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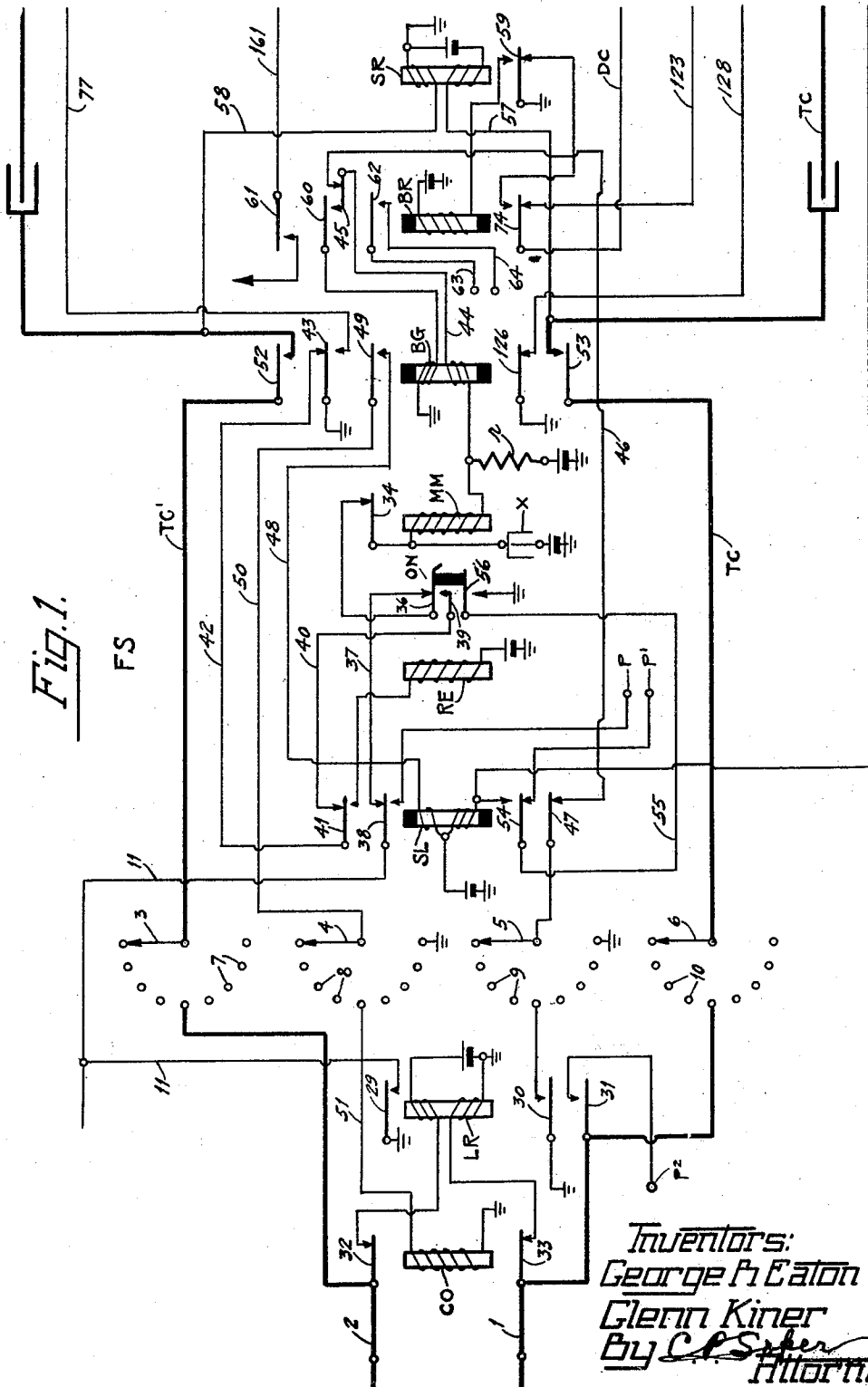
G. R. EATON ET AL

