June 24, 1930. R. F. STEHLIK 1,767,862

TELEPHONE SYSTEM

Original Filed July 6, 1926 4 Sheets-Sheet 1

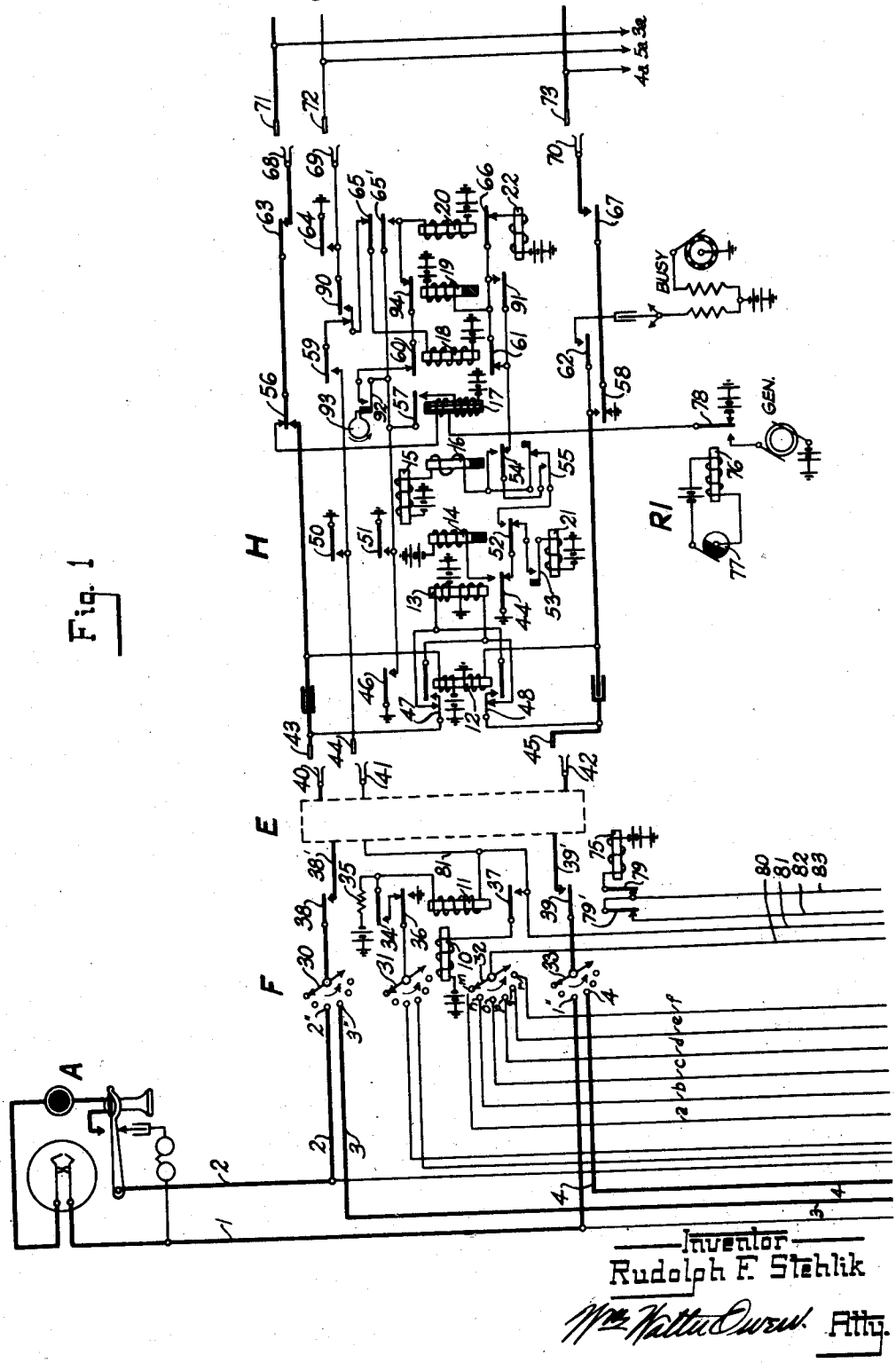


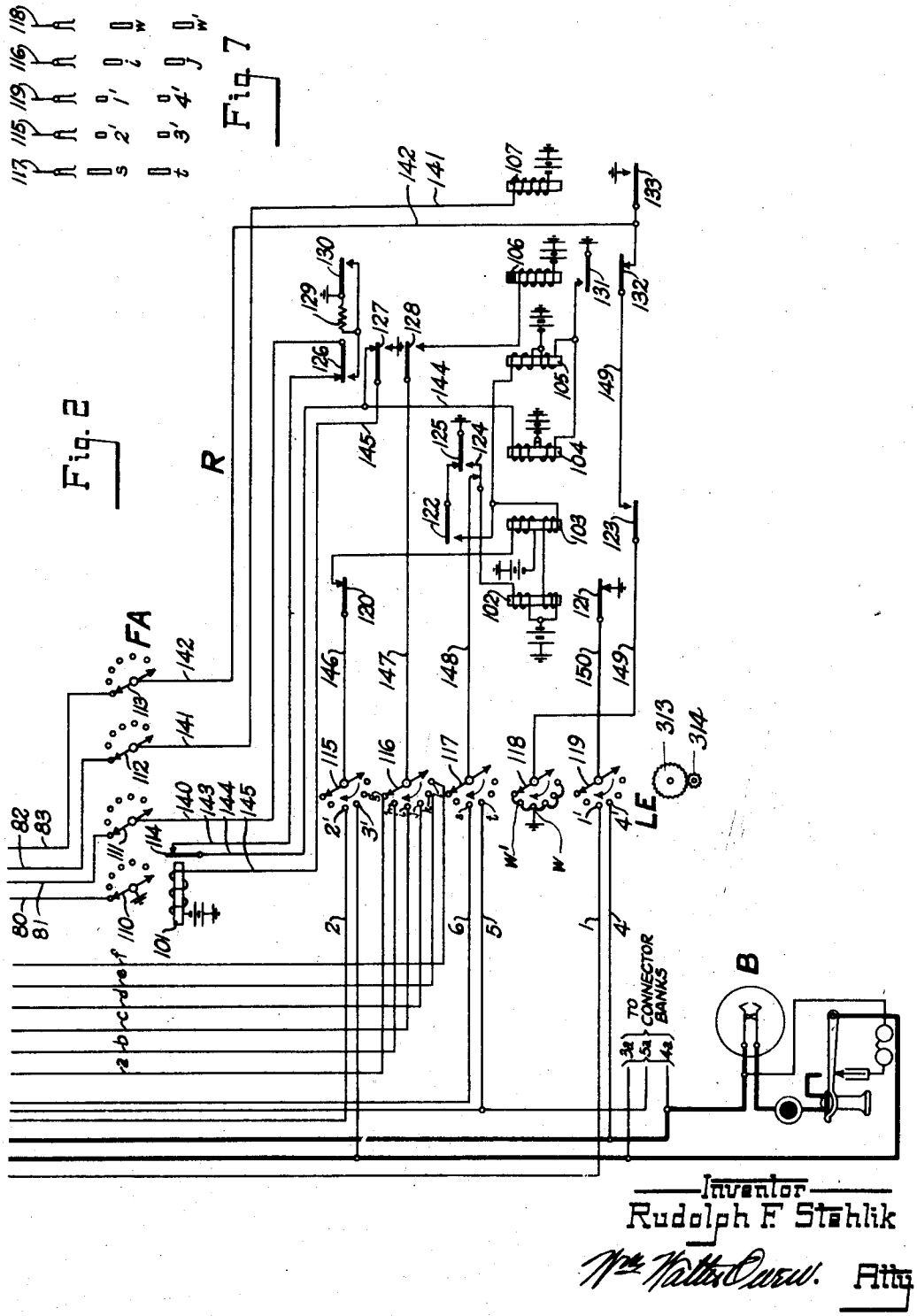
Fig. 1

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Fig. 4

