

Oct. 29, 1929.

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1,733,568

TELEPHONE SYSTEM

Filed March 31, 1927

3 Sheets-Sheet 1

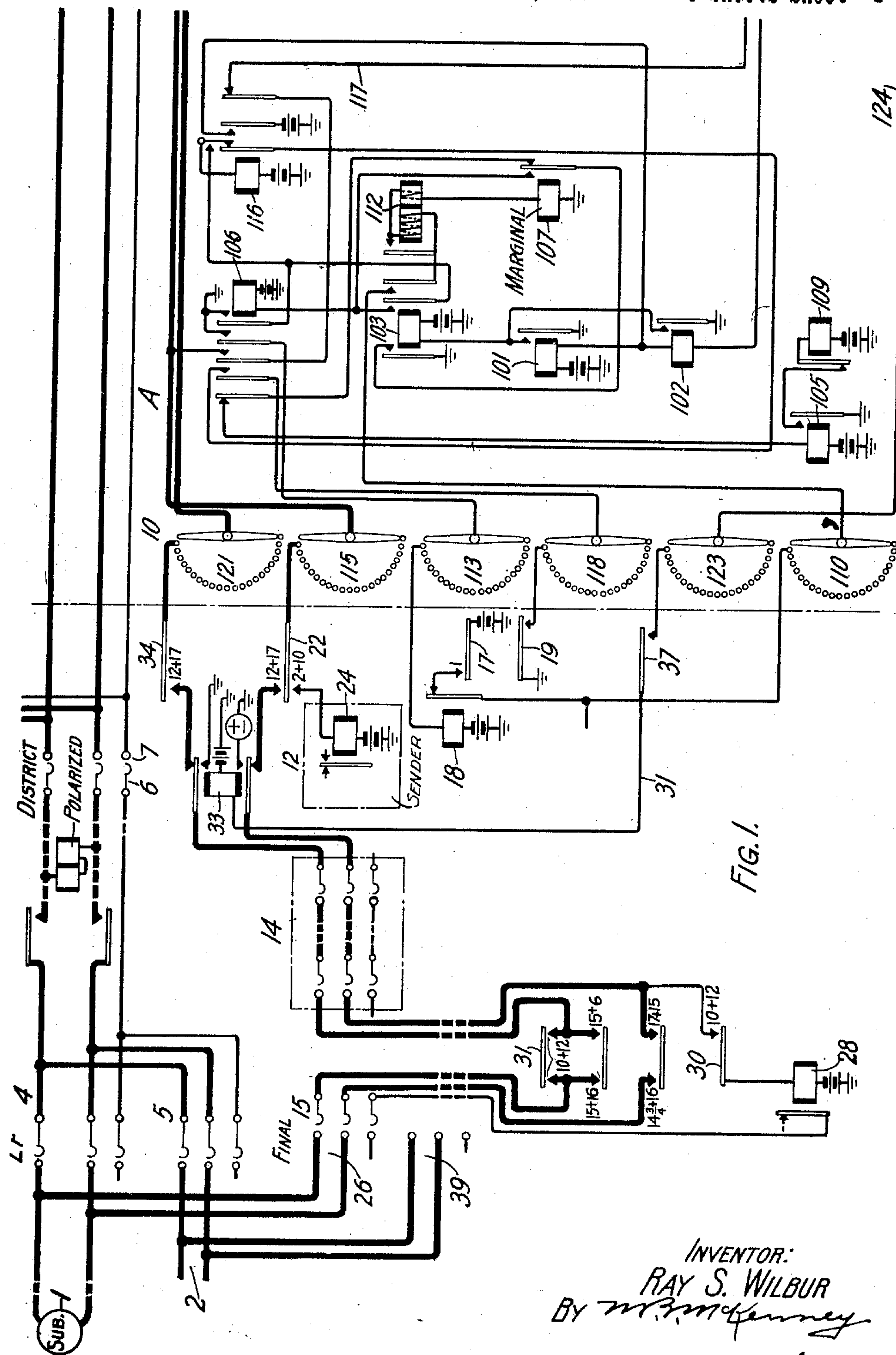


FIG. 1.