1,899,084

TELEPHONE SYSTEM

Filed Sept. 21, 1931

3 Sheets-Sheet 1



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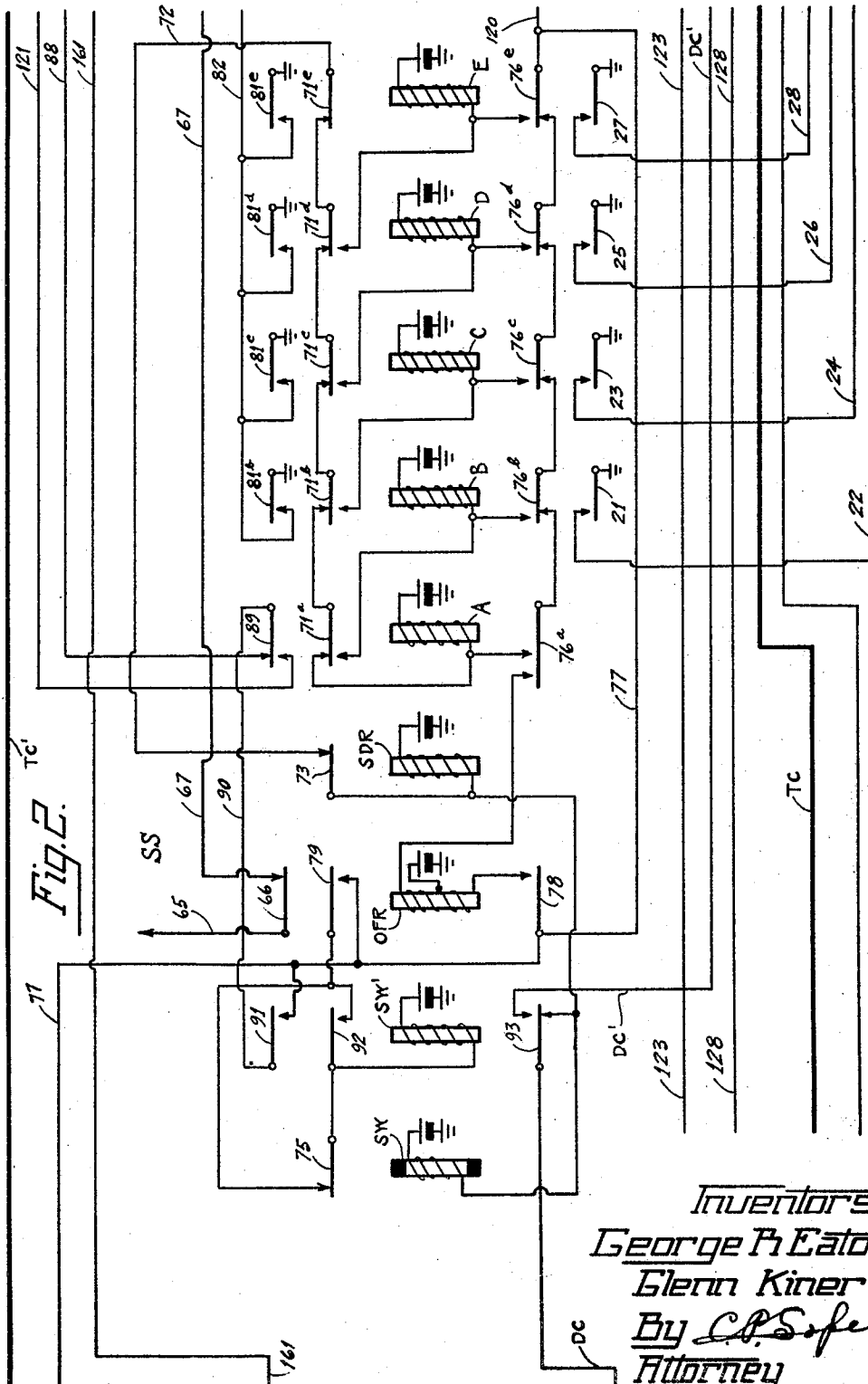
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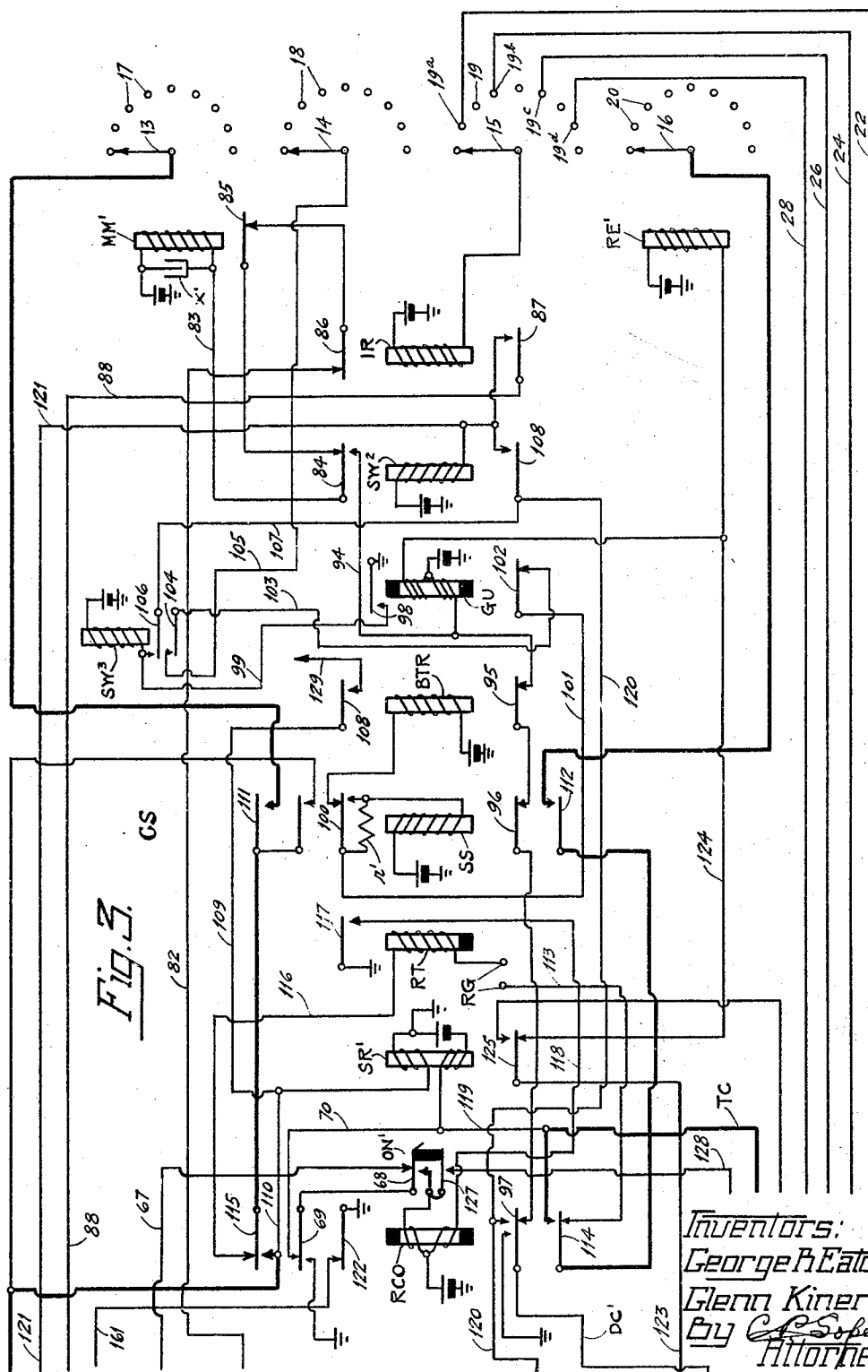
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## UNITED STATES PATENT OFFICE

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## TELEPHONE SYSTEM

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Our invention relates to automatic telephone systems of the two-wire or metallic line type in which directly controlled switches at the exchange are operated in response to a series of rapid interruptions of the subscribers' line circuits to connect the calling subscriber thereat to the contacts of the line being called. The system which is herein disclosed is applicable to private automatic exchange or PAX systems as they are commonly known.

When in the usual system of this type, a subscriber removes his receiver to initiate a call, a line finder switch connects his line to a selector whereupon he operates his dialing device to step the switch wipers of the rotary selector switch into engagement with contacts leading to a connector which in turn is operated to have its switch wipers connect to the contacts of the desired line. It is an object of our invention to provide an improved circuit arrangement using a plurality of counting relays in the selector circuit which eliminates the selector switch and its associated banks of contacts.

A further feature of our invention is the use of a single level rotary switch (shown herein as provided with 50 sets of contacts) in the connector circuit to which the subscribers' stations are connected.

Another feature is the provision in a telephone system of the type described of means for driving the switch wipers to a predetermined point and then stepping them into engagement with the desired set of contacts.

Other features will be disclosed from time to time as the description of the invention progresses.

In the accompanying drawings like reference characters indicate like parts and

Fig. 1 is a schematic drawing of the apparatus comprising the line finder switch of our invention;

Fig. 2 shows the selector circuit, and

Fig. 3 shows the connector circuit.

