April 8, 1930. T. V. CURLEY 1,753,334

TELEPHONE SYSTEM

Filed May 10, 1928 2 Sheets-Sheet 1

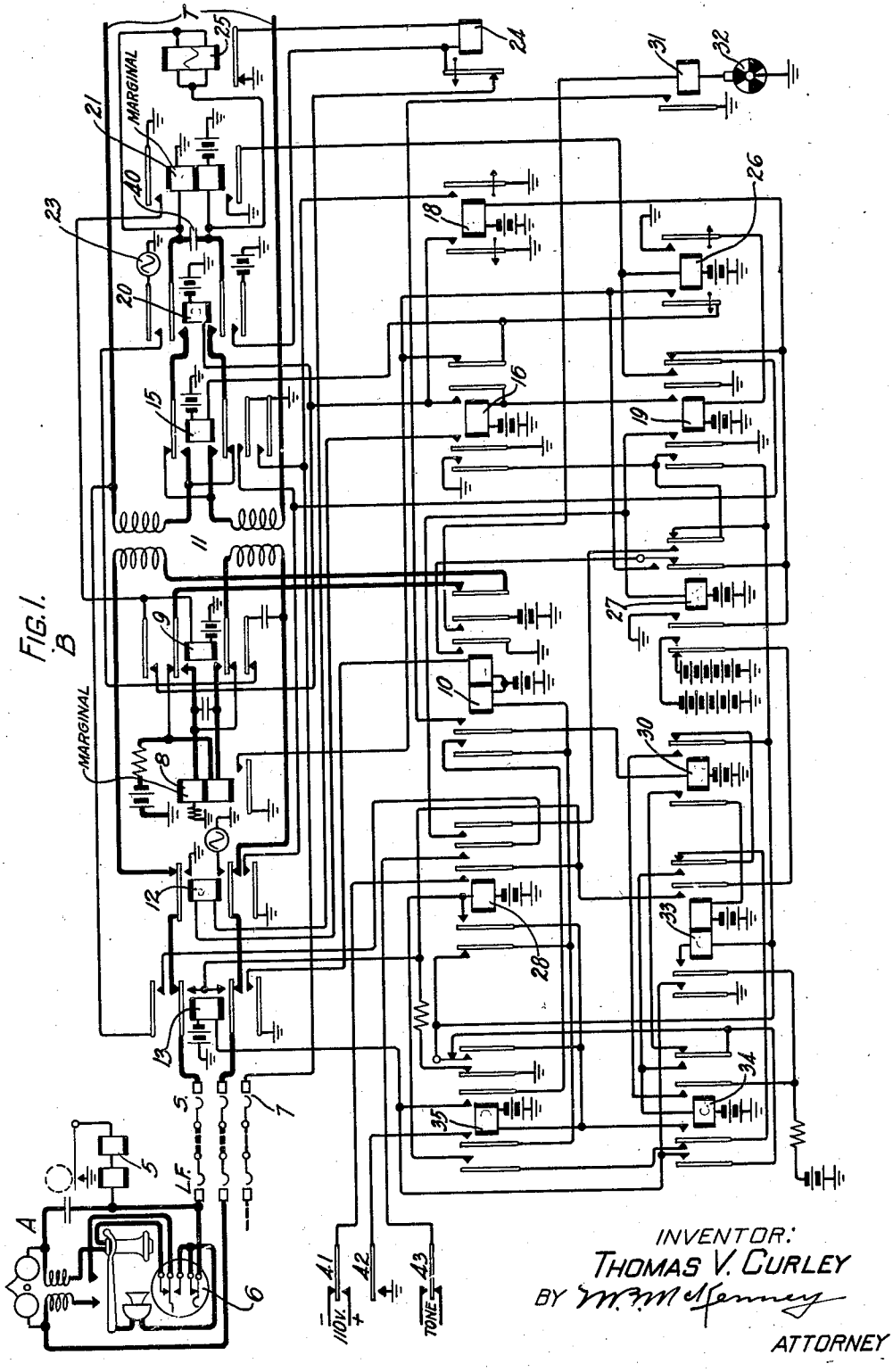

FIG. 1.

