

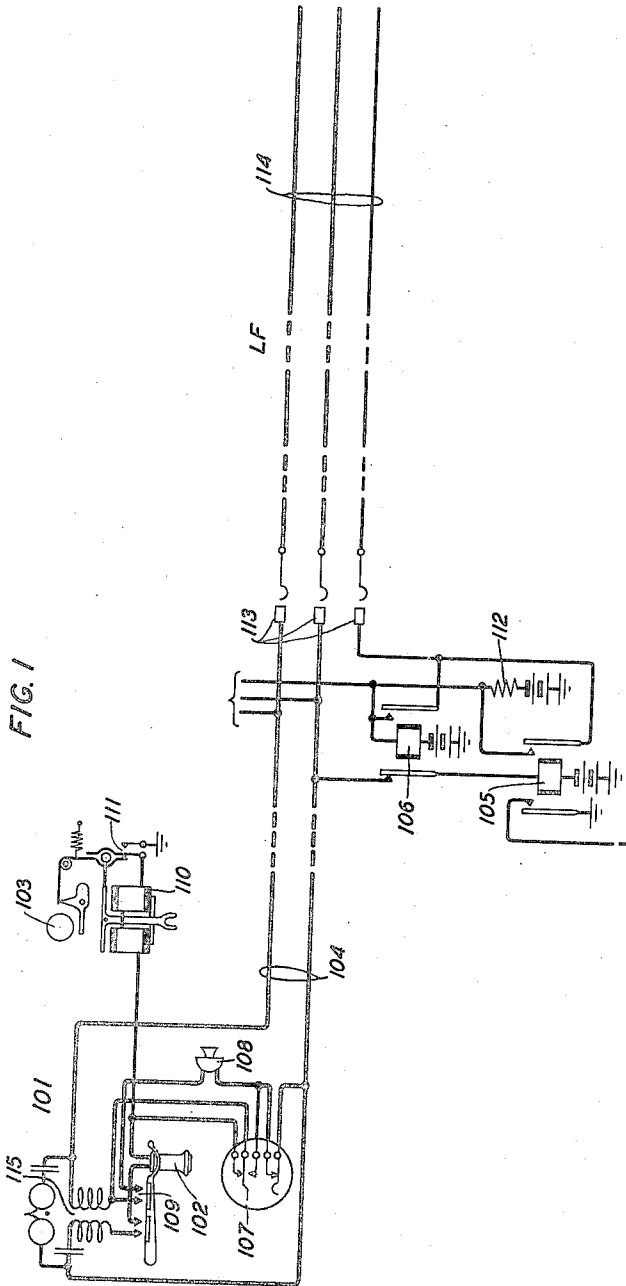
Oct. 4, 1938.

H. HOVLAND
TELEPHONE SYSTEM

2,132,241

Filed June 11, 1935

3 Sheets-Sheet 1



INVENTOR
H. HOVLAND
BY *M. D. Penney*
ATTORNEY

Oct. 4, 1938.

