys.

When the No. 7 digit key is depressed, the

operations which take place at the fourth digit storage device are similar to those described in the case of the other storage devices. The No. 7 digit relay is energized over conductor 237, and this relay causes the digit 7 to be displayed at the fourth digit bank of the lamp indicating device and also prepares a circuit for grounding conductor 267, which conductor terminates in bank contact 297 of the sending switch S. After the No. 7 digit key is released, the energized digit relay becomes locked in series with a relay, corresponding to relay 303, which is energized in order to ground the holding conductor 223 and also to break the circuit of the relays which have previously been effective to connect the ten digit relays of the fourth digit storage device with the conductors coming from the digit keys.

From the foregoing it will be understood that the fourth, fifth, sixth and seventh digit relays in the first, second, third, and fourth storage devices, respectively, are now locked up, with the result that the telephone number 4567 has been displayed on the lamp indicating device, and with the further result that bank contact 294 of the sending switch S has been grounded, while bank contacts 295, 296 and 297 have been connected with in the last three storage devices, respectively, wherein circuits have been prepared for grounding these bank contacts also at the proper time. It should be remembered also that the holding conductor 223 has been grounded at each of the four storage devices. The pilot lamp L^4, which is located in line with the digit keys of the sender, upon which the number has just been registered, is also lighted inasmuch as it is connected with the grounded holding conductor 223. When the key K' is operated by the B operator, which takes place immediately after the operation of the various digit keys, the relay 45 is energized over a circuit extending from ground on the holding conductor 223, springs of key K', and through the winding of relay 45 to battery. Relay 45, upon energizing, at armature 54 locks itself to grounded conductor 223, at armature 53 prepares the circuit of the relay 46, at armature 52 prepares the circuit of relay 44, and at armature 51 lights the calling lamp L^5. The function of the lamp indicating device, upon which the digits are displayed as fast as they are registered, is to indicate completed telephone numbers to the B operator with a view to affording her a check on the accuracy of her work. In order to obtain the best results and the maximum speed of operation it is intended that the B operator will register the digits in the telephone numbers as they are transmitted to her by the A operator, from which it will be evident that the digit keys are necessarily operated with great rapidity, and in quick succession. Although an experienced operator soon becomes accustomed to this and will make very few mistakes, there will be times nevertheless when she is interrupted in her work or for some other reason is uncertain whether she has registered the correct number or not, and at such times the lamp indicating device affords a convenient method of at once ascertaining what number has actually been registered. If it is not desired to use the indicating device constantly, a key may be inserted in the battery conductor in order to disconnect the current supply from the lamp, and the key may then be operated whenever it is desired to show up some particular number. In case an inspection of the indicating device should show that a telephone number has been registered inaccurately, the release key R may be actuated in order to energize relay 203 for the purpose of restoring the digit relays of the several storage devices to normal position. The manner in which this is accomplished by the operation of relay 203 will be clear from the subsequent explanation of the restoration of these relays under ordinary circumstances, consequently it will not be necessary to make any detailed explanation of it at this time.

Having completed the registration of the number, the B operator assigns a trunk to the A operator, as previously explained and need pay no further attention to the call. As soon as the A operator takes the trunk, the B operator is notified of the fact by the lighting of the busy lamp L^3. Another result of the energization of the bridged relay 40 is that a circuit is completed in multiple with that of the lamp L^3 for the upper winding of relay 46 by way of grounded conductor 62. Upon energizing, relay 46 locks itself to the grounded holding conductor 223 at its armature 57, closes a circuit for the upper winding of relay 44 at armature 56, and at armatures 55 and 59 connects the trunk conductors 60 and 61 with the conductors 221 and 222 coming from the sending switch S, Fig. 5. Conductors 221 and 222 are normally connected together at armature 212 and also at armature 214 of relays 201 and 202 of the sending switch S, and it follows, therefore, that a circuit is completed over the trunk conductors 60 and 61 for the line relay 65 of the first selector D, Fig. 3. Upon energizing, relay 65 closes a circuit for the slow acting release relay 66. The latter relay, upon energizing, opens a point in the circuit of the release magnet 72 and prepares a circuit for the vertical magnet 70 in the customary manner.

