

June 12, 1928.

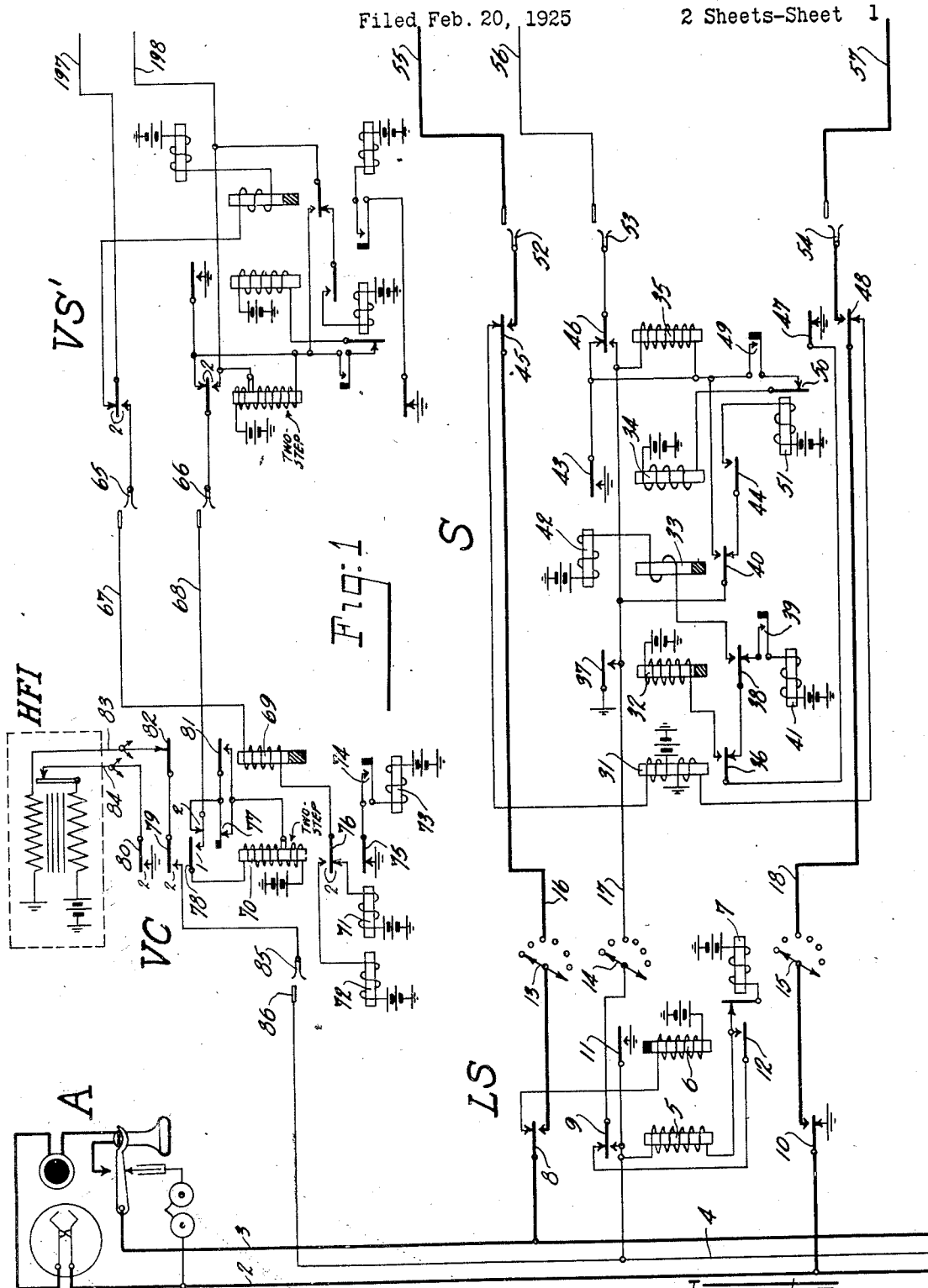
1,673,420

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AUTOMATIC TELEPHONE SYSTEM

Filed Feb. 20, 1925

2 Sheets-Sheet 1



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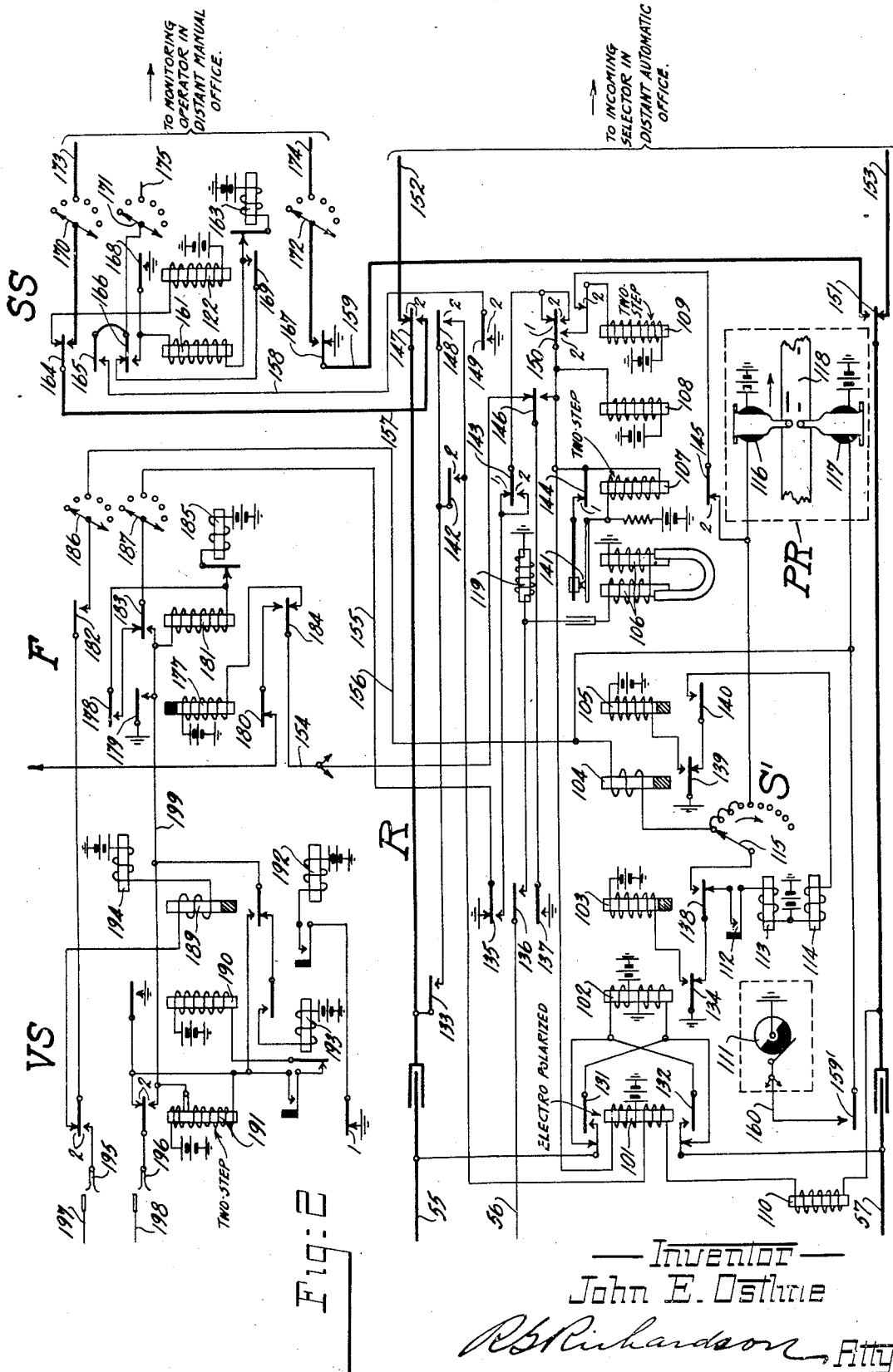
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE.

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AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

AUTOMATIC TELEPHONE SYSTEM.

Application filed February 20, 1925. Serial No. 10,461.

The present invention relates to automatic telephone systems in general, but is concerned more particularly with automatic telephone systems in which arrangements are provided for making so-called "two-number" toll calls, and the broad general object is the provision of an effective arrangement whereby the calling subscriber is compelled to register his own number on a suitable registering device at the central exchange in order to be able to complete a two-number toll connection.

As a matter of review, it may be pointed out that it is common practice in telephone systems for a calling subscriber, desiring to obtain a toll connection which is extended over a short distance only, to call the so-called "express" or "two-number" operator who ascertains the number of the calling subscriber and the number of the called subscriber and then completes the connection. This arrangement proves fairly satisfactory in an automatic system installed in a city of a thickly settled district but proves to be more or less expensive in a system embracing several small automatic exchanges more or less widely separated. Accordingly, the present system has been developed to enable the automatic subscribers to complete the express calls themselves while retaining the feature that the subscribers are charged for all express calls.

According to another feature of the invention, arrangements are provided for automatically timing the duration of the conversation.

According to another feature of the invention, arrangements are made for extending any call to a monitoring operator in a remote manual office in case the calling subscriber (either intentionally or otherwise) registers some other number as his own, arrangements being provided so that the desired connection is not in this case completed.