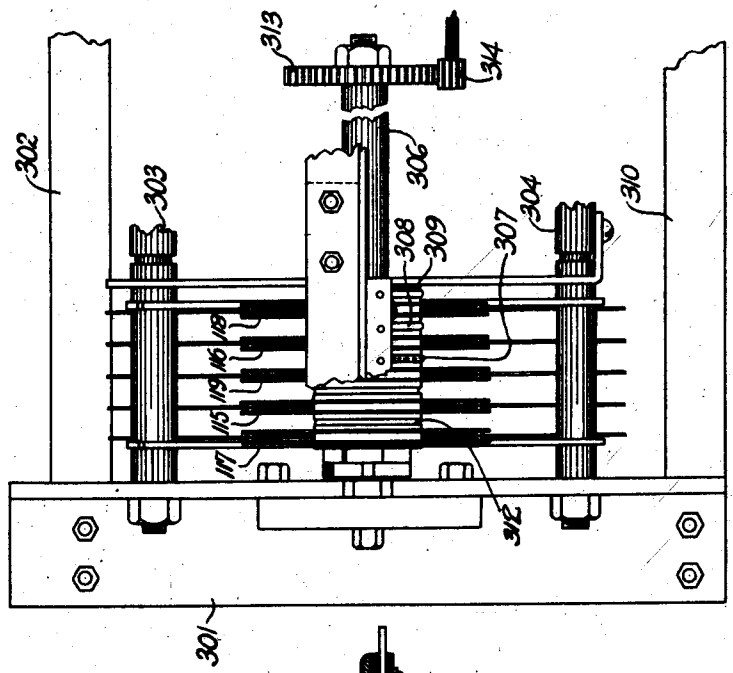
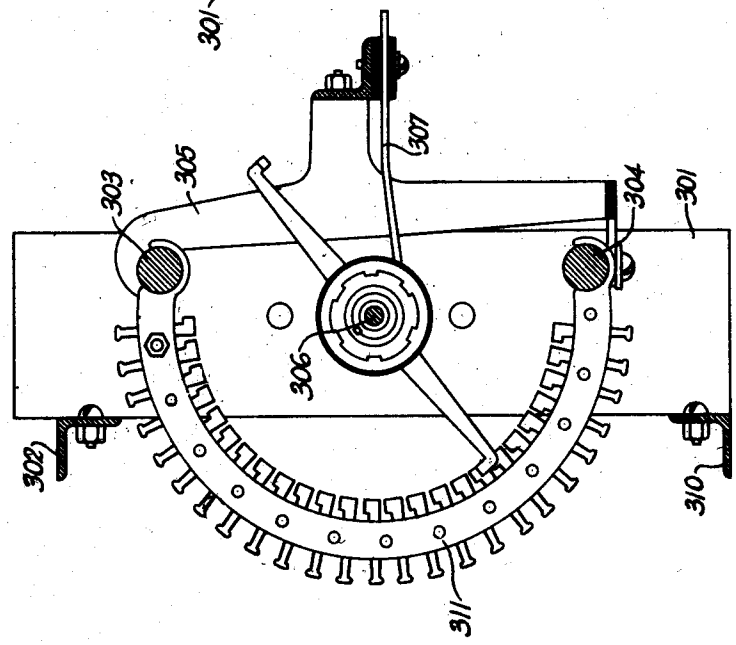


Fig. 3



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Fig. 6

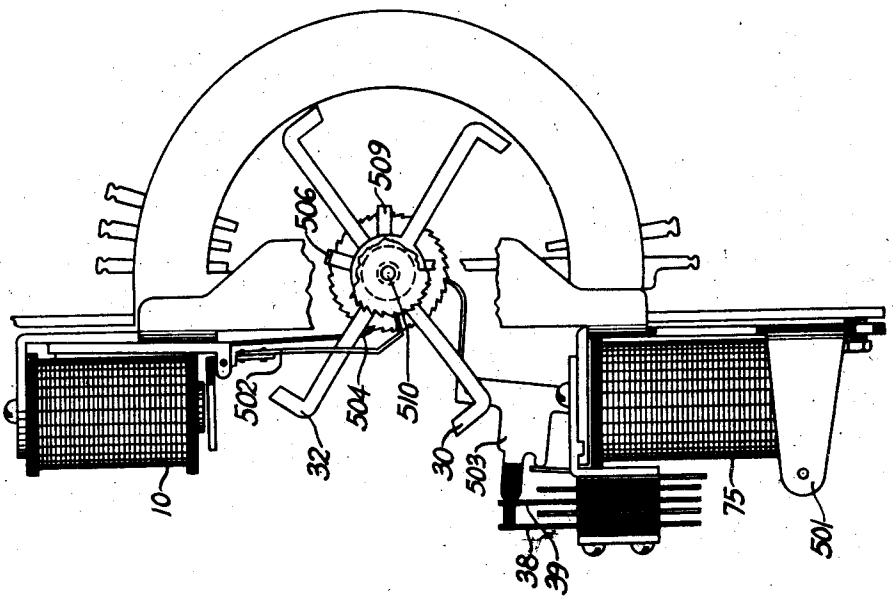
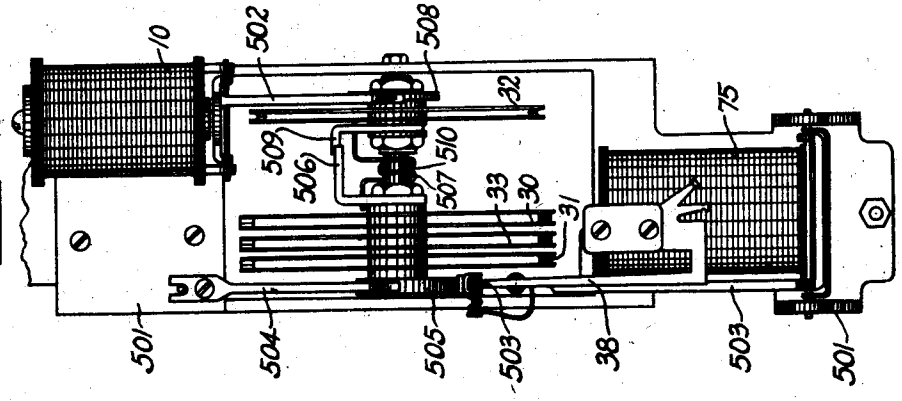