Relay 44 is operated when the circuit is closed through its upper winding and completes a locking circuit for itself at its armature 61. In addition relay 44 closes a pair of contacts in the trunk conductors in order that when the relay 46 deenergizes, as will

occur shortly, the said trunk line may extend continuously through the operator's position. When relay 46 is energized, as just explained, the conductor 224 is grounded, being connected with conductor 223 at armature 58, and a circuit is completed for slow acting relay 204, Fig 5. Upon energizing, relay 204 closes a circuit for slow acting relay 205 at its armature 217 and its armature 218 disconnects ground from the conductor 228. The latter operation extinguishes the lights in the lamp indicating device, and when the slow acting relay 205 pulls up it opens the normal ground connection to conductor 226 at its armature 219 and substitutes therefor a ground coming from the working contact of armature 218 of relay 204. Since relay 204 is already energized and since the contacts at armature 219 are of the make before break type, conductor 226 is held grounded continuously during this operation. In addition to causing the operation of relays 204 and 205, the grounding of conductor 224 produces another result, which is the closure of a circuit for the impulsing relay 202. This circuit is broken at the rate of about ten times per second by the constantly rotating cam 298, and the circuit is accordingly closed the first time the said cam comes into the proper position after the conductor 224 is grounded. Relay 202 is now intermittently energized and deenergized by the operation of cam 298. At the first energization relay 202 does not open the circuit of the line relay 65 of the first selector D at armature 214 because this circuit is closed also at armature 212 of relay 201. At armature 215, however, a circuit is completed for the stepping magnet 206 of the sending switch S and this magnet is energized. Upon the deenergization of relay 202 the circuit of the stepping magnet 206 is broken and the said magnet retracts its armature, thereby advancing the wipers 207 and 208 one step. The wiper 207 now engages the first grounded contact in its associated bank and thereby closes a circuit for the slow acting relay 201 which energizes and prepares a locking circuit for slow acting relay 200. Relay 201 also opens, at armature 212, the shunt circuit which normally renders the impulsing relay 202 ineffective to interrupt the circuit of the line relay of the selector D. The impulsing relay 202 continues to be energized and deenergized intermittently by the operation of the cam 298, and at each energization this relay will separate the two conductors 221 and 222 and will thereby produce a series of interruptions in the circuit of the line relay 65 of the selector D. At the same time relay 202 transmits a series of impulses to the stepping magnet 206 at armature 215, and the sending switch S is thus driven synchronously with the first selector. After four interruptions have been produced in this way, the stepping magnet 206 will have been energized four more times, and the wiper 208 will be advanced into engagement with the now grounded bank contact 294. A circuit is thus completed for the slow acting relay 200, which immediately energizes, establishes a locking circuit for itself at its armature 210, and at its armature 211 opens the circuit of the impulsing relay 202, thus preventing the transmission of any more impulses over the trunk circuit for the time being. Relay 200 also closes a new circuit for the stepping magnet 206 at armature 209, and since this circuit includes an interrupter contact controlled by the stepping magnet itself, the said stepping magnet will operate in the manner of a buzzer and the switch will be advanced automatically until wiper 207 arrives at the first ungrounded contact in its bank which, as shown in the drawing, is the twelfth bank contact. During this time certain operations are taking place at the first digit storage device which will now be explained.

At the same time that a circuit is completed for relay 200 by the arrival of wiper 208 at grounded bank contact 294, a circuit is completed by this wiper which extends over conductor 227 and by way of armature 255 and its resting contact to relay 251 at the first digit storage device, thus energizing this relay. As explained before, the switch S continues to advance its wipers and as soon as another step is taken, wiper 208 will leave the grounded bank contact 294 and will come into engagement with an ungrounded bank contact. Ground is thus removed from conductor 227, and relay 251 will become locked in operated position over a circuit which includes relay 250 and the grounded conductor 226. Relay 250 is, therefore, energized with the result that conductor 227 is disconnected from relay 251 and is transferred by way of conductor 287 to the corresponding relay 302 of the second digit storage device. Further results of the energization of relay 250 are the opening of the ground connection at armature 257 to the holding conductor 223 in the first digit storage device (it will be recollected that this holding conductor is still grounded in each of the other three storage devices); the removal of ground from conductor 288, at armature 256, whereby ground is disconnected from bank contact 294 in the bank of the sending switch S; and the grounding conductor 286 at the same armature 256, whereby ground is extended by way of the energized digit relay 325 of the second digit storage device, and conductor 265 to bank contact 295 of the sending switch S. The operations so far described have resulted in the transmission of a series of four im-

pulses to the selector D, or more specifically speaking, the circuit of the line relay 65 of the said selector has been interrupted four times and in response to these interruptions the selector is operated to raise its wipers to the fourth level, and at the end of the series of impulses it operates automatically to select an idle trunk leading to a second selector, such as the second selector E.