There are various other objects and features having to do mainly with the circuit details necessary in carrying out the foregoing. These other objects and features, together with the foregoing, may be fully understood upon a further perusal of the description.

Referring now to the drawings comprising

Figs. 1 and 2, they show by means of the usual circuit diagrams a sufficient amount of apparatus in a telephone system embodying the principles of the invention to enable the invention to be understood and to enable its utility to be appreciated.

Fig. 1 shows the line of substation A which terminates at the exchange in the line switch LS, which line switch, upon a call being made, extends the calling line into engagement with an idle selector, such, for example, as the selector S. Fig. 2 shows the repeater R which is accessible upon one level to the selector S. This repeater, or another like it, is taken into use when a two-number or express service connection is desired.

The trunk comprising conductors 152 and 153 extends from the right hand end of the repeater R to an incoming selector in the distant automatic office, and it is through this office that the express connections are set up.

Fig. 2 shows also the secondary line switch SS which is individual to the repeater R and which is operated when the calling subscriber registers some number other than his own and extends the connection to a monitoring operator in a distant manual office.

Fig. 2 shows also the finder F which is operated to associate the verification selector VS with the repeater R when the repeater R is seized. The verification selector VS has access on one level to the verification selector VS' and others. The verification selector VS' has access on one level to the verification connector VC, which, in turn, has access to the private normal conductor of the line of substation A and others. In short, the local trunking system within the automatic office is reproduced in miniature by verification selectors, such as VS and VS', and verification connectors, such as VC.

