

Dec. 1, 1931.

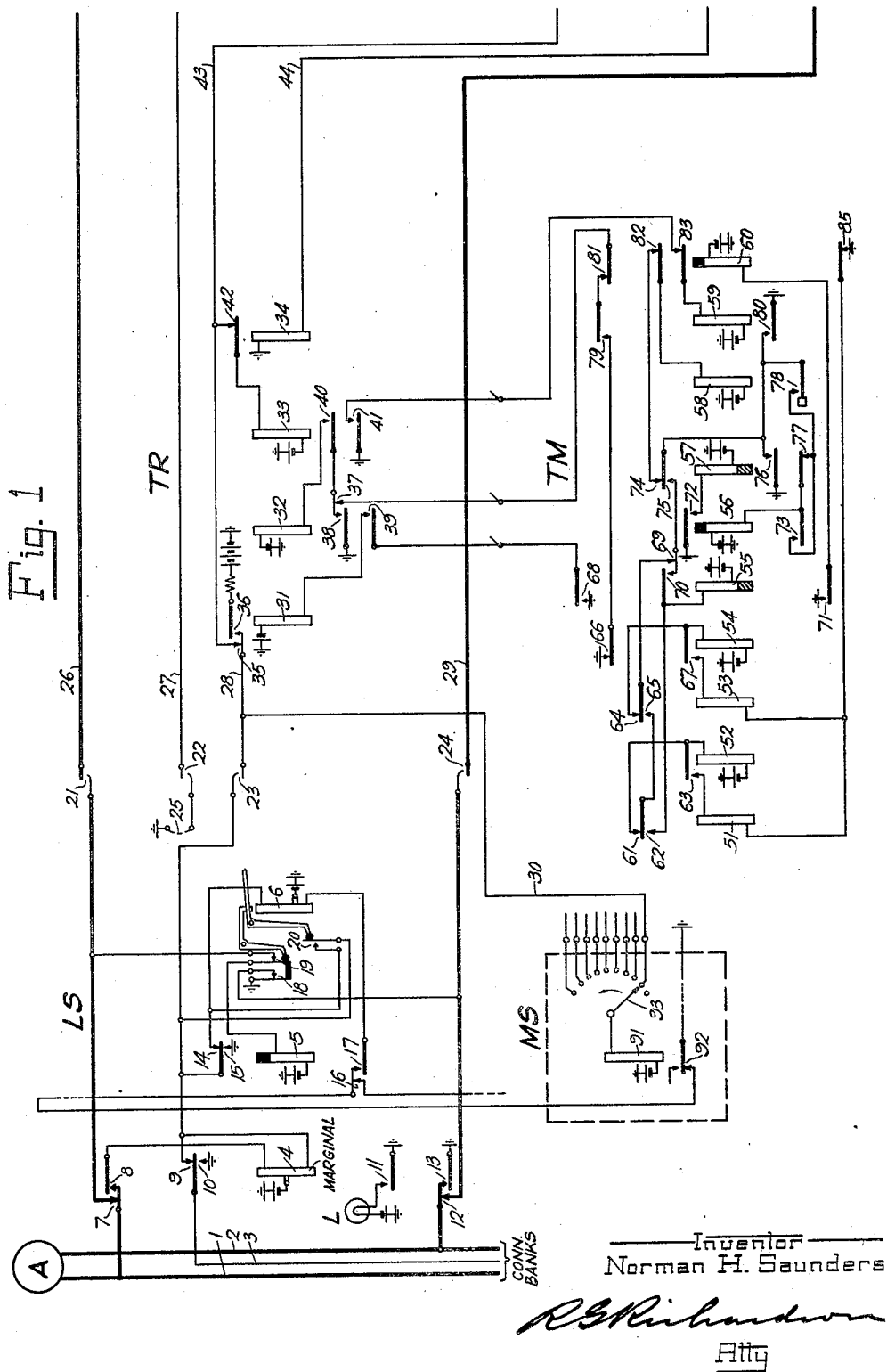
N. H. SAUNDERS

1,834,649

TELEPHONE SYSTEM

Filed Jan. 2, 1931

3 Sheets-Sheet 1



Dec. 1, 1931.