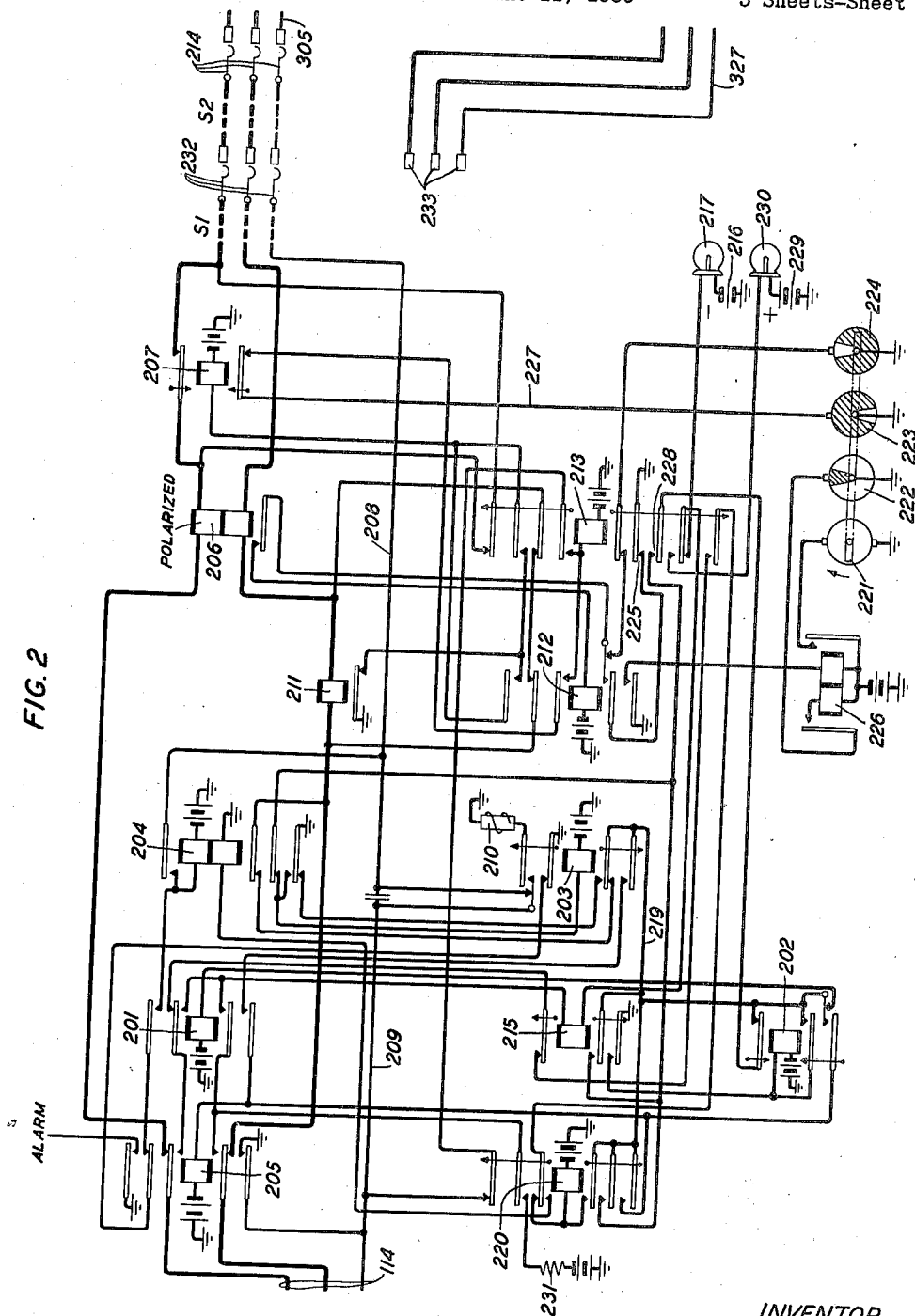
H. HOVLAND

2,132,241

TELEPHONE SYSTEM

Filed June 11, 1935

3 Sheets-Sheet 2



INVENTOR
H. HOVLAND
BY *Wm. H. McFarlane*
ATTORNEY

Oct. 4, 1938.

H. HOVLAND

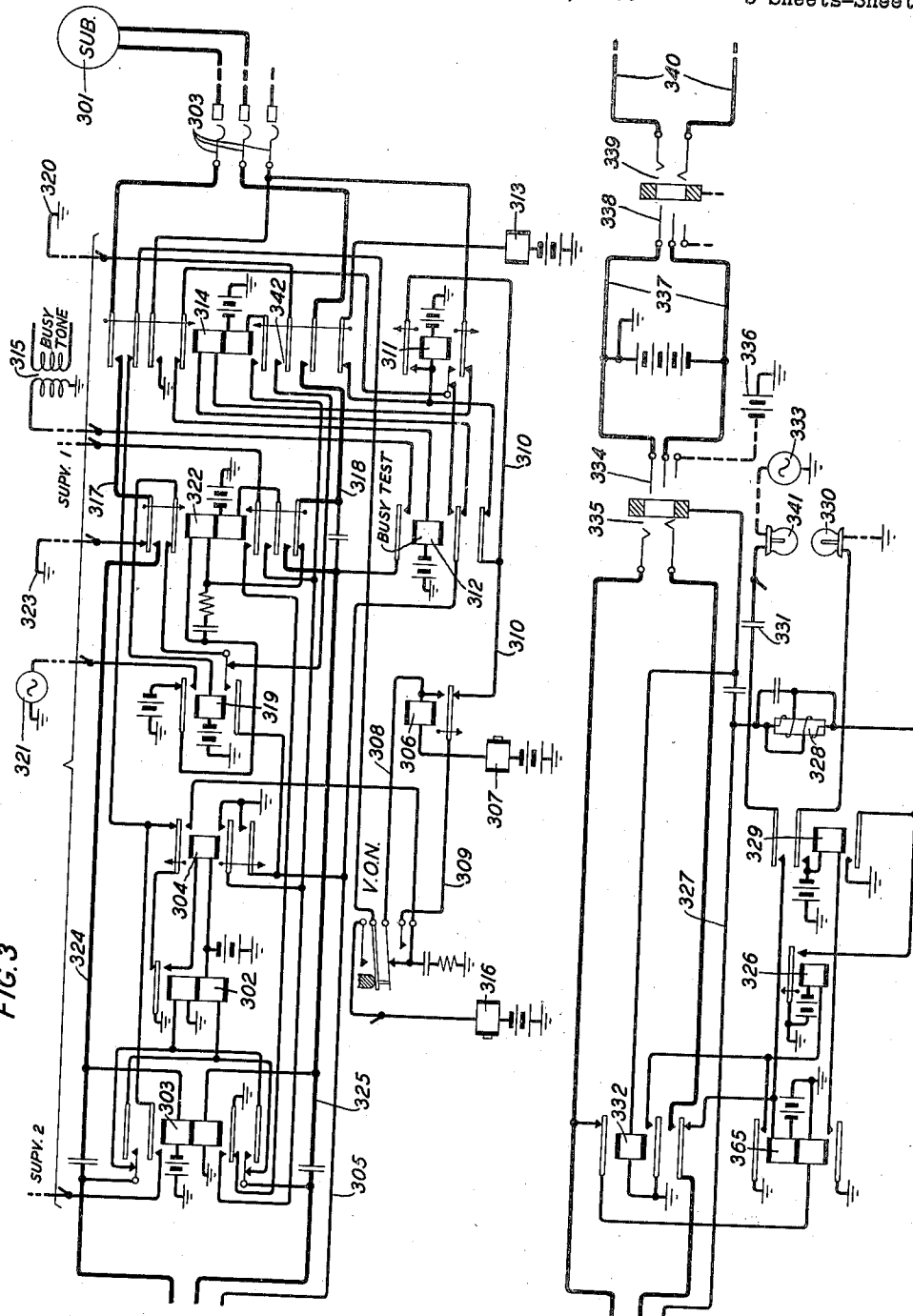
2,132,241

TELEPHONE SYSTEM

Filed June 11, 1935

3 Sheets-Sheet 3

FIG. 3



INVENTOR
H. HOVLAND
BY *H. J. McFerry*
ATTORNEY

UNITED STATES PATENT OFFICE

2,132,241

TELEPHONE SYSTEM

Henry Hovland, Williston Park, N. Y., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application June 11, 1935, Serial No. 26,014

9 Claims. (Cl. 179-6.3)

This invention relates to telephone systems and particularly to automatic systems having coin controlled lines.