Regarding the equipment shown, the line switch LS is mechanically of the usual rotary type in which the wipers have no normal position and move in a forward direction only. The construction of this switch is such that the wipers are advanced upon the backward stroke of the stepping magnet rather than upon the forward stroke. The finder F, Fig. 2, and the secondary

switch SS are similar mechanically to the line switch LS.

The selector S, Fig. 1, is an automatic switch of the well known vertical and rotary type. Accordingly, its bank contacts are arranged in horizontal rows or levels. The verification switches VS, VS' and VC are similar mechanically to the selector S.

The sequence switch S', individual to the repeater R, Fig. 2, is a simple switch having the wiper 115 which moves forward in one plane only under the control of the operating magnet 114 and which is restored to its normal position by release magnet 113 under the control of off normal contacts 112.

The so-called "pen" register PR may be of any well known or desired type and comprises essentially a pair of magnets 116 and 117, either of which may be operated to bring its associated pen into engagement with the moving tape 118. Accordingly, two separate parallel records may be made, as will hereinafter appear.

The apparatus having been described generally, a detailed description of its operation will now be given. For this purpose it will be assumed that the subscriber at substation A, desiring to set up an express (or two-number) toll connection, removes his receiver.

When the receiver is removed at substation A, a circuit is closed over line conductors 2 and 3 for line relay 6 of the line switch LS. Line relay 6 thereupon energizes and places ground upon private normal conductor 4 at armature 11, thereby making the calling line busy in the banks of the connector switches having access to it and closing a circuit through switching relay 5 and stepping magnet 7 in series. As a further result of its energization, line relay 6 connects test wiper 14 to the junction of switching relay 5 and stepping magnet 7 at armature 12.

In case the trunk upon which the wipers of the line switch LS are standing is idle, this latter operation has no particular utility and switching relay 5 energizes right away, seizing the trunk.

Assuming on the other hand that the trunk upon which the wipers of the line switch are standing is busy, test wiper 14 is in engagement with a grounded test contact, and switching relay 5, being short circuited, does not energize. In this case, the stepping magnet 7 energizes through the grounded test wiper 14 and, being self-interrupting, operates in a buzzer-like manner to advance the wipers 13—15 step by step in search of an idle trunk.

When an idle trunk is reached, which trunk, it will be assumed, is the one comprising conductors 16—18, switching relay 5, being no longer short circuited, energizes in series with stepping magnet 7. Stepping

magnet 7 does not pull up at this time on account of the relatively high resistance of switching relay 5. Upon energizing, switching relay 5 opens the test circuit and prepares the holding circuit at armature 9, thereby placing ground on the release trunk conductor 17 of the seized trunk through test wiper 14 so as to make the seized trunk busy immediately. At armatures 8 and 10, switching relay 5 disconnects the line conductors 2 and 3 from line relay 6 and ground, respectively, and extends them by way of wipers 13 and 15, conductors 16 and 18, and armatures 45 and 48 to the windings of line relay 31 of the selector S. Line relay 31 now pulls up and closes a circuit for release relay 32 which energizes and grounds the release trunk conductor 17 at armature 37, and at armature 38 opens a point in the circuit of release magnet 41 and prepares a circuit for vertical magnet 42. The grounding of release trunk conductor 17 closes the usual holding circuit through test wiper 14 and armature 9 and its working contact of switching relay 5 of the line switch LS before the slow acting line relay 6 has had time to fall back.

The circuits are now in readiness for the calling subscriber to dial the first digit, which is the digit necessary to trunk the call to an outgoing repeater, such as the repeater R, and, when he does so, line relay 31 deenergizes a number of times corresponding to the digit dialled. Upon each deenergization of line relay 31, a circuit is closed at armature 36 through armature 38 and its working contact and the slow acting series relay 33 for vertical magnet 42. By the operation of vertical magnet 42, the wipers 52—54 are raised step by step until they come to rest opposite the desired level of bank contacts. Relay 33 is energized in series with vertical magnet 42 upon the first impulse of current being delivered to the latter and, being slow acting, maintains its armature attracted throughout the vertical movement. As soon as the off normal contacts 49 close upon the completion of the first vertical step of the switch, a circuit is completed from the grounded release trunk conductor 17 through armature 40 and its working contact, off normal contacts 49 and interrupter contacts 50 for the stepping relay 34. Relay 34 thereupon energizes and closes a locking circuit for itself at armature 43, and at armature 44 prepares a circuit for rotary magnet 51.

At the end of the vertical movement, the slow acting series relay 33 falls back and completes the circuit of rotary magnet 51 through armature 44 and its working contact. Rotary magnet 51 thereupon energizes and advances the wipers of the selector into engagement with the first set of contacts in the level opposite which they were previously

raised and, near the end of its stroke, opens the circuit of stepping relay 34 at the interrupter contacts 50. Relay 34 deenergizes in response to this and opens the circuit of the rotary magnet at armature 44, where-

upon the rotary magnet deenergizes also. From this point, the operation depends upon whether the first trunk is busy or idle. If it is idle, the switching relay 35 now energizes, seizing the trunk. Assuming, however, that the trunk is busy, switching relay 35 is short circuited by the ground potential encountered upon the busy test contact by test wiper 53 and does not energize. In this case, the stepping relay 34 energizes again due to ground encountered by wiper 53 and extended through armature 46 and its resting contact and contacts 49 and 50, and again closes the circuit of the rotary magnet 51 at armature 44. When this occurs, the rotary magnet 51 energizes again and advances the wipers another step. This alternate operation of the stepping relay 34 and rotary magnet 51 continues as described until an idle trunk is reached, which trunk, it will be assumed, is the one comprising conductors 56-57.