Fig. 5



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1,767,862

UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Original application filed July 6, 1926, Serial No. 120,547. Divided and this application filed October 27, 1927. Serial No. 223,018.

This invention relates in general to telephone systems but is concerned particularly with such systems in which line finders are employed to connect an idle trunk line with a calling line; and the principal object of the invention briefly stated, is the production of a new and improved finder switch system, which is so designed as to permit cheapness in manufacture and maintenance without impairing the reliability and efficiency of the system.

Finder switch systems which have been devised heretofore employ one or more relays individual to each line in the system, those relays being operated, when that line makes a call, to start a finder in operation to connect with that line. In addition to the relays individual to the lines such systems have employed a certain amount of control equipment common to a group of lines, through which equipment the actual setting of the various finders of the system is exercised. The combination of individual line relays and common control equipment for a group of lines, makes the initial cost of the system and the expense of maintenance, so high as to be objectionable. A relay is not an expensive device, however and individual relay for every line in an exchange runs into considerable money, as obviously there would be ten thousand of such relays in a ten thousand line exchange.

In accordance with one of the objects of my invention I provide a finder switch system which uses no individual relays to connect the lines with the control equipment but rather uses a single line and cutoff relay set common to a relatively large group of lines.

As the principal and further object of the application I provide a new and improved line equipment of the constantly moving type, to search over the group of lines to which it is common, and to associate calling ones of said lines with the line relay which is common thereto that relay energizing to control a finder and equipment, to operate that finder into connection with that line.

As a further object of my invention I arrange the constantly moving line equipment so that it acts as an impulse sender, delivering impulses to the motor magnets of a finder switch to step that switch into connection with the calling line.

As a further object of my invention I use finder switches similar in structure to the well known rotary line switch whose wipers have no normal position remaining when not in use on the contacts last used, modified and improved by the inclusion of a marking wiper and associated control apparatus, through which the position in which the finder is standing is marked in the control equipment, to determine the number of impulses which must be delivered to the finder magnet to position its wipers upon the contacts of the calling line.

In the instant application, the claims are directed to the constantly moving switch mechanism. The features of the other objects are being claimed in my co-pending application Ser. No. 120,547, filed July 6, 1926, of which this application is a division.

Automatic telephone systems of the well known type employ a connector switch which depends upon the finding of a battery potential on the test contact of a called line for the establishment of a connection to that line. That battery potential is supplied to the testing contact through one of the individual relays associated with that line. Since in the finder system of the present invention there are no individual relays associated with the line, it is necessary to provide a connector arranged to establish a connection with one of these lines.

Further objects of my invention not specifically mentioned here will be apparent from the detailed specification and claims which follow.

The drawings comprising Figs. 1 to 7, inclusive show sufficient mechanical and electrical details to enable a clear understanding of my invention. Figs. 1 and 2, when arranged with Fig. 2 beneath Fig. 1 with correspondingly numbered lines in alignment, show the usual circuit details of an embodiment of my invention. Figs. 3 and 4 are respectively side and front views of the constantly rotating line equipment switch used

in the invention. Figs. 5 and 6 are respectively front and side views of the finder switch mechanism employed in this system, while Fig. 7 is a detailed view of the arrangement of the contacts in the banks of the line equipment switch shown in Figs. 3 and 4.

Referring now to Fig. 1 in more detail, I have shown a subscriber's station A, which is of the usual type automatic substation set, comprising a transmitter and receiver in series, an impulse sending device with which the automatic switches at the central office are controlled. In Fig. 1 I also show the finder F, connected directly to the first selector E, and having access to the subscriber's lines. The selector E is of the well known Strowger type of two-motion switch, whose wipers are moved in a vertical direction under the control of the calling device at the subscriber's station, and then rotated automatically under the control of a local testing circuit to pick out the first idle trunk in the selected group, in this case trunk leading to the connector switch H. Of course it will be understood that by the inclusion of second and third selectors, the total number of lines that can be handled by the system can be increased, but since the selectors form no essential part of this invention, they are not shown, and the selector E shown only in outlined form. The connector H, may be of the well known Strowger type two-motion type switch, whose wipers are moved first in a vertical direction to select a level of their banks, and then in a horizontal direction to select the desired line in that level, the connector differing from the selector in that both the vertical and rotary motions of the shaft are under the control of the calling device at the subscriber's station. The connector H differs from the well known Strowger connector in that the private or testing wiper does not have to find battery in order to switch through and connect with the called line. In the well known Strowger automatic telephone system, an idle line is designated by a high resistance battery potential found on the contacts encountered by the testing wiper, and a busy line is designated by a ground potential upon the same contacts. In the switches employed in this system it is necessary that the test wiper of the conector encounters battery potential in order to switch through and connect with the called line. In modifying the standard connector in accordance with the objects of this invention, I have retained the busy guarding feature, that is a circuit is provided such that the connector will not switch through and connect with a called line if the test wiper of the connector encounters ground potential on the test contact of that line, however, I have modified the circuits of the connector so that it is unnecessary for the test wiper to pick up a battery potential in order to switch through and connect with a called line, the reason for this change will be apparent hereinafter. In Fig. 1 I have also shown the usual ringing interrupter, generator, and busy tone sources, they being auxiliary equipment essential to the operation of the connector, but forming no vital part of the present invention.