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3 Sheets-Sheet 2

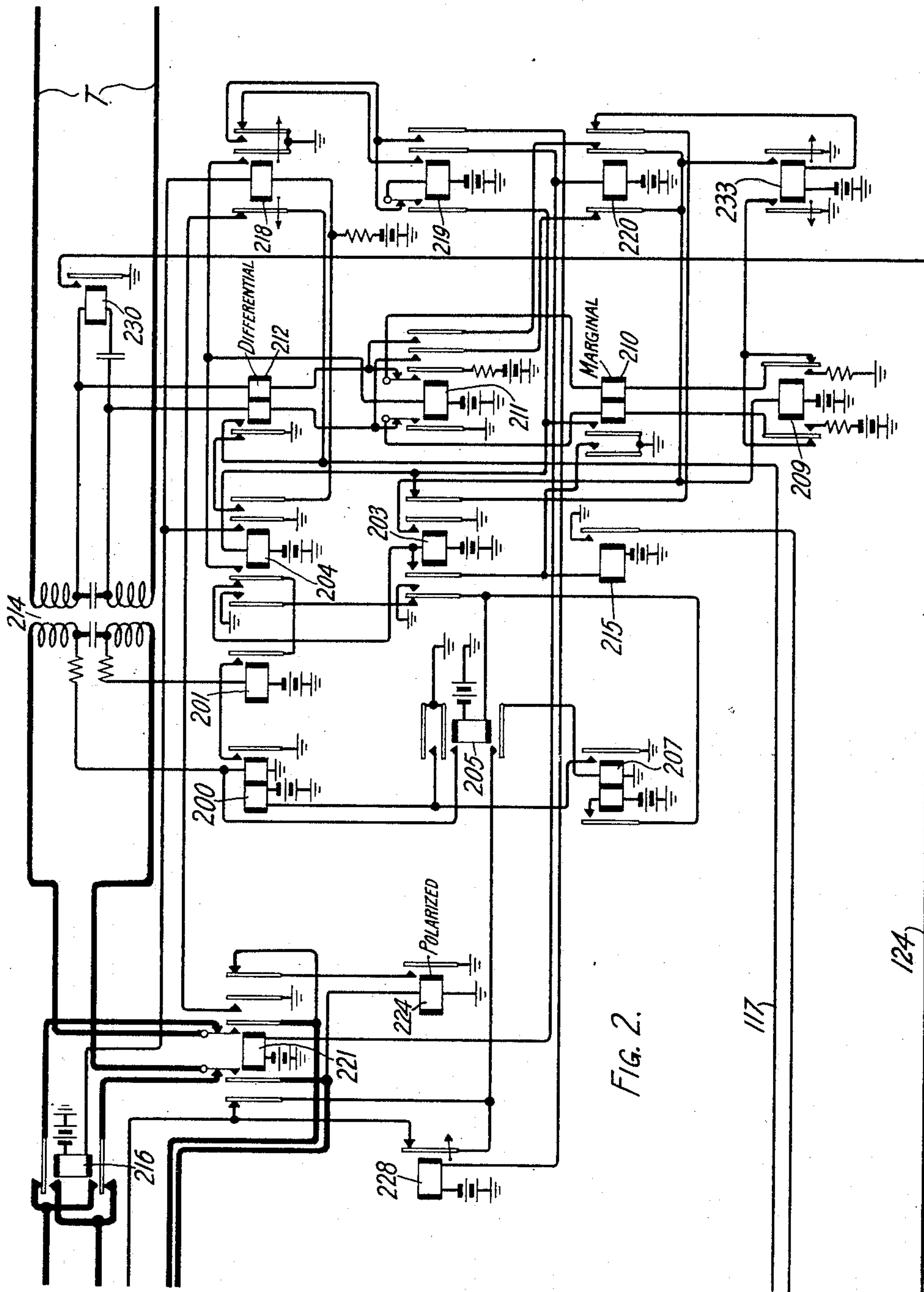


FIG. 2.

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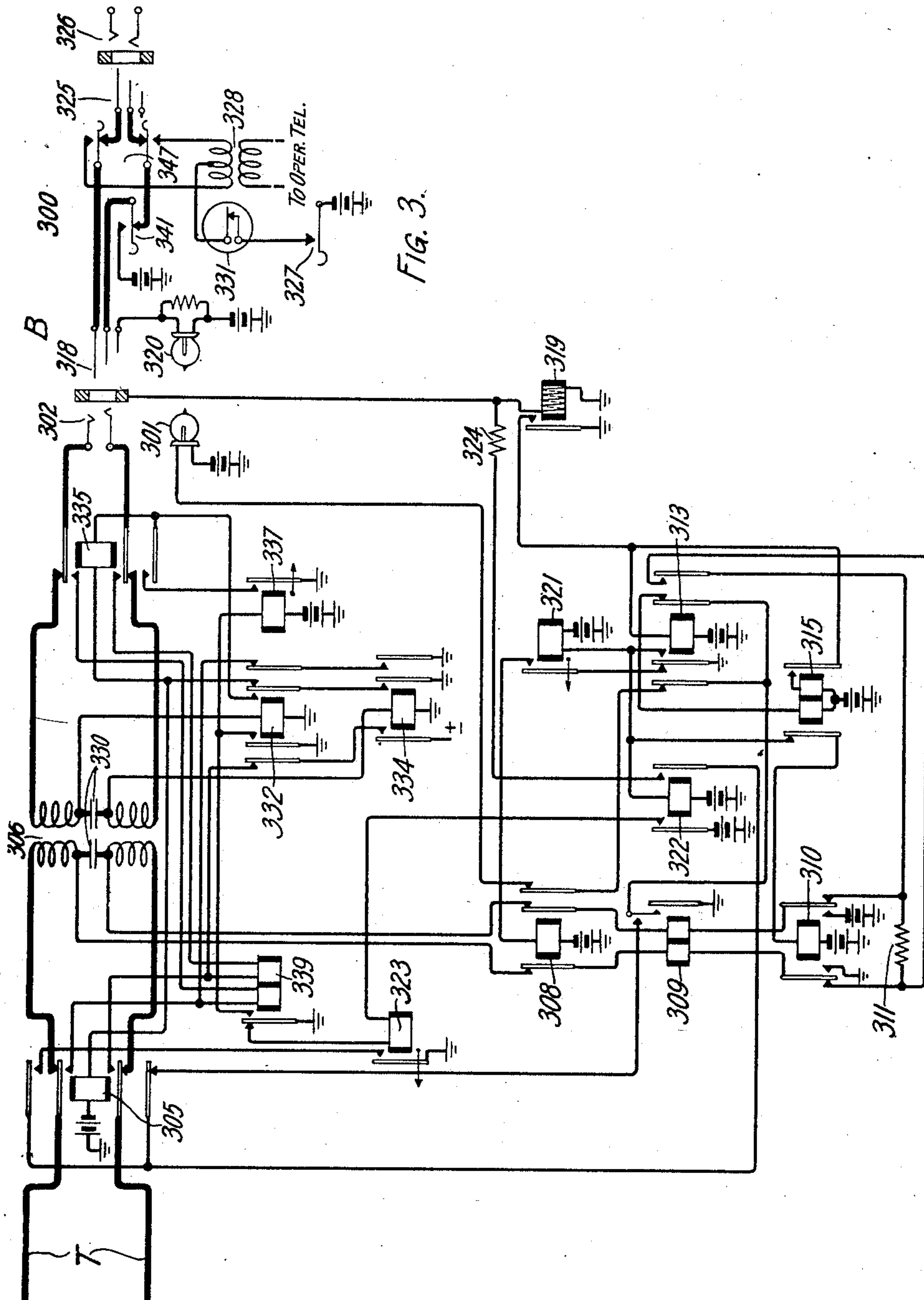
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3 Sheets-Sheet 3



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TELEPHONE SYSTEM

Application filed March 31, 1927. Serial No. 179,827.