The objects of the invention are to improve the dialing operation; to guard against fraudulent operation of the pay station; to reduce the number of current changes in the line; and to effect other improvements in systems of this character.

It has been proposed heretofore in party line systems, where a ground connection at one of the substations serves as a means for identifying the station when calling, to remove such ground connection during dialing in order to improve the pulsing conditions at the central office.

It is also well known to perform certain tests on coin lines to determine the presence or absence of a coin at the pay station, and in some cases circuits have been devised to detect fraudulent manipulation by the party at the coin station.

According to a feature of the present invention, the ground connection that is applied when the coin is deposited to initiate the call and to make it possible for the patron to dial, which ground connection is necessary subsequently for the disposition of the coin, is automatically removed from the line while the dial is sending impulses to set the switches in the central office. This makes it possible to improve the operation of the impulse mechanism that responds to the substation dial and also to avoid the use of impulse repeating equipment at the central office. Moreover, the elimination of this repeating equipment simplifies the operation of the central office circuits, particularly on calls to an operator. Heretofore, on calls to the operator it has been the practice to remove the repeater, following dialing, by a current reversal the same as on full dial calls to subscribers. But this reversal also sets the circuits to collect the coin, whereas oftentimes the calls to operators require no charge, thus making it necessary for the operator to refund the coin. With the present invention there is no repeater to be removed, and the circuits can be arranged to refund the coin in all cases on calls to the operator unless she disposes of it before release.

Another feature is a system in which a test of the line is made when collect current is applied to determine if a ground connection is present at the substation. If not, an alarm is given. If, however, the first test shows a ground present, a second test is made to determine if the ground

was removed by the collect or refund current or if it continues to exist following the removal of such current. If it does continue, this indicates either that it is a fraudulent ground or that the patron has deposited another coin immediately following the disposition of the first coin and wishes to make a second call. Accordingly, a third test is then made to determine whether the ground is fraudulent or is the result of a newly deposited coin. In case this latter test finds the ground was fraudulently applied, an alarm is given. But, if it finds a second coin has been deposited, the original connection of the line to the selector is held, and the patron is free to proceed with the dialing of the new connection.

A further feature is an improved release arrangement whereby it is possible to release the established connection although the coin ground is maintained on the line following the replacement of the receiver at the pay station. Since the coin ground remains on one side of the line, tip side, after the receiver is replaced, and since the line relay in the final switch has its battery winding connected to the other side, ring side, of the connection, which is reversed when the called subscriber answers, this relay will continue to hold in a circuit to the coin ground. To enable release under this condition, a control relay is inserted in the ring side of the trunk preceding the first selector. This relay releases when the calling party hangs up his receiver, and it opens the circuit of the line relay causing the release of all selectors. In this way it is unnecessary to introduce, as is sometimes done, a second reversal of the talking conductors to neutralize the effect of the reversal caused by the answer of the called subscriber. Not only is the system simplified by the elimination of a current reversal but the consequent changes of current in the telephone receiver at the calling station are also obviated.

The foregoing and other features of the invention will be described more fully in detail in the following specification.

Fig. 1 of the drawings shows a coin-box station and line arranged according to this invention and connected at a step-by-step central office to a line circuit of the well-known type to which the usual line finder, shown schematically, has access.

Fig. 2 which connects with Fig. 1, shows the circuit details of a coin-box trunk circuit arranged according to this invention and connecting with Fig. 3 through a first and second selector

of the usual step-by-step type, indicated here in an abbreviated schematic form.

Fig. 3 shows circuit details of a well-known arrangement of a step-by-step connector circuit, the brushes of which have access to the terminals of a subscriber's line, and also of a trunk circuit extending to an operator's position.

The system will now be described in detail. Let it be assumed that the subscriber of station 101 desires to establish a connection with the station 301. When a coin 103 is deposited and receiver 102 is removed from the associated switchhook, a circuit is closed for operating line relay 105. This circuit may be traced from central office battery through the winding of relay 105, left-hand contacts of cut-off relay 106, over lower conductor of line 104, through lower contacts of dial 107, transmitter 108, switchhook contacts 109, upper normally closed contacts of dial 107, winding of coin magnet 110 and coin operated contacts 111 to ground. Coin magnet 110 is marginal and does not operate through this circuit. Line relay 105, in operating, connects battery through its right-hand contacts and the winding of cut-off relay 106 and resistance 112 in multiple to the sleeve terminal of line finder LF and also connects ground with its left-hand contacts to a relay, not shown, in the circuit of line finder LF, which causes it to hunt for this line. When terminals 113 are seized and the connection is extended over conductors 114 to Fig. 2, ground is connected to the sleeve terminal, operating relay 106 through the right-hand operated contacts of relay 105. Relay 106 locks to the sleeve terminal and opens the circuit through the winding of relay 105 which releases.