When this idle trunk is reached, switching relay 35, being no longer short circuited, energizes in series with stepping relay 34. Stepping relay 34, however, does not energize at this time on account of the comparatively high resistance of switching relay 35. Upon energizing, switching relay 35 opens the test circuit and prepares the holding circuit at armature 46; removes ground from armature 36 of line relay 31 at armature 47, thereby opening the circuit of release relay 32; and at armatures 45 and 48 disconnects conductors 16 and 18 from line relay 31 and extends them by way of wipers 52 and 54, the bank contacts on which these wipers are standing, conductors 55 and 57, and the normally closed contacts controlled by armatures 131 and 132 of relay 101 to the windings of line relay 102 of the repeater R. Relay 102 now energizes over the calling subscriber's loop and closes at armature 134 a circuit for release relay 103. Release relay 103 responsively energizes and places ground on release trunk conductor 56 at armature 136 through the low wound impedance coil 119, thereby establishing the usual holding circuit for the switches LS and S before the slow acting release relay 32 of the selector S has had time to fall back.

As a further result of the energization of release relay 103 of the repeater R, it opens at armature 138 a point in the circuit of release magnet 113 of the sequence switch S' and prepares an operating circuit which will be pointed out later; disconnects conductor 155 coming from the banks of the finders, such as F from ground at armature 135 and connects it instead through the resting con-

tact and armature 143 and the resting contact and armature 150 to relay 108; and at armature 137 places ground through armature 146 and its resting contact on the common start conductor 154.

The start relay 177 of the finder F (assuming that the finder F is idle) now energizes through armature 184 and its resting contact and closes at armature 179 a circuit through switching relay 181 and stepping magnet 185 in series. At armature 178 relay 177 connects test wiper 187 to the junction of relay 181 and magnet 185. Accordingly, switching relay 181 does not energize because it is short circuited by the ground encountered upon the grounded contact upon which wiper 187 is standing. Magnet 185 energizes through wiper 187, and, being self-interrupting, advances the wipers 186 and 187 step by step in search of the repeater R.

When the contacts in which the conductors 155 and 156 of the repeater R terminate are reached, the stepping operation of the finder F ceases because there is no ground potential on conductor 155, the ground potential having previously been removed at armature 135, as above pointed out. Switching relay 181 is no longer short circuited and it energizes in series with magnet 185; opens the test circuit at armature 183 and prepares the holding circuit, thereby placing ground from armature 179 and its working contact on the test wiper 187; disconnects start relay 177 and prepares to extend the start conductor at armature 184; and at armature 182 connects up wiper 186.

In the repeater R, responsive to the placing of ground on wiper 187 of the finder F, a circuit is closed over conductor 155, armature 135 and its working contact, resting contact and armature 143, and the resting contact and armature 150, for relay 108. Relay 108 accordingly energizes and disconnects ground from start conductor 154 at armature 146, at the same time closing a local locking circuit for itself. This locking circuit is closed, it will be understood, before the slow acting start relay 177 of the finder F has had time to fall back. Accordingly, the ground applied to relay 108 by this locking circuit at armature 146 passes back through armature 150 and its resting contact, armature 143 and its resting contact, working contact and armature 135, conductor 155, wiper 187, and armature 183 and its working contact, to maintain the switching relay 181 of the finder F operated after start relay 177 falls back.

A circuit in multiple with relay 108 of the repeater R is closed through relay 107 and the associated resistance, but relay 107, being short circuited through armature 144 and its resting contact, and contacts 141, does not operate at this time. Moreover, the polarizing winding of the electropolarized re-

lay 101 is energized in parallel with relay 108, but, as is well known, this winding alone cannot operate the relay.

Referring now particularly to the verification selector VS, it will be noted that when the circuit is originally closed through switching relay 191 of the finder F, ground is placed on conductor 199 leading to the verification selector VS. When this occurs, current flows through the upper winding of the two-step switching relay 191, thereby energizing relay 191 through its first step only. This comes about owing to the fact that the upper winding of relay 191 is composed of a relatively small number of turns of wire having a relatively high resistance. When relay 191 operates through its first step, its lower armature is operated but its two upper armatures remain inert and are not operated until the relay operates through its second step. This is indicated by the labels 1 and 2. At its lower armature, relay 191 opens a point in the circuit of release magnet 192.

The circuits are now in condition for the calling subscriber to dial the first digit in his own number which he is instructed to do in order that he will register his own number on the paper tape 118 of the pen register PR. When the calling subscriber dials the first digit in his number, line relay 102 of the repeater R is deenergized a corresponding number of times. Upon each deenergization, line-relay 102 closes at armature 184 a circuit through armature 138 and its working contact, wiper 115 of the sequence switch S in its first position, slow acting series relay 104, conductor 156, wiper 186 of the finder F, working contact and armature 182, upper armature and resting contact of relay 191 of the verification selector VS, slow acting series relay 189, and vertical magnet 194 to battery. By the operation of vertical magnet 194 the wipers 195 and 196 are raised step by step until they come to rest opposite the level of bank contacts corresponding to the digit dialled. Relay 189 is energized in series with vertical magnet 194 and, in conjunction with the off normal contacts associated with stepping relay 190, closes a circuit for the said stepping relay 190 which thereupon energizes and closes a locking circuit for itself and prepares a circuit for the rotary magnet 193.