This invention relates to semi-automatic telephone systems and more particularly to trunking arrangements between automatic switching equipment and operators' positions.

In accordance with this invention a trunking system is provided whereby connections extending over a trunk between an automatic exchange and an operator's position may be checked to ascertain the calling subscriber's number by having the operator call back over the trunk to establish a different connection without interrupting the conversation that may be in progress between the calling subscriber and the operator over said trunk.

A feature of this invention is an arrangement whereby the dialing impulses are transmitted over the trunk as a simplex circuit.

According to another feature means are provided whereby the toll operator may call an automatic subscriber through the automatic exchange over said trunk.

Another feature is an arrangement whereby the calling line may be either a regular automatic subscriber's line or a line leading to a private branch exchange and whereby connections initiated by the toll operator may be established to either of these two types of lines.

The invention is particularly applicable to systems for checking the numbers of calling lines by toll switching operators. If the calling line is a regular automatic subscriber's line the arrangement is such that the checking connection will be established through the usual automatic switches at the automatic exchange regardless of the fact that this subscriber's line is busy and if the line is a P. B. X. line the arrangement is such that the checking connection will be established to this particular busy P. B. X. line.

This invention has been illustrated in the accompanying drawing in which; Fig. 1 shows partly in detail and partly in diagrammatic form the automatic circuit equipments at an automatic exchange, which may be employed in the establishing of connections between an automatic subscriber's line or a

P. B. X. line to two-way trunks leading to toll operator's positions at a distant manual exchange.

Fig. 2 shows the equipment at the automatic exchange which is required for a two-way trunk connection between the automatic exchange and a toll operator's position at the manual exchange.

Fig. 3 shows the equipment required at the terminating end of a two-way trunk at the toll operator's position in the manual exchange. A toll operator's cord circuit has also been shown in diagrammatic form in this figure for extending toll connections from the two-way trunk.

In general the apparatus required and the operations of the arrangement as shown in the drawings for establishing connections of these types may be outlined as follows: When the subscriber, of a line such as 1, or the operator at the distant end of a P. B. X. line, such as 2, dials to establish a connection to a toll operator's position, such as 300, at the manual exchange B, the automatic switches at the automatic exchange A, such as the line-finders 4 or 5 and district switch 6, shown diagrammatically, are operated to connect the calling line to a two-way trunk, T, terminating through the circuits shown in Fig. 2 in terminals 7 at the bank of the district switch 6 or at the multiple banks of other district switches. When this connection is completed the line lamp 301 at the jack 302 of the trunk T lights and indicates to the toll operator that a connection is desired over this trunk.

When the toll operator answers the call by connecting her telephone set to the cord 300 and inserting plug 318 into jack 302, the battery supplied to the calling line from the trunk T is reversed so that battery is present on the tip and ground on the ring at the calling line, which is opposite to the condition occurring when a connection is established over the automatic switches between the calling subscriber's line and an ordinary called subscriber's line. The toll operator now asks the calling subscriber for the number of his line and for the information relating to the toll connection. As soon as the

toll operator receives the number of the calling subscriber's line she connects her dial 331 through key 327 to the cord and dials this number. The dial impulses are transmitted back over the trunk T arranged as a simplex circuit. That is, the impulses are transmitted over the two conductors of the trunk in parallel.

The arrangement is such that the line finder 10 and its associated apparatus were prepared during the establishing of the connection to the toll operator to cause the selection of an idle sender and switching equipment for extending the checking connection to the calling subscriber. Therefore, when the dialing impulses are received through this line finder they are registered on the sender 12, and when the sender is satisfied it will control the establishment of a connection to the calling subscriber's line over the ordinary switching equipments at the automatic exchange such as 14 and a final switch such as 15. If the calling subscriber gave the correct number the final switch will find on the multiple terminals of this line the above mentioned reversal of battery, and through suitable means hereinafter described the final switch will thereby be actuated to stop with its brushes on these terminals even though these terminals are in the ordinary sense made busy.

In the case the calling line is a P. B. X. line the final switch starts to hunt for a P. B. X. line in the ordinary manner but will, due to reversal of battery, stop with its brushes on the particular P. B. X. line used in the original connection, even through this P. B. X. line would in the ordinary sense be busy. To make this particular P. B. X. line busy to other final switches the battery is reversed to its normal condition as soon as it has been found and the busy sleeve condition restored so that it will test busy to other final switches hunting for an idle P. B. X. line. When the final switch has connected with the calling line the circuit arrangement is such that the original connection over line finders 4 or 5 and district switch 6 to the trunk is opened and the trunk connected through to the connection established through line finder 10 and switches 14 and 15. In this manner calls, from subscribers' lines or P. B. X. lines terminating in an automatic exchange, intended for toll connections may be checked as to their identity by the toll operator at the distant manual exchange B by having the toll operator dial the calling line number to set up a separate automatic connection.

The trunk line T is also arranged so that the toll operator can establish a connection to a subscriber in an automatic exchange or to a P. B. X. line on incoming toll calls. In these cases the sleeve terminals at the district switches such as 6 are made busy and connec-

tion to the desired line is extended over the trunk in the same manner as the checking connection.