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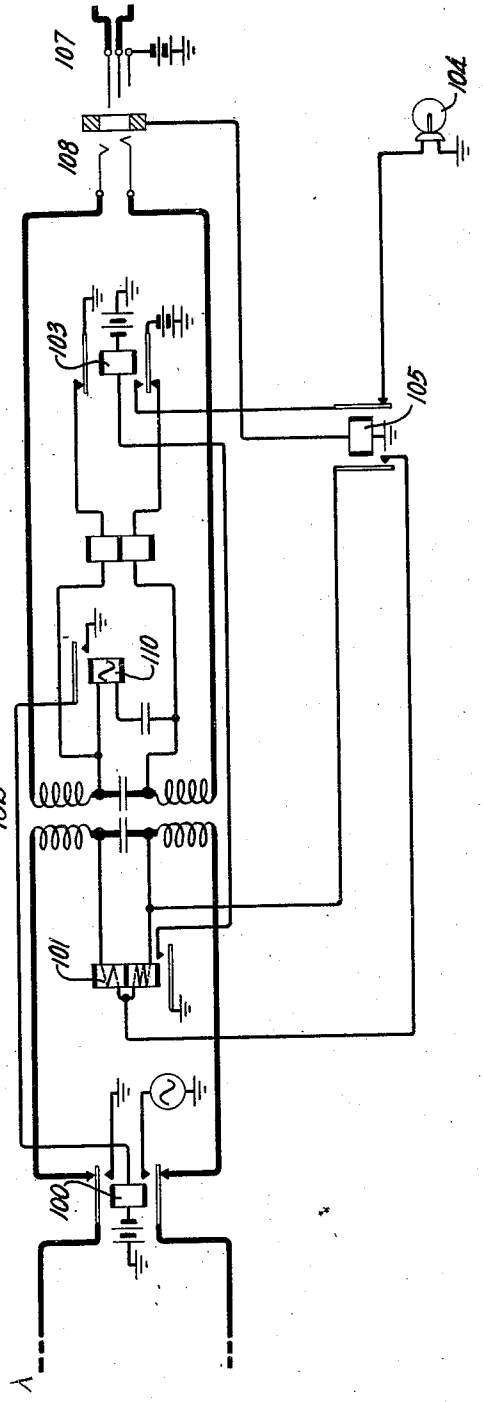

FIG. 2.

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Patented Apr. 8, 1930 1,753,334

UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed May 10, 1928. Serial No. 276,653.

This invention relates to telephone systems and particularly to improvements in trunking systems.

The object is to simplify the equipment and to increase the reliability of operation in a toll trunking system serving coin lines.

In the past it has been the practice for the toll operator to collect the coins deposited by the calling subscriber in payment for the call by means of a key.

According to the present invention this system has been simplified and rendered more reliable by eliminating the operator's collect key and providing means responsive when the calling subscriber hangs up his receiver and the toll operator releases the connection by the removal of a cord from the trunk at the distant office or at the toll switchboard for collecting the coins.

A feature of the invention is a trunk circuit in which the usual condenser, inserted between the outgoing windings of the usual repeating coil to provide a talking circuit path, is placed directly across the control relay windings between this relay and the contacts of the usual current reversing relay. This arrangement is to prevent discharges and charges from the condenser from falsely operating the control relay.

Another feature is an arrangement for increasing the ampere turns on the marginal supervisory relay, controlled by the calling subscriber during switchhook operation, without materially increasing the resistance in series with the line.

Another feature is an arrangement for preventing the interruptions, for coin collect or refund purposes, of the connection between the calling subscriber's line and the central office talking battery from producing clicks in the calling subscriber's receiver. For this purpose means is provided for opening the connection between the talking battery and the repeating coil in the line before said interruptions take place and for closing said connection after said interruptions have ceased.

The invention has been illustrated in the accompanying drawings, in which Fig. 1 shows a trunk at an automatic office arranged in accordance with this invention, a coin box subscriber's station, and intervening automatic switches in diagrammatic form for seizing the trunk.

Fig. 2 shows the incoming end of this trunk terminating in a jack at a toll operator's position. A portion of the toll operator's cord is also shown in this figure in diagrammatic form.