At the end of the vertical movement of the switch, relay 189 falls back and completes the circuit of the rotary magnet 193, which thereupon operates in the same manner as previously described for the rotary magnet 51 of the selector S to advance the switch wipers into engagement with the first set of contacts in the selected level. Similarly, the rotary movement of the verification selector VS continues in the manner described in connection with the selector S until an

idle trunk is reached, which trunk, it will be assumed, is the one comprising conductors 197 and 198. When this idle trunk is reached, the lower winding of switching relay 191 energizes in series with stepping relay 190; opens the test circuit and extends ground to conductor 198 at its middle armature; and at its upper armature disconnects the operating conductor from the vertical magnet 194 and extends it through wiper 195 and conductor 197 to the operating magnet of the verification selector VS'.

The two step switching relay of the verification selector VS' now operates through its first step and opens a point in the circuit of the associated release magnet.

When the calling subscriber dials the second digit in his own manner, the verification selector VS' operates in the same manner described for the verification selector VS and raises its wipers 65 and 66 opposite the corresponding level of contacts and selects an idle trunk, which trunk, it will be assumed, is the one comprising conductors 67 and 68. When this trunk is reached, the switching relay of the verification selector VS' energizes fully and extends the grounded release trunk conductor 198 to release trunk conductor 68 of the connector VC, and extends the operating conductor 197 to the operating conductor 67 of the connector VC.

Responsive to the extension of the grounded release trunk conductor, the first step winding of the two step relay 70 is energized through the normally closed contacts controlled by armature 78 and the normally closed off normal contacts 77. Accordingly, relay 70 operates through its first step, thereby opening a point in the circuit of release magnet 73 at armature 75, and closing a locking circuit for itself through its two windings in series at armature 78. However, the locking circuit through the upper winding of relay 70 remains ineffective because the upper winding of relay 70 is short circuited through the normally closed contacts controlled by armature 78 and off normal contacts 77.

When the calling subscriber dials the third digit in his own number, the impulses which are sent forward over the operating conductor 197 from the verification selector VS pass through the verification selector VS' and over conductor 67 to the connector VC. These impulses pass through series relay 69 and armature 76 and its resting contact to the vertical magnet 71. By the operation of vertical magnet 71, the wiper 85 is raised opposite the corresponding level of bank contacts. Relay 69 is energized in series with vertical magnet 71 upon the first impulse of current being delivered to the latter, and, being slow acting, maintains its armature attracted throughout the

vertical movement. At armature 81, relay 69 serves to maintain the short circuit closed around the upper winding of relay 70 after the off normal contacts 77 open, as they do upon the first vertical step of the switch.

At the end of the vertical movement, relay 69 falls back and opens the short circuit from around the upper winding of relay 70, whereupon relay 70 operates through its second step; shifts the operating circuit from the vertical magnet to the rotary magnet at armature 76; opens a further point in the previously closed short circuit around its upper winding at the normally closed contacts controlled by armature 78; connects up wiper 85 at armature 79; and at armature 80 places ground on the common start conductor 84 of the high frequency interrupter HFI. Accordingly, the high frequency interrupter starts buzzing preparatory to sending high frequency current out through wiper 85 to the selected private normal conductor at the end of the rotary movement which is to take place subsequently.

When the calling subscriber dials the next and last digit in his own number, the resulting series of impulses are transmitted over the path as previously traced to series relay 69 of the verification connector VC and thence over armature 76 and its working contact to rotary magnet 72. By the operation of rotary magnet 72, the wiper 85 is advanced step by step until it comes into engagement with the bank contact 86 in which the private normal conductor 4 terminates. Relay 69 energizes in series with rotary magnet 72 and maintains its armature attracted throughout the rotary movement. At armature 82, relay 69 maintains wiper 85 disconnected from conductor 83 during the rotary movement so as to prevent interference with the private normal conductors passed over during such movement.

At the end of the rotary movement, relay 69 falls back and connects the high frequency 83 through armature 79 and its working contact to wiper 85, thereby placing the high frequency current on private normal conductor 4. Before the effect of this high frequency current is taken up in detail, certain operations which have taken place in the meantime in the repeater R will now be explained.

In the repeater R, relay 104 energizes over the operating circuit each time a series of impulses is delivered to the train of verification switches, as above described, and, being slow acting, maintains its armature attracted throughout the series of impulses. Upon energizing, relay 104 closes at armature 139 a circuit for relay 105 which energizes and prepares at armature 140 a circuit for stepping magnet 114 of the sequence

switch S'. At the end of each series of impulses, relay 104 falls back and closes the circuit of stepping magnet 114 through armature 140, and opens the circuit of relay 105, with the result that relay 105 deenergizes, after a momentary interval, thereby terminating the impulse of current delivered to stepping magnet 114. The net result of this operation is that wiper 115 is advanced one step at the end of each series of impulses. Accordingly, at the end of the fourth series of impulses, stepping magnet 115 advances from the fourth position to the fifth position, thereby disconnecting the operating conductor which it controls from the operating conductor 156 leading to the finder and extending the operating conductor to the magnet 116 of the upper pen of the pen register PR preparatory to the registration of the desired number.

It will be noted that a branch of impulse conductor 156 extends to the magnet 117 of the lower pen of the pen register PR. That being the case, the four series of impulses delivered, as above explained, to the train of verification selectors are effective in operating the magnet 117 to register the calling subscriber's number on the tape 118.