When the coin-box trunk of Fig. 2 is connected to the line 104, as hereinbefore described, a circuit is closed for operating relay 201 which may be traced from battery through the winding of relay 201, lower normally closed contacts of relay 202, lower normally closed contacts of relay 203, lower inner contacts of relay 204, lower normally closed contacts of relay 205 thence over the ring conductor and through the ring contacts of line finder LF, over the lower conductor of subscriber line 104 through lower normally closed contacts of dial 107, transmitter 108, switchhook contacts 109, upper normally closed contacts of dial 107, winding of coin magnet 110 and coin operated contacts 111 to ground. From switchhook contacts 109 another circuit to ground may be followed through the right-hand winding of induction coil 115, over the upper conductor of line 104, through upper contacts of line finder LF, upper inner back contacts of relay 205, upper winding of polarized relay 206, upper contacts of relay 207 and to ground through one winding of the line relay, not shown, of first selector S1. Relay 206 is poled so that it does not operate at this time. Relay 201, in operating, operates relay 204 from battery through the upper winding of relay 204, upper outer contacts of relay 201, upper outer normally closed contacts of relay 205 to ground on the upper inner break contacts of relay 203.

The operation of relay 204 opens the operating circuit of relay 201 previously traced. Relay 201 releases, opening the operating circuit of relay 204 but relay 204 does not release as its upper contacts close before its other contacts function, thereby assuring the locking of relay 204 to sleeve conductor 208 to which ground was connected when the line relay of selector S1 operated. Relay 204 also operates with its lower

outer front contacts relay 203 which, in operating, opens the direct current path between sleeve conductors 208 and 209 and connects conductor 209 to ground through the winding of retardation coil 210, thereby preventing the immediate release of line finder LF when ground is removed from conductor 208 after the disconnection of station 101. This delay in the release of the line finder LF is to hold the connection until the coin relay 110 has operated. This feature will be described subsequently. The calling subscriber of station 101 may now dial the number of the called station 301.

When the dial 107 is moved off-normal, the upper break contacts open, disconnecting the ground through coin relay 110 and providing thereby a clear metallic circuit for pulsing. As hereinbefore stated this feature of the invention improves the pulsing circuit, making it unnecessary to use impulse repeating equipment at the central office, as heretofore, to provide for the loss of pulsing range due to the coin-box ground. Pulses from dial 107 are transmitted by the lower of pulsing contacts of dial 107, through its operated off-normal contacts, and the right-hand winding of induction coil 115 over the tip and ring conductors of Figs. 1 and 2, the connection being extended in the usual manner through selectors S1 and S2. The pulsing current passes through the windings of polarized relay 206, but this relay does not operate at this time as the direction of current opposes operation. The pulsing current is also without effect on relay 211 as the winding of this relay is short-circuited through break contacts on relays 212 and 213. When brushes 214 of selector S2 connect with the terminals of the connector of Fig. 3, the pulsing circuit is extended through upper and lower outer break contacts of reversing relay 303 to the winding of relay 302 which operates over the subscriber's loop.

The calling subscriber now dials the tens digits of the called number. When relay 302 operated it operated, through an obvious circuit, relay 304, which connects ground to sleeve lead 305, thereby holding operated, in the usual manner the preceding switches and guarding the connector of Fig. 3 from seizure by other selectors. On the first break of the dial, relay 302 releases and closes a circuit from ground on its back contacts through the operated upper front contacts of relay 304, normally closed contacts of vertical off-normal springs VON and windings of relay 306 and vertical magnet 307 to battery. Relay 306 and vertical magnet 307 operate. Relays 304 and 306 are slow-to-release and do not release between breaks of the dial. As soon as the shaft moves one vertical step the VON springs operate and the energizing circuit for relay 306 and magnet 307 is transferred from conductor 308 to conductor 309, and is completed through the operated front contacts of relay 306. Vertical stepping continues until the level is reached in which are located the terminals of the called line.

After the pulsing of the tens digit is thus completed, relays 302 and 304 both being operated, the circuit through the winding of relay 306 and magnet 307 is opened. Relay 306 releases and transfers the pulsing lead 309 to lead 310 to provide for rotary stepping.

On the first break of the dial for rotary stepping, that is, for dialing the units digit of the called number, ground on conductor 310 operates relay 311 through the lower outer break contacts

of relay 312, and in multiple with relay 311, operates rotary magnet 313 through the lower outer break contacts of relay 310. When relay 311 operates, it locks to conductor 310 and being slow to release remains operated during the dialing of the units digit. The operation of rotary magnet 313 causes the shaft to step in a rotary direction until the terminals of the called line are seized by the brushes 303. After the last pulse is delivered and relays 302 and 304 are both operated, the circuit through relay 311 and magnet 313 is opened. Before slow releasing relay 311 releases, however, if ground is found on the sleeve of the called line indicating that it is busy, relay 312 operates from battery through its winding, upper inner break contacts of relay 314, lower operated make contacts of relay 311 to the aforesaid busy ground. When relay 311 finally releases, a circuit is closed for locking relay 312 which is traced from battery through the winding of relay 312, upper inner break contacts of relay 314, lower inner break contacts of relay 311, and lower inner operated make contacts of relay 312 to ground on conductor 305. Relay 312 operated connects a busy tone potential from transformer 315, through an interrupter not shown, to the ring conductor through its upper make contacts.