In Fig. 2 I show the constantly retating line equipment LE driven by the motor F through the gears 313 and 314. I also show a subscriber's station B which is identical in every respect with the subscriber's station A in Fig. 1. It will be noted that the lines leading from the subscribers' stations A and B terminate only in the banks of the finder F and of the line equipment LE, being devoid of the usual individual line and cut-off relay through which the finder switches used heretofore have been controlled. Associated with and individual to the line equipment LE is the relay equipment R, through which the finders are controlled to pick-up a calling line in the manner which will be explained in detail hereinafter. In Fig. 2 I also show the finder allotter FA, which is mechanically similar to the well known rotary line switch, whose wipers move in a forward direction only, and stand when idle upon the contacts last used.

In Figs. 3 and 4 I show the mechanical details of the line equipment LE of Fig. 2, that equipment being somewhat similar to the well known Strowger rotary line switch, in that the wipers move in one direction only. The line equipment in this case is mechanically larger than the line switch, and is further arranged so that the wipers are constantly moving over the bank contacts, which consists of the bank assembly 311, which comprises five rows of contacts placed in a semi-circle, there being 25 contacts in each row. Five sets of wipers or brushes are carried on a shaft, one of these brushes encountering each of the contact rows. The bank assembly is supported by the means of support rods 303 and 304, these rods being so spaced and grooved as to properly line the banks with respect to the main drive shaft. The wiper assemblies are carried on the main drive shaft 306, which is driven through gears 314 and 313, and which is supported by the main supporting frame comprising 301, 302 and 310. Contact with the rotating wipers is obtained by means of a slip ring and brush, the brushes being designated in Fig. 4 as 307, 308 and 309. One of the slip rings is shown designated as 312. It should be noted that the slip ring for a wiper set, such as the ring 312 for the wiper set 117, is placed at the side so that the brush serving that wiper set lies between it and the next set. That is the brush engaging ring 312 will lie between wiper sets 117 and

115. In the well known rotary line switch after which this line equipment is patterned, the brush through which connection is made to a wiper set, lies between the members of that set. Since the mechanism LE is constantly moving, the line switch brush arrangement will result in excessive wear, and I have therefore provided the arrangement mentoned above to reduce this wear as much as possible.

Figs. 5 and 6 show respectively the front and side view of the finder switch such as F of Fig. 1 which I propose to use in an embodiment of the invention. It will be noted that this finder is quite similar to the aforementioned rotary line switch, and that I have added another wiper 32, and a control magnet 10, which controls the movement of the wiper 32 through the retaining pawl 502. This wiper 32 is mounted upon the same shaft as the main wipers, 30 to 33, inclusive, and is arranged to rotate with them, or to rotate independently. Attached to the main wiper assembly, is the stop 506, and attached to the wiper 32 is the stop 509. Lying over on the main shaft 510 is the retaining spring 507, which is wound up when the wipers 30, 31 and 33 are advanced, and the wiper 32 is held stationary by the retaining pawl 502. Subsequent energization of the magnet 10, withdraws the pawl 502 from the ratchet wheel 508 of the wiper assembly 32, permitting the springs 507 to unwind and advance the wiper 32 until the stop 509 engages the stop 506 of the main wiper assembly, at which time wiper 32 will come to rest in line with the remaining wipers of the switch. The wipers of the switch have access to a semicircular bank, containing 25 contacts in each row, and in this case there are four rows of these contacts. The number of contacts in each row, and the number of rows of contacts of the finder F can be increased or decreased, it being necessary only to keep the number of contacts in the row the same as the number of contacts in the rows of the banks of the line equipment LE shown in Fig. 3. In Fig. 5, and Fig. 6, the wiper 32 is shown in different positions with respect to the main wipers 30, 31, 33, the positions being altered to enable a clearer understanding of the structure.

Fig. 7 shows a schematic representation of the bank contacts of the line equipment LE, showing the order in which the wipers 115 to 119 encounter their respective contacts. It will be noted that with the wipers moving in the direction shown by the arrow in Fig. 2, wiper 117 first encounters the contact S belonging to a particular line. Wipers 115 and 119 engage the contacts 2′ and 1′ respectively, at the same time, wiper 116 engages contact 1 a brief interval later, and wiper 118 engages contact W after wipers 115, 117 and 119 have swung free from their respective contacts. Contacts S, 2′ 1′, *i*, and W comprise a group of contacts which is individual to one line, there being 25 such groups in the line equipment as shown in Figs. 3 and 4.

In order to simplify the drawings as much as possible I have shown a plurality of batteries, whereas in an actual installation these would be but one battery, preferably with its positive pole grounded.

The operation of the system of my invention is briefly as follows: The constantly moving line equipment LE together with the relay group R, takes the place of the usual individual line and cut-off relays of the well known finder switch systems, and operate jointly to control the positioning of the wipers of the finders such as F, upon the contacts leading to a calling line such as A. When a line initiates a call, for example, the receiver is removed from the hook of substation A, that line is in a position to pick up a finder and start a call. The removal of the receiver from substation A does not accomplish any function until the wipers of the line equipment LE engage the bank contacts associated with that line. When the contacts 115 and 119 of the line equipment engage the contacts 1′ and 2′ which are associated with the calling line A, a circuit is completed over the loop of the calling line for the start relay in the relay equipment R. That relay energizing to prepare circuits for the subsequent control of the finder F. Since the finder F has no normal position, it may happen that its wipers are standing upon the contacts associated with the line A, in which case it will not be necessary to deliver any impulses to the finder F, but only necessary to switch that finder through and connect the calling line with the first selector E. After the wipers 115 and 119 have found a closed loop and energized the start relay, the marking wiper 116 has to determine the position of the finder F, and if that finder is standing upon the contacts of the line A, a circuit is completed through the marking wiper 116, and the control equipment R switches the finder through without delivering impulses to it. In a majority of instances it will be necessary that the finder be stepped one or more steps to set its wipers upon the contacts of the calling line, in which case no circuit will be completed through the marking wiper 116. As the line equipment LE continues to move, pulse wiper 118 encounters the contact W, closing a circuit through the control equipment R and the finder allotter FA to the motor magnet of the finder F, energizing it preparatory to advancing the finder wipers one step. The energization of the motor magnet of the finder F advances all of the wipers except the marking wiper 32, which is under

the control of the individual magnet 10. When the control equipment R is taken into use, all of the wipers except wipers 118 and 116 of LE are temporarily cut out of service, since they have no further function in connection with the setting of the present call. When the equipment rotates so that the wiper 116 engages the next contact in its row, it tests that contact to determine whether or not the wipers of the finder have been moved a sufficient number of steps to position them upon the contacts of the calling line, and if the wipers are so positioned a circuit is completed through wiper 116 to switch through the finder and open the pulsing circuit so that no further impulses will be delivered to it. In this manner the finder is advanced under the control of wipers 118 and 116 of the line equipment LE. When the calling line is found, and the finder switches through, the line equipment and the relay group R are released, the finder allotter FA is stepped ahead, to automatically preselect the next idle finder of the group, and associate it with the equipment R in readiness for the next call.