When Fig. 2 is placed to the right of Fig. 1 and Fig. 3 is placed to the right of Fig. 2 the entire circuit arrangement will be disclosed.

The present invention will be best understood from a consideration of the following

detailed description taken in connection with the accompanying drawings forming a part of this specification, with the understanding, however, that the invention is not confined to any strict conformity with the showing of the drawings but may be changed or modified so long as such changes and modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

Referring particularly to Fig. 1 of the drawings the line conductors 1 and 2, at the left of the drawing lead to a subscriber's station, not shown, which is equipped with the usual automatic substation equipment such as is well known to those skilled in the art. The conductors 1 and 2 terminate at the private automatic exchange in a line circuit L which consists of a line relay LR and cut-off relay CO.

The line finder switch apparatus comprises a motor magnet MM which automatically operates when a call is initiated by a subscriber to step the wipers 3, 4, 5 and 6 over the bank contacts 7, 8, 9 and 10 to select the contacts of the calling line. A bridging relay BG is provided which energizes when the calling line is seized by the switch FS to shunt the motor magnet MM to prevent further advancement of the wipers 3, 4, 5 and 6 and to connect the calling line to the selector mechanism or switch SS. The sleeve relay SL energizes upon the actuation of relay BG to extend the starting conductor 11 to the next finder switch FS (not shown) of the group. A release magnet RE which restores the wipers 3, 4, 5 and 6 to normal is provided. A supervisory relay SR supplies talking battery to the subscriber's line and is alternately energized and deenergized when the subscriber actuates his dialing mechanism to cause the actuation of the selector SS and connector CS. A busy relay BR is provided to cause the operation of an associated part of group busy means (not shown) and to start a tone machine operating as is well known in the art. If all the finder switches in the group with which the calling subscriber is associated are busy a group busy tone will be given the sub-

scriber as soon as the line relay LR closes its alternate contact 31 and connects the conductor *c* to line 1. The relay BR in each finder switch of the group operates to condition apparatus to connect a group busy tone to the conductor *c* when all the finder switches are busy.

The selector switch SS is devoid of any rotary switch and bank contacts as are customary in the present art but is provided with a group of so-called impulse or counting relays A, B, C, D and E which operate under the control of a switching relay SW and an impulse relay IM to control the operation of the motor magnet MM' of the connector switch CS. An off normal relay OF and a switching relay SW' which extends the dialing conductor DC to the connector switch CS are also provided.

The connector switch CS shown in Fig. 3 is of a construction substantially similar to that of the finder switch FS and comprises a shaft which carries the wipers 13, 14, 15 and 16 which are adapted to be stepped into engagement with the bank contacts 17, 18, 19 and 20 through the medium of a motor magnet MM'. A release magnet RE' is also provided which when actuated releases the switch wipers 13, 14, 15 and 16 and restores them to normal. The contacts 17, 18, and 20 which are the tip, sleeve and ring conductors respectively, are multiplied to contacts 7, 8 and 10 respectively of line circuits associated with the called subscribers' stations, not shown in the drawings but similar to the line circuit L of Fig. 1 associated with the calling subscriber's line, and lead to called subscribers' lines.

The present embodiment of our invention utilizes a fifty point switch which allows an exchange to consist of fifty single lines. However, it is readily apparent that a larger switch could be used to enlarge the exchange to the desired number of subscribers. If a larger switch is used it will be necessary to add one more counting relay in the selector switch for each ten lines added as will be apparent from the ensuing specification.

As it is necessary to dial twice to cause the proper functioning of the selector and connector switches the first line in the group will be arbitrarily designated number 11, the second number 12, and so on to the first "tenth" contact which leads to line number 10. The contact after line number 10 will be number 21 and then number 22 and so forth to the second "tenth" contact which is associated with line number 20. The next line is line number 31 and the contact after line number 30 will be line number 41. The next to the last contact is number 59 while the last contact is number 50. It will thus be seen that provision is made for fifty subscribers whose numbers are 10 to 59 inclusive. Each tenth contact 19, which is known as the

local contact, is adapted to be grounded by contacts of one of the impulse or counting relays when the relays are operated under control of the substation sending device. When the relay B operates it closes its contact 21 to ground the contact 19<sup>a</sup> by means of conductor 22. When relay C operates alternate contact 23 grounds conductor 24 and contact 19<sup>b</sup>; when relay D operates contact 25 grounds conductor 26 and contact 19<sup>c</sup>; when relay E operates the contact 27 grounds conductor 28 and the fifth "tenth" contact 19<sup>d</sup>.

In the system of our invention the brushes of the connector switch CS are driven to the tenth contact lower than the contact leading to the called subscriber's line and then stepped under direct control of the substation sending device into engagement with the desired set of contacts. Upon the first dialing movement the counting relays A, B, C, etc. operate in sequence to ground the "tenth" contact selected and drive the connector switch CS to this contact where it will come to rest. Upon the second dialing movement the connector switch CS is stepped one point for each interruption of the line conductors 1 and 2 and after the last interruption reaches the desired contact.

For instance, if the number of the called party is 35 the calling subscriber will dial 3 in the usual manner which will interrupt the line conductors three times and cause the operation of relays A, B and C which will ground contact 19<sup>b</sup> which is the second "tenth" contact and leads to the subscriber's station whose number is twenty. The magnet MM' will drive the wipers 13, 14, 15 and 16 to the set of contacts in which grounded contact 19<sup>b</sup> is located where they will stop. The calling subscriber will next dial the five and the motor magnet MM' will step the wipers to the fifth set of contacts after 19<sup>b</sup> which contacts lead to the line number 35.

The connector switch circuit is also provided with a ringing trip relay RT and a ringing cut-off relay RCO which operate when the called party responds to disconnect ringing current from the line. Also provided is a supervisory relay SR' which is under the control of the called subscriber and supplies talking battery current to his line. A busy tone relay BTR is provided and operates when the called line is busy to supply a distinctive busy tone to the calling subscriber's line. A secret service relay SS, a guard relay GU, an interrupter relay IR and switching relays SW<sup>2</sup> and SW<sup>3</sup> are also supplied.

Having described in general the circuit of the apparatus used in our invention, we will next describe the operation of the same in establishing the different connections.