Returning again to the operation of the sending switch, when the wiper 207 arrives at the twelfth contact in its associated bank, which is ungrounded, the circuit of the slow acting relay 201 is broken and after an instant this relay will fall back, thus opening the locking circuit of slow acting relay 200 and at the same time closing the normal shunt circuit around the impulsing contact at armature 214 of the impulsing relay 202. Its circuit having been broken, the slow acting relay 200 also deenergizes after a brief instant and at its armature 211 again closes the circuit of the impulsing relay 202. Thus relay now begins operating as before and on its first energization transmits an impulse of current to the stepping magnet 206 without, however, interrupting the switch control circuit over the trunk line, which now extends through to the second selector E. On the first step of the sending switch S, wiper 207 arrives at the thirteenth bank contact and since this contact is grounded a circuit is completed for the slow acting relay 201 which operates to open the shunt circuit at its armature 212 as before. Subsequent energizations of the impulsing relay 202 now cause the control circuit extending to the selector E to be interrupted a plurality of times, while at the same time the stepping magnet 206 is intermittently energized to drive the wipers of the sending switch. When wiper 208 arrives at the eighteenth contact in its associated bank, which contact it connected in multiple with the bank contact 295, a circuit will be completed for relay 200, and this relay is energized as before to open the circuit of the impulsing relay 202 and thus stop the further transmission of impulses. Relay 200 also closes the usual circuit for continuing the operation of the stepping magnet 206 and the sending switch is, therefore, continued in motion until the wiper 207 arrives at the next ungrounded bank contact, which is the twenty-fifth. At the same time that relay 200 is energized, a circuit is completed by way of conductors 227 and 287 for relay 302 in the second digit storage device and the said relay 302 is energized. As the sending switch continues its advance, this circuit is broken and relay 302 becomes locked in series with relay 301 to the grounded conductor 285. Relay 301 is accordingly energized and at its armature 306 disconnects conductor 287 from the winding of relay 302 and transfers it by way of conductor 287 to a similar relay in the third digit storage device. In addition, relay 301 disconnects the grounded conductor 286 from conductor 388, thereby removing ground from the bank contact 295 in the bank of the sending switch S, and transfers it into connection with conductor 386, whereby ground is extended by way of the new energized sixth digit relay in the third digit storage device, to bank contact 296 in the bank of the sending switch, and at armature 308 of relay 301 the ground connection to the holding conductor 223 in the second digit storage device is broken.

The second series of operations at the operator's sending equipment resulted in the transmission of five impulses to the selector E, or rather in the production of five interruptions in the circuit of its line relay 90, whereby the switch shaft and wipers are raised opposite the fifth level of bank contacts. Upon the cessation of the series of impulses, the second selector E automatically operates to select an idle trunk leading to a connector switch, such as the connector H, Fig. 4.

When the wiper 207 of the sending switch arrives at the twenty-fifth bank contact it finds this contact ungrounded, the advance of the switch is stopped temporarily, and relay 201 is deenergized, thus again shunting the impulsing contact at armature 214. After a brief further interval, the slow acting relay 200 will fall back and again close the circuit of impulsing relay 202, which now begins operating as before, and produces a series of interruptions in the control circuit of the connector H to operate this switch vertically, while at the same time the impulses are transmitted to the stepping magnet 206, in order to drive the sending switch S. It is understood, of course, that the first energization of relay 202 is ineffective to interrupt the control circuit. It will be unnecessary to minutely consider all the operations which take place during the transmission of the third and fourth series of impulses. The third series is terminated by the arrival of wiper 208 at grounded bank contact 296 which causes relay 200 to be energized, in order to advance the sending switch automatically to the twelfth contact in its bank, and which closes a circuit over conductors 227, 287, and 387 to the relay in the third digit storage device which corresponds to relay 382 of the second digit storage device. Upon the removal of ground from conductor 227 by the further advance of the sending switch S, a relay in the third digit storage device, corresponding to relay 301 of the second digit storage device, is energized and various transfer oper-

ations take place which result in the removal of ground from bank contact 296 and in the grounding of bank contact 297.

The connector H responds to the third series of impulses, and its shaft and wipers are raised five steps until they stand opposite the fifth level of bank contacts. No automatic movement takes place at the connector, however, upon the cessation of the series of impulses and further movement of the connector is deferred until the arrival of the next series of impulses.