The effect of the placing of the high frequency current on the private normal conductor 4 of the line of substation A by the switch VC will now be explained. This high frequency current passes forward over the release trunk conductor of the established connection through the selector S to release trunk conductor 56 of the repeater R. At this point the current divides and part of it passes to ground through the low wound impedance 119 and part of it passes to ground through the condenser and the high frequency relay 106. It may be pointed out that while relay 119 is low wound as regards direct current and low frequency alternating current, this relay offers considerable inductive impedance to a current of high frequency and therefore shunts most of the current through the high frequency relay 106 whose induction is practically nullified by the presence of the associated condenser, as may be readily understood. The relay 106 vibrates its armature in response to the high frequency current, thereby setting the associated weighted spring into action. The result is that the associated weighted spring vibrates at a relatively low frequency and with sufficient amplitude to permit the short circuit to be removed from around the two-step relay 107 a sufficiently long time to allow relay 107 to energize. This relay is provided with a highly inductive winding. Accordingly the building up of flux is gradual. When the flux reaches a relatively slight value, the first step contacts, which are as usual lightly adjusted, operate. Upon operating through its first step,

relay 107 open at armature 144 a further point in the short circuit previously closed around its winding, thereby removing itself from under the control of relay 106, and at armature 143 removes ground from the conductor 155 which is supplying holding ground to the finder F and to the verification switches. Responsive to this, relay 181 of the finder F, relay 191 of the switch VS, the corresponding relay in the switch VS', and relay 70 of the verification connector VC deenergize. Relay 70 of the verification connector VC disconnects wiper 85 at armature 79, and at armature 75 closes a circuit through the off normal contacts 74 for release magnet 73, which energizes and restores wiper 85 to normal. Release magnet 73 is now disconnected at off normal contacts 74.

Similarly, relay 191 of the selector VS closes at its lower armature a circuit through the associated off normal contacts for release magnet 192, which energizes with the result that the wipers 195 and 196 are restored to their normal position in the usual manner. The same remarks apply to the switch VS'.

The deenergization of relay 181 of the finder F restores the conditions at the finder F to normal.

The verification connection is now released and the switches involved therein are ready to be used in setting up a subsequent verification connection.

Returning now to the repeater R, as a further result of the energization of relay 107 through its second step which occurs only after the flux reaches a high value, it replaces ground on conductor 155 so as to render the repeater busy to the finder; disconnects relay 109 at armature 145; and at armature 142 completes a bridge across the conductors 152 and 153 which was previously prepared at armature 133 of line relay 102 and which includes the lower winding of the electro-polarized relay 101 and the impedance 110, in addition to the resting contacts and armatures 147 and 151. Responsive to the closure of this bridge, the distant incoming selector in the automatic office is prepared for operation in the usual manner. The electro-polarized relay 101, however, does not operate at this time on account of the fact that the current flow in either winding opposes the current flow in the other winding.

The calling subscriber now proceeds to dial the digits in the desired number, responsive to which the desired connection is completed in the usual manner and the called subscriber's bell is rung. The impulses for operating the automatic switches are repeated at armature 133 of line relay 102. Owing to the position of wiper 115 of the sequence switch S' (on its fifth con-

tact), the impulses generated at armature 134 and its resting contact are transmitted to the pen-register magnet 116. Accordingly, the upper pen of the pen register PR makes a record of the called number on the moving tape 118.

When the called subscriber responds, the connector switch in use reverses the direction of current flow in the calling loop and, accordingly, in conductors 152 and 153, whereupon the electro-polarized relay 101 responds by operating. At armatures 131 and 132, relay 101 reverses the direction of current flow in conductors 55 and 57. This does not have any particular utility in the present case but is standard practice and may be used wherever desired to operate meters, give supervision to operators, and the like. As a further result of the energization of relay 101, it connects the interrupted ground conductor 160 at armature 159 to the magnet 117 of the lower pen of the pen register PR. The interrupter 111 grounds the conductor 160 at predetermined and accurately timed intervals. Accordingly, the record made at this time by the pen associated with the magnet 117 is an accurate record of the length of the ensuing conversation which may, of course, now take place as the called subscriber has answered.

When the conversation is terminated, the two subscribers replace their receivers.

When the receiver is replaced at the called substation, relay 101 deenergizes and reverses the current flow in the calling loop back to normal at armatures 131 and 132, and at armature 159 disconnects magnet 117 from the timing lead 160, thereby terminating the record being made on the tape 118 of the length of the conversation.

When the calling subscriber replaces his receiver, line relay 102 falls back and opens the bridge across conductors 152 and 153 at armature 133, responsive to which the connection extending to the called subscriber through the automatic switches in the distant office is released in the usual manner. Line relay 102 also opens the circuit of the slow acting release relay 103 and closes a circuit for magnet 116 of the upper pen of the pen register PR. This operation is incidental but it serves nevertheless as a record of the time of the replacing of the receiver at the calling substation. After a slight interval, relay 103 falls back; removes ground from release trunk conductor 56 at armature 136; opens the circuit of the upper winding of the electro-polarized relay 101 and of relays 107 and 108 at armature 137, whereupon relays 107 and 108 fall back; and at armature 138 opens the circuit of magnet 116 and closes a circuit through the off normal contacts 112 for release magnet 113 of the sequence switch S'. Release magnet 113 now operates and releases the wiper 115

which returns to its normal position. The circuit of magnet 113 is opened at contacts 112 when wiper 115 reaches its normal position.