To explain a little more fully the operation of the marking wipers in conjunction with the control equipment R and the line equipment LE, it will be noted that the wiper 110 of the finder allotter FA places ground potential upon the conductor 80 and the wiper 32 of the finder F. With the wipers of F and FA in the position shown in Figs. 1 and 2, and if a call is initiated on the line terminating in the contacts of which the wipers 115 and 119 are resting, that line will also appear in the contacts upon which wipers 30 and 33 of the finder F are resting, a circuit may then be traced from this ground on conductor 80 through wiper 32, contact *m*, conductor *a*, contact *g*, wiper 116, through springs 128 which are now closed, through the cut-off relay 106 of the control equipment R, that relay energizing to prepare a switch-through circuit to springs 130 and to open the impulsing circuit at springs 132. If a call is initiated by a line one space ahead of where the wipers of the finder F are now resting, wiper 116 which is then engaged with the contact *h*, will not find a ground potential and the switch-through circuit will not be completed. Accordingly an impulse will be sent to the finder F, to move the wipers 30, 31 and 33 one step in the direction indicated by the arrow. Similarly the wipers 115 and 119 of the line equipment LE are moved one step, at which time wiper 116 again engages contact *g*, and the circuit for relay 106 is completed as before and the finder F is switched through after having taken one step. Magnet 10 of the finder F is then energized, and the wiper 32 is released and moved under the control of spring 507 into alignment with the remaining wipers of the switch. If the line A is the calling line, with the wipers of the finder F in the position shown in Fig. 1, it will be necessary to move the wipers two steps to engage the contacts of that line. The circuit for the start relay will be completed when the wiper 115 engages the contact 2′, the wiper 119 engages the contact 1′, and the wiper 116 engages the contact *i*. The circuit for relay 106 will not be closed, the impulsing circuit will be closed and the finder will be stepped up one step, at which time the testing wiper 116 will again seek ground. Since two steps are necessary ground potential will not be present on the contact *h*, and the pulsing circuit will be again closed to step the wipers one more step at which time contact *g* is encountered by the wiper 116 and the circuit of relay 106 closed. It will be noted that the wipers of the line equipment LE and the wipers of the finder F move in opposite directions, that is the wipers of the finder F move, from line 1 to line 25, while the wipers of the line equipment LE move from line 25 to line 1. If the wipers of the finder F were standing on line 1, and line 25 called, it would be necessary to move the wipers of the finder F 24 steps in order to engage the contacts of the calling line. Similarly if the wipers of the finder are standing on the contacts in line 10, and line 15 calls it will be necessary to move the wipers 5 steps in order to bring them in engagement with the contacts of the calling line.

Having thus described my invention in general I will now proceed with a detailed description of its operation.

Line A calls

When the receiver is removed from the hook switch of the station A, a bridge is completed across the line conductors 1 and 2, that bridge including the transmitter, receiver, and impulse springs in series. The closure of the direct current bridge across the line conductors is without effect until the wipers of the constantly moving line equipment LE engages the contacts of that line, in this case the contacts 1′ and 2′ at which time a circuit for the start relay 103 of the equipment R, is closed, that circuit being traceable from ground through springs 124, conductor 150, wiper 119 now engaging contact 1′, conductor 1, through the subscriber's loop and the substation to conductor 2, contact 2′, wiper 115, conductor 146, through springs 120, through the upper winding of relay 103 to grounded battery. Relay 103 energizes in this circuit and at springs 122 closes a circuit from ground through spring 125 and its break contact, springs 122, thence over two paths in parallel, the one

through the upper winding of relay 105 to grounded battery, and the other through the lower winding of relay 103, through the lower winding of relay 102, to grounded battery, energizing relays 102 and 105. Relay 103 is thus maintained energized independent of its initial circuit which is broken by the energization of relay 102 to operate springs 120 and 121. Relay 105 energizes and at spring 127 and its make contact closes a circuit through conductor 145, through the winding of the motor magnet 101 of the finder allotter FA, energizing that magnet preparatory to advancing the wipers of the allotter one step. Relay 105 at springs 128 closes a point in the circuit of relay 106, that circuit being held open elsewhere at the moment. Relay 105 at springs 126 closes a high resistance ground through conductor 140 to the finder F, that circuit being traceable from ground through resistance 129, spring 126 and its make contact, conductor 140, wiper 111 of allotter FA, conductor 81, through the winding of relay 11, through resistance 35 to grounded battery. Relay 11 when energized in series with resistances 129 and 35 is capable of closing springs 34, but not sufficiently strong to operate the remaining springs in its assembly. The closure of springs 34, prepares a testing circuit which will be explained in detail hereinafter. Relay 103 upon energizing, closes at spring 123 a point in the impulsing circuit, preparatory to stepping the wipers of the finder if necessary. The operation of the system from this point on depends upon whether or not the wipers of the finder F happen to be standing upon the contacts of the calling line A at the time.