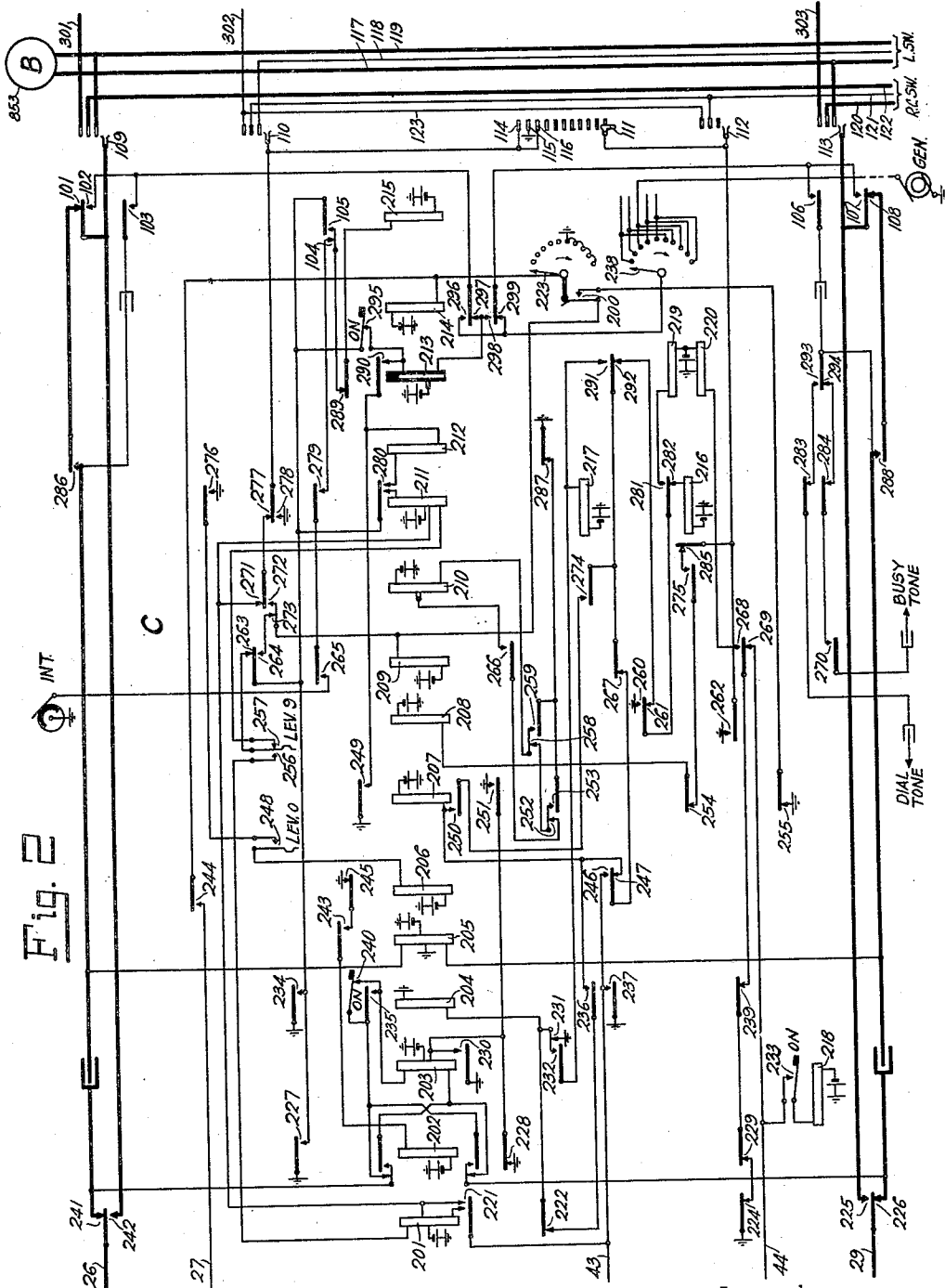
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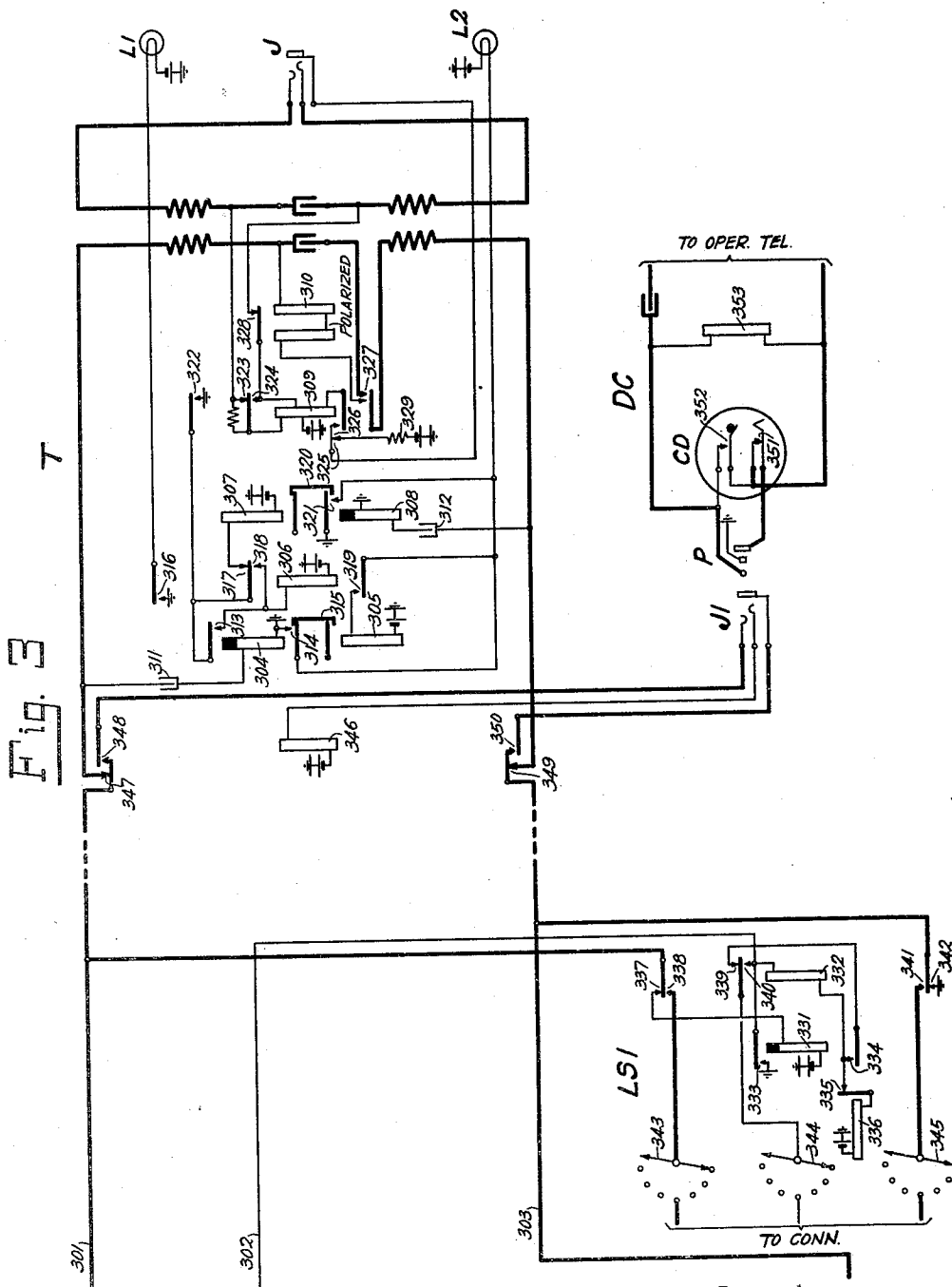
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3 Sheets-Sheet 3



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TELEPHONE SYSTEM

Application filed January 2, 1931. Serial No. 506,003.

This invention relates, in general, to multi-office telephone systems which include one or more relatively small automatic offices or exchanges, and is concerned particularly with the switching apparatus and inter-office trunking facilities provided for such exchanges. The object of the invention is the provision of new and improved circuits and apparatus for rendering a more complete and efficient service in such system than has heretofore been practical.

The automatic exchange designed to serve a small community and surrounding territory is commonly known as a community automatic exchange or C. A. X. and will be designated by the latter term hereinafter. A C. A. X. of this type, upon which the present invention may be considered as an improvement, is disclosed in applicant's co-pending application, Serial No. 361,311, filed May 8, 1929, now Patent No. 1,805,726, of May 19, 1931.

In a C. A. X. of less than one-hundred-line capacity, it is the usual practice to provide single rank switches which serve as connectors in local and incoming calls and as trunk-selecting switches in outgoing and reverting calls. In order to simplify the calling operation it has been found desirable to arrange the C. A. X. connectors to hunt for an idle trunk after the receipt of a single digit. This arrangement has been applied to straight line connectors, although in the case of connectors of the party-line type which require an additional digit for ringing current selection, a two-digit trunk calling code has been necessary for calling "ring down" trunk lines. The first digit selects the group of trunk lines called whereon the connector automatically hunts for and connects with an idle trunk. The second digit sets the auxiliary ringing current selecting switch of the connector to initiate the signaling. One of the features of the present invention is the arrangement whereby the ringing current selecting switch associated with the connector is automatically set upon the seizure of a "ring down" trunk line.

Another feature of the invention is the simple and efficient arrangement of the

C. A. X. connectors so that visual indication of the class of a calling line is given to the operator on calls to a manual exchange.

Another feature of the invention is the arrangement for preventing defective lines from unnecessarily tying up the switching apparatus of the automatic exchange. This feature is particularly advantageous in a C. A. X. inasmuch as the C. A. X. connectors are necessarily somewhat more complicated and expensive than the connectors required for large exchanges, which makes it desirable to install the minimum number of such switches as will carry the traffic of the exchange.

An incidental feature is the association of the apparatus for controlling the disconnection of defective lines with the primary trunks instead of with the switches themselves. This permits the disconnecting arrangement to be readily applied in existing exchanges without modification of the switches. It also permits its use in exchanges of any size in connection with standard selectors or connectors.