Detailed descriptions will now be made of calls from an automatic subscriber's line and from a P. B. X. line to a toll operator's position and the checking of the number of the calling line followed by a description of a call from a toll operator's position to an automatic subscriber's line and a P. B. X. line. If the subscriber of an automatic line 1 desires to make a toll connection he will dial a certain code number which will connect him with an idle trunk line T through the line-finder 4 and a district switch 6. As such selections through switches of an automatic exchange are now well known in the art and form no part of this invention the automatic equipment has been shown merely in diagrammatic form. When the brushes of the district switch 6 land on the terminals 7, relays 200 and 201 are operated, due to the closure of the tip and ring conductors in the district switch circuits, as is also well known in the art. The operation of these relays closes a circuit for the operation of relay 203 from battery, through the winding of relay 203, inner left-hand armature and back contact of relay 204, through the right-hand armatures and front contacts of relays 201 and 200 in series to ground. The operation of relay 203 causes an obvious circuit to be closed for relay 205 and this relay in turn closes a circuit through the left-hand winding of relay 200 for the locking of this relay under control of relay 205 and at the same time relay 205 short-circuits the right-hand winding of relay 200. Ground is also connected to the sleeve conductor terminating at the district switch 6. This ground is connected through the right-hand winding of relay 207 for the purpose of making trunk T busy to other district switches. Relay 207 is operated through this sleeve circuit and locks through its left-hand winding under control of relay 203. The operation of relay 203 also closes an obvious circuit for the operation of relay 209. Relay 209 in operating supplies at its armatures and front contacts battery and ground to the trunk T through the windings of the marginal relay 210, make-before-break contacts of relay 211, windings of the differentially wound relay 212, right-hand windings of repeating coil 214, the conductors of trunk T, inner armatures and back contacts of relay 305, left-hand windings of repeating coil 306, left-hand armature and inner right-hand armature and back contacts of relay 308, windings of relay 309, armatures and back contacts of relay 310, through the loop including resistance 311. Relay 210 is marginal in character and relay 212 is differentially wound and neither of these relays will operate in this circuit as arranged at this time. Relay 309, however operates to close a circuit

for the lighting of lamp 301. The circuit for the lamp may be traced from battery, through lamp 301, outer right-hand armature and back contact of relay 308, outer left-hand armature and back contact of relay 313, armature and front contact of relay 309 to ground. Relay 315 is also operated due to the operation of relay 309 from battery, through the left-hand winding of relay 315, inner right-hand armature and back contact of relay 313, armature and front contact of relay 309 to ground. The operation of relay 315 prevents the operation of relay 310 during this call on the subsequent operation of relay 313, as will hereinafter be described.

At the operation of relay 203 as hereinbefore described a circuit was also closed for the operation of relay 215. This relay is used to prepare a connection for the checking circuit so that it will be ready for use by the toll operator when she desires to dial the subscriber's number. The results produced by the operation of relay 215 may be outlined as follows: Relays 101 and 102 are operated in series over an obvious circuit closed to ground through the armature and front contact of relay 215. The operation of these two relays closes an obvious circuit for the operation of relay 103. Relay 103 in operating closes a circuit for relay 105 as follows: battery, winding of relay 105, outer armature and back contact of relay 106, armature and back contact of relay 107, left-hand armature and front contact of relay 103 to ground. Relay 105 in operating closes an obvious circuit for the step-by-step magnet 109 and this magnet in operating causes the brushes of the switch 10 to be advanced to find an idle sender 12 and a connection having access to switches 14. An idle connection of this type will be identified through a battery connection on the terminals of switch bank 110. When such a connection has been reached a circuit will therefore be established for the operation of relay 112 as follows: battery, sequence switch contact 17, (position 1) armature and back contact of relay 18, terminal bank 110, outer right-hand armature and front contact of relay 103, both windings of relay 112 in series, winding of marginal relay 107 to ground. The high resistance of the left-hand winding of relay 112 prevents the immediate operation of relay 107 but on the operation of relay 112 this left-hand winding is short-circuited so that relay 107 will then operate. The delay in the operation of relay 107 permits relay 105 to remain operated long enough to allow the magnet 109 to complete the last step that centers the brushes of finder 10 squarely on the terminals of the idle sender circuit. It should be noted that when relay 107 operates the circuit for relay 105 is broken at the armature and back contact of relay 107, so that relay 105 may release and stop the operation of the stepping magnet 109.

Another circuit is closed by the operation of relay 107 from ground at the left-hand armature and front contact of relay 103, through the armature and front contact of relay 107 and winding of relay 106 to battery so that relay 106 will now operate. Relay 106 in operating opens the circuit from relay 105 at another point and prepares a number of other circuits hereinafter described.

One circuit is closed by relay 106 to lock this relay in operated position under control of relay 103. Another circuit is closed for the operation of relay 18 through the contacts of terminal bank of 113. Relay 18 in operating opens the circuit from battery at sequence switch 17 to the test bank 110 thereby making the sender nonselectable. The operation of relay 18 also opens the circuit through relays 112 and 107 which release but as relay 106 is now operated the circuit for relay 105 remains open. Another circuit closed by relay 106 is a connection between the ring conductor terminating at bank 115 through the outer right-hand armature and back contact of relay 116 to lead 117. This lead is the so-called dialing lead over which dialing impulses from the toll operator's position are transmitted to the sender 12 for the selection of the calling subscriber's line through the checking circuit. This lead 117 terminates at the front contact for the armature of relay 212 which is the pulsing relay responsive to dialing impulses from the toll operator's position as will hereinafter be described. Another circuit is closed by relay 106 through the bank 118 to the sequence switch 19 for the subsequent operation of relay 116, as will hereinafter be described.

The sender 12 is now ready to receive dialing impulses. A complete description of a line-finder and sender circuit of the type diagrammatically shown in Fig. 1 may be had by referring to Patent No. 1,395,977 to Stearn and Scudder, issued November 1, 1921 and since this apparatus forms no part of this invention, no complete description of its operation has been made here but only such as is necessary for the proper understanding of the invention.

As previously mentioned lamp 301 is lighted to indicate to the toll operator that a connection is desired. The toll operator will now insert the plug 318 into jack 302 of trunk T and connect her telephone set to the cord by operating talking key 347. This causes the operation of relay 319 over the sleeve circuit but due to the high resistance of the winding of relay 319, lamp 320 is not lighted at this time. The operation of relay 319 closes an obvious circuit for the operation of relay 313 and this relay in operating opens the previously mentioned circuit for lamp 301 which is now extinguished. Relay 315 is locked through its right-hand winding by the operation of relay 319 as the original ener-

gizing circuit for this relay is opened by the operation of relay 313. On the operation of relay 313 an obvious circuit is closed for the operation of relays 321 and 322. The operation of relay 321 performs no function at this time. The operation of relay 322 causes the operation of relay 323 over an obvious circuit, although relay 323 performs no function at this time. Another circuit closed by the operation of relay 322 to include a resistance 324 to ground for the sleeve circuit may be traced as follows: From the sleeve circuit at jack 302, resistance 324, right-hand armature and front contact of relay 322, lower outer armature and back contact of relay 305, armature and a front contact of relay 309 to ground. This resistance is lower than the resistance of winding of relay 319 so that lamp 320 is now lighted.