Finder standing on calling line

Assume first that the wipers of the finder F are standing on the contacts of the calling line, that is wiper 30 engaging contact 2″, and wiper 33 engaging contact 1″ and wiper 32 is engaging the contact *o*. In this case it will not be necessary to send any impulses to the finder, and the circuit will be closed through wiper 110 of the finder allotter FA, conductor 80, wiper 32 of the finder F now engaging contact *o*, conductor *c*, contact *i*, wiper 116 which is engaging that contact, conductor 147, through springs 128, through the winding of relay 106 to negative battery. Relay 106 energizes and at springs 132 opens a point in the impulsing circuit, to prevent the delivery of any impulses to the motor magnet of the finder. Relay 106 at springs 131 closes parallel circuits for the lower winding of relay 105 to grounded battery, to maintain that relay in its energized position independent of the previously traced circuit through springs 125, and through the lower winding of relay 104 to grounded battery to energize that relay. Relay 104 upon energizing at spring 125 opens the circuit previously traced for relays 102, 103, and 105, and at springs 124 and 125 closes a substitute circuit through the upper winding of relay 102 thereby maintaining that relay energized and permitting the relay 103 to deenergize. Relay 103 upon deenergizing opens an additional point in the impulsing circuit at springs 123. The operation of relay 106 closes at spring 130 a circuit traceable from ground through that spring, through spring 126 and its make contact, conductor 140, through wiper 111 of the finder allotter FA, conductor 81 to springs 37, through the winding of magnet 10 of the finder F to grounded battery, with a parallel branch to the winding of relay 11, through resistance 35 to grounded battery. Magnet 10 and relay 11 energize over this circuit, the former to release the wiper 32 to permit it to align itself with the remaining wipers of the switch, but since the finder is assumed to be standing upon the contacts of the calling line, this wiper 32 is already aligned with the remaining wipers of the switch, and the energization of relay 10 therefore performs no useful function. The complete energization of relay 11 connects the calling line to the line relay of the first selector E, that circuit extending from ground through the lower winding of the line relay of E, conductor 39′, through the springs 39, wiper 33, line conductor 1, through the subscribers loop to line conductor 2, wiper 30, springs 38, conductor 38′, through the upper winding of said line relay to grounded battery. The line relay energizes and closes a circuit for the release relay of the selector, that relay energizing to send back ground over the conductor 81 in the well known manner, that ground serving to maintain relay 11 in its energized position. Relay 11 upon energizing operates spring 36, to close ground through the wiper 31, which is now engaging the private conductor 6 associated with the calling line A, to guard the connection against intrusion by a connector. The calling subscriber is now connected to the first selector and the usual dial tone is audible to notify that the equipment is in readiness to receive the impulses from the calling device, to extend the connection to the desired line. Returning now to the equipment R, the wiper 116 of the line equipment LE continues to revolve and after a brief interval loses the ground which is present upon the contact *i*, thereby opening the circuit of relay 106 which falls back after a brief interval. Relay 106 upon falling back opens the circuit of relays 105 and 104, permitting those relays to deenergize, the former to open at springs 127 the circuit of the magnet 101 of the finder allotter FA, that magnet deenergizing to advance

the wipers 110 to 113 onto the next contacts in the well known manner. The deenergization of relay 104 opens the springs 125 and 124, thereby opening the circuit of relay 102, permitting that relay to deenergize to again connect up the start relay 103, thereby returning the equipment R to normal in readiness for the next call. The finder allotter FA functions in the well known manner to preselect the next idle finder of the group, as will be explained in detail hereinafter.

Finder not standing on contacts of calling line

It will most frequently happen that the wipers of the finder F will not be standing on the contacts of the calling line when a call is initiated, and that the control equipment will have to step the wipers one or more steps in order to bring them into engagement with the desired contacts. Assume now that at the time line A is calling, the wipers of F are standing in the position shown in Fig. 1, in which case it will be necessary to move them two steps in order to bring them into engagement with contacts 2″ and 1″ in which the calling line terminates. Referring now to Fig. 7 it will be noted that shortly after the wipers 115 and 119 engage contacts 2′ and 1′, respectively, wiper 116 engages the contact *i*, which contact tests the position of the finder F. Since wiper 32 of the finder F is not standing upon the contact *o*, wiper 116 will not complete the circuit for the winding of relay 106, and the pulsing circuit will be left intact preparatory to sending impulses to the magnet of the finder F. When the wiper 118 advances to engage the contact F, a circuit may be traced from ground through contact W, wiper 118, conductor 149, springs 123, springs 132, to conductor 142, wiper 113 of the finder allotter FA, conductor 83 and thence over two paths in parallel, the one through springs 79 through the winding of the motor magnet 75 of the finder F to grounded battery, energizing that magnet preparatory to advancing the wipers of the switch, the second parallel circuit leads through springs 79′, conductor 82, wiper 112 of the finder allotter, conductor 141, through the winding of pulse locking relay 107, to grounded battery, energizing that relay which at springs 133 places a ground on conductor 142 in multiple with that from wiper 118, to lock itself and magnet 75 dependent upon springs 79 and 79′. When the magnet becomes fully energized, springs 79 and 79′ are operated, opening the circuit of relay 107, and permitting the magnet 75 to deenergize, the wiper 118 having passed off the contact W by this time. Magnet 75 upon deenergizing advances the wipers 30, 31 and 33 of the finder F one step, in the direction indicated by the arrow, the wiper 32 remaining upon the contact *m*, being held there by pawl 502 which is controlled by the magnet 10. Since two steps are required to bring the wipers of F into engagement with the contacts of the calling line, and since the marking wiper 116 of the line equipment LE is now engaging the contact *h*, having moved to the contact *h* when the wiper 118 moved off of contact W, no circuit will be completed for the relay 106, and an additional impulse will be sent to the magnet 75 when the wiper 118 encounters contact W′, the circuit being the same as before. When the magnet 75 again falls back and advances the wipers 30, 31 and 33 another step, wiper 30 engages the contact 2″ and wiper 33 engages contact 1″ those contacts being the contact of the calling line. Wiper 32 still being retained by retaining pawl 502, remains upon contact *m* and at the end of the impulse when wiper 116 of the line equipment LE moves into engagement with the contact *g*, a circuit may be traced from ground through wiper 110 of the finder allotter FA, conductor 80, wiper 32 now engaging contact *m*, conductor *a*, contact *g*, wiper 116, conductor 147, springs 128, through the winding of relay 106 to grounded battery, energizing that relay which causes the finder to be switched through in the manner hereinbefore explained. The calling subscriber then hears the dial tone, and manipulates his calling device in accordance with the digits of the number of the called station, the first digit operating the first selector E to elevate the wipers 40, 41 and 42, vertically opposite the desired level. The selector E then rotates automatically under control of the testing circuit through wiper 41, coming to rest upon the contacts of the first idle trunk line, assumed to be the contacts 43, 44 and 45 of the trunk line leading to the connector H.