The foregoing features and others not specifically mentioned, together with the operation of the apparatus comprising the invention, will be described in detail hereinafter, reference being had to the accompanying drawings comprising Figs. 1 to 3, inclusive. These drawings show by means of the usual circuit diagrams the embodiment of the invention in a system including a small automatic exchange and a manual exchange. Fig. 1 shows a subscriber's line and lineswitch, a primary trunk with a control relay group, and a timing mechanism associated with the relay group. Fig. 2 shows a C. A. X. connector terminating the primary trunk of Fig. 1. Fig. 3 shows a trunk line connecting to the automatic and manual exchange, together with the lineswitch associated with the trunk at the automatic exchange and the trunk apparatus at the manual exchange. A dialling cord is also shown in this figure of drawings.

Referring now to Fig. 1, the subscriber's line shown here may be of the usual multi-party code ringing type with the bells at the

substations bridged from one side of the line to ground. A lineswitch of any suitable type may terminate the trunk. The lineswitch LS, shown, being of the chain ground type disclosed in the J. H. Voss et al., Patent No. 1,809,086, of June 9, 1931, modified in accordance with the requirements of the present invention. This lineswitch and other similar lineswitches are controlled by the common master switch MS shown in skeleton form. The various lineswitches have access to trunks of which the one terminating in connector C (Fig. 2) is shown. A group of trunk relays TR is associated with this trunk and also with the common timing mechanism TM.

Referring now to Fig. 2, connector C is similar, in general, to the C. A. X. connector shown in Patent No. 1,805,726, previously referred to, modified in accordance with the requirements of the present invention. The connector is provided with a set of four wipers engaging the regular bank contacts and also with a vertical wiper or commutator which during the primary stepping operation engages the contacts of a vertical bank individual to the connector. The vertical wiper is so constructed that it engages both the contact corresponding to the level to which the regular wipers are operated and the contact corresponding to the next level below that. Two sets of shaft springs are provided which, for convenience are shown as operating when the shaft and wipers are raised to the ninth and tenth levels, respectively. In practice the shaft springs are made so that they can be adjusted to operate on any desired level. An auxiliary ringing current switch of the type commonly known as a "minor" switch is associated with the connector. This switch selects the various codes of ringing current which are produced by a code interrupter (not shown) of the type shown in Patent No. 1,805,726, above referred to. The subscriber's line B and other C. A. X. subscribers' lines are accessible in the first eight levels of the connector banks. The subscriber's line shown may be a party line similar in all respects to subscriber's line A (Fig. 1). The reverting call switch trunks of which one is shown are accessible in the ninth level of the connector banks. The reverting call switches themselves are not shown and may be similar to the reverting call switches shown in the above-referred-to Patent No. 1,805,726. Trunks to the manual exchange and toll office are accessible in the tenth level of the connector banks.

A trunk line connecting the automatic exchange and the manual exchange is shown in Fig. 3. This trunk line is arranged for two-way service and is equipped with the lineswitch LS1 at the automatic exchange end.

Lineswitch LS1 is of the ordinary rotary type

whose wipers move only in a forward direction and have no normal or home position. The lineswitch has access to connectors such as connector C in common with a subscriber's lineswitch such as lineswitch LS and is used for calls from the manual exchange to subscribers in the automatic exchange. The trunk line terminates in the manual exchange in the trunk apparatus T and is provided with an answering jack J and a dialling jack J1 at the switchboard. Any suitable cord circuit arranged for loop supervision may be used for answering and extending calls over jack J. The dialling cord DC is used only in outgoing calls for controlling the operation of the switches at the automatic exchange.

Having briefly described the invention, the operations involved in establishing various connections in a system embodying the invention will now be described in detail.

Local calls

The establishment of a connection from substation A (Fig. 1) to substation B (Fig. 2) will be described, by way of example, to illustrate the operation of the apparatus in local calls. In the system shown, the C. A. X. is of the one-hundred line type and it will, therefore, be necessary to dial two digits to select a called line. A third digit will be required to select the ringing code required to signal the wanted subscriber on the called line. It will be assumed for convenience, that the line extending to substation B terminates in the fifth set of contacts of the eighth level of the banks in connector C and that the particular station on the line being called, in this instance, is the one designated by the third ringing code.

On the initiation of the call at substation A, a circuit is completed for line relay 5 of line-switch LS over contacts 19 and 7, line conductor 1, through the loop at the calling substation, line conductor 2, contacts 12 and 18 to ground. Relay 5 operates and connects ground to the test conductor at contacts 15 to mark the line busy to connectors, and at contacts 17 connects the lower winding of magnet 6 to the chain ground circuit. It may be assumed that master switch MS has aligned the plungers of the various lineswitches opposite the trunk line comprising conductors 26 to 29. In case the master switch is not in operation or no other lineswitch is in the act of seizing a trunk, ground on the chain circuit by way of contacts 92 will energize magnet 6 of the lineswitch when the circuit is completed as above described. Relay 6 upon operating will force the plunger into the banks thereby closing contacts 21—24, and in addition, the magnet disconnects relay 5 and ground from the calling line at contacts 18 and 19 and completes a holding circuit for its upper winding at contacts 20.

Relay 5 is slow to release and maintains ground on the holding circuit of the magnet until such time as a holding ground can be returned by the connector, as will be explained hereinafter. It may be noted at this time that marginal relay 4 does not operate from ground on the test conductor. On the closure of contacts 21 and 24 the calling line loop is extended over conductors 26 and 29, contacts 241 and 226, reversing contacts of relay 202, upper and lower windings of relay 203, to battery and ground respectively. Off-normal contacts 240 are included in the circuit of the upper winding of relay 203 and normally closed contacts 228 of reversing relay 202 are included in the circuit of the lower winding of that relay. Relay 203 operates over the calling line loop, connects an additional ground to its lower winding at contacts 230 and at contacts 232 connects relay 204 in series with vertical magnet 217. Relay 204 operates and connects ground to the local holding circuit at contacts 234, completes a circuit for the upper winding of relay 203 at contacts 235 so that this circuit will not be open when off-normal contacts 240 open on the first vertical step of the switch, completes a point in the impulsing circuit at contacts 236, connects ground to test conductor 43 at contacts 237, and opens a point in the release circuit at contacts 239. The ground on conductor 43 extends by way of contacts 35, conductor 28, and contacts 23 to the test conductor of the lineswitch to maintain magnet 6 in operated position after relay 5 releases. Ground on the test conductor by way of contacts 42 energizes relay 32 of the trunk relay group TR, and this relay initiates the operation of the timing mechanism TM by closing contacts 41 as will be explained hereinafter. Referring again to the connector it will be recalled that vertical magnet 217 has been connected in series with release relay 204. Due to the high resistance of relay 204 the magnet does not operate in this circuit. Relay 207 is connected to the impulsing circuit at contacts 247 in parallel with magnet 217 and is also in series with relay 204 but does not operate due to the high resistance of the latter relay. Relay 213 operates, from ground by way of contacts 234 and off-normal contacts 295. This relay in operating completes the impulsing circuit for the vertical magnet at contacts 291 and, at contacts 293 connects dial tone to the lower talking conductor of the trunk. The dial tone is audible to the calling subscriber and indicates that the apparatus is ready to receive the dial impulses.