When the wipers of the sending switch S arrive at the twelfth set of bank contacts, wiper 207 will find no ground and relays 201 and 200 are accordingly deenergized to again start the operation of the switch. The impulsing relay 202 now begins to step the switch S around as before, and after the first step begins to transmit the final series of impulses over the control circuit to the connector H. This last series of impulses is terminated by the arrival of wiper 208 at the twentieth contact in its bank which is connected in multiple with bank contact 297 and which is, therefore, grounded. When this occurs, relay 200 is energized as usual to stop the transmission of impulses and to close the automatic stepping circuit for the stepping magnet 206 of the sending switch. At the same time conductor 227 is grounded, and a circuit is completed over said conductor and conductors 287 and 387 and thence by way of a similar conductor, in the third digit storage device, to a relay in the fourth digit storage device which corresponds to relay 302 of the second digit storage device. As the sending switch continues its advance ground is removed from conductor 227, whereupon a transfer relay in the fourth digit storage device, which corresponds to transfer relay 301 of the second digit storage device, is energized. Since the fourth digit storage device is the last one, it will be apparent that those conductors, corresponding to conductors 385, 386, and 387, will be omitted, and the principal result of the operation of the transfer relay is the removal of ground from the holding conductor 223. Ground has already been removed from this holding conductor at each of the other three storage devices, and it follows that conductor 223 will now be entirely clear of ground. At the same time that conductor 223 is cleared, conductor 224 is cleared of ground also for this conductor has been maintained grounded through its connection with conductor 223 at armature 58 of relay 46. The removal of ground from conductor 224 permanently opens the circuit of the impulsing relay 202 and thus prevents any further operation of the sending switch S at this time. The removal of ground from conductor 224 also causes the deenergization of the slow acting relay 204, which opens the circuit of the slow acting relay 205 at armature 217 and at the same time disconnects ground from conductor 226 at armature 218. As a result of the latter operation, relays 250, 251, 252, and 274 of the first digit storage device are deenergized. Relay 252, upon deenergizing, opens the circuit of relays 253 and 254 which are thus deenergized also, and also removes ground from conductor 285 at armature 259. By the latter operation relays 301, 302, 303, and 325 of the second digit storage device are deenergized. Relay 303, upon deenergizing, removes ground from conductor 385 extending to the third digit storage device, and as a result the corresponding relays in this storage device are deenergized also. In a similar way, the relays in the fourth digit storage device, which have been locked up, are deenergized an instant later. The operator's sending equipment, including the four digit storage devices and the sending switch S, is thus entirely restored to normal position and is ready for use again in registering another telephone number.

At the trunk line, Fig. 2, when ground is removed from the holding conductor 223 the locking circuit of relay 46 is broken and thus the relay is accordingly deenergized. As a result the circuit of relay 44 is broken, but this relay remains locked up to the grounded conductor 56 at its armature 61. By the deenergization of relay 46, the incoming conductors 30 and 31 of the inter-office trunk line, are connected through the two condensers by way of armatures 49 and 50 of relay 44, and through the normally closed sets of contact springs controlled by relays 46 and 48 to the outgoing trunk conductors 60 and 61, which have been extended, by the operation of selectors D and E and the connector H, to the desired called line. It will be observed that there is a bridge across the trunk conductors 60 and 61 at the B operator's position which includes the impedance coil 43 and upper winding of the electropolarized relay 42. Thus, the continuity of the switch control circuit extending through to the connector H is preserved and the switches are prevented from releasing. The two windings of relay 42 are in opposition at this time and consequently this relay is not operated. By the removal of ground from the holding trunk conductor 223 the locking circuit of the relay 45 is opened and this relay deenergizes to restore certain circuits to normal and to extinguish the calling lamp L^5. By the effacement of this signal the B operator is notified that the connection has been completed and the sending equipment is free.

The operation of the automatic switches will now be explained a little more in detail, in order that the entire system may be fully

understood without reference to other publications. As previously explained, the control circuit of the first selector D includes the conductors 221 and 222 coming from the sending switch S, and the trunk conductors 60 and 61, and when the first series of interruptions is produced in this circuit by the intermittent impulsing relay 202 of the said sending switch, the line relay 65 of the first selector is caused to retract its armature a corresponding plurality of times. At each retraction of its armature, relay 65 sends a current impulse through the slow acting series relay 67 and the vertical magnet 70 in series, and the vertical magnet is operated to raise the switch shaft step by step until the wipers 80, 81, and 82 stand opposite the fourth level of bank contacts. Relay 67 is energized in series with the vertical magnet, and being slow acting retains its armature in operated position throughout the vertical movement of the switch. At the first upward step, the off normal springs 78 are closed and since relay 67 is in operated position a circuit is completed for the stepping relay 68. Upon energizing, relay 68 establishes a locking circuit for itself at its upper armature, and at its lower armature prepares a circuit for the rotary magnet 71. At the end of the vertical movement of the switch, the slow acting relay 67 is deenergized and closes the circuit of the rotary magnet 71 which accordingly operates to rotate the switch shaft one step and brings the switch wipers into engagement with the first set of bank contacts in the fourth level. At the same time the rotary magnet opens its interrupter contact and thus breaks the locking circuit of the stepping relay 68, which accordingly deenergizes and breaks the circuit of the rotary magnet which thereupon deenergizes also and again closes its interrupter contact. The operation now depends upon whether the trunk line terminating in the first set of contacts is busy or idle. If this trunk line is busy, there will be a ground potential on the test contact engaged by the test wiper 81 and the stepping relay 68 will again be energized, resulting in another closure of the rotary magnet circuit and the advance of the switch wipers into engagement with the second set of bank contacts, and this operation will continue as long as the test wiper 81 continues to engage grounded test contacts. When the first idle trunk line is reached, which we will assume to be the trunk line extending to the second selector E, the test wiper 81 will find no ground potential on the test contact 84 and the stepping relay 68 will not again be operated. Instead the switching relay 69, which has heretofore been short circuited, is energized in series with the stepping relay 68, the latter relay remaining inoperative due to the high resistance of the said switching relay. Upon energizing, relay 69 grounds the test wiper 81 at its armature 75 in order to make the selected trunk line busy, and at its armatures 74 and 77 disconnects the trunk conductors 60 and 61 from the winding of the line relay 65 and extends then by way of wipers 80 and 82, bank contacts 83 and 85, conductors 86 and 88, and armatures 94 and 96 and their resting contacts to the upper and lower windings of the line relay 90 of the second selector E.