Operation of the connector H

Upon seizure of the connector H, the loop circuit is closed for the line relay 13 through the contacts 47 and 48 of the back bridge relay 12, through the contacts engaged by wipers 40 and 41 and thence over the previously traced circuit back through the loop of the calling station. Relay 13 energizes over this circuit and closes a circuit to release relay 14, which energizes to prepare the impulsing circuit at springs 52, supplies ground to holding conductor at springs 51, and applies ground to the release trunk conductor at springs 50, that ground traversing a circuit through contact 44 and wiper 41 to hold the operated relays of the selector E and the finder F in their operated position. When the impulsing device at the substation A interrupts the circuit of relay 13 in accordance with the next digit

of the call number, line relay 13 falls back, and delivers impulses first to the vertical magnet 15 over the circuit including relay 16 in series, that magnet and relay operating to elevate the shaft and wipers 68 to 70, inclusive, vertically, the latter remaining energized throughout the impulsing to perform certain control functions. The first vertical step of the shaft operates the off-normal spring 55, in the well known manner, so that when the relay 16 falls back at the end of the impulse series, a circuit is extended to the rotary magnet 22 and the rotary multiple relay 19, to which the next digit dialled into the line relay 13 is delivered. At the end of the second digit dialled into the connector H, the wipers 68, 69, and 70 are positioned upon the contacts of the calling line, assumed to be the contacts 71, 72, and 73, which are connected by the usual multiple cables 4^a, 5^a and 3^a, to the lines 3, 4, and 5, of the substation B. In order to avoid unnecessary complications of the drawing this multiple cable is omitted, being indicated by correspondingly numbered wires. The operation of the connector H from this point on depends upon whether or not the called line is busy at the moment. Assume first that it is busy. Contact 72, associated with the called line, will contain a ground potential if the line is busy. After the wipers have come to rest on the contact and before the slow acting multiple relay 19 falls back a circuit may be traced from ground on contact 72, through wiper 69, spring 90 and its make contact, springs 65 through the winding of busy relay 18 to grounded battery, energizing that relay which locks itself to release trunk conductor grounded at spring 50, through spring 59, the normally closed contacts controlled by spring 90, those contacts being closed when the relay 19 restores an instant later, through spring 65 and then through the winding of the relay to grounded battery. The calling subscriber is informed of the busy condition of the line by the busy tone from the busy generator placed on the line through springs 62, in the well known manner. The calling subscriber upon hearing this tone will replace the receiver and release the connection in the manner which will be explained hereinafter. Assume however that the calling line is idle at the time the wipers 68 to 70, inclusive, are positioned upon the contacts associated with it. In this case the contact 72 will contain neither battery nor ground potential, and the connector H will establish the connection to the contacts 71 to 73, inclusive. During the operation of the rotary magnet 22, to rotate the shaft bearing wipers 68 to 70 into connection with the contacts 71 to 73, cam 93 is operated upon the first rotary step, closing springs 92 preparatory to switching the connector through if the called line be idle. When the relay 19 falls back after the wiper 69 is positioned on contacts 72 and found that that contact contains no ground potential, a circuit may be traced from ground through springs 51, off-normal springs 92, springs 60, spring 94, winding of switching relay 20 to grounded battery, energizing that relay which locks itself from ground on spring 51, through springs 65′ and then through the winding of the relay to battery. Switching relay 20 upon energizing places ground on contact 72 at springs 64 through the wiper 69, that ground marking the line busy to other connectors to prevent intrusion upon the pending call. Relay 20 at springs 63 and 67 connects the wipers 68 and 70 to the remainder of the connector, establishing a ringing connection to the called line. Interrupted ringing current is projected out over this connection from the generator *Gen.* under the control of the ringing interrupter RI, the circuit that the ringing current traverses being the usual and well known circuit which is conductive to alternating current and open circuited to the direct current, because of the condenser at the substation B. When the called station B responds to the call, by removing the receiver from the hook switch, a direct current bridge is closed across the conductor to the line, energizing the ring cut-off relay 17, which cuts off the ring and switches the connector through as usual. Ring cut-off relay 17 upon energizing operates springs 56 and 58, extending the connection from the called line through to the back ridge relay 12, which furnishes battery to the transmitter of the called station. Relay 12 energizes and at springs 47 and 48 reverses the polarity of the calling line A in the usual manner, placing the two stations in a telephonic connection over which the conversation is carried on.

Release

When the station A and B have completed their conversation, and both replace their receivers, ground is removed from the release trunk conductor at springs 50 by the deenergization of relay 14, and from the connector holding conductor by the deenergization of back bridge relay 12 and release relay 14 at springs 46 and 51, respectively, whereupon all relays which were locked to the conductors are released, and restored to normal in the well known manner, placing the equipment in its normal position in readiness for the next call. It will be understood of course, that the wipers of the finder F, remain upon the contacts leading to the calling line A, until the finder F is seized again and operated into connection with some other line.

Line equipment rotating over busy line

After the finder F has connected with the calling line A, and at springs 36 supplied ground to the private conductor 6, and after the connector H is connected with the called line B, and at springs 64 applied ground to the private conductor 5, those lines are protected from intrusion either by a connector or by another finder. The line equipment LE continues to revolve, the wiper 117 testing the private conductors of the various lines in order. When the wiper 117 engages the contacts of the private conductor 6 of the calling line A, a circuit can be traced from ground upon that conductor, through wiper 117, conductor 148, through normally closed springs 124, through the upper winding of relay 102 to grounded battery, energizing that relay which at springs 121 and 120 disconnects the ground and start relay circuit from the wipers 119 and 115, respectively. Since the calling line A is in use at this time a direct current bridge is closed across it, and if the relay 102 were not provided to open the testing circuit, the relay 103 would energize each time the wipers 115 and 119 engage the contacts associated with the line A. This would result in unnecessary operation of the finder, and in addition would produce an undesirable click in the receiver of the calling station A. By arranging the wipers of the line equipment LE as shown in Fig. 7, the private wiper 117 first engages the contacts associated with any line. If that wiper picks up a ground potential, relay 102 is energized as just explained, and no further tests are made upon that particular line, the relay 102 remaining energized until the wiper 117 passes off of that particular private contact. It will be noted in Fig. 7, that the private contact *s* is so shaped that the wiper 117 engages it until after the testing wipers 115 and 119 have freed themselves from the line contacts 1′ and 2′ so that it is assured that relay 102 will remain energized until after the wipers of the line equipment LE have passed the line contacts of a busy line.

Connector calls line A before finder connects with it

Since the removal of the receiver from the substation A does not apply ground to the private conductor 6 associated therewith, and since the conductor 6 is not grounded until the finder F connects with the calling line, it is entirely possible that a connector may call the line after the receiver is removed from the switch hook and before the finder has connected with the line. The line conductors 1 and 2 and the associated private conductor 6 are connected to the banks of the connectors through the usual normal cable, this cable being omitted from the drawings to avoid any unnecessary complication. When the connector connects with the line A, ground will be applied to the private conductor 6, and when the wiper 31 of the finder F is positioned on the contact to which this conductor 6 is connected, that wiper will pick up a ground potential. Since the line A is the calling line, the equipment R will try to switch through the finder to connect with that line. When the relay 105 of the equipment R was energized during the initiation of a call, a ground was connected through resistance 129, springs 126, conductor 140, through the wiper 111 to the conductor 81, hence through the winding of relay 11 and resistance 35 to grounded battery. Relay 11 is so constructed that the springs 34 close before the remainder of the springs are moved, that construction being old and well known to those skilled in the art. When the relay 11 is energized in series with resistances 129 and 35, it has sufficient strength to close the springs 34, however it does not have sufficient strength to fully energize and operate the remainder of its springs. When the wiper 31 picks up the ground on conductor 6, relay 11 is short circuited from that ground through that wiper, through springs 36 and its break contact, springs 34, through the upper terminal of the relay, the lower terminal having been grounded previously from conductor 81. When the relay 105 of the equipment R energizes to switch through the finder, relay 11 is prevented from energizing because of the short circuit, but the equipment R and the finder allotter FA are operated in the usual manner, the former to restore to normal and the latter to seek out the next idle finder of the group. When the line equipment LE rotates far enough so that the wiper 117 again engages the contact 6 ground potential will be present on that contact, and the relay 102 will energize to guard that line from intrusion by the control equipment R.