The foregoing operations take place responsive to the initiation of the call. The calling subscriber will now dial the first digit of the called number, in this case the digit 8, and the circuit of relay 203 of the connector will be interrupted accordingly. Each time relay 203 restores in response to an open

impulse, a circuit will be completed from ground, contacts 231, 222, 236, 247, 267, and 291 to vertical magnet 217. The magnet will operate in the usual manner and raise the wipers of the connector step-by-step to the called level. Relay 204 will be short-circuited at each impulse by ground through contacts 231. This short circuit renders the relay slow-to-release and consequently the relay remains operated throughout the series of impulses. Relay 207, which as previously stated, is connected to the impulsing circuit in parallel with the vertical magnet operates in response to the first impulse and remains operated throughout the series of impulses as its connection to relay 204 renders it slow-to-release. Relay 207 completes a holding circuit by way of contact 249 and 290 to maintain relay 213 operated when off-normal contacts 295 open on the first vertical step of the wipers. An additional ground is connected to the lower winding of relay 203 at contacts 251, a circuit is completed for relay 210 at contacts 253, a point of the circuit of relay 208 is opened at contacts 254, and ground is disconnected from the off-normal contacts of the auxiliary switch at contacts 255. Relay 210 operates and completes a number of circuits, the only one of which is of any utility at this time is the auxiliary impulsing circuit by way of contacts 250 and 274. This auxiliary circuit is to prevent any interference with the impulsing which might be caused by momentary operation of relays 206 or 209. Upon the first vertical step of the wipers off-normal contacts 240 and 295 open and contacts 233 close. The opening of contacts 240 is without any particular results at this time since the circuit for relay 203 now includes contacts 235. Release magnet 218 is connected to trunk conductor 44 on the closure of contacts 233. This conductor extends to relay 34 of the trunk relay group and the relay operates in series with the release magnet. Due to the high resistance of the relay the release magnet does not operate at this time. Relay 34 disconnects relay 33 from conductor 43 at contacts 42 and relay 33 releases and restores the timing mechanism to normal condition.

At the end of the first series of impulses relay 203 will remain operated and again connect relay 204 in series with relay 207 and vertical magnet 217. Relay 207 does not remain energized in series with relay 204 and consequently restores after a short interval and opens the circuit of relays 213 and 210. Relay 213 restores, disconnects dial tone from the trunk at contacts 293, transfers the impulsing circuit over to rotary magnet 216 at contacts 292 and opens its own locking circuit at contacts 290. Relay 210 restores and opens the previously traced auxiliary impulsing circuit at contacts 274.

The calling subscriber now dials the second

digit of the called number, that is the digit 5, and relay 203 responds as in the previous case. The impulses are repeated over the impulsing circuit previously traced which now extends by way of contacts 292, 261, and 282 to rotary magnet 216. Magnet 216 responds to the impulses and steps the wipers of the switch around to the contacts of the called line. Relays 207 and 210 again operate, during the series of impulses, the latter relay in addition to the function previously described also completes a test circuit by way of contacts 272.

In case the called line is busy, test wiper 110 will find ground on the associated test contact and relay 209 will operate. Relay 209 prepares a locking circuit for itself at contacts 264, prepares a short circuit for the lower winding of relay 210 at contacts 266 to make the relay slow-to-release, opens the impulsing circuit at contacts 267, opens a point in the release circuit at contacts 269 and connects busy tone to the lower talking conductor of the trunk by way of contacts 270, 284, and 294. When relays 207 and 210 restore shortly after the last impulse of the series relay 209 will lock up over contacts 273 and 264 to ground at contacts 234. The busy tone on the line will be audible to the calling subscriber who is expected to hang up and release the connection.

When the called subscriber hangs up, the circuit for relay 203 will be opened and that relay will restore. Relay 203 opens the circuit of relay 204 which also restores and disconnects ground from the local holding circuit at contacts 234. Relay 209 releases and a circuit is completed for release magnet 218 by way of contacts 224, 229, 239, 269, and 233. Magnet 218 will restore the switch wipers to normal position in the usual manner and its circuit will be opened at off-normal contacts 233 which open when the wipers reach normal positions.

In the event that the called line is not busy when a connection is extended thereto as above described, test wiper 110 will find battery through the cut-off relay of the line-switch on the test contact instead of ground as in the previous case. Relay 209 consequently will not operate and when relays 207 and 210 restore shortly after the last impulse of the series, a circuit will be completed from battery on the test contact, wiper 110, contacts 277 and 271, lower winding of relay 211, contacts 257 and 263 to ground on the local holding circuit. Relay 211 operates in the above circuit, connects direct ground to the test wiper at contacts 278 to operate the cut-off relay of the line-switch associated with the called line, closes a point in the circuit of pick-up relay 215 at contacts 279, disconnects rotary magnet 216 from the impulsing circuit at contacts 282 and extends this circuit by way of contacts 281 to stepping

magnet 219 of the auxiliary switch, opens a point in the dial tone circuit at contacts 283, and opens a point in the busy tone circuit at contacts 284.

The calling subscriber will now dial the last digit of the called number, in this case the digit 3, and relay 203 will respond and transmit impulses over the previously traced impulse circuit to stepping magnet 219 of the auxiliary switch. Magnet 219 will respond to the impulses and step wipers 223 and 238 of the auxiliary switch around to the third set of contacts of the bank. Relays 207 and 210 will again operate during the series of impulses, the former relay opening a point in the circuit of relay 209 at contacts 255. Off-normal contacts 200 close when the wipers of the auxiliary switch are moved from normal position, and, when relay 207 restores shortly after the last impulse of the series, an obvious circuit is closed for relay 209 and the relay operates. Relay 209 completes a locking circuit for itself at contacts 264, closes a point of the circuit of relay 215 at contacts 265 and opens the impulsing circuit at contacts 267. The busy tone circuit is closed at contacts 270 as explained in the previous connection but this is without effect since relay 211 is energized and contacts 284 are open.

Interrupter INT is associated with the ringing current interrupter and is arranged to send out a ground impulse preceding each series of ringing current impulses constituting a code. The code interrupter which may be of any suitable type has not been shown but is indicated by the broken section of the conductor extending to generator GEN. At the proper time, therefore, a ground impulse from interrupter INT by way of contacts 265, 279, 104, and 289 will operate relay 215. This relay will lock to the local holding circuit at contacts 105 and will complete the ringing circuit for signalling the called subscriber. The ringing circuit in this case may be traced from the grounded generator, third contact of the bank engaged by wiper 238 of the auxiliary switch, contacts 299 and 107, wiper 113, line conductor 117, through the bells and condenser at the substation, to ground. The lower winding of relay 213 is connected by way of contacts 297 and 102, wiper 109, to line conductor 119. Ringing current is now applied to the called line over the above circuit in accordance with the code selected by the digit 3. Ring-back-tone is transmitted to the calling subscriber over contacts 103 to indicate that the called subscriber is being signalled.