The calling subscriber of station 101 on hearing the busy tone will now hang up the receiver, opening the circuit over the loop causing the release of relays 302 and 304. Relay 304 in releasing removes ground from the release lead 305, causing the release of selectors S1 and S2 and of relay 312. A circuit is also closed for the operation of the release magnet 316 which is traceable from battery through the winding of magnet 316, upper operated make contacts of springs VON, upper outer break contacts of relay 314, and break contacts of relays 304 and 302 to ground. Release magnet 316 now restores the connector switch, including springs VON, to normal. When ground is removed from the sleeve lead 208 by the release of the selectors, relay 204 releases, which operates relay 201 through a circuit from battery, through the winding of relay 201, normally closed contacts of relay 202, lower operated inner front contacts of relay 203 to ground on the lower outer back contacts of relay 204. The release of relay 204 also opens the holding circuit for relay 203 which is slow to release and remains operated until relay 215 operates as hereinafter described. When relay 201 operates, it closes a circuit for operating relay 205 which is traced from battery through the winding of relay 205, lower outer make contacts of relays 201 and 203, lower inner front contacts of relay 203 to ground on the lower outer back contacts of relay 204. When relay 201 operates, it connects negative or return coin battery 216 to the tip and ring conductors leading to the coin-box station 101. This connection is made from battery 216, resistance lamp 217, lower outer back contacts of relay 213, winding of relay 215, upper and lower operated inner make contacts of relays 201 and 205, thence over the tip and ring conductors to station 101, where negative potential from the aforesaid battery 216 is applied from the tip conductor through right-hand winding of induction coil 115, upper normally closed contacts of dial 107, to the winding of coin magnet 110, grounded through the coin operated contacts 111. As the receiver at station 101 is on its switchhook, the negative coin battery over the ring conductor is ineffective at this time due to switchhook contact 109 being open. Coin magnet 110 which is polarized is, however,

energized over the tip conductor and actuates its armature in the direction to cause the return of the deposited coin 103. Relay 215 operates through the circuit above traced and closes a holding circuit for relay 203 which may be followed from battery through the winding of relay 203, lower middle break contacts of relay 204, lower inner operated contacts of relay 215, lower inner operated front contacts of relay 203 to ground on the lower outer back contacts of relay 204. Relay 215 also operates through an obvious circuit relay 202 which locks to ground on conductor 219 to which it also connects the winding of relay 205, holding this relay operated. Relay 202 is slow to operate so as to delay the release of relay 201 until the coin relay 110 has completely operated. When relay 201 releases the circuit through coin relay 110 and relay 215 is opened. Relay 215 releases and springs 111 of the coin magnet 110 are opened, removing ground from the tip of the line. The release of relay 215 allows relays 202, 203 and 205 to release. The release of relay 205 allows the line finder LF and cut-off relay 106 to release, all apparatus now being restored to normal.

The operation has been described for the condition existing when the line of the called station is busy. If the subscriber of the calling station should abandon the call, that is, hang up the receiver at any time before the terminals of the called line have been seized by the brushes 303 of the connector of Fig. 3, the system functions in a similar manner to cause the refund of the deposited coin 103. After selectors S1 and S2 release, ground is removed from sleeve lead 208, causing the release of relay 204. The sequence of relay operations that follow thereafter are the same as those hereinbefore described. The operation of the system will now be discussed for the condition wherein the call to the called line is completed.

For a completed call, the discussion will be continued from that point of the hereinbefore given description at which the connector brushes 303 seized the terminals of the called line and found them busy. Let it be assumed that the line is not busy and that battery is found on the sleeve terminal. Relay 314 operates from ground on the lower outer operated contacts of relay 304 through lower inner break contacts of relay 312, upper winding of relay 314, lower outer break contacts of relay 311 to battery on the sleeve brush 303 and seized sleeve terminal of the called line. Relay 314, in operating, locks through its lower winding and lower inner make contacts to ground on the lower inner make contacts of relay 304 and grounds through its upper inner make contacts the sleeve of the called line, thereby guarding the line against seizure by another connector. The operation of relay 314 also connects, with its upper outer make contacts, conductor 317 through to the tip terminal of the called line, and with its lower outer make contacts connects the conductor 318 through to the ring terminal of the called line.

Ringing current is not connected to the called line until relay 319 operates from ground 320 supplied through a pick-up interrupter circuit which is of the usual well-known arrangement and is not shown here in detail. Relay 319 operates from ground 320, operated contacts 342 of relay 314, lower break contacts of relay 319, upper inner break contacts of relay 322 to battery through the winding of relay 319. Relay 319 locks to ground on conductor 305. When relay

319 operates, ringing current is supplied from source 321 through an interrupter circuit, not shown, upper operated front contacts of relay 319, upper winding of relay 322, lower outer back contacts of relay 322, over conductor 318, through lower outer make contacts of relay 314, ring brush 303 and associated contacts, thence over the conductors and through the station 301 of the called subscriber's line, through tip brush 303 and associated contacts, upper outer make contacts of relay 314 and upper outer break contacts of relay 322 to ringing ground 323. Relay 322 is slow to operate and does not operate on ringing current through the ringer, not shown, at station 301.