Assuming that the subscriber whose line terminates in Fig. 1 desires to converse with

another subscriber at the private branch exchange, he will remove his receiver from its switchhook which establishes an energizing circuit for the line relay LR of line circuit

5 L. This circuit may be traced from battery, through the upper winding of relay LR, normal contact 32 of relay CO, conductor 2, through the closed switchhook contacts at the calling subscriber's station (not shown) 10 back over conductor 1, normal contact 33, of relay CO, and through the lower winding of relay LR to ground. The line relay LR energizes and closes its alternate contacts 29, 30 and 31. The closure of contact 29 grounds 15 the conductor 11 and causes the motor magnet MM to operate to step the wipers 3, 4, 5 and 6 into engagement with the first set of contacts 7, 8, 9 and 10. The energizing circuit of motor magnet MM may be traced from bat- 20 tery, resistance R, motor magnet MM, normal closed contact 34, normal closed contact 36 of the off normal springs ON, conductor 37, normally closed contact 38, of sleeve relay SL, conductor 11, to ground at alter- 25 nate contact 29 of relay LR. The circuit of the motor magnet MM is opened upon the first step of the wipers 3, 4, 5 and 6 due to the opening of contact 36, of the off normal springs ON which assume their alternate position upon the first movement of the wipers 30 3, 4, 5 and 6. The closure of alternate contact 56 of ON establishes an illuminating circuit for an off normal pilot (not shown) through the punching *p'*. This off normal 35 pilot lamp remains illuminated during the time the switch is hunting the calling line and if the switch does not find the line the lamp will indicate which switch is giving the trouble.

40 A substitute circuit for the motor magnet MM is established if the first set of contacts 7, 8, 9 and 10 are not the contacts of the line of the calling subscriber. This circuit may be traced from battery, resistance 45 R, motor magnet MM, closed contact 34, alternate contact 39, of the off normal springs ON, conductor 40, normal contact 41, conductor 42 to ground at normal closed contact 32 of the bridging relay BG. The contact 34 50 of the motor magnet MM is moved to its alternate position upon the energization of the motor magnet MM and thus opens the energizing circuit of the same which immediately releases its armature and again closes the 55 contact 34 to establish another energizing circuit for the magnet MM to step the wipers 3, 4, 5 and 6 into engagement with the next set of contacts. The alternate opening and closing of the contact 34 causes the wipers to 60 be stepped over the contacts 7, 8, 9 and 10 in search of the contacts of the calling line. Condenser *x* is bridged across the motor magnet MM to prevent sparking during the rapid opening and closing of the contact 31. 65 The instant wiper 5 engages the contact 9

associated with the calling line, a shunt circuit for the motor magnet MM is established which prevents the further operation of the motor magnet and the wipers remain in en- 70 gagement with contacts 7, 8, 9 and 10 of the calling line. This shunt circuit which is also an energizing circuit for the bridging relay BG may be traced from battery through resistance R, lower winding of the relay BG, 75 conductor 44, normal closed contact 45 of the relay BR, conductor 46, normal closed contact 47 of the sleeve relay SL, wiper 5, contact 9, to ground at alternate contact 30 of relay LR.

Upon energizing, bridging relay BG also 80 opens the circuit of the motor magnet MM at its contact 43 and establishes an energizing circuit for the sleeve relay SL and the cut off relay CO which circuit may be traced from battery, through the upper winding of relay 85 SL, conductor 48, alternate closed contact 49 of relay BG, conductor 50, wiper 4, contact 8, conductor 51, through the winding of relay CO to ground. The cut off relay CO energizes and opens its contacts 32 and 33 to deenergize 90 relay LR which removes ground from contact 9 and starting conductor 11. The removal of ground from contact 9 allows the wipers of another finder switch of the group to pass over the line of this calling subscriber 95 should another finder switch of the group be operated during the present connection.

The heavily marked talking conductors TC and TC' are closed at alternate contacts 52 100 and 53 of the bridging relay BG to complete the talking circuit through to the connector switch. The closing of contact 54 of the relay SL opens the circuit of the off normal pilot lamp and also establishes a locking circuit for the said relay which may be traced from bat- 105 tery through the lower winding of the relay SL, alternate contact 54, conductor 55, to ground at alternate contact 56 of the off normal springs ON. This circuit maintains the sleeve relay SL in its energized position until the off normal springs ON are restored to normal which restoration does not take place 110 until the wipers 3, 4, 5 and 6 have been restored to their normal position by the operation of the release relay RE. The conductor 115 11 is a common starting conductor and is associated with the contact 29 of all the relays LR of the group. Upon the energization of relay SL its contact 38 assumes its alternate position to extend the common starting con- 120 ductor 11 through to the next finder switch of the group by way of punching *p*.

Upon the closure of alternate contacts 52 and 53 of BG an energizing circuit is estab- 125 lished for the supervisory relay SR which circuit may be traced from battery through the lower winding of relay SR, conductor 57, alternate contact 53 of relay BG, wiper 6, and contact 10, over the subscriber's line and back 130 through contact 7 and wiper 3, alternate con-

tact 52 of BG, contact 58, through the upper winding of relay SR to ground. Relay SR energizes and closes its alternate contact 59 which establishes an energizing circuit for  
 25 busying relay BR. This circuit may be traced from battery, through the relay BR, to ground at alternate contact 59 of relay SR. The opening of contact 47 of relay SL interrupted the original energizing circuit of the  
 10 bridging relay BG but as the relay BG is slow to release a substitute circuit is closed through alternate make-before-break contact 60 of relay BR, and the bridging relay BG is maintained energized by current flowing from bat-  
 15 tery, through resistance R, lower winding of relay BG, conductor 44, make-before-break contact 60 and upper winding of BG to ground.

The closing of alternate contact 61 of relay  
 20 BR establishes a starting circuit for a ringing tone machine (not shown) which supplies ringing current, a dialing tone, a busy tone and a group busy tone. The closing of alternate contact 62 of relay BR conditions appar-  
 25 paratus in a group busying circuit (not shown) over conductors 63 and 64.

As soon as the relay BG operates to connect the finder switch FS to the selector switch SS the calling subscriber will receive a dialing  
 30 tone which informs the subscriber that the dialing may be started. This dialing tone circuit may be traced from conductor 65 which leads to the ringing tone machine, normal contact 66 of off normal relay OFR of the  
 35 selector circuit, conductor 67, normal contact 68 of the off normal springs ON', normal contact 69 of relay RCO, conductor 70, over the heavily marked talking conductor TC, alternate contact 53 of relay BG, wiper 6, con-  
 40 tact 10, conductor 1 to the subscriber's receiver. Upon receiving this signal the calling subscriber will know that the apparatus is in condition for the dialing operation.