When the trunk conductors are extended to the selector E, as above described, the line relay 90 is energized and closes a circuit for the slow acting release relay 91. Upon energizing, relay 91 prepares the selector for operation in its vertical movement in the usual manner, and also connects ground to the release trunk conductor 87, thereby establishing a holding circuit which extends by way of said conductor 87, test contact 84, test wiper 81, armature 75 and its working contact, winding of the switching relay 69, interrupter contacts of the rotary magnet 71, off normal springs 78, and the winding of the stepping relay 68 to battery.

The operations just described whereby trunk conductors 60 and 61 have been extended through to the second selector E have occurred in response to the transmission of the first series of impulses by the sending switch S. The automatic rotary movement of the selector D in selecting an idle trunk line in the particular level, which was selected under the directive control of the sender, takes place during the time interval between the transmission of the first and the second series of impulses. It will be recollected that this time interval is introduced by the relays 201 and 200, of the sending switch, which are slow acting and which, therefore, require an appreciable length of time to fall back. It may be apprehended that an additional time interval is introduced between each two series of impulses, owing to the fact that the sending switch S is forced to complete its travel from one of its normal positions to the next each time a series of impulses is transmitted. This is true to a certain extent, but the time interval thus introduced is so short as to be inappreciable. The switch S travels over its bank contacts at a rate of about sixty per second when it is advancing its wipers automatically.

When the next series of impulses come in over the trunk conductors 60 and 61, the line relay 90 of the second selector E is deenergized a plurality of times and controls the vertical magnet 92 to raise the shaft and wipers 100–102, inclusive, to the fifth level, the second digit in the number being the digit 5, as explained heretofore. The operation of the second selector E is

precisely the same as that of the first selector E, and consequently it will be unnecessary to consider it in detail. It will be sufficient to say that at the end of the vertical movement of the switch, the rotary movement is initiated automatically and the wipers are rotated step by step in search of an idle trunk line leading to a connector switch. Assuming that the first idle trunk line encountered is the one shown in the drawing and extending to the connector H, Fig. 4, when the test wiper 100 arrives at test contact 104 it will find the said test contact unguarded, and the selecting movement of the switch will be arrested. The switching relay 99 is now energized, and the trunk conductors 86 and 88 incoming to the selector are disconnected from the windings of the line relay 90 and are extended by way of armatures 94 and 96 and their working contacts, wipers 100 and 102, bank contacts 103 and 105, conductors 106 and 108, normally closed contact springs of the back bridge relay 110 to the upper and lower windings of the double wound line relay 111 of the connector H.

On the extension of the control circuit to the connector H in the above manner, the line relay 111 is energized and completes a circuit for the slow acting release relay 112. Upon energizing, relay 112 prepares the connector for operation in its vertical movement in the usual way and at armature 125 connects ground to the release trunk conductor 107. A holding circuit is thus established which extends by way of the said conductor 107, test contact 104, test wiper 101, and armature 95 and its working contact, to conductor 87 where it joins a previously described holding circuit extending back to the first selector D. The switching relay 99 at the second selector E is connected to the holding circuit the same as was described in the case of the switching relay 69 of the first selector.

When the third series of impulses, corresponding to the digit 6, are transmitted over the control circuit by the operator's sender, the line relay 111 of the connector H is momentarily deenergized six times and at each deenergization transmits an impulse of current to the vertical magnet 118 over a path which extends from ground by way of armature 124 and its resting contact, armature 126 and its working contact, off normal springs 121 and 123, winding of the slow acting series relay 113, and the winding of the vertical magnet 118 to battery. By the operation of the vertical magnet the wipers 150–152, inclusive, are raised step by step, until they stand opposite the sixth level of bank contacts. Relay 113 is energized in series with the vertical magnet 118 and being slow acting holds up continuously during the vertical operation of the switch. By the operation of this relay, the vertical magnet circuit is preserved intact, notwithstanding the shifting of the off normal springs, which occurs at the first vertical step of the switch. At the end of the vertical movement, relay 113 deenergizes and transfers the operating circuit to the rotary magnet 119.