Responsive to the above mentioned removal of ground from release trunk conductor 56 by the repeater R, relays 5 and 35 of the switches LS and S, respectively, fall back. When relay 35 falls back, it closes at armature 47 a circuit through armatures 36 and 38 and off normal contacts 39 for release magnet 41, whereupon the selector S is released in the usual manner.

The entire connection is now released and the apparatus involved is ready for use in completing a subsequent connection.

The way in which a subscriber is prevented from completing a desired connection when he registers as his own number some number other than his own will now be pointed out. It will be apparent that the high frequency relay 106 of the repeater R is not operated in case the calling subscriber dials some number other than his own, because, at such a time, the verification connector VC is not set upon the private normal conductor 4 of the calling line. Accordingly, relay 107 is not operated to close a repeating bridge across conductors 152 and 153. Under this condition, relay 109 is left connected in multiple with the magnet 116 of the pen register PR at armature 145 and its resting contact, and, when the calling subscriber dials the first digit in the number of the desired subscriber, magnet 116 is operated as before, but the two step relay 109 energizes in multiple with magnet 116 upon the first impulse of current being delivered to the latter. Relay 109 is of the same type as relay 107 and, therefore, operates first through its first step only and removes ground from conductor 155 at armature 150, whereupon the verification connection is released.

Upon operating through its second step, relay 109 again grounds conductor 155 at armature 150 so as to render the repeater R busy to the finders. Also relay 109 locks itself energized in multiple with relay 108 and opens its initial circuit at armature 150; places ground on conductor 158 at armature 149; and at armatures 147 and 151 disconnects the upper and lower talking conductors from conductors 152 and 153 and connects them instead to conductors 157 and 159, respectively. Also, relay 109 completes the bridge across the talking conductors at armature 148 through the lower winding of the electro-polarized relay and the impedance 110.

Line relay 122 of the secondary switch SS is now operated over conductors 157 and 159; closes a circuit through switching relay 161 and stepping magnet 163 in series at armature 168; and at armature 169 connects

test wiper 171 to the junction of the switching relay and the stepping magnet. Accordingly, the secondary switch SS operates in a manner similar to that described in connection with the line switch LS and selects an idle trunk, which trunk, it will be assumed, is the one comprising conductors 173 and 174. When this idle trunk is reached, relay 161 pulls up because there is no ground potential on the local test conductor 175. Upon energizing, relay 161 opens the test circuit and extends ground to wiper 171 to make the seized trunk busy at armature 166; connects the grounded release trunk conductor 158 to armature 166 at armature 165; and at armatures 164 and 167 disconnects conductors 157 and 159 from line relay 122 and the ground, and extends them by way of wipers 170 and 172 to the conductors 173 and 174. Line relay 122, being now disconnected, quickly falls back and opens the initial circuit of relay 161 at armature 168, but relay 161 does not fall back and the test wiper 171 remains grounded owing to the fact that ground is supplied to the secondary switch SS from armature 149 of relay 109 over conductor 158.

Responsive to the extension of the conductors 157 and 159 to the conductors 173 and 174, the distant operator in the manual office is signalled in any well known or desired manner and she converses with the calling subscriber and reminds him that he must call his own number correctly in order to obtain the desired connection.

At the end of his conversation with the operator, the calling subscriber replaces his receiver, whereupon the connection is released in the manner described hereinbefore. Relay 109 deenergizes and at armature 149 opens the circuit of relay 161 of the secondary switch SS, whereupon relay 161 deenergizes also.

What is claimed is:

1. In a telephone system, normally operative means for connecting a calling line with a called line, means under the control of a calling subscriber for making a permanent record of the number of the calling line, and means responsive to the act of making such record for rendering the connecting means operative.

2. In a telephone system, normally operative means for completing a connection from a calling line to a called line, a calling device under the control of the subscriber on the calling line for calling the number of the calling line, and means at the central exchange responsive to such operation of the calling device for registering the number of the calling line and for rendering the connecting means operative.

3. In a telephone system, a calling line, means under the control of the subscriber

on said line for making a permanent record of the calling number at the central exchange and for subsequently making a permanent record of the called line at the central exchange, and automatic switching mechanism operated simultaneously with the making of the record of the number of the called line to extend a connection from the calling line to such called line.

4. In a telephone system, a calling line, means under the control of the subscriber on said line for making a permanent record of the calling number at the central exchange and for subsequently making a permanent record of the called line at the central exchange, automatic switching mechanism operated simultaneously with the making of the record of the number of the called line to extend a connection from the calling line to such called line, and means operated upon the response of the subscriber on the called line to make a permanent record of the time of the ensuing conversation.

5. In a telephone system, normally inoperative means for connecting a calling line with a called line, automatic switches controlled by the calling subscriber by dialling the digits of his own telephone number to connect with his own line, and means responsive to the completion of such connection for rendering said normally inoperative means operative.

6. In a telephone system, normally inoperative means for connecting a calling line with a called line, automatic switches controlled by the calling subscriber by dialling the digits of his own telephone number to connect with his own line, means responsive to the completion of such connection for rendering said normally inoperative means operative, and means responsive to the calling subscriber operating said switches to connect with some line other than his own for automatically connecting his line to an operator's position.