A description will now be made of the functions of the circuit arrangement shown by tracing a call from the calling coin box subscriber's station A, through the switches LF and S at the automatic office B, and through trunk T to the toll operator's position C. As the apparatus at the automatic office whereby calling subscribers may seize trunks such as T is not essential for the description of this invention, none of this apparatus has been illustrated except to indicate the brushes for the line finder LF and the selector S. None of the apparatus at the toll operator's position has been shown, except the answering plug of an ordinary cord circuit, as this equipment is not essential for the description thereof.

Assuming then that the subscriber at station A has deposited a coin to close a connection to ground for the coin box magnet 5 to enable him to operate dial 6; that he has dialed a certain code number to secure a connection to a toll operator, and that the connection has been extended through the line finder LF and the brushes of switch S have seized the terminals 7 of the trunk T. The first effect of this seizure will be that a connection through a comparatively high resistance will be momentarily closed for one winding of relay 8. The characteristics of this winding of relay 8 are such that while the resistance is very low, its ampere turns with the high resistance of the circuit at this time will not permit the relay to operate. The momentary closure is effected due to certain circuit operations in the selector S that of themselves are of no importance in connection with this invention, except in so far that the electrical condition of the circuits serves to demonstrate the operating characteristics of relay 8. This momentary closure may, for example, take place through overflow relays in a sender

circuit that may be connected during this period of operation in the selector, although it is immaterial as far as this invention is concerned in what manner and by what means this momentary circuit closure is established. It is sufficient to mention that relay 8 in accordance with this invention is designed to meet several changing conditions, in the circuit between the calling subscriber and the trunk, of which this momentary closure through a high resistance is the first. Succeeding changes will hereinafter be described. In any event, it is not desirable to have the relay operate in response to this first momentary circuit closure through one of its windings at present in order to prevent the premature operation of the lamp 104 at the toll operator's position, which operation would indicate that the trunk is seized. However, after the momentary closure in this circuit has passed, the circuit arrangements change so that a connection will be established, for example, through a polarized relay bridged across the tip and ring conductors. The resistance of this circuit in this instance will be considerably less than during the first momentary closure. The direction of the current in this circuit will be such that the polarized relay will not operate. The polarized relay has not been shown, but the circuit therefor through one winding of relay 8 may be as follows: battery and resistance through the upper inner armature and contact of relay 9, outer right hand armature and back contact of relay 10, upper left hand winding of repeating coil 11, upper armature and back contact of relay 12, upper inner armature and back contact of relay 13 to the tip terminal and brush of switch S through the polarized relay, back through the ring brush and terminal of switch S and the trunk T, lower inner armatures and back contacts of relays 13 and 12, lower right hand winding of repeating coil 11, lower inner armature and back contact of relay 9, one winding of relay 8 through a resistance to ground.

When the selector has completed this connection (through the polarized relay) the resistance conditions of the above circuit are such that relay 8 will operate. Relay 8 closes an obvious circuit for the operation of relay 15 as follows: battery, winding of relay 15, outer right hand armature and back contact of relay 16, armature and front contact of relay 8 to ground. The operation of this relay closes a circuit to ground for the sleeve terminal connected to the switch S to prevent the selection of trunk T by other selectors. Another circuit closed by the operation of relay 15 is as follows: battery, winding of relay 18, outer right hand armature and back contact of relay 19 to ground at the middle lower armature of front contact of relay 15. Relay 18 operates and closes an obvious circuit for the operation of relay 20. Relay 20 closes battery and ground connections for the trunk T through the winding of relay 21, inner upper and lower armatures and front contact of relay 20, upper armature and inner low armature and front contacts of relay 15, right hand windings of repeating coil 11, tip and ring conductors of trunk T, armatures and back contacts of relay 100 through the left hand windings of repeating coil 102 and the windings of relay 101 in series. This circuit connection causes the operation of relay 101, but due to the lower high resistance winding of relay 101 relay 21 will not operate at this time. The operation of relay 101 closes an obvious circuit for relay 103, which in turn closes an obvious circuit for the lighting of lamp 104 to indicate to the toll operator that a connection is desired over trunk T.

The operation of relay 20 also establishes a connection at its upper armature and front contact from a ringing source 23 which is thereby connected through the lower outer armature and back contact of relay 9 and the condenser and the ring conductor of the trunk to the calling subscriber's telephone to provide a ringing induction tone this tone indicating to the calling subscriber that the connection has been completed to the toll operator's position. The operation of relay 20 also closes an obvious circuit for the operation of relay 24 in an obvious circuit and this relay remains operated during the call under control of the alternating current responsive relay 25, as shown.