The last series of impulses comprises seven interruptions in the control circuit corresponding to the final digit 7 of the called telephone number. Responsive to these interruptions the line relay 111 is deenergized seven times and now sends impulses to the rotary magnet 119 over the following circuit: from ground by way of armature 124 and its resting contact, armature 126 and its working contact, off normal springs 121 and 122, armature 127 and its resting contact, resting contact of armature 132, and the said armature, armature 139 and its resting contact, and the winding of the rotary magnet 119 to battery. By the operation of the rotary magnet, the wipers 150–152, inclusive, are rotated step by step and are finally brought to rest in engagement with the particular set of bank contacts in which the line of substation A′ is terminated, these contacts being indicated in the drawings by reference characters 153, 154 and 155. The slow acting relay 116 is energized in parallel with the rotary magnet and remains continuously energized during the rotary movement. In operated position, relay 116 connects the test wiper 151 to the winding of the test relay 115 by means of its armature 133 and at armature 135 closes an alternative point in the circuit of the rotary magnet, to guard against the possibility of having this circuit opened by the operation of the test relay while the test wiper 151 is passing over grounded test contacts.

The final series of impulses has now been received, and the connector wipers have been placed in connection with the terminals of the called line. If the line is busy there will be a ground potential on the test contact 154 and the test relay 115 will be energized. When this relay operates it prepares a locking circuit for itself at its armature 131, which is completed when the slow acting relay 116 falls back an instant later, opens the rotary magnet circuit at armature 132, and at armature 134 connects a lead from the busy signalling machine to the lower side of the line. By this time the relay 45 at the B operator's position has been deenergized, the operator's sender has been disconnected, and the trunk conductors 30 and 31 have been connected through by way of the condensers to the trunk conductors 60 and 61, respectively, all as previously explained. It will be evident then that an audible busy signal will be transmitted to the calling subscriber in the distant manual exchange. On perceiving the signal, the

subscriber will replace his receiver thereby signalling the operator who will pull down the connection and the automatic switches will be released, as will be explained subsequently.

Suppose now that the called line is idle when connection therewith is attempted. Under these circumstances there will be no ground on the test contact 154, and the test relay 115 will not be energized. Then when the slow acting relay 116 falls back a circuit is completed for the switching relay 117 which may be traced from the grounded conductor 107 by way of armature 131 and its resting contact, the upper winding of the switching relay 117, resting contact of armature 113 and the said armature, test wiper 151, test contact 154, winding of the cut off or switching relay 162 of the line switch C, and winding of the stepping magnet 164 to battery. Relays 117 and 162 are energized in series over this circuit, and the latter relay is effective to clear the line conductors 160 and 161 of their normal battery and ground connections in the line switch. It may be explained that owing to a mechanical interlocking device between the armatures of the switching relay 162 and the line relay 163, the former relay is operated only about half way at this time, and the wipers of the line switch are not connected up.

At the connector H, when the switching relay 117 pulls up, it establishes a locking circuit for itself at armature 138, grounds the test wiper 151 at armature 137, opens the rotary magnet circuit at armature 139, and at armatures 136 and 140 connects up the two line wipers 150 and 152. By the latter operation a signalling circuit is established whereby ringing current from the generator GEN is intermittently projected out over the called line to operate the bridged ringer at substation A′, and notify the called subscriber that he is wanted. The return path for the ringing current includes the upper winding of the ring cut off relay 114, and when the called subscriber answers this relay is operated. Upon energizing, relay 114 establishes a locking circuit for itself at its armature 129, breaks the ringing circuit at armatures 128 and 130, and at the working contacts of these same armatures finally completes the talking connection.

Current is now supplied to the transmitter at substation A′ through the windings of the double wound back bridge relay 110 which is accordingly energized. This relay is a reversing relay and has the well known function of reversing the incoming trunk conductors 106 and 108 as regards their connections with the windings of the line relay 111. It will be recalled now that the circuit of the line relay 111 is completed by way of the bridge through the impedance coil 43, and the upper winding of the electro polarized relay 42 in the trunk equipment at the B operator's position, the operator's sender having been disconnected by this time, and the operation of the reversing relay 110, therefore, will reverse the direction of current flow in the trunk line and more particularly in the bridge thereof which includes the upper winding of the said electropolarized relay 42. As a result, the two windings of this relay now co-operate and it is able to attract its armature whereby the upper high resistance winding of relay 40 is shunted by means of the relatively low resistance impedance coil 41. Relay 40 remains energized, owing to the fact that its lower winding is still connected in the bridge across conductors 30 and 31, and the result of shunting out the upper high resistance winding of this relay is to augment the flow of current sufficiently to operate the supervisory relay 7 at the operator's cord circuit in the manual exchange. This serves to extinguish the supervisory lamp L^2 and notifies the operator that the called subscriber in the automatic exchange has answered his telephone. The subscribers may now converse as desired.