Assuming that the called subscriber's number is "45", the calling subscriber will first dial the number 4 and thereby interrupt the  
 45 talking conductors four times in the usual manner. Upon the first interruption of the talking conductors the supervisory relay SR will restore to normal and close its normal  
 50 contact 59. The relay BR will remain in its operated position due to the copper slugs which make it slow acting, thus grounding the dialing conductor DC and closing the en-  
 55 ergizing circuits for the switching relay SW, the secret dialing relay SDR and the first counting or impulse relay A. The circuit for the switching relay SW may be traced from battery through the winding of the relay  
 60 SW, normal contact 93 of SW', to the conductor DC; the one for the secret dialing relay SDR from battery through the winding of the relay SDR to the dialing conductor DC; and the circuit for the relay A from  
 65 battery through the relay A, normally closed

contact 71<sup>a</sup> of relay A, normal contacts 71<sup>b</sup>, 71<sup>c</sup>, 71<sup>d</sup>, 71<sup>e</sup>, conductor 72, normal contact 73 of SDR, to the dialing conductor, which  
 70 dialing conductor is connected to ground at normal contact 59 of relay SR, through alternate contact 74 of relay BR. Switching relay SW will open its normally closed contact 75 to prevent switching relay SW' from  
 75 operating at this time and as it is slow to release will remain operated during the dialing operation. The secret dialing relay SDR will operate and open its contact 73 to prevent the operation of more than the relay  
 80 A of the counting relays. If the interruption of the talking conductors is prolonged the relays A, B, and even C, may operate and to prevent the operation of relays B and C at this time the secret dialing relay SDR is inserted to time the length of impulse to the  
 85 counting relays. This timing of the impulse assures the desired operation of the relay A. Relay A energizes and attracts its contacts 76<sup>a</sup> to close the energizing circuit for the off normal relay OFR which may be traced from  
 90 battery through the upper winding of the relay OFR, alternate contact 76<sup>a</sup>, normal contacts 76<sup>b</sup>, 76<sup>c</sup>, 76<sup>d</sup> and 76<sup>e</sup> of the relays B, C, D and E, conductor 77 to ground at alternate contact 43 of bridging relay BG. The off  
 95 normal relay closes a locking circuit for itself through its alternate contact 78 and attracts its contact 66 to disconnect the dialing tone from the talking conductors.

Upon the next interruption of the talking  
 100 conductors the relay SR again deenergizes and restores its contact 59 to normal thereby again placing ground upon the dialing conductor DC and closing a circuit for the relay SDR which again regulates the length  
 105 of the impulse to the second impulse relay B which circuit may be traced from battery through the winding of the relay B, alternate contact 71<sup>a</sup>, of relay A, to ground at normal contact 59 over the previously de-  
 110 scribed path. The relay B attracts its armature 76<sup>b</sup> to open the energizing circuit of the relay A which restores to normal. The relay B also closes its alternate contact 21 thereby furnishing ground to contact 19<sup>a</sup> as  
 115 above explained. It also attracts its contact 81<sup>b</sup> to furnish ground to the motor magnet MM' of the connector switch CS which operates over the following circuit; battery, through the winding of the motor magnet  
 120 MM', conductor 83, normal contact 84, of SW<sup>2</sup>, normally closed contact 85 of MM', normal contact 86 of IR, conductor 82 to ground at 81<sup>b</sup> of the relay B. The motor magnet MM' operates to step the wipers 13,  
 125 14, 15 and 16 to the first set of contacts 17, 18, 19 and 20 and also opens its contact 85 which interrupts the energizing circuit for the motor magnet MM' which accordingly restores to normal and again closes its con-  
 130 tact 85 to form another energizing circuit

for itself. Each time the motor magnet MM' is energized it steps the wipers of the switch to the next set of contacts as explained in connection with the motor magnet MM of the finder switch FS.

Upon the third interruption of the talking conductors a circuit is provided for a third impulse relay C which circuit may be traced from battery, through the winding of the relay C, alternate contact 71<sup>b</sup> of relay B, to ground at normal contact 59 of the relay SR. The attraction of the armature 76<sup>c</sup> opens the energizing circuit of the relay B which restores to normal and opens its contact 21 to remove ground from the contact 19<sup>a</sup> and restores its contact 81<sup>b</sup> to remove ground from the circuit of the motor magnet MM'. However, the contact 81<sup>c</sup> of relay C closes before the contact 81<sup>b</sup> opens to supply ground to the circuit of the motor magnet MM' which continues to operate. The closing of alternate contact 23 of relay C grounds the contact 19<sup>b</sup>. Each of the relays A, B, C, etc. establishes a locking circuit for itself through its alternate contact 76<sup>a</sup>, 76<sup>b</sup>, 76<sup>c</sup>, etc. and conductor 77 to ground at alternate contact 43 of BG. However, each relay A, B, C, D, and E opens the locking circuit for the previous relay so that all except the last relay to operate restore to normal.

Upon the fourth interruption of the talking conductor the relay D operates over a circuit traced from battery through the winding of the relay D, alternate contact 71<sup>c</sup> of the relay C, to ground at normal contact 59 of the relay SR. The relay D closes its alternate contact 25 to supply ground to the contact 19<sup>c</sup> and opens its contact 76<sup>d</sup> to open the circuit for the relay C which deenergizes and restores its contact 23 which disconnects ground from the contact 19<sup>b</sup> and also restores its contact 81<sup>c</sup> which disconnects ground from the conductor 82 leading to the motor magnet MM'. The closing of contact 81<sup>d</sup> of relay D supplies ground to the motor magnet MM' which continues to operate over the previously described circuit. As we have assumed that the number of the called party is "45" this fourth interruption is the last one and the locking circuit for the relay D will be closed which circuit may be traced from battery through the winding of the relay D, alternate contact 76<sup>d</sup>, normal contact 76<sup>e</sup>, and conductor 77 to ground at alternate contact 43 of BG.