7. In an automatic telephone system, a calling line, a repeater, means for extending said line to said repeater, automatic switches for extending said line from said repeater to a called line, said repeater being normally inoperative to control said automatic switches, and means for rendering said repeater operative responsive to the calling subscriber dialling his own number.

8. In an automatic telephone system, a calling line, a repeater, means for extending said line to said repeater, automatic switches for extending said line from said repeater to a called line, said repeater being normally inoperative to control said automatic switches, means for rendering said repeater operative responsive to the calling subscriber dialling his own number, and means for automatically connecting the calling line

with an operator's position responsive to the calling subscriber dialling some number other than his own.

9. In an automatic telephone system, a calling line, a repeater, means for extending said line to said repeater, automatic switches for extending said line from said repeater to a called line, said repeater being normally inoperative to control said automatic switches, means for rendering said repeater operative responsive to the calling subscriber dialling his own number, and means in said repeater for making a printed record of the calling and called number and the duration of conversation over the connection.

10. In a telephone system, a plurality of subscribers' lines, a repeater, an automatic switch for extending a calling one of said lines into connection with said repeater, an automatic switch having access to said subscribers' lines, means controlled by the calling subscriber over said first automatic switch and repeater for operating the said second automatic switch to connect with said calling line, a responsive device associated with said repeater, and means responsive to the extension of the last named connection for operating said responsive device over the first named connection.

11. In an automatic telephone system, a calling line, a switching device adapted to control the connection of said calling line with a called line or an operator's position, means for connecting said calling line with said device, and means in said device dependent on the calling subscriber calling his own number or the number of another line for determining which connection is established.

12. In a telephone system, a repeater having two outgoing branches, automatic switches for extending a calling line to said repeater, a release trunk conductor for maintaining said switches in operated position, means including other switches controlled by the calling subscriber for connecting a source of alternating current with said conductor at a section thereof which is individual to the calling line, and a device in said repeater controlled by current from said source to automatically select one of said outgoing branches over which a connection to a called line can be completed.

13. In a telephone system, verifying means including automatic switches controlled by the calling subscriber for enabling a calling subscriber to automatically verify his own number preparatory to extending a toll connection, said means comprising switches and associated apparatus for transmitting a distinctive current over an established connection from a section thereof which is individual to the calling line, apparatus for establishing said toll connection, and means

responsive to said distinctive current, if received, for rendering said apparatus capable of being controlled by the calling subscriber.

14. In a telephone system, a repeater, an automatic switch for extending a calling line to said repeater, a second automatic switch, and means controlled by the calling subscriber for operating said second switch over said first automatic switch and repeater to set up a verification circuit to said calling line while the first automatic switch remains operated.

15. In a telephone system, a repeater, an automatic switch for extending a calling line to said repeater, said repeater having two outgoing branches, means responsive to the calling subscriber dialling his own number for automatically seizing one of said outgoing branches, and means responsive to the calling subscriber dialling some number other than his own for seizing the other of said outgoing branches.

16. In an automatic toll system, automatic switches for connecting a calling line with a called line, means controlled by the calling subscriber for recording his own number before the connection is established, so as to determine to whom the call is to be charged, means responsive to the operation of said last means for placing said switches under the control of the calling subscriber so as to complete the connection, and means controlled by the called subscriber for recording the duration of the call so as to determine the amount of the charge.

17. In an automatic toll system, automatic switches for connecting a calling line with a called line, and means at the exchange controlled by the calling subscriber for recording his own number and the number of the called line before the connection can be established.

18. In an automatic toll system, automatic switches for connecting a calling line with a called line, means controlled by the calling subscriber for recording his own number and the number of the called line before the connection is established, and means for preventing the establishment of the connection in case the number of the calling line is not correctly recorded.

19. In a telephone system, a plurality of repeaters, a plurality of finders having access to said repeaters, holding conductors extending from said repeaters to the banks of said finders, said repeaters normally grounding said holding conductors thereby

rendering said repeaters busy to said finders, a start conductor common to all said repeaters and finders, means for seizing one of said repeaters, means responsive to such seizure for grounding the start conductor to start up the first idle one of said finders and for removing the normal busy condition from the holding conductor of said seized repeater, means in the started finder for causing it to seize the repeater, means in the repeater responsive to its seizure for switching the ground connection from said starting conductor to said holding conductor in order to maintain the finder, and means in said repeater subsequently operated for momentarily removing said ground connection from said holding conductor to permit the release of said finder.

20. In a telephone system, a plurality of repeaters, a plurality of finders having access to said repeaters, holding conductors extending from said repeaters to the banks of said finders, said repeaters normally grounding said holding conductors thereby rendering said repeaters busy to said finders, a start conductor common to all said repeaters and finders, means for seizing one of said repeaters, means responsive to such seizure for grounding the start conductor to start up the first idle one of said finders and for removing the normal busy condition from the holding conductor of said seized repeater, means in the started finder for causing it to seize the repeater, means in the repeater responsive to its seizure for switching the ground connection from said starting conductor to said holding conductor in order to maintain the finder, said repeater having two outgoing branches, a first device and a second device in said repeater, means for operating said first device responsive to the calling subscriber dialling his own number for momentarily removing said ground connection from said holding conductor to permit the release of said finder and for seizing the first of said branches, and means for operating said second device responsive to the calling subscriber dialling some number other than his own for momentarily removing said ground connection from said holding conductor to permit the release of said finder and for seizing the other of said branches.

In witness whereof, I hereunto subscribe my name this 23rd day of January, A. D. 1925.

JOHN E. OSTLINE.