When the subscribers are through talking, they will replace their receivers. By the replacement of the receiver at substation A, the supervisory relay 8 is deenergized, and the supervisory lamp L′ is lighted. When the subscriber at substation A′ replaces his receiver, the back bridge relay 110 in the connector H is deenergized and the direction of current flow in the section of the trunk to the right of the condensers is reversed to normal, thereby causing the electropolarized relay 42 to retract its armature. By this operation the upper high resistance winding of relay 40 is again included in the circuit of the supervisory relay 7 at the A operator's cord circuit, and this relay is deenergized to light the supervisory lamp L^2. By the disconnect signals thus given the operator, she is advised that the conversation is finished and she will accordingly pull down the connection. When the plug is removed from the jack J′, the circuit over which relay 40 at the B operator's position has been maintained energized, is broken and relay 40 will accordingly fall back and remove ground from conductor 56. This extinguishes the busy lamp L^3 and also breaks the locking circuit of relay 44. On deenergizing, relay 44 opens the trunk line at armatures 49 and 50 thereby clearing the bridge across the trunk conductors 60 and 61. As a result, the line and release relays 111 and 112 of the connector H are permitted to fall back and these relays jointly close a circuit for the release magnet 120, whereby the connector H is restored to normal in the usual manner. Relay 112 also removes ground from the release trunk

conductor 107 and this operation breaks the holding circuit for the switching relays 69 and 99 of the selectors D and E, respectively. These relays are, therefore, deenergized and circuits are completed for release magnets 72 and 93 which operate to restore their associated switches to normal position. All the apparatus is thus returned to normal and is ready for use in setting up other connections.

It will now be convenient to explain certain details of the operation of the sending circuits which have not been taken into account in the foregoing. Under certain conditions the A operator may not take the trunk assigned to her by the B operator, this may be from various reasons such as the calling subscriber hanging up, and it is necessary that the B operator be informed of this fact so that the registering equipment in use will not be tied up indefinitely. It will be remembered that the lamp L^5 is lighted immediately upon the operation of the key K'. If this lamp continues to burn without the operation of the lamp L^3 the B operator will know that the trunk has not been seized and she will operate the release key R thereby restoring the apparatus to normal in a manner similar to that already described.

It will, of course, be appreciated that the B operator does not necessarily have to operate the key K' immediately after the operation of the digit keys and that she may do so after the trunk has been seized by the A operator. Under these conditions, the sending operations take place immediately upon the operation of the key K'. However, the usual method of operation will be to actuate the key K' immediately after the operation of the digit keys as this procedure saves considerable of the B operator's time and minimizes the attention that the operator has to give to each connection.

It will be seen from the foregoing that I have devised a simple and efficient arrangement of circuits and apparatus for handling calls between manual and automatic exchanges, introducing a variety of new features which not only simplify and reduce the cost of the equipment, but add to the speed and facility with which necessary duties are performed by the operators.

Having described my invention, what I consider to be new and desire to have protected by Letters Patent will be pointed out in the appended claims.

What I claim is:

1. In a telephone system, A and B operators' positions, trunk lines extending from the A operator's position through the B operator's position to automatic switches, other automatic switches, means for manually connecting a calling line with one of said trunk lines at said A operator's position, an operator's sender including a registering device at said B operator's position, means whereby the B operator can set up the called number on said registering device and prepare the sender for connection to the trunk line in use, means independent of further attention on the part of the B operator and responsive to the connection of said calling line with the selected trunk line for automatically connecting the sender to the trunk line in use, and means controlled by said registering device for causing said sender to send successive series of impulses over said trunk line to operate a series of said switches to extend a connection to a called line.

2. In a telephone system, A and B operators' positions, trunk lines coming from the A operator's position and passing through the B operator's position to automatic switches, other automatic switches, means for manually connecting a calling line with one of said trunk lines at the A operator's position, an operator's sender at the B position comprising a sending switch and a plurality of storage devices, means whereby the B operator can register the digits in the number of the called line on said devices and prepare the sender for connection to the trunk line in use, automatic means independent of further attention on the part of the B operator and responsive to the manual connection of the said calling line with the selected trunk line for connecting the sender with the said trunk line, means also responsive to such manual connection whereby the sending switch is then controlled by said storage devices successively to transmit series of impulses over the trunk conductors to operate a series of said switches to connect with the called line, and means for automatically disconnecting the sender when the connection is completed.

3. In a telephone system, A and B operators' positions, trunk lines coming from the A operator's position and passing through the B operator's position to automatic switches, other automatic switches, means for manually connecting a calling line with one of said trunk lines at the A operator's position, an operator's sender at the B position comprising a sending switch and a plurality of storage devices, means whereby the B operator can register the digits in the number of the called line on said devices, automatic means responsive to the manual connection of the said calling line with the selected trunk line and to a previously completed momentary operation on the part of the B operator for connecting the sender with the said trunk line, means whereby the sending switch is then controlled by said storage devices successively to transmit series of impulses over the trunk conductors to operate a series of said switches to connect with the called line, and

means for automatically disconnecting the sender when the connection is completed.