When, however, in response to the sound of the ringer the subscriber of station 301 answers, a bridge of low impedance is connected across the line at station 301, which now causes relay 322 to operate, closing first its lower middle make contacts and thereby through its lower winding a locking circuit to ground on the lower inner make contacts of relay 304. The operation of relay 322 through its lower winding opens the initial operating circuits through its upper winding, thereby disconnecting ringing current from the line of station 301 and connects conductors 317 and 318 through its upper and lower outer contacts to talking conductors 324 and 325, respectively, completing thereby the talking connection. If the called subscriber answers during the silent period, then relay 322 operates from battery on the upper back contacts of relay 319. When relay 322 operates, it releases relay 319 if this relay has previously operated. Relay 303 now operates from battery and ground through its upper and lower windings, over conductors 324 and 325 and thence through operated contacts of relays 322 and 314 and the loop of station 301. In operating, relay 303 reverses the current from relay 302 that is transmitted back to the station 101 of the called subscriber, causing the operation of polarized relay 206. When relay 206 operates, the operation of charge relay 213 is delayed for a minimum period of about two seconds so as to avoid the possibility of charging on a momentary operation of relay 206. This is accomplished by the use of the pick-up relay 212 which operates from battery through its winding, operated contacts of relay 206, lower break contacts of relay 212, lower inner break contacts of relay 213 to ground on interrupter drum 224. Relay 212 locks to ground through its lower inner make contacts and contacts 225 of relay 213, and closes an obvious circuit through the right-hand winding of start relay 226 which operates and connects with its right-hand contacts battery to motor 221 which starts and causes the rotation of interrupters 222, 223 and 224. When drum 223 rotates through 180 degrees, lead 227 is grounded causing the operation of relay 213 through lower break contacts of relay 207 and upper inner operated contacts of relay 212. Relay 213 locks through its upper inner contacts to ground on lead 209, through the upper outer contacts of relay 220 and opens the circuit of relay 212 which releases. When drum 222 has rotated through 360 degrees, the locking circuit through the left-hand winding of relay 226 is opened, relay 226 releasing and opening the circuit through motor 221. Interrupter drums 222, 223 and 224 are accordingly again in their normal positions as shown by the drawings. When relay 213 operates, it also opens with its upper inner break contacts the short circuit around the winding of relay 211 which operates on the cur-

rent over the calling subscriber's loop thereby avoiding the operation of relay 207.

When the subscriber of station 101 hangs up his receiver, the line loop is opened by switch-hook contacts 109 and the ground through the coin relay winding remains on the top side of the line. If the called station 301 has not hung up, the coin ground over the tip side of the line will hold operated relays 302 and 304 and thereby hold the connection. However, relay 211 releases and connects ground to the winding of relay 207 through the upper outer make contacts of relay 213. Relay 207 operates and opens the tip side of the line and allows selectors S1 and S2 to release. Relay 207 is arranged to operate slowly to avoid releasing the circuit on a momentary opening of the line loop such as may occur if the dial is operated inadvertently. The release of the selectors S1 and S2 removes ground from the sleeve conductor 208 which allows relay 204 to release. Relay 203 is now held from battery through its winding, lower middle break contacts of relay 204, operated contacts 228 of relay 213, break contacts of relay 202, over conductor 219, through lower inner make contacts of relay 203 to ground on the lower outer break contacts of relay 204. The release of relay 204 operates relay 201 from battery through the winding of relay 201, break contacts of relay 202, to ground on conductor 219. Relay 201 operates relay 205 from battery through its winding, lower outer make contacts of relay 201, lower outer make contacts of relay 203 to ground on conductor 219. Positive coin battery 229 is connected through resistance lamp 230, lower outer front contacts of relay 213, winding of relay 215, upper and lower inner front contacts of relays 201 and 205 to the tip and ring of the line to the calling station. Under normal operating conditions, ground is at this time connected to the winding of coin relay 110 due to the operation of the contacts 111 by the coin 103. Relay 215 operates in series with the winding of coin relay 110 which operates and collects coin 103. Relay 215 closes an obvious circuit through the winding of relay 202. Relay 202 is slow to operate and after an interval sufficiently long to assure the operation of coin magnet 110, relay 202 operates and releases relay 201, disconnecting positive coin battery 229 and releasing relay 215. Relay 215 releases slowly and after an interval sufficient to assure the release of coin relay 110 closes a circuit for operating relay 220 over the tip of the line. This circuit is traced from battery, through the winding of relay 220, upper inner back contacts of relay 220, lower outer make contacts of relay 213, upper break contacts of relay 215, upper back contacts of relay 205 to the tip conductor, relay 205 being held through lower outer make contacts of relay 202 to ground on conductor 219. Under normal conditions, coin 103 having been collected and contacts 103 being open, there will be no ground at station 101. Consequently, relay 220 does not operate and does not close with its lower make contacts locking circuits for relays 202 and 203, which accordingly release after an interval since relay 203 is slow-to-release and likewise relay 202 under control of relay 203. Relay 202 in releasing releases relay 205 which, in releasing, releases the line finder LF and also relay 213. All apparatus is now restored to normal.

From the hereinbefore given description, it is seen that the purpose of relay 220 is to test for ground at the calling station, immediately after

the application of positive coin battery potential. If the ground at the calling station is due to the deposit of a second coin then relay 220 operates through the winding of coin magnet 110 to ground over the tip conductor. The locking contacts of relay 220 close first before the initial operating circuit through the upper inner back contacts is opened and relay 220 locks to ground on conductor 219. Relay 220, in operating, closes a circuit for maintaining relay 203 operated. This circuit extends from battery through the winding of relay 203, lower middle break contacts of relay 204, lower middle make contacts of relay 220, lower inner make contacts of relay 203 to ground on the lower outer break contacts of relay 204. Relay 220 also closes another circuit for maintaining relay 205 operated. This extends from battery through the winding of relay 205, lower outer make contacts of relay 220, to ground on conductor 219. Relay 202 is also held through its lower inner make contacts to ground on conductor 219. Relay 220 closes a circuit for operating relay 204 which may be traced from ground through lower winding of relay 204, upper inner make contacts of relay 220, lower outer make contacts of relay 213, upper break contacts of relay 215, upper break contacts of relay 201, upper inner operated from contacts of relay 205 thence over the subscriber's loop, through lower inner operated make contacts of relay 205, upper outer make contacts of relay 220 to battery through resistance 231. Relay 213 is slow to release on the opening of its locking circuit by the opening of the upper outer break contacts of relay 220 so that relay 204 can operate before its operating circuit is opened by the release of relay 213. Relay 204 locks to ground on conductor 208 through its upper winding and removes ground from conductor 219, thereby releasing relays 202, 205 and 220. From this point, the second connection is established as described for the original call.