When the called subscriber answers a direct current bridge is closed across the line at the substation and relay 213 operates over the called loop from ground superimposed on the ringing current. Relay 215, in operating, opens the circuit of relay 213, and locks over its upper winding in series with relay

212 by way of contacts 290 and 280. Relay 212 operates and closes points in the talking circuit at contacts 286 and 288. Relay 215 releases following the operation of relay 213, opens the previously traced ringing circuit and completes the talking circuit at contacts 101 and 108. Relay 205 feeds talking battery to the called subscriber and operates over the called loop. A circuit is closed at contacts 243 for relay 202 which operates and reverses the connection of relay 203 to the trunk. Relay 202 also applies an additional ground to the local holding circuit and opens a point in the release circuit.

The calling and called subscribers may now converse. In case the called subscriber hangs up first, relays 205 and 202 will release but the switch will not be restored to normal since the release circuit will be maintained open at contacts 239. In case the calling subscriber hangs up first relays 203 and 204 will restore, but relay 202 will maintain an open point in the release circuit at contacts 229. When both subscribers hang up the relays above-referred-to will release and a circuit will be closed by way of contacts 224, 229, 239, and 268 for release magnet 220 of the auxiliary switch. Magnet 220 will operate to restore the wipers of the auxiliary switch to normal in the usual manner. Off-normal contacts 200 open when the switch wipers reach normal position and relay 209 restores, its locking circuit having been opened previously by the release of relay 204. Relay 209 on restoring transfers the release circuit over to release magnet 218 at contacts 269 and magnet 218 restores the wipers of the connector to normal position in the usual manner.

In the foregoing example it was assumed that the called subscriber was the one designated by the final digit 3. In calls to other subscribers on this line, for example to the subscriber designated by the final digit 8, the operations involved in setting up the connection will be exactly the same as previously described, except that the wipers of the auxiliary switch will be stepped to the eighth contact of the bank. In positions 6 to 10 wiper 23 encounters grounded contacts and a circuit is completed for relay 214 which operates and reverses the connection of the ringing current generator and relay 213 with respect to the wipers. The ringing current is, therefore, applied to the upper wiper by way of contacts 296 and rings the bells at the substations bridged to line conductor 119. The operation of relay 213 on the answering of the call and the talking circuit are exactly the same as described for the previous connection.

Reverting calls

Reverting calls in the present system are made in the same manner as in the system described in Patent No. 1,805,726, previously

referred to, and will be described only in so far as the apparatus comprising the present invention is concerned. It is assumed in this case that the trunks to reverting call switches are accessible in the ninth level of the connector banks. The reverting call apparatus itself has not been shown and may be similar to that shown in the above referred to patent.

The operations resulting on the initiation of a call are exactly the same as described for local connections. It will be assumed that the subscriber at substation A is the calling subscriber and that lineswitch LS has seized connector C. The called subscriber dials the digit 9 and the wipers of the connector are stepped to the ninth level exactly as in the previously described connection. In calls to this level, however, vertical wiper 111 bridges vertical bank contacts 115 and 116 and the shaft springs designated LEV.9 are operated. Relays 207 and 210 are energized during the impulsing, as in previous instances, and when wiper 111 bridges contacts 115 and 116, ground over this wiper by way of contacts 277 and 272 operates relay 209. Relay 209 completes a short circuit around the lower winding of relay 210 to make this relay slow-to-release. A short time after the last impulse of the series, relay 207 restores and completes a circuit from ground on contacts 116, wiper 111, contacts 285, 275, and 254 for relay 208. Relay 208 energizes and completes a holding circuit for relay 210 which incidentally has not yet had time to restore. Relay 208 also completes a locking circuit for itself by closing contacts 262 and at contacts 260 completes a circuit for rotary magnet 216. Magnet 216 operates and steps the wipers of the switch in on the first set of contacts of the called level. Magnet 216 on operating opens the circuit of relay 208 at contacts 285, and relay 208 consequently restores and opens the circuit of the magnet at contacts 260. Wiper 111 is disengaged from the vertical bank contact upon the first rotary step of the wipers and the circuit of relay 209 is opened at this point. The further operation will now depend on whether the first trunk of the called level is busy or idle. Assuming that the trunk is busy, wiper 110 will find ground on the test contact and relay 209 will remain energized. It will be noted that the test contacts engaged by wipers 110 and 112 are connected to the same test conductors and consequently when the trunk is busy, wiper 112 will also find ground and when magnet 216 restores this ground will reoperate relay 208. Relay 208 will again complete a circuit for relay 210 and magnet 216, and the wipers will be advanced another step. This stepping operation will be repeated until an idle trunk is found or until the last trunk of the group is reached. The last trunk of the group is marked by leaving the test contacts engaged

by wiper 112 unconnected. Consequently, when this trunk is reached relay 209 will remain operated but no circuit will be completed for relay 208 and no further stepping will take place. Relay 210 will release a short time after the last rotary step and relay 209 will remain locked to ground on the local holding circuit. Busy tone will be applied to the lower talking conductor of the trunk by way of contacts 270, 284, and 294 to inform the calling subscriber that no trunk is available at this time. The calling subscriber will then hang up and release the connection in the same manner as described for calls to a busy line.

Assuming that an idle trunk line in this level is accessible, for example the trunk line comprising conductors 120—122, when the wipers of the switch engage the set of contacts terminating this trunk, test wiper 110 will find no ground and relay 209 will restore. When relay 210 restores shortly after the release of relay 207, a circuit will be completed from battery on the test conductor of the seized trunk, wiper 110, contacts 277 and 271, upper winding of relay 201, contacts 256 and 263 to ground on the local holding circuit. Relay 201 on operating, completes a holding circuit for its lower winding including the test wiper 110 and also extends the holding circuit over conductor 43 to the magnet 6 of the lineswitch. Talking conductors 26 and 29 are disconnected from the relay 203 and extended by way of contacts 242 and 225 directly to wipers 109 and 113. Relays 203 and 204 release but the release of the switch is prevented at this time since the release magnet circuit is open at contacts 224. The remaining impulses required to set the reverting call switch are transmitted over the talking conductors of the switch in the usual manner. The release of the connector and lineswitch is prevented by the ground fed back over the test conductor from the reverting call switch which maintains relay 201 operated. This same ground extending over conductors 43, contacts 35 and conductor 28, maintains magnet 6 to the lineswitch operated. The operation of the reverting call switch is well known and will not be described. Ground will be removed from the test conductor when the reverting call switch is released after the connection has been completed and relay 201 will release. The circuit of release magnet 218 will be completed at contacts 224. This relay will operate to restore the switch in the usual manner. Removal of ground from conductor 43 will permit magnet 6 of the lineswitch to release and the plunger of the switch will be withdrawn from the bank by its restoring spring in the well known manner.

Trunk calls

In the foregoing connection no reference

was made to the discriminating service feature of the system. This feature is adapted to function only in trunk calls and will be described in connection with a call from subscriber A to the operator's position (Fig. 3). One class of lines is marked by ground on the discriminating contact of the lineswitch and the other marked by the absence of ground on these contacts. A restricted line will have this contact connected to ground by means of jumper 25.