Relay 313 in operating closes a connection through its outer right-hand armature and front contact to short-circuit resistance 311 so that the loop through trunk T previously mentioned will now cause the operation of marginal relay 210. The operation of this relay closes an obvious circuit for the operation of relay 204 and at the same time closes a circuit for holding relays 203 and 215 operated after relay 204 becomes operated to open the original energizing circuit for these relays. The operation of relay 204 closes an obvious circuit for the operation of relay 216. This relay in operating reverses the current, supplied from the battery and ground connected through the left-hand windings of repeating coil 214, for the tip and ring conductors terminating at the district switch 6. This causes the operation of the polarized relay of the district switch which now connects the calling subscriber's line through to the repeating coil 214. The operation of relay 216 connects battery to the tip conductor and ground to the ring conductor. This, as is well known in the art, is a reversal of the usual talking battery connections from a subscriber's lines through automatic switches. The purpose of this reversal of the battery and ground connections will be explained later in connection with the seizing of the subscriber's line by the checking connection.

The operation of relay 204 also causes the operation of relay 211 over a circuit as follows: Battery, winding of relay 211, inner left-hand armature and back contact of relay 204, armatures and back contacts of relays 201 and 200 in series to ground. The operation of this relay initiates the preparation of a connection for dialing from the toll operator's position. This relay connects through its two outer right-hand armatures and front contacts the circuit from the two windings of relay 212, through a loop established through the left-hand armature and inner right-hand armature and back contacts of relay 220. This loop is now connected to

ground at the inner right-hand armature and front contact of relay 203 so that the simplex circuit for dialing is established at this end of the trunk T from the two conductors of trunk T through the windings of differential relay 212 to ground. The operation of relay 211 does not cause the release of relay 210 but maintains this relay operated through circuits established from the two windings of relay 210 to ground and battery at its left-hand armature and the inner right-hand armature and front contacts.

The connection to ground through the windings of relay 212 for the conductors of trunk T causes the release of relay 309. This relay in releasing causes lamp 320 to be extinguished, due to the opening of the circuit to ground for resistance 324 through the armature and front contact of this relay. The extinguishing of lamp 320 indicates to the toll operator that the trunk connection is completed from the calling automatic subscriber and that the circuits are ready for dialing as soon as the toll operator has obtained the number of the calling automatic subscriber. As dialing is done over a simplex circuit comprising the two conductors of the trunk T the toll operator may begin to dial the calling subscriber's number as soon as she has received it and simultaneously maintain a conversation with this subscriber in regard to receiving the information required for the extension of the toll connection. The toll connection may be extended by inserting plug 325 of the cord circuit 300 into jack 326 associated with a toll line.

To dial the calling subscriber's number the toll operator will actuate her dialing key 327. A connection is thereby established from battery through the dial contacts of dial 331 to a central point of the secondary windings of repeating coil 328. The tip and ring conductors of the cord are now, therefore, connected in simplex from this battery, through the dialing contacts towards trunk T, while the trunk itself is connected in simplex through the windings of differentially wound relay 212 to the ground at the inner right-hand armature and front contact of relay 203. However, the talking connection from cord 300 to trunk T which originally extended through repeating coil 306 is not suitable for simplex operation due to the presence of this coil and the condensers 330 in the circuit. To initiate the establishing of a complete metallic connection, it will be noted that when the dialing key is operated a connection of battery is completed through the dial contacts and relays 332 and 334 are thereby operated. The circuit for relay 332 extends through the tip conductor and upper right-hand winding of repeating cord 306, while the circuit for relay 334 extends through the ring conductor and the lower right-hand winding of repeating coil 306. The operation of these relays closes

a circuit for the operation of relays 305 and 335 as follows: Battery, windings of these relays in series through the inner right-hand armatures and front contacts of relays 332 and 334 in series to ground. The operation of these latter relays connect the tip and ring conductors of trunk T through the inner upper and lower armatures and front contacts of the two relays directly to the tip and ring conductors of cord 300 and opens the connection through repeating coil 306 and condensers 330. When relay 335 operates the circuit for relays 332 and 334 is opened so that these relays will now release but relays 305 and 335 are locked in operated position through the ground at the armature and front contact of relay 337, this relay having been operated over an obvious circuit on the operation of relay 332. As relay 337 is slow-to-release, it will be held operated for a short period after the release of relay 332 sufficient to maintain it operated until relay 339 operates to hold it in operated condition. It will be noted that relay 339 has its left-hand winding included in the connection through the tip conductors of trunk T and cord 300 and its right-hand winding included in the connection through the ring conductors so that relay 339 will operate as soon as the simplex circuit is established and thus maintain relays 337, 305 and 335 operated.

On the operation of relay 339 relay 323 releases, but as it is slow-to-release lamp 320 will be momentarily lighted due to the fact that relay 305 is now operated. The circuit may be traced as follows: Battery, lamp 320, sleeve terminals of plug 318 and jack 302, resistance 324, right-hand armature and front contact of relay 322, upper outer armature and front contact of relay 305, armature and front contact of relay 323 to ground. This momentary lighting of lamp 320 indicates to the operator that she may begin to operate the dial.