Let it be assumed now that an attempt is made at station 101 to obtain a connection fraudulently by connecting a direct ground to the tip of the line, instead of making the ground connection in the legitimate manner by the insertion of the coin 103. In this case, the system functions as hereinbefore described except that now relay 204 does not operate after relay 220 has operated due to the fraudulent ground connected to the tip conductor at station 101. This follows from the fact that this ground acts as a low resistance shunt on the lower winding of relay 204, preventing its operation as hereinbefore described. When relay 204 fails to operate, ground is maintained on conductor 219, thereby preventing the release of relays 202, 203, 205, and 220. The operation of relay 220 releases relay 213, and when this relay releases, the operating circuit through the lower winding of relay 204, hereinbefore traced, is opened, so that if the fraudulent ground at station 101 is subsequently removed and a coin is deposited, relay 204 will not operate. Accordingly, with the locked-up condition just described existing, ground on the upper outer contacts of relay 205, after a predetermined interval, causes an alarm circuit, not shown, to function and thereby to indicate to the maintenance force at the central office, that the apparatus at station 101 has been manipulated in an irregular manner.

The system has been discussed for fraudulent operation at the calling station, when a direct ground was applied to the tip conductor of the

line and maintained during the established connection. The system also functions so as to give an alarm, if the ground is applied to the tip conductor only momentarily—only sufficiently long to cause the operation of the line finder and connection to a selector. When, after the receiver at the calling station has been restored to the switch-hook, the positive coin battery 229 is connected to the tip and ring conductors through the winding of relay 215 and there is no ground existing at station 101, relay 215 does not operate, and consequently there can be no further operation as described hereinbefore. Relay 205 remains operated and after an interval effects the sounding of the alarm by the ground on its upper outer contacts. The system also functions to bring in an alarm, should a coin be deposited in the regular manner and an attempt be subsequently made to prevent its collection by holding the dial off-normal. In this case also relay 215 does not operate due to the absence of ground and the circuit operation is blocked as hereinbefore described.

The invention will now be described for its operation when the station 101 calls an operator. As hereinbefore stated it is a feature of this invention, that no reversal of the line current is required for operator calls, since there is no repeater equipment to be removed from the connection by reversal, as is the usual practice. Consequently, with this invention, the coin-trunk circuit is not always automatically set for collection of the coin, regardless of whether the call is to be charged for or not and is arranged so that, if the operator neglects to refund the coin by operating the coin control key, the coin is automatically refunded on disconnection.

Let it be assumed that the coin 103 has been deposited at station 101, that the calling party has dialed the operator's number, and that brushes 232 of selector S1 have seized terminals 233 connecting with the operator's trunk of Fig. 3. Relay 365 will now operate over the loop of station 101 and operate relay 326 through an obvious circuit. Relay 326 in operating will ground sleeve conductor 327 through the winding of retardation coil 328, and thereby cause the terminals 233 to test busy to other hunting selectors. Relay 362 will also operate relay 329 which closes an obvious circuit through line lamp 330 and connects a source of grounded ringing current 333 through resistance lamp 341, condenser 331, upper make contacts of relay 329 and lower break contacts of relay 332 to the ring conductor of the line, thereby transmitting a ringing signal to the calling station 101. When the operator responds to the lighted lamp 330 by inserting plug 334 of cord circuit 337 into answering jack 335 relay 332 operates over the sleeve from battery 336, disconnects the windings of relay 365 from the talking conductors of the trunk with its break contacts and connects ground to the winding of relay 326. Relay 365 releases, releasing relay 329 which disconnects ringing current source 333 and extinguishes lamp 330. Holding ground is maintained through the winding of retardation coil 328 by the operated contacts of relay 326. The operator can now, if required, extend the call over line 340 by inserting plug 338 into jack 339.

Cord circuit 337 is provided with a coin control key, not shown, whereby negative or positive coin battery may be connected, respectively, for refunding or collecting the coin 103 at station 101. The coin battery is connected to both conductors

of cord circuit 337. Let it be assumed that the operator desires to refund the coin 103. Refunding may be accomplished by the operation of the coin control key, not shown, to the refund position, or automatically, when the operator and subscriber have both disconnected, should the operator fail to operate the refund key. When the coin control key is operated for refunding, negative coin battery is connected to the tip and ring conductors of cord circuit 337. If the receiver at station 101 is off the hook, approximately equal currents will flow over the tip and ring conductors of the established connection to ground through the winding of coin magnet 110 which is actuated by the negative current and returns coin 103. Polarized relay 206 on account of the differential action of the equal currents through its windings will not operate. After the established connection is released by the hanging up of the receiver at station 101, and the withdrawal of cord circuit plug 334 from jack 335, the system functions to connect automatically negative coin battery 216 to the tip and ring conductors as hereinbefore described in the case of an uncompleted call, but this operation is without effect at this time as the coin has already been returned. If the receiver at station 101 is on the switch-hook when negative coin battery is applied, relay 206 may operate on the current through its upper winding as the coin 103 is returned at station 101, in response to the negative current over the tip conductor. Under this condition relay 206 operates pick-up relay 212, as before described. Relay 212 locks to ground on break contact 225 of relay 213 and removes the shunt around the winding of relay 211 which, however, does not operate as the ring conductor at station 101 is now open. Ground on the back contacts of relay 211 now operates relay 207 through the operated outer make contacts of relay 212. Relay 207 disconnects interrupter lead 227, preventing the operation of relay 213. When the operator disconnects the selector S1 releases removing ground from sleeve conductor 208 releasing relay 204. The release of relay 204 causes the coin-trunk to function as hereinbefore described in connection with an uncompleted call, negative coin battery being connected to the tip and ring conductors. Since the coin has already been refunded, this action is without effect at this time.