As soon as the dialing is discontinued the energizing circuit of the relay SW is opened at contact 59 of SR and SW deenergizes and restores its contact 75 to normal thereby closing an energizing circuit for the switching relay SW'. The circuit may be traced from battery through the winding of the relay SW', normal contact 75, alternate contact 79 of OFR, conductor 77 to ground at alternate contact 43 of BG. The relay SW' closes a

locking circuit for itself through its alternate contact 92. The motor magnet MM' continues to operate until the wiper 15 reaches the contact 19<sup>c</sup> which is the third "tenth" contact of the group, which was connected to ground by the closing of alternate contact 25 of relay D. When the wiper 15 reaches this contact 19<sup>c</sup> an energizing circuit for the interrupter relay IR is established; current flowing from battery through the winding of the relay IR, wiper 15, contact 19<sup>c</sup>, conductor 26, to ground at alternate contact 25. Relay IR opens its normally closed contact 86 which interrupts the circuit of the motor magnet MM' and stops the movement of the wipers 13, 14, 15 and 16. The closing of alternate contact 87 of the relay IR closes an initial energizing circuit for the switching relay SW<sup>2</sup> which may be traced from battery through the winding of SW<sup>2</sup>, alternate contact 87, conductor 88, normal contact 89 of relay A, conductor 90, alternate contact 91 of SW<sup>2</sup>, conductor 77, to ground at alternate contact 43 of BG. The relay SW<sup>2</sup> energizes over this circuit and closes a locking circuit for itself which may be traced from battery through the winding of SW<sup>2</sup>, alternate contact 108, conductor 120, conductor 77, to ground at alternate contact 43 of relay BG.

Tens operation of the connector switch in reality consists merely in an automatic hunting for a "tens" contact which has been grounded by a selected counting relay A, B, C, D or E.

The step by step operation of the connector switch is so rapid that by the time the last tens impulse has been registered the brushes of the connector switch are traversing the final group of tens contacts so that the tens selection is completed before the dial can possibly be operated to send the units impulses.

The subscriber next dials the digit 5 and thereby causes the energizing circuit of the relay SR to be interrupted 5 times. Upon the first interruption the relay SR restores its contact 59 to normal thereby closing the energizing circuit for the motor magnet MM' which may be traced from battery through the winding to motor magnet MM', conductor 83, alternate contact 84 of SW<sup>2</sup>, conductor 94, normal closed contact 95 of BTR, normal closed contact 96 of SS, normal closed contact 97 of RCO, dialing conductor DC', alternate contact 93 of SW', dialing conductor DC, alternate contact 74 of BR to ground at normal contact 59 of SR. The motor magnet MM' operates over this circuit and steps the wipers 13, 14, 15 and 16 to the next set of contacts in the bank. The guard relay GU also operates over this circuit and closes its alternate contact 98 thereby establishing an energizing circuit for the switching relay SW<sup>3</sup> which may be traced from battery through the winding of SW<sup>3</sup>, conductor 99,



alternate contact 98 of GU. The relay SW<sup>3</sup> closes a locking circuit for itself which may be traced from battery through the winding of SW<sup>3</sup>, alternate contact 106, conductor 107, conductor 120, conductor 77 to ground at alternate contact 43 of relay BG. Each time the relay SR is restored to normal the contact 59 closes an energizing circuit for the motor magnet MM' as described to step the wipers to the next set of contacts.

Upon the fifth interruption the wipers are caused to engage the contacts of the called line. The relay GU being slow to release remains energized during the stepping of the wipers to the contacts of the called line, and maintains its contact 102 in its alternate position to prevent the premature operation of the secret service relay SS.

If the called line is idle the secret service relay SS will operate by current flowing over the following described path; battery, winding of relay SS, resistance  $r'$ , conductor 101, normal contact 102 of GU which has restored to normal, conductor 103, alternate contact 104 of SW<sup>3</sup>, conductor 105, wiper 14, contact 18 and through the winding of a relay CO associated with the line circuit of the called subscriber's line. An energizing circuit for the busy test relay BTR through the normally closed contact 100 of relay SS and the described energizing circuit for relay SS is also closed, but the relay BTR being of high resistance and slow-acting does not energize at this time as the relay SS is quick to operate and causes its contact 100 to assume its alternate position and thereby shunt the resistance  $r'$ . Should the wiper of another connector switch engage a multiple of the contact 18 here shown, the contacts will test busy and the operative connection of the second switch will not be established. Relay SS closes its alternate contacts 111 and 112 to connect ringing current to the called line. The path for the ringing current may be traced from one of the ringing generator punchings RG, conductor 113, normal contact 114 of RCO, alternate contact 112 of SS over the heavily marked conductor to wiper 16, contact 20, through the subscriber's loop (not shown) back to contact 17, wiper 13, alternate contact 111 of SS, normal closed contact 115 of RCO, conductor 116 through the winding of the ringing tip relay RT, back to the other ringing generator punching. Interrupted ringing current flows over this path until the called subscriber answers by removing his receiver from its switchhook which closes an energizing circuit for the ringing trip relay RT which is operated by direct current flowing over the path described for the ringing current.

The closure of contact 117, of relay RT establishes an energizing circuit for the ringing cut-off relay RCO which may be traced from battery through the lower winding of

RCO, conductor 118 to ground at alternate contact 117 of RT. The ringing cut-off relay RCO energizes and closes a locking circuit for itself which may be traced from battery through the winding of RCO, alternate contact 68 of ON', alternate contact 69 to ground. It also opens its normal contacts 114 and 115 to disconnect ringing current from the called subscriber's line and to close the talking conductors and opens its contact 122 to disconnect ground from the ringing tone machine and cause the same to stop operating. Upon the closure of alternate contacts 114 and 115 an energizing circuit for the supervisory relay SR' is established. This circuit may be traced from battery through the lower winding of the relay SR', conductor 119, alternate contact 114 of RCO, alternate contact 112 of relay SS, wiper 16, contact 20, over the subscriber's loop, contact 17, wiper 13, alternate contact 111 of relay SS, alternate contact 115 of relay RCO, conductor 110, to the upper winding of relay SR' to ground. The subscribers are now in conversational circuit.

Upon the termination of the conversation the called subscriber replaces his receiver upon its switchhook which interrupts the energizing circuit of the supervisory relay SR' which restores to normal. When the calling subscriber replaces his receiver upon its switchhook the supervisory relay SR of the finder switch restores to normal and opens its alternate contact 59 thereby interrupting the circuit for the busy relay BR which restores to normal and opens its make-before-break contact 60 to interrupt the circuit for the relay BG which also restores and closes its normal contact 43 to establish an energizing circuit for the release magnet RE which circuit may be traced from battery through the winding of release magnet RE, alternate contact 41, sleeve relay SL, conductor 42, and normal contact 43 to ground. The release magnet RE operates to return the wipers 3, 4, 5 and 6 and the off-normal springs ON to their normal position. The restoration of the off-normal springs ON interrupts the locking circuit for the sleeve relay SL at contact 56. The opening of contact 49 of relay BG interrupts the energizing circuit of the relay CO and causes the same to restore. The opening of normal contact 41 of relay SL interrupts the circuit of the release magnet RE which also restores.