When the simplex circuit was first completed from battery through the dial contacts, trunk T and the windings of the differential relay 212 to ground, this relay was operated. Relay 212 in operating causes relay 218 to operate over the circuit from battery, winding of relay 218, inner right-hand armature and front contact of relay 204 to ground as it will be noted that this circuit for 218 is normally shorted by a circuit completed to ground through the outer right-hand armature and front contact of relay 204 and the armature and back contact of relay 212, this latter circuit being opened on the operation of relay 212. Relay 218 is sufficiently slow-to-release to hold it operated during the dialing impulses, that is, when relay 212 is subsequently released, due to the dialing, as will be hereinafter described. Relay 218 in operating closes a holding circuit for relay 211 completed at its inner right-

hand armature and front contact. The operation of relay 218 will also close an obvious circuit for relay 219 and relay 219 in operating will provide a locking circuit for itself to the ground at the inner left-hand armature and front contact of relay 210. The purpose of the operation of relay 219 will be explained hereinafter.

When now the operator actuates the dial 331 in accordance with the number of the calling subscriber, the connection to battery through the dial contacts is alternately broken, and relay 212 will, therefore, be alternately released and operated in accordance with the impulses transmitted over the simplex circuit. It will be noted that the first operation of relay 212 closed the pulsing lead 117 to ground. A circuit is now completed through the winding of pulsing relay 24 in the sender 12, sequence switch 22, bank 115 of line-finder 10, an armature and front contact of relay 106, outer right-hand armature and back contact of relay 116, lead 117 to ground at the armature and front contact of relay 212. The succeeding impulses will, therefore, alternately operate and release relay 24 so that the sender 12 will be set in accordance with the number of the wanted subscriber.

When the toll operator finishes dialing the sender will control switches 14 to select a final switch 15 and the final switch 15 will be operated to connect with the terminals 26 of the calling line, if the number given by the calling subscriber is the correct number. At this time the sequence switch 19 will close a connection to ground for bank 118 and a circuit will be completed for relay 116 as follows: Battery, winding of relay 116, inner right-hand armature and back contact of this relay, the second outer left-hand armature and back contact of relay 106 through bank 118, sequence switch 19 to ground. Relay 116 in operating provides a locking circuit for itself, to ground at the inner left-hand armature and front contact of relay 106, and opens the connection through its outer left-hand armature and back contact for the pulsing lead 117 which will thereby be disabled. This relay also by closing a connection to battery at its middle right-hand armature and back contact causes relay 101 to be released. Relay 102 will, therefore, be the only relay maintained operated from the ground at the armature and front contact of relay 215.

When the contacts 26 are reached by the brushes of the final switch 15 the circuit changes in switch 15 would ordinarily take place to send a busy tone back over the connection to the toll operator, as these terminals would test busy. However, due to the fact that the battery connections for the tip and ring conductor through the line-finder 4 and the district switch 6 have been reversed, this

usual busy condition will not be established to cause the sequence switch of the final switch 15 to advance to the position where it would cause the busy tone to be sent back over the line, but will remain in a position where changes will take place to cause the switch to be maintained with its brushes connected to the terminals 26. It is unnecessary to show and describe in detail how the usual busy tone signal is produced, and how the final switch acts under the usual condition as it forms no part of this invention. For a complete disclosure of an arrangement of this kind in a final switch reference may be had to the above mentioned patent to Stearn et al. To produce this effect, to wit, to cause the switch to stop with its brushes on terminals 26, sequence switch cams 30 and 31, relay 28 and associate circuits have been added to the usual equipment for the final switch 15. It should be understood that the usual functions of the switch 15 are not disturbed, except in this respect, that the switch circuits act to perform the additional functions as hereinafter set forth. These functions are as follows: When the brushes of switch 15 are brought in contact with the terminals 26, the sequence switch will be driven from position 9 to position 12. In positions 10+12 the sequence switch cam 30 will close a connection from relay 28 to the ring conductor leading back through switches 14, and the sequence switch cam 31 will in these positions (10+12) close a connection through for the tip conductor of the switch 15 from the tip brush of the switch 15 to the tip conductor of the switches 14. A circuit is, therefore, first completed for actuating relay 224 the moment the brushes of switch 15 come in contact with terminals 26 as follows: battery, winding of relay 201, lower left-hand winding of repeating coil 214, left-hand make-before-break contacts of relay 221, lower armature and front contact of relay 216, tip conductor of the connection through the district switch 6 and line-finder 4, tip conductor of line 1, tip brush of final switch 15, sequence switch cam 31, positions 10+12, tip conductor of the switches 14, upper armature and back contact of relay 33, sequence switch cam 34, bank 121, winding of relay 224 to ground. Relay 224 is polarized and operates in this circuit. A circuit is thereupon closed by the operation of relay 224 for the operation of relay 28 as follows: battery, winding of relay 28, sequence switch cam 30, positions 10+12, ring conductors of switches 14, lower armature and back contact of relay 33, sequence switch cam 22, bank 115, outer armature and back contact of relay 222, armature and front contact of relay 224 to ground. Relay 28, by attracting its left-hand armature may cause the switch 15 to remain with its brushes on terminals 26 and not give the usual busy tone, and to complete the talking connection as described

in the above mentioned patent to Stearn et al., that is, relay 28 would open at its left-hand armature and back contact the connection to the sleeve brush causing the advance of the sequence switch to the talking position.

As the dialing is now completed the toll operator may restore the dialing key 327 to normal. This causes the release of relays 339 and 212. The release of relay 339 causes the release of relay 337 and this relay in releasing opens the holding circuit for relays 335 and 305 which are now also released. By the release of the two last mentioned relays the tip and ring conductors of the trunk will now be reconnected through the repeating coil 306. The release of relay 212 causes relay 218 to release and this relay in releasing closes an obvious circuit for the operation of relay 220. Relay 220 in operating opens the loop to ground for the simplex circuit through the windings of relay 212. Relay 218 also by releasing closes an obvious circuit for the operation of relay 221. The operation of this relay opens the connection from trunk T to the district switch 6 at the make-before-break contacts of this relay so that the talking connection between the calling subscriber and the toll operator will now extend through the checking circuit by way of the inner left and right hand armatures and front contacts of relay 221. Relay 228 is also released by relay 218. It will be noted that this relay was operated when relays 218 and 219 were operated. The operation of relay 221 opens at its outer left-hand armature and back contact the sleeve circuit for the district switch 6 to cause the release of the original connection through this switch. Sufficient time to allow this disconnection to be completed is provided as relay 228 is slow-to-release. That is, relay 228 does not again close the sleeve circuit until a short period after the operation of relay 221 to give sufficient time for the district switch and the connection to the line 1 to release. The release of relay 228 thus re-establishes the busy condition on the sleeve terminal of the district switches, and this busy condition remains until relay 205 is released, as will hereinafter be described. The circuits are now in condition for conversation between the calling subscriber at 1 and the toll operator at 300 through the checking circuit while the originally established circuit through line-finder 4 and district switch 6 is released. It will be noted that the release of the dialing key to establish this new talking connection does not in any way interfere with the conversation between the subscriber and the toll operator, which may not be finished when the transfer takes place.