4. In a telephone system, A and B operators' positions, trunk lines coming from the A operator's position and passing through the B operator's position to automatic switches, other automatic switches, a call circuit extending between said positions whereby the A operator can transmit a desired called number to the B operator, an operator's sender at the B position comprising a sending switch and a plurality of storage devices, means whereby the B operator can register the digits in the called number on said devices, manual means at the A operator's position for connecting a calling line with a particular one of said trunk lines assigned by the B operator over said call circuit, automatic means responsive to the seizing of said trunk for connecting said sender with the trunk line assigned independent of any contemporaneous or subsequent operation on the part of the B operator, and means also responsive to the seizure of said trunk for then automatically operating said sending switch under the control of said storage devices to transmit a plurality of series of impulses over the trunk conductors to operate a series of said switches to complete the connection to the called line.

5. In a telephone system, A and B operators' positions, trunk lines coming from the A operator's position and passing through the B operator's position to automatic switches, other automatic switches, a call circuit extending between said positions whereby the A operator can transmit a desired called number to the B operator, an operator's sender at the B position comprising a sending switch and a plurality of storage devices, means whereby the B operator can register the digits in the called number on said devices, manual means at the A operator's position for connecting a calling line with a particular one of said trunk lines assigned by the B operator over said call circuit, automatic means responsive to the seizing of said trunk line and to a previously completed operation of relatively short duration on the part of the B operator for connecting said sender with the trunk line assigned, and means for then automatically operating said sending switch under the control of said storage devices to transmit a plurality of series of impulses over the trunk conductors to operate a series of said switches to complete the connection to the called line.

6. In a telephone system, A and B operators' positions, trunk lines extending from the A operator's position through the B operator's position to automatic switches, other automatic switches, means for manually connecting a calling line with one of said trunk lines at said A operator's position, an operator's sender at the B position comprising a sending switch and a plurality of storage devices, means whereby the B operator can register the digits in the number of the called line on said devices, a relay for connecting the sender with the trunk in use, a second relay, a circuit for said first relay controlled by said second relay, a third relay controlling an open point in said circuit and means for energizing the said third relay responsive to a momentary operation on the part of the B operator, means for energizing said second relay when said calling line is connected to said trunk line whereby the sender is connected to the trunk also, and means then automatically responsive whereby the sending switch is controlled by said storage devices to successively transmit series of impulses over the trunk conductors to operate a series of said switches to connect with a called line.

7. In a telephone system, A and B operators' positions, trunk lines extending from the A operator's position through the B operator's position to automatic switches, other automatic switches, means for manually connecting a calling line with one of said trunk lines at said A operator's position, an operator's sender including a registering device at said B operator's position, means whereby the B operator can set up the called number on said registering device and prepare the sender for operation by performing an act of relatively short duration, means responsive to the subsequent connection of the calling line with the selected trunk line for initiating the operation of said sender, and means for automatically continuing the operation of said sender under control of said registering device to send successive series of impulses over said trunk line to operate a series of said switches to extend a connection to a called line.

8. In a telephone system, a first and a second manual switchboard, a line extending from the first switchboard and passing through the second switchboard, a sending device at the second switchboard means for transmitting a telephone number to the operator at the second switchboard, means under the control of said operator for adjusting said device in accordance with said number and for preparing to start the sender to retransmit the registered number over said trunk line, means at the first switchboard for subsequently completing a connection to the line thereat, and means for starting said device responsive jointly to the said completion of the connection at the first switchboard and to said preparation and without further attention from the operator at the second switchboard.

9. In a telephone system, a first and a second manual switchboard, a line extending from the first switchboard and passing

through the second switchboard, a sending device at the second switchboard for transmitting impulses over said trunk line, means responsive to a momentary act on the part of the operator at the second switchboard for preparing said sender for operation, means responsive to an act on the part of the operator at the first switchboard for preparing said sender for operation, and means responsive to whichever of said acts is performed last for initiating the operation of said sender.

10. In a telephone system, an operator's switchboard, a trunk line extending therefrom, a sender at said switchboard, means for connecting said sender to said trunk line and for starting the sender to transmit a plurality of series of impulses over said trunk line, a supervisory device individual to said trunk line and common to said sender and one or more other senders, means for energizing said supervisory device during the time said sender is connected to said trunk line, means for automatically disconnecting said sender from said trunk line without further attention on the part of the operator at said switchboard, and means for deenergizing said supervisory device responsive to such disconnection.

In witness whereof, I hereunto subscribe my name this 9th day of August, A. D., 1921.

MARTIN L. NELSON.