Assuming first that a non-restricted line is making a call, the operations resulting on the initiation of a call will be the same as those described for previous calls. Connector C will be operated in the same manner as for reverting calls, except in this case the wipers will be raised to the tenth level whereon vertical wiper 111 will bridge vertical bank contacts 114 and 115 and shaft springs designated LEV.0 will be operated. Relays 207 and 210 will operate during the stepping of the switch and at the completion of the stepping operation, circuits, as previously described, will be completed over wiper 111 for relays 209 and 208. The switch wipers will be given an initial rotary step in the same manner as described for reverting calls and the hunting operation will also be performed as described in connection with such calls. When an idle trunk is found, for example the trunk comprising conductors 301—303, wiper 110 will find battery potential on the test contact and relay 209 will restore. When relay 210 restores shortly after the release of relay 207, the test wiper will be extended by way of contacts 271 to the lower winding of relay 211 and this relay will operate in series with the cut-off relay of the lineswitch associated with the trunk. Relay 211 on operating, completes a circuit for relay 206 by way of contacts 276 and shaft contacts 248, connects direct ground to the test wiper at contacts 278 to operate the cut-off relay of the lineswitch associated with the trunk, closes a point in the circuit of relay 215 at contacts 279, completes a locking circuit for itself and prepares a holding circuit for relay 213 and relay 212 at contacts 280, disconnects rotary magnet 216 from the impulsing circuit at contacts 282 and extends this circuit by way of contacts 281 to stepping magnet 219 of the auxiliary switch, and opens the dial tone and busy tone circuits at contacts 283 and 284, respectively. Relay 206 operates over the above circuit, opens a point in the circuit of relay 202 at contacts 245 to prevent the operation of this relay and the subsequent reversal of current over the trunk, and at contacts 246 opens the original impulsing circuit and extends this circuit to which stepping magnet 219 has been connected to ground at contacts 237. Magnet 219 operates and advances the wipers of the auxiliary switch one step. A circuit is closed for relay 209 on the opera-

tion of off-normal contacts 200 and this relay operates to open the circuit of the stepping magnet at contacts 267. Relay 209 locks up by way of contacts 264 and at contacts 265 connects the pick-up interrupter through to relay 215. A ground impulse from interrupter INT operates relay 215, and the relay locks by way of contacts 105 to the grounded local holding circuit. Ringing current is now transmitted over the first bank contact engaged by wiper 238, contacts 299 and 107, wiper 113, trunk conductor 303, contacts 349, condenser 312, winding of relay 308 to battery. Relay 308 operates and locks mechanically, completing a circuit at contacts 321 for line lamp L2. Lamp L2 glows to notify the operator of an incoming call.

Upon noting the lighted condition of the lamp the operator answers the call by inserting the plug of an ordinary answering cord into jack J, thereby completing a circuit for the upper winding of relay 309. Relay 309 operates and locks over its lower winding and contacts 326 to ground on the sleeve of the jack and plug. Relay 309 closes a circuit by way of contacts 322 and 317 for relay 307 and that relay operates and by means of the interlocking mechanism 320 restores the armature of relay 308 to normal. Lamp L2 is extinguished at this time. In addition to completing the foregoing circuit, relay 309 at contacts 327 connects polarized relay 310 across the talking conductors of the trunk. The ring-cut-off relay in the connector now operates in series with the polarized relay and switches the connector over to talking condition in exactly the same manner as described for calls to a subscriber's line. Polarized relay 310 operates and opens the direct current bridge across the talking conductors of the right-hand section of the trunk at contacts 328. The operator may now converse with the calling subscriber and determine his requirements. Since line lamp L1 did not glow the operator is informed that the call is from a non-restricted line and may complete the call in any well known manner as required by the operating conditions of the particular system involved.

In the case of a call from a restricted line to the operator, the connection will be set up in exactly the same manner as described above for a call from a non-restricted line. In this case, however, ground by way of jumper 25, contacts 22, and conductor 27, will be extended by way of contacts 244 to relay 214, when relay 206 operates on the seizure of the trunk. Relay 214 on operating will reverse the connection of the ringing current generator and ring-cut-off relay 213 with respect to the wipers. When relay 215 operates in response to the pick-up impulse, as previously described, ringing current will be transmitted over wiper 238 of the auxiliary switch in first position, contacts 296 and 102,

wiper 109, trunk conductor 301, contacts 347, condenser 311, winding of relay 304 to ground to operate that relay. Relay 304 is arranged to lock its armature mechanically when operated and is unlocked by the interlocking mechanism 315, controlled by relay 305. Relay 304 on operating, completes a circuit at contacts 314 for the lamp L2 and the lamp glows to indicate the incoming call.

The operator on noting the lighted condition of the line lamp will answer the call as previously described whereupon relay 309 will operate and lock to the sleeve of the jack and plug. A circuit will be closed over contacts 322 and 313 for relay 306. Relay 306 operates, closes a circuit for lamp L1 at contacts 316, opens the circuit of relay 307 at contacts 317, closes a holding circuit for itself at contacts 318 and completes a circuit for relay 305 at contacts 319. Relay 305 operates and unlocks the armatures of relay 304, thereby extinguishing lamp L2. The glowing of lamp L1 indicates to the operator that the line is in the restricted class and the connection may be then handled in the manner required by local conditions. The release of this connection is the same as previously described.

Manual to automatic calls

To extend a connection from the manual exchange to a subscriber at the automatic exchange, the operator will insert the plug of a regular cord circuit into the jack of an idle trunk line, for example the jack J of trunk line T. Relay 309 will operate over the battery feed loop of the cord and lock to ground on the sleeve of the jack and cord by way of contacts 326. Polarized relay 310 is thereby bridged across the trunk conductors and line relay 331 of lineswitch LS1 at the automatic exchange will operate over a circuit including contacts 337, trunk conductor 301, contacts 347, upper left-hand winding of repeating coil R, windings of polarized relay 310, contacts 327, lower left hand winding of the repeating coil, contacts 349, trunk conductor 303, and contacts 342 to ground. Relay 331 in operating completes a circuit at contacts 333 for relay 332 and magnet 336 in series, and at contacts 334 connects test wiper 344 in the circuit at a point between the magnet and relay 332. In case wiper 344 is standing on the contacts of a busy trunk at this time, ground on the test contact will operate magnet 336 and shunt relay 332. Magnet 336 in operating opens its own circuit at contacts 335, and on restoring, steps the wipers of the switch ahead one step. This hunting operation will be repeated until an idle trunk is found, whereupon wiper 344 will no longer find ground on the contact and relay 332 will operate. The resistance of relay 332 is such that magnet 336 will not operate in series therewith. Relay 332 connects the talking

conductors of the line through to wipers 343 and 345 at contacts 338 and 341, opens the circuit of relay 331 at contacts 337 and 342, and disconnects test wiper 344 from its lower terminal at contacts 339 and connects it to its upper terminal at contacts 340. Relay 331 will release after a slight delay which is sufficient to maintain relay 332 operated until a holding ground is returned over the seized trunk line.