The connection may now be extended by the toll operator by releasing the talking key 347 and by inserting plug 325 into jack 326 of a toll line leading to the desired exchange and from there the connection may be com-

pleted in the standard manner to the wanted subscriber.

To release this connection the calling subscriber on line 1 hangs up his receiver and thus causes the release of relay 201. Relay 201 in releasing opens the circuit for relay 211 and this relay in releasing causes the operation of relay 309. The operation of relay 309 closes a circuit for the lighting of lamp 320 by establishing a connection to ground from the resistance 224 as hereinbefore described. The toll operator noting the lighting of lamp 320 removes plug 318 from jack 302, thus causing the release of relay 319, and relay 319 in releasing causes the release of relays 313 and 315. Relay 313 in releasing causes the release of relays 321 and 322. As relay 321 is slow-to-release, a circuit will be momentarily closed for the operation of relay 308 through the armature and front contact of relay 321 from the ground at the inner left-hand armature and back contact of relay 313. The operation of relay 308 prevents the momentary lighting of lamp 301 on the release of relay 313 and also causes the release of relay 309.

The momentary operation of relay 308 opens the circuit to the conductors of trunk T so that relay 210 will now release. Relay 210 in releasing causes the release of relays 204, 203, 215 and 219. The release of relay 204 causes the release of relay 216. The release of relay 203 causes the release of relays 209, 205 and 207. Relay 205 in releasing causes the release of relay 200 and opens the busy connection to ground for the sleeve conductor at the terminals 7. The release of relay 219 causes the release of relay 220, while the release of relay 215 causes the release of the checking connection through the line-finder 10 and the switches 14 and 15 of the calling subscriber's line. That is, ground is removed at the armature and front contact of this relay which causes the release of relay 102. Relay 102 in releasing causes the release of relay 103 and the release of relay 103 causes the release of relays 106 and 116. 106 in releasing causes the release of relay 18 and the line-finder 10 and the succeeding switches are therefore restored to normal condition in a manner well known in the art.

If it is desired to re-ring the calling subscriber of line 1, ringing key 341 is operated to connect battery to the tip conductor of the cord 300. This battery connection causes the operation of relay 334 and this relay in operating closes a circuit for the operation of relay 305 and also connects ringing battery and ground at its left-hand armature and outer right-hand armatures and front contacts to the ring and tip conductors respectively of trunk T at the upper inner and lower inner armatures and front contacts of relay 305. This ringing current causes the operation of ringing relay 230

and relay 230 in operating closes a circuit for the operation of relay 33; from battery, winding of relay 33, sequence switch contact 37, bank 123 of line-finder 10, conductor 124 to ground at the armature and front contact of relay 230. Relay 33 applies ringing battery and ground at its armatures and front contacts to the tip and ring conductors of the connection to the calling subscriber 1. The flashing of the ringing key 341 causes corresponding impulses of current to be transmitted to the calling subscriber's line.

If the calling line is a P. B. X. line such as line 2, the conditions relating to the establishing of a connection to this line and the busy condition for the line 2 will be similar to the conditions when a connection is made with an ordinary subscriber's line. In this case the brushes of the final switch will be stopped on the terminals 39 by the operation of relay 28 in the same manner as they are stopped on terminals 26. The switch 15 will, of course, first be directed to the point where it will begin to hunt for the P. B. X. line 2. The normal busy condition of a P. B. X. line is, as is well known, such that battery is connected to the ring terminal and ground to the tip terminal, while the terminals 39 of line 2 have battery on the tip terminal and ground on the ring terminal. Hence, when the switch has passed by the terminals of busy P. B. X. lines in the usual manner and lands with its brushes on the terminals 39, the circuits previously mentioned will be closed as follows: first to actuate the relay 224 and then to actuate the relay 28. The actuation of relay 28 causing the switch 15 to remain with its brushes on terminals 39 and cause the sequence switch to advance to the talking position in the same manner as hereinbefore described and in accordance with the arrangement shown in the above mentioned patent to Stearn et al. It is evident that the final switch in hunting for terminals 39 might encounter the terminals of idle P. B. X. lines and in this case the switch would naturally stop with its brushes on the terminals of the first idle line encountered. The operation of the circuits would in this case be identical with the operation when the switch stops on terminals 39. It should be understood that it is only necessary to avoid having the switch stop with its brushes on any other busy terminals except terminals 39 as it is the P. B. X. that it is desired to check but not necessarily the particular P. B. X. line employed in the first instance. The completion of the connection is identical with that for the automatic subscriber of line 1 and will, therefore, not be further described.