When the relay BR restores and closes its normal contact 74 energizing circuits for the release magnet RE' and the guard relay GU are established which circuit may be traced from battery through the windings of the relays GU and RE' respectively, conductor 124, normal contact 125 of BR', conductor 123, normal contact 74 of BR, dialing conductor DC, alternate contact 93 of SW', dialing conductor DC', alternate contact 97 of

relay RCO to ground. The relay GU opens its contact 102 to interrupt the energizing circuit for the secret service relay SS and the cut off relay CO which restore and place the contacts of the called subscriber's line in condition to be selected by another switch. Release magnet RE' restores the wipers 13, 14, 15 and 16 and the off normal springs ON' to their normal position. The opening of alternate contact 68 of ON' interrupts the locking circuit of the relay RCO which restores to normal and opens the talking conductors at its alternate contacts 114 and 115. The opening of alternate contact 43 of relay BG removes ground from the conductor 77 and causes the relays SW', OFR, D, SW<sup>2</sup>, SW<sup>3</sup>, and GU to restore to normal, thus placing all the apparatus in its normal condition ready for a new call.

If the called subscriber does not answer when the ringing current is applied to the line, the calling subscriber, after waiting a reasonable length of time, replaces his receiver to cause the restoration of the apparatus in the following manner; the relays SR, BR and BG restore as before explained and the restoration of normal contact 126 of BG closes an energizing circuit for the ringing cut-off relay RCO which circuit may be traced from battery through the upper winding of the relay RCO, alternate contact 127 of off-normal springs ON', conductor 128, to ground at normal contact 126 of relay BG. The relay RCO energizes and closes its alternate contact 97 to form an energizing circuit for the release magnet RE' and guard relay GU as traced previously. The switches 13, 14, 15 and 16 are restored to normal under the influence of the release magnet RE' as before explained.

If the called line is busy the operation of the apparatus will be the same up to the point where the switches 13, 14, 15 and 16 engage the contacts 17, 18, 19 and 20 of the called line. If the called line is busy as a called line the secret service relay SS of another connector switch CS will have operated in series with the cut-off relay of the line circuit of the called subscriber and closed its alternate contact 100 to shunt the resistance R' in the other switch CS. Therefore, when the contacts 13, 14, 15 and 16 of this connector switch engage the contacts of the called line the secret service relay SS of this connector will not operate due to the inclusion of the resistance R' in the circuits. The busy test relay BTR will operate by current flowing from battery through the busy test relay BTR, normal contact 100 of SS, conductor 101, normal contact 102 of GU, conductor 103, alternate contact 104 of SW<sup>3</sup>, conductor 105, wiper 14, contact 18 to ground through the cut-off relay. The busy test relay BTR closes its alternate contact 108 to

connect a distinctive busy tone to the calling subscriber's receiver. This tone may be traced from conductor 129, which leads to the ringing tone machine previously mentioned, alternate contact 108 of BTR, conductors 109 and 110 to the calling subscriber's station over the heavily marked talking conductors. The calling subscriber will recognize this tone and replace his receiver to restore the apparatus to normal in the previously described manner. The relay BTR also opens its contact 95 which prevents the operation of the motor magnet MM' when the subscriber hangs up. If contact 95 was not opened the restoration of 59 of SR would cause the energization of MM' and the stepping of the wipers to the next set of contacts.

If the called line is busy as a calling line the sleeve relay SL of another finder switch FC will be energized through the winding of the cut-off relay CO associated with the line circuit of the called subscriber. The secret service relay SS of the connector switch CS shown in the drawings will not operate because of the resistance r' but the busy test relay BTR will operate to connect the busy tone signal to the calling subscriber's receiver.

If the contacts of the called subscriber are within the first ten, which contacts are associated with lines numbers 10 to 19 inclusive, the operation of the finder switch will be the same as previously described. The calling subscriber will dial 1 as the first digit of the called party's number which will cause the operation of the switching relay SW, the secret dialing relay SDR and impulse relay A and relay OFR, all as before described. The relay A remains energized, after contact 59 of SR has been again attracted, through its locking circuit which may be traced from battery through the winding of relay A, alternate contact 76<sup>a</sup>, normal contacts 76<sup>b</sup>, 76<sup>c</sup>, 76<sup>d</sup> and 76<sup>e</sup>, and conductor 77, to ground at alternate contact 43 of relay BG. The relay A closes an energizing circuit at its alternate contact 89 for the switching relay SW<sup>2</sup> which circuit may be traced from battery through the switching relay SW<sup>2</sup>, conductor 121, alternate contact 89 of A, conductor 90, alternate contact 91 of SW', which has also energized, conductor 77 to ground at alternate contact 43 of relay BG. The switching relay SW<sup>2</sup> operates to attract its contact 84 to connect the motor magnet MM' to dialing conductor DC'. It will be noted that the magnet MM' has not operated and the wipers have not moved.

Assuming that the desired called party's number is "14" the calling subscriber will next dial "4" which will interrupt the circuit of the supervisory relay SR four times and connect ground to the dialing conductors DC and DC' four times to cause the motor magnet MM' to operate and

step the wipers 13, 14, 15 and 16 to the fourth set of contacts which lead to the line of the desired party. The operation of the apparatus from then on is the same as in the previously traced connection.

Assuming that the number of the called party is number "20", the subscriber will first dial "2" which will interrupt the talking conductors twice. The first interruption causes the operation of the relay A and the second interruption causes the operation of the relay B which closes its alternate contact 21 to ground the contact 19<sup>a</sup> which is the first "tenth" contact in the bank. The motor magnet MM' will be caused to operate due to the closure of alternate contact 81<sup>b</sup> to drive the wipers until they reach the contact 19<sup>a</sup> at which point they will stop due to the energization of the interrupter relay IR as explained in the previous circuit connection. The subscriber will next dial "zero" which interrupts the talking conductors ten times to step the wipers 13, 14, 15 and 16 over ten contacts to the second "tenth" set of contacts which will be line number 20. The conversational circuit is then established as described hereinbefore.

Obviously, the invention is susceptible of embodiment in forms other than that which is illustrated in the accompanying drawings and described herein, such, for instance, as the substitution of a switch for the counting relays to progressively ground the "tenth" contacts of the connector switch, and we therefore consider as our own all such modifications and adaptations of the form of the invention herein described as fairly fall within the scope of our invention.

Having described our invention what we claim is new and desire to secure by United States Letters Patent is:

1. A telephone system including a plurality of subscribers' stations, a link circuit for interconnecting certain of said stations, a switch, a plurality of contacts and means including a group of counting relays for altering the potential of a predetermined contact and other means for driving said switch to said predetermined contact and then stepping said switch to a desired contact.