Lineswitch LS1 has access to connectors, such as connector C (Fig. 2) and this switch operates on seizure by lineswitch LS1 in exactly the same manner as when seized by a local subscriber in the automatic exchange. The operator now inserts the plug P of the dialling cord DC into the jack J1 of the trunk line in use. Ground on the ring contact of the plug energizes relay 346 and this relay transfers the talking conductors of the trunk to the tip and sleeve contacts of the jack at contacts 348 and 350, respectively. The connector switch is now held operated over a circuit including the tip and sleeve contacts of the jack and plug, retardation coil 353, and impulse contacts 351 of the calling device CD. The operator now dials the number of the wanted subscriber in the usual way and connector C operates to extend the connection in exactly the same manner as described for local calls. Retardation coil 353 is shunted by off-normal contacts 352 during the impulsing to improve the quality of the impulsing.

After setting up the connection as above described, the operator will withdraw plug P from the dialling jack and relay 346 will restore. The talking conductors of the trunk are now extended by way of contacts 347 and 349 and the left-hand windings of repeating coil R to relay 310. Relay 310 does not operate at this time due to the direction of current flow over the trunk line. When the called subscriber answers, current flow over the trunk is reversed and relay 210 operates and opens the loop to the operator's cord circuit. This gives the operator the usual answering supervision and she may converse with the subscriber and complete the connection in the usual manner. When the called subscriber hangs up battery is again reversed over the trunk line and relay 310 restores, again closing the bridge across the talking conductors of the cord to give the disconnect supervision. The operator then withdraws the plug from jack J and relay 309 releases. Relay 309 opens the bridge across the trunk conductors thereby permitting the release of the lineswitch and a connector.

Defective line lockout

In case a line becomes short circuited or the receiver is accidentally knocked from the switch-hook and also in case the negative side of the line becomes grounded, the line-

switch will operate in the same manner as when a call is initiated and extend the line to an idle connector. A short circuit on the line terminating in substation A for instance, will cause lineswitch LS to operate and seize an idle connector which may be the connector C. The operation of the lineswitch LS, trunk relay group TR, and connector C are exactly the same as described for a call initiated by the subscriber at substation A. Referring to the previous description it will be recalled that relay 33 operated from ground on the holding conductor and that relay 34 operated on the first vertical step of the switch and disconnected relay 33. In the present instance since the connection has been extended as the result of trouble on the line, no impulses will be transmitted to the connector, hence, relay 34 will not be operated. Relay 33 on operating closes a point of the circuit of relay 32 at contacts 40 and at contacts 41 completes a circuit by way of contacts 83 for relay 59. Relay 59 operates and completes a circuit via contacts 80, 74, and 82 for relay 58. Relay 58 is provided with a weighted armature spring which vibrates when the relay operates, thereby intermittently closing a circuit for relay 56 at contacts 78. After a period of vibration which depends upon the adjustment of the weight on the armature spring, contacts 78 will remain closed long enough to permit relay 56 to operate. Relay 56 on operating, completes a circuit for relay 57 at contacts 72. Relay 57 operates, opens the circuit of relay 58 and completes a circuit by way of contacts 76, 75, 69 and 64 for relay 54. Relay 58 releases as soon as the circuit is opened but relay 56 is slow-to-release as well as slow-to-operate and maintains the circuit of relay 57 for a short time after its own circuit is opened. Relay 54 operates, prepares a locking circuit for itself and relay 53 in series at contacts 67 and opens a point in the initial energizing circuit of relay 32 at contact 66. This is to prevent interference with calls on other trunk lines to which the timing mechanism TM is common. Relay 53 cannot operate at this time since it is short-circuited by the ground from the contacts of relay 67. Relay 56 eventually restores and opens the circuit of relay 57 and the latter relay also releases after a slight delay. Ground is thereby removed from the upper terminal of relay 53 and that relay operates in series with relay 54 to ground at contacts 85. Relay 53 transfers the circuit over which relay 54 was initially operated to relay 52 by way of contacts 65 and 61. Meanwhile, relay 57 has released and again closed the circuit of relay 58 which again operates to initiate the operation of relays 56 and 57. Relay 57 on operating transmits a second ground impulse over the previously traced circuit to relay 52. Relays

56, 57, and 58 again restore as in the previous instance and relay 52 operates in series with relay 51. The operating circuit is now transferred to relay 55 at contacts 62.

5 On the next cycle of operation of relays 56, 57, and 58, a circuit is completed for relay 55 and this relay operates and locks directly to contacts of relay 57. Relays 56, 57, and 58, restore as before and open the circuit of relay 55 eventually. Relay 55, however, is

10 slow-to-release and remains operated a short time after its circuit is opened. A circuit is completed by way of contacts 68 and 39 for relay 31 and a circuit is completed for relay 60 at contacts 71. Relay 60 is slow-to operate and after a slight delay operates to open the circuits of relays 51—54 at contacts 85, opens the circuits of relays 58 and 59 at contacts 82 and 83, respectively, and

20 opens a point in the energizing circuit of relay 32 at contacts 81. Relay 31 on operating connects high potential positive battery commonly called booster battery to holding conductor 28. Relay 4 of the lineswitch

25 now operates and completes a holding circuit for its upper winding by way of contacts 8, line conductor 1, through the short circuit on the line, conductor 2, contacts 13, to ground. The talking conductors are disconnected from the conductors of the lineswitch at contacts 7 and 12. Test conductor 3 is disconnected from the holding circuit at contacts 9 and a direct ground is applied to the conductor at contacts 10, and a circuit is

35 closed for lamp L at contacts 11. The opening of the line conductors permits the line and release relays of the seized connector to restore to normal and remove ground from the holding conductor. When this occurs relays 32 and 33 restore. Relay 31 is operated only momentarily and the booster battery is disconnected from the holding conductor on the release of the relay. Magnet 6 of the lineswitch restores and the plunger

45 is withdrawn from the banks by its restoring spring. The trunk extending to the connector is now available for other calls, while cut-off-relay 4 remains locked up over the line and prevents the line from again seizing a connector. The line is marked busy

50 to connectors by the ground on test conductor 3. Lamp L glows to indicate to the exchange attendant that the line associated therewith is locked out because of trouble.

55 When the trouble is cleared from the line the line is automatically restored to service upon the release of relay 4. The release of relay 33, as previously mentioned, permits the timing mechanism TM to restore.

60 What is claimed is:

1. In a telephone system, a two conductor trunk line, two classes of calling lines, an automatic switch for extending connections from a calling line to the trunk line, means

65 in the switch responsive to a call from a line

of one class for applying signalling current to one conductor of the trunk line, and means in the switch responsive to a call from a line of the other class for applying signalling current to the other conductor of the trunk

70 line.

2. In a telephone system, an automatic switch accessible to calling lines of two classes for extending connections to a trunk line, means in the switch for automatically

75 applying ringing current to the trunk line, and means in the switch for determining the side of the trunk line to which ringing current is to be applied, said last means being controlled by the class of the calling line.

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3. In a telephone system, an automatic switch for extending connections to a trunk line, means in the switch for normally applying ringing current to one side of the trunk line, and means in the switch controlled by a

85 preceding switch for causing said first means to apply ringing current to the other side of the trunk line.