If the operator should fail to operate the coin control key, the coin is returned automatically as before stated, as soon as the connection is released following disconnection of both the calling station and the operator's trunk. Under this condition the system functions as in the case of an uncompleted call, polarized relay 206 not operating since there is no reversal of the battery polarity in the operator's trunk.

When the operator applies positive coin battery for collecting the coin 103 none of the relays of the coin trunk of Fig. 2 operate in response since polarized relay 206 does not operate under this condition. With the receiver on the hook at station 101, positive coin current passes through the upper winding of relay 206 without effect; with the receiver off the hook equal positive coin currents pass through both windings of relay 206 and are now without effect due to the differential action of the two windings. All apparatus is released following disconnection at both calling and called ends, as before described.

What is claimed is:

1. In a telephone system, a telephone line having a pay station thereon, automatic switches for

extending said line, switch-hook contacts and an impulse dial at said pay station, automatic switches responsive to impulses sent by said dial, means responsive to the deposit of a coin at said pay station for establishing a ground connection thereat to both talking conductors of said line, the ground connection to one of said talking conductors depending on said switch-hook contacts, and off-normal contacts for said dial for removing said ground connection from both sides of the line.

2. In a telephone system, a telephone line having a station with coin receiving means thereat, means responsive to the deposit of a coin in said receiving means for closing a ground connection to said line at said station, a circuit for applying current to the line to dispose of a deposited coin, means in said circuit for testing the presence of said ground connection, means effective following the application of said coin-disposal current for again testing said line to determine if the ground connection is still present, and further test means for testing said line to determine the character of the ground connection at said station.

3. In a telephone system, a line having a station with coin receiving means thereat, means responsive to the deposit of a coin for closing a ground connection to said line at said station, a circuit for applying current to the line to dispose of a deposited coin, relay means in said circuit for testing for the presence of said ground connection, means effective if the first test discloses a ground connection for again testing said line to determine if such connection is still present following the removal of said coin-disposal current, and further test means for testing said line to determine the character of the ground connection at said station.

4. In a telephone system, a line having a pay station thereon, means responsive to the deposit of a coin at said station for establishing a ground connection to the conductors of said line, a source of coin-disposal current and means for applying it to said line, means for testing said line to determine whether the ground connection is still present following the application of said disposal current, and other test means effective if the first test discloses the ground connection present for testing said line to determine the character of such ground connection.

5. The combination in a telephone system of a line having a pay station thereon, means responsive to the deposit of a coin at said station for establishing a ground connection to the conductors of said line, a circuit for applying coin-disposal current to said line to dispose of a deposited coin and open the ground connection, test means for making a test of the line after the application of said coin-disposal current to determine whether the ground connection is still present, and further test means effective according to the result of said first test to determine the nature of the ground connection.

6. In a telephone system, a line having a pay station thereon, a magnet at the pay station for disposing of a deposited coin, means responsive to the deposit of a coin for establishing a connection from ground through the winding of said magnet to said line, means for applying current to the line to operate said magnet to dispose of the coin and to open said ground connection, testing means for testing the line to determine whether the ground connection is still present, and other test means for testing said line to de-

terminate the resistance of the ground connection.

5 7. In a telephone system, a telephone line having a coin station thereon, automatic switches for extending said line to establish a talking circuit therefor, a line relay associated with one of said switches and connected to one of the conductors of the established talking circuit, means controlled by a deposited coin for establishing a ground connection to said line at said station, 10 a circuit including said ground connection for holding said line relay energized following the replacement of the receiver at said station, means in the established talking circuit responsive to the replacement of said receiver for opening the circuit of said relay to permit the same to release, 15 and means responsive to the release of said relay for causing the release of said automatic switches.

20 8. In a telephone system, a calling line having a pay station thereon, a called subscriber's line, a series of selective switches, means for operating said switches to establish a talking circuit from said calling line to said called line, a line relay associated with one of said switches, a source of current connected through the winding of said relay to one of the conductors of said extended 25 talking circuit, means responsive to the answer by the called subscriber for reversing the con-

ductors of said talking circuit, means responsive to the deposit of a coin at said pay station for applying a ground connection to one of the conductors of said line, a circuit including one of the talking conductors of the established connection 5 and the ground connection at said pay station for holding said relay energized following the replacement of the receiver at said pay station, a relay in one of the talking conductors of the established connection which releases when the 10 receiver is replaced at the calling station, means controlled by said last-mentioned relay for opening the circuit of said line relay causing the latter to release, and means controlled by the release of said line relay for restoring said selective 15 switches to normal.

9. In a telephone system, a telephone line having a pay station thereon, automatic switches for extending said line, an impulse dial at said pay station, automatic switches responsive to im- 20 pulses sent by said dial, means responsive to the deposit of a coin at said pay station for establishing a ground connection thereat to both talking conductors of said line, and off-normal contacts for said dial for removing said connection from 25 both sides of the line.

HENRY HOVLAND.