Finder allotter seeks idle finder

Returning now to the deenergization of magnet 101 of the finder allotter FA to advance the wipers 110—113 one step in search of the next idle. Assume that the step positioned the wipers on the contacts to which conductors 80—83 are connected and that the finder F is busy at the moment. Conductor 81 will receive a ground potential from the release trunk conductor, as explained above, that ground being picked up by wiper 111 to complete a circuit over which magnet 101 is again energized, that circuit being traceable through wiper 111, conductor 140, spring 126 and its break contact, conductor 143, springs 114, conductor 144, spring 127 and its break contact, conductor 145, through

the winding of magnet 101 to grounded battery. Magnet 101 again energizes and opens the above circuit at springs 114, falling back to advance the wipers of FA one step. If the finder associated therewith is busy, wiper 111 will pick up another ground, and the magnet 101 will operate in the above buzzer like fashion until that wiper loses ground, at which time the wipers 110—113 will be brought to rest upon the contacts of the idle finder.

From the foregoing description it is apparent that I have designed a new useful finder system which is simple in its construction and which can be easily maintained. In order to avoid unnecessary complications of the drawings, I have shown the system in its simplest form, that is with the calling line multipled only through one finder group and through one line equipment group. In a commercial installation however, I propose to multiple the line conductors to two or more finder groups and to two or more line equipments, thereby increasing the reliability and speed of the system. With the line equipment such as shown in Figs. 3 and 4, I am able to rotate the wipers at the speed of about 25 revolutions per second, since the wipers are double ending, the lines are tested at the rate of 50 per second. By multipling each line conductors to two of the line equipments, and by spacing the wipers of the two line equipments 90 degrees apart, each line is tested every quarter of a second instead of every half a second as is the case when a single line equipment is used. Since the line equipments are being driven by a common motor, it is not difficult to space the wipers in this manner and to maintain that spacing. Each line equipment and its associated control equipment R, has access to a different group of finders, through the finder allotter such as FA. In this manner the calls are doubly tested, so that in the event one line equipment fails to function properly due to a mechanical or electrical defect, the other line equipment will pick up the call a quarter of a second later and handle it in the usual manner. In the event of serious trouble in one of the line equipments, the wipers can be thrown out of gear, and repaired at leisure, without in any way interrupting the service of the line group, since the other line equipment will handle all of the calls occurring therein at that time. Moreover, I have shown the invention applied to a twenty-five line system, that being a convenient size and is shown by way of example only, as it is entirely possible to apply the same principles to larger line units of 50 or 100 lines or more.

While I have chosen to show the invention in connection with the equipment of a particular design, I have done so merely by way of example as there are many modifications and adaptations which can be made by one skilled in the art without departing from the scope of the invention.

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

1. In a telephone system, a switch mechanism containing a shaft, a plurality of wipers mounted on said shaft, the entire contacting surface of said wipers being disposed in a plane containing the axis of said shaft, a plurality of contact sets arranged in a semicircular bank and accessible to the contact surface of said wipers, a plurality of contacts in each of said sets, one for each of said wipers, means for rotating said shaft to move said wipers from one contact set to another, said contacts being so shaped and arranged with respect to each other that the wipers engage their respective contacts of a set at different times in a definite sequence and depart therefrom at different times in another definite sequence.

2. In a telephone system, a switch mechanism containing a shaft, a plurality of wipers mounted on said shaft, the ends of said wipers being disposed in a plane containing the axis of said shaft, a plurality of contact sets arranged in a semicircular bank and accessible to said wipers, each of said contact sets comprising a private contact, two line contacts, a marking contact and a pulsing contact, said wiper assembly containing a wiper for each of said contacts, said contacts being so spaced that the private wiper engages its contact first, the two line wipers engage their respective contacts simultaneously and before said private wiper has disengaged its contact, said marking wiper engages its contact before said line wipers disengage their contacts, and said pulsing wiper engages its contact after said private and line wipers have disengaged their respective contacts and before said marking wiper has disengaged its contact.

3. In a telephone system, a switch mechanism containing a shaft, a plurality of wipers mounted on said shaft, a plurality of contact sets arranged in a semicircular bank and accessible to said wipers, a plurality of contacts in each of said sets, means for rotating said shaft to move said wipers from one contact set to another, said contacts being so shaped and arranged with respect to each other that the wipers engage their respective contacts of a set in a definite sequence, and all wipers leave the contacts of one set before any wiper engages a contact of the next set.

4. In a telephone system, a switch mechanism containing a shaft, a plurality of contact sets arranged in a semicircular bank, each of said contact sets comprising a pri-

vate contact, two line contacts, a marking contact and a pulsing contact, a set of wipers mounted on said shaft comprising a wiper for each of the contacts in said contact sets, means for moving said shaft and wipers at a uniform speed said wipers engaging their respective contacts in the order named, and impulsing wiper engaging its contacts less than one half of the time during said movement.

5. The combination with a shaft carrying a plurality of wipers having knife edge bearing surfaces aligned in a plane through the axis of said shaft and a means for rotating said shaft, of a bank contact arrangement wherein the wipers engage their respective contacts in a definite sequence, remain engaged with their respective contacts for different periods, and depart from their respective contacts in a different definite sequence while said shaft is rotating at a uniform rate.

6. In a telephone system, a switch mechanism containing a shaft, a plurality of double end wipers on said shaft disposed in planes lying at right angles to the axis of said shaft, a collecting ring for each of said wipers having its contacting surface parallel with said shaft and disposed concentrically to said shaft, and a brush for engaging the contacting surface of each collecting ring, said brushes lying in planes parallel to the planes of said wipers and midway between adjacent wipers.

In witness whereof, I hereunto subscribe my name this 7th day of October, A. D. 1927.

RUDOLPH F. STEHLIK.