4. In a telephone system, a two-conductor trunk line connecting an automatic exchange and a manual switchboard, an automatic switch at the exchange for extending

90 calls of two classes over the trunk line and for applying signalling current to one or the other of the trunk conductors depending on the class of the call, a signal at the switchboard operated responsive to the application of signalling current to either trunk conductor when a call is extended over the trunk

95 line, and a second signal at the switchboard operated responsive to the answering of the call provided the signalling current has been connected to a particular one of the trunk conductors.

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5. In a telephone system, a two-conductor trunk line connecting an automatic exchange and a manual switchboard, an automatic switch at the exchange for extending calls of two classes over the trunk line and for

105 applying ringing current to one or the other of the trunk conductors depending on the class of the call, a relay connected to each conductor of the trunk at the switchboard end and operated responsive to ringing current transmitted over the associated conductor when a call is extended over the trunk

110 line, a signal at the switchboard controlled by both relays, and a second signal at the switchboard controlled only by one of the relays.

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6. In a telephone system, an automatic switch for extending connections to subscribers' lines and to trunk lines, a source of signalling current adapted to be connected to either side of any of said lines, means in said

125 switch for determining the side of the line to which said current source is to be connected, subscriber controlled means for controlling said first means in connections extended to subscribers' lines, and means independent of

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subscriber control for controlling said first means in connections extended to trunk lines.

7. In a telephone system, an automatic switch equipped with a plurality of wipers for extending calls, a source of signalling current, a relay in the switch for determining the particular one of said wipers to which said current source is to be connected, subscriber controlled means in the switch for operating said relay in certain calls, and means for operating said relay independent of said subscriber controlled means in certain other calls.

8. In a telephone system, an automatic switch for extending calls to subscribers' lines and to trunk lines, an auxiliary switch associated with said first switch for selecting one of a plurality of sources of ringing current to be applied to a called line, means for operating both of said switches to extend a call, a relay in the first switch for determining the particular side of the called line to which the current source selected by the auxiliary switch is to be applied, means controlled by the auxiliary switch for operating said relay in calls to subscribers' lines, and means independent of said auxiliary switch for operating said relay in calls to trunk lines.

9. In a telephone system, a train of automatic switches for extending calls to subscribers' lines and to trunk lines, an auxiliary ringing current switch associated with the last switch of the train, means for operating all of said switches to extend a call, a relay in the last switch of the train for determining the particular side of the called line to which the ringing current selected by the auxiliary switch is to be applied, means for operating said relay responsive to the operation of the auxiliary switch to a particular position in calls to a subscriber's line, and means in a preceding switch for operating said relay independent of the position to which the auxiliary switch is operated in calls to a trunk line.

10. In a telephone system, a directly controlled automatic switch for extending calls to subscribers' lines and to trunk lines, an auxiliary ringing current selecting switch associated with said first switch, subscriber controlled means for operating said auxiliary switch in calls to subscribers' lines, and automatic means for operating said auxiliary switch in calls to trunk lines.

11. In a telephone system, a two-motion automatic switch for extending calls to subscribers' lines and to trunk lines, an auxiliary ringing current selecting switch associated with said first switch, means controlled by a calling subscriber for directly operating the first switch in its primary movement to extend a call, means controlled by the calling subscriber for directly operating the first switch in its secondary movement and

for directly operating the auxiliary switch provided the call is directed to another subscriber's line, means for automatically operating the first switch in its secondary movement provided the call is directed to a trunk line, and means for automatically operating the auxiliary switch provided the call is directed to a trunk line.

12. In a telephone system, a two-motion automatic switch for extending calls to subscribers' lines and to trunk lines of two classes, an auxiliary ringing current selecting switch associated with said first switch, means controlled by a calling subscriber for directly operating the first switch in its primary movement in calls to any line, means controlled by a calling subscriber for directly operating the first switch in its secondary movement and for directly operating the auxiliary switch provided the call is directed to the subscriber's line, means for automatically operating the first switch in its secondary movement provided the call is directed to a trunk line of either class, and means for automatically operating the auxiliary switch provided the call is directed to a trunk line of one class.

13. In a telephone system, an automatic switch for extending calls to subscribers' lines and to trunk lines, an auxiliary switch associated with said first switch, a line relay, a primary stepping magnet and a secondary stepping magnet for the first switch, a stepping magnet for the auxiliary switch, means for successively placing said magnets under control of said relay for extending a call to a subscribers' line, and means for placing said primary magnet under control of said relay and for automatically operating said other magnets for extending a call to a trunk line.

14. In a telephone system, an automatic switch adapted to connect with a called subscriber's line responsive to the receipt of two series of digit impulses and to automatically hunt for and connect with an idle trunk line responsive to the receipt of one series of digit impulses, an auxiliary ringing current selecting switch associated with said first switch, means for rendering said auxiliary switch controllable by a third series of digit impulses when a subscriber's line is connected with, and means for operating said auxiliary switch independent of any further digit impulses when a trunk line is connected with.

15. In a telephone system, a two-motion automatic switch and an associated auxiliary switch, means for directly operating the first switch in its primary movement, and means controlled by the extent of said primary movement for determining whether the secondary movement of the first switch and the operation of the auxiliary switch shall be directly or automatically controlled.

16. In a telephone system, a two-motion

- automatic switch and an associated auxiliary switch, means for directly operating the first switch in its primary movement, means normally effective for rendering the first switch subject to directive control in its secondary movement responsive to the completion of the primary movement, means operated responsive to the primary movement of the first switch to a particular position for disabling said second means and for causing the switch to be operated automatically in its secondary movement, means for rendering the auxiliary switch subject to directive control responsive to the completion of the directive secondary movement of the first switch, and means for automatically operating the auxiliary switch independent of directive control responsive to the completion of the automatic secondary movement of the first switch.
17. In a telephone system, an automatic switch and an associated ringing current selecting switch, means for operating both switches to extend a connection to a called line, a release magnet for each switch for restoring the switches to normal, a circuit for the release magnet of the auxiliary switch closed responsive to the termination of the connection, and means for transferring said circuit to the release magnet of the first switch responsive to the restoration of the auxiliary switch.
18. In a telephone system, a trunk selecting switch terminating a line, a trunk including two talking conductors and a holding conductor accessible to said switch, means responsive to a call on said line for operating said switch to connect the line with said trunk, means controlled over said holding conductor for maintaining the switch operated, and means controlled over said holding conductor for disconnecting said line from said switch to release the switch and said trunk.
19. In a telephone system, a trunk selecting switch terminating a line, a trunk including two talking conductors and a holding conductor accessible to said switch, means for operating the switch to seize said trunk responsive to an unstandard condition on said line, means in the switch for freeing both the switch and said trunk while said unstandard condition remains on the line, and a timing device associated with said trunk for operating said last means over the holding conductor of the trunk.
20. In a telephone system, lines terminating in trunk selecting switches, a plurality of trunk lines accessible to said switches, a timing device common to said trunk lines for releasing the trunk lines from connections extended thereto but not further extended for a predetermined interval, a relay for each trunk line, contacts controlled by the respective relays for connecting said device indi-
- vidually with their associated trunk lines, and means for preventing the operation of more than one relay at a time.
- In witness whereof, I hereunto subscribe my name this 26th day of December, A. D. 1930.
- NORMAN H. SAUNDERS.

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