It is now assumed that the toll operator at 300 desires to call a subscriber such as 1 or any other subscriber's line or a P. B. X. She will insert plug 318 into jack 302 and

thus cause the operation of relay 319. Relay 319 in operating causes the operation of relay 313 and relay 313 causes the operation of relays 321, 322 and 310. Relay 322 in operating closes a circuit for the operation of relay 323 which relay performs no function in this connection but relay 322 in operating brings the resistance 324 under control of relay 309 for the purpose of actuating lamp 230 for supervisory purposes as will hereinafter appear. Relay 310 in operating connects battery and ground at its armatures and front contacts through the windings of relay 309 and armatures and back contacts of relay 308 over trunk T, repeating coil 218, windings of relay 212, make-before-break contacts of relay 211, windings of relay 210 and through the loop established through the armature and back contacts of relay 209. This causes the operation of relay 309 and causes lamp 320 to be lighted over a circuit as hereinbefore mentioned to indicate to the operator that the connection is now being prepared for dialing. The connection of battery and ground to the armatures and front contacts of relay 310 causes also the operation of the marginal relay 210. Relay 210 in operating causes the operation in succession of relays 204, 205 and 200 for purposes hereinafter to be described. Relay 215 is also operated by relay 210 to prepare the line-finder 10 for establishing a connection through switches 14 and final switch 15 to the wanted subscriber's line. Relay 233 is also operated by the operation of relay 210 over a circuit as follows: battery, winding of relay 233, outer right-hand armature and back contact of relay 220, outer right-hand armature and back contact of relay 203 to the inner armature and front contact of relay 210. The operation of relay 233 connects ground to the mid-point of the simplex circuit connected from the trunk through the windings of relay 212, make-before-break contacts of relay 211, windings of relay 210, armatures and back contacts of relay 209. Relay 210 although marginal will not release in this circuit.

The toll operator now operates the talking key 347 and the dialing key 327 and this causes the operation of relays 332 and 334 and these relays in turn cause the operation of relays 305, 335, 337 and 339 while relays 332 and 334 are released as hereinbefore described. Relay 339 in operating closes the holding circuit for relay 337 and causes the release of relay 323. On the operation of relay 305 and release of relay 323, the lamp 320 will be extinguished to indicate that the dialing may begin. The operator now actuates her dial 331 to call the wanted subscriber and causes the alternate operation and release of relay 212. The first operation of relay 212 on the actuation of relays 305 and 335 caused the operation of relay 218 which remains op-

erated during the pulsing. Relay 219 is also operated and maintained locked in operated position under control of relay 210. Relay 211 is operated by the operation of relay 218 and connects the simplex circuit through the windings of relay 212, the outer right-hand armatures and front contacts of relay 211 and the left-hand armature and back contact and inner right-hand armature and back contact of relay 220 to ground at the right-hand armature and front contact of relay 233 which is operated as hereinbefore described. The operation of relay 211 connects battery and ground through the windings of relay 210 to hold it operated as hereinbefore described. The dialing may now proceed and the wanted line selected as hereinbefore described in connection with the establishing of a checking circuit.

When the dialing key is released relay 339 is released to cause the release of relay 337. Relay 337 causes the release of relays 305 and 335 to establish the connection from the toll operator to trunk T through the repeating coil 306. Relay 212 is released and causes the release of relay 218. Relay 218 causes the release of relay 211 and relay 228 and the operation of relays 220 and 221. The operation of relay 221 connects the trunk T through to the tip and ring conductors of the established connection through line-finder 10, while the operation of relay 220 opens the circuit for relay 233 which is released to remove the connections for the simplex circuit. Relay 211 in releasing reestablishes the connection through the windings of relay 210 from the toll operator's cord. On ringing the wanted subscriber's line the operation of ringing key 341 will operate relays 334 and 305 to establish a circuit for the operation of relay 230, this relay in turn operating relay 33 to transmit ringing current to the called line. When the called subscriber answers relay 201 is operated. A circuit is thereby established for the reoperation of relay 211 so as to remove the battery and ground from the trunk T and cause the release of relay 309. This relay in releasing causes lamp 320 to be extinguished. If the called subscriber actuates his hook he may thereby cause lamp 320 to flash for supervisory purposes. The release of the connection is the same as hereinbefore described in relation to the release of a checking circuit.

While the invention has been shown as applied to a given toll switching arrangement it is not so limited, but may be applied to systems of other types.

What is claimed is:

1. In a telephone system, an exchange, a line incoming to said exchange, a trunk outgoing from said exchange, an operator's position at which said trunk terminates, switching means at said exchange for connecting said line and trunk, and other switching

means at said exchange controllable from said operator's position over said trunk for establishing a different connection between said line and trunk and for breaking said first connection.

establishing a busy condition on the trunk for the automatic connecting means from said line to said trunk.

7. In a telephone system, a plurality of lines, a trunk, means at one end of said trunk for automatically connecting any one of said lines to said trunk, means for automatically extending said trunk to any one of said lines, a manual extension means at the opposite end of said trunk, means for dialing over said trunk from said manual extension means for controlling said automatic extension means to select any one of said lines, and means operative if a line has been selected for releasing a connection from one of said lines to the trunk if it has been established and if no such connection is established to prevent such a connection from being established.

8. In a telephone system, an exchange, lines of different characteristics incoming to said exchange, a trunk outgoing from said exchange, an operator's position at which said trunk terminates, switching means at said exchange for connecting any one of said lines with said trunk, and other switching means at said exchange controllable from said operator's position over said trunk for establishing a different connection with any one of said lines and for breaking down the first mentioned connection.

In witness whereof, I hereunto subscribe my name this 24 day of March, A. D. 1927.

RAY S. WILBUR.

4. In a telephone system, an exchange, a line incoming to said exchange, a trunk outgoing from said exchange, an operator's position at which said trunk terminates, switching means at said exchange for connecting said line and trunk, and another switching means at said exchange controllable from said operator's position over said trunk for establishing a different connection between said line and trunk and for breaking said first mentioned connection without interrupting a conversation that may be in progress over said trunk.

5. In a telephone system, a plurality of lines, an operator's position, a trunk terminating at said operator's position, means for establishing a communicative connection from any one of said lines to said operator's position over said trunk, means for automatically establishing a separate communicative connection from said operator's position to any one of said lines over said trunk, and means for releasing said first mentioned connection from said operator's position.

6. In a telephone system, a line, a trunk, means at one end of said trunk for automatically connecting said line to the trunk and for automatically extending the trunk to the line, manual extension means at the opposite end of said trunk, means for dialing over said trunk from said manual extension means for controlling said automatic extension means to select said line, and means for

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