2. A telephone system including a plurality of subscribers' stations, a link circuit for interconnecting certain of said stations, a switch, a plurality of contacts, and means including a group of counting relays adapted to alter the potential of certain predetermined contacts and to drive said switch to one of said predetermined contacts.

3. A telephone system including a plurality of subscribers' stations, a link circuit for interconnecting certain of said stations, a switch, a plurality of contacts, means including a group of counting relays adapted to alter the potential of certain predeter-

mined contacts and to drive said switch and to stop said switch on one of said predetermined contacts.

4. A telephone system including a plurality of subscribers' stations, a link circuit for interconnecting certain of said stations, a switch, a plurality of contacts, actuating means for said switch and means including a group of counting relays adapted to alter the potential of certain of said contacts and stop said switch on said certain contact.

5. A telephone system including a plurality of subscribers' stations, a link circuit for interconnecting certain of said stations, a switch, operating means for said switch, a plurality of contacts, a group of counting relays adapted to respectively alter the potential of certain of said contacts and thereby controlling the operating means of said switch.

6. A telephone system including a plurality of subscribers' stations, means for interconnecting certain of said stations, a plurality of sets of contacts each associated with a subscriber's station, switch wipers associated with said sets of contacts, operating means for said wipers, a group of counting relays controlling the potential of a predetermined contact to drive said wipers to said predetermined contact and means for stepping said wipers into engagement with the contacts of a desired subscriber's station.

7. A telephone system including a plurality of subscribers' stations, means including a group of counting relays for interconnecting any two of said stations, dialing means at said subscribers' stations and a group of counting relays responsive to said dialing means for altering the potential of certain of said contacts.

8. A telephone system including a plurality of subscribers' stations, means including a plurality of contacts for interconnecting any two of said stations, dialing means at said subscribers' stations, a group of counting relays responsive to said dialing means for altering the potential of certain of said contacts and a switch controlled by said group of counting relays.

9. A telephone system including a plurality of subscribers' stations, means including a plurality of contacts for interconnecting any two of said stations, impulse imparting means at said subscribers' stations, a group of counting relays for altering the potential of certain of said contacts, each succeeding relay being responsive to each succeeding impulse of said impulse imparting means.

10. A telephone system including a plurality of subscribers' lines, contacts for each of said lines arranged in groups, a switch adapted to engage said contacts, operating means for said switch, a group of counting relays controlling the potential of one contact in each group and controlling said switch op-

erating means to drive said switch to a predetermined group of contacts.

11. A telephone system including a plurality of subscribers' lines, contacts for each of said lines arranged in groups, a switch adapted to engage said contacts, operating means for said switch, a group of counting relays controlling the potential of one contact in each group and controlling said switch operating means to drive said switch to a predetermined group of contacts and means associated with said counting relays to stop said switch at said predetermined group of contacts.

12. A telephone system including a plurality of subscribers' lines, contacts for each of said lines arranged in groups, a switch adapted to engage said contacts, operating means for said switch, a group of counting relays controlling the potential of one contact in each group and controlling said switch operating means to drive said switch to a predetermined group of contacts and other means adapted to step said switch into engagement with the contacts of a desired line.

13. A telephone system including a calling subscriber's line and a called subscriber's line, contacts associated with each of said lines, a switch associated with said contacts, operating means for said switch, dialing means and a group of counting relays responsive to said dialing means controlling the potential of certain of said contacts and thereby controlling said switch operating means.

14. In an automatic telephone system, an impulse sending device, an automatic switch, contacts for said switch divided into groups, certain of said contacts designating the groups, respectively, means operated under the control of said sending device for altering the potential of a desired group contact, and means for causing said switch to automatically hunt for said altered contact.

15. In an automatic telephone system, an impulse sending device, an automatic switch, a brush for said switch, contacts for said switch divided into groups, certain of said contacts designating the groups, respectively, means operated under the control of said sending device for altering the potential of a desired group contact, a stepping magnet and controlling means therefor for causing said brush to automatically hunt for said altered contact.

16. In an automatic telephone system, an impulse sending device, an automatic switch, contacts for said switch divided into groups, certain of said contacts designating the groups, respectively, means operated under the control of said sending device for altering the potential of a desired group contact, and means for causing said switch to simultaneously automatically hunt for said altered contact.

17. In an automatic telephone system a substation, an impulse sending device thereat, an automatic switch, a brush for said switch movable in a single plane, contacts for said switch divided into groups, certain of said contacts designating the groups respectively, a series of counting relays operated under the control of said sending device for altering the potential of a desired group contact, a stepping magnet and controlling means therefor for causing said brush to automatically hunt for said altered contact.

18. In an automatic telephone system, an impulse sending device, an automatic switch, a brush for said switch, contacts for said switch divided into groups, certain of said contacts designating the groups respectively, means operated under the control of said sending device for altering the potential of a desired group contact, a stepping magnet and controlling means therefor for automatically moving said brush over said contacts, and means for interrupting the movement of said brush incident to engagement with a contact having altered potential thereon.

19. In an automatic telephone system, an impulse sending device, an automatic switch, a brush for said switch, contacts for said switch divided into groups, certain of said contacts designating the groups respectively, means operated under the control of said sending device for altering the potential of a desired group contact, a stepping magnet and controlling means therefor for automatically moving said brush step by step over said contacts, and means for interrupting the movement of said brush incident to engagement with a contact having altered potential thereon.

20. In an automatic telephone system, an impulse sending device, an automatic switch, a brush for said switch movable in a single plane, contacts for said switch divided into groups, certain of said contacts designating the groups, respectively, means operated under the control of said sending device for altering the potential of a desired group contact, a stepping magnet and controlling means for simultaneously automatically moving said brush step by step over said contacts, and means for interrupting the movement of said brush incident to engagement with a contact having altered potential thereon.

21. In an automatic telephone system, a substation, an impulse sending device thereat, an automatic switch, a brush for said switch movable in a single plane, contacts for said switch divided into groups, certain of said contacts designating the groups respectively, a series of counting relays operated under the control of said sending device for altering the potential of a desired group contact, a stepping magnet and con-

trolling means therefor for simultaneously  
automatically moving said brush step by  
step over said contacts, and means for inter-  
rupting the movement of said brush incident  
5 to engagement with a contact having altered  
potential thereon.

Signed by us, at Chicago, in the county of  
Cook and State of Illinois, this 17th day of  
September, 1931.

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GEORGE R. EATON.  
GLENN KINER.

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