The A operator answers this call by inserting plug 107 of an ordinary standard toll cord into jack 108. A circuit is thereby established over the sleeve terminals for the operation of relay 105. Relay 105 in operating opens the circuit for lamp 104, which is thereby extinguished and closes a circuit at its left hand armature and front contact for the short-circuiting of the high resistance winding of relay 101. Sufficient current will flow through the tip and ring conductors of trunk T to cause relay 21 to operate. Relay 21 in operating closes an obvious circuit for the operation of relay 9. This relay in operating reverses the connections from the battery through the upper left hand winding of repeating coil 11 and from the ground through the winding of relay 8 for the subscriber's line to effect certain operations in the switches between the calling subscriber's line and the trunk, which are of no importance in connection with this invention and will not be described here, except to state that the above mentioned polarized relay will operate to establish a connection without encumbrances over the tip and ring conductors directly to the calling subscriber's line from the trunk. Due to the operation of relay 9 the battery connections to the calling subscriber's line are now established through both windings of relay 8. The battery con-

nection through the associated resistance extends through one winding of relay 8 and the lower inner armature and front contact of relay 9, while the ground connection through an associated resistance extends through the other winding of relay 8 and the upper inner armature and front contact of relay 9. The purpose of now connecting two windings of relay 8, in the circuit to the calling subscriber, is to make relay 8 more sensitive to current interruptions such as will be produced by the calling subscriber during supervision, as will hereinafter be described. Relay 8 is so constructed that a comparatively small resistance is added by the inclusion of the second winding in the circuit, while the ampere turns will be materially increased. This relay will therefore remain operated when the connection is extended to the calling subscriber's line as hereinbefore described, even though the resistance of this connection is substantially increased over the resistance of the previous circuit through the polarized relay. Hence, the characteristics of relay 8 are now changed from a non-operate characteristic for a high resistance circuit, which is the circuit first established on the momentary closure hereinbefore mentioned, to an operate characteristic for a second high resistance circuit, which is the circuit to the calling subscriber.

Relay 9 in operating closes a locking circuit for itself through its upper outer armature and front contact to ground at the left hand armature and front contact of relay 18. It also opens the connection through the lower outer armature and back contact and thereby removes the tone for the calling subscriber. The operation of relay 21 also closes an obvious circuit for the operation of relay 26. This relay in operating provides a substitute circuit for maintaining relay 15 operated by closing a connection through its left hand armature and front contact. The original circuit for the operation of relay 15 was closed through the outer right hand armature and back contact of relay 16 and the purpose of this substitute circuit will become apparent as the description proceeds. As relay 26 operates, an obvious circuit is closed for the operation of relay 19. This relay in operating closes an obvious circuit for the operation of relay 16. It also closes an obvious circuit for the operation of relay 27. As relay 27 operated a substitute circuit is closed for maintaining relay 18 operated as it should be noted that on the operation of relay 19 the original energizing circuit for relay 18 was opened at the outer right hand armature and back contact of this relay. Relay 18 is slow to release so it is maintained operated until the new circuit is closed by relay 27. The relays 19 and 16 provide circuits to be described hereinafter for the control of the return of the coin deposited by the calling subscriber to enable him to make a call.

Relay 16 provides a locking circuit for itself through its inner right hand armature and front contact to ground at the left hand armature and front contact of relay 18. It also establishes a connection to ground through its outer left hand armature and front contact and the outer left hand armature and front contact of relay 19 for operating relay 10. The circuit for relay 10 may be traced from battery to the left hand winding of this relay, outer left hand armature of relay 28, through the outer left hand armatures and front contacts of relays 19 and 16 to ground. Another circuit closed by relay 16 is a ground connection through its inner left hand armature and front contact. This circuit is for the operation of relay 12 in case a calling subscriber has to be rerung or recalled by the toll operator, as will hereinafter be described. The ground connection established through the outer left hand armature and front contact of relay 16 is also provided for the maintenance of relay 27 operated after relay 19 is released, which will take place at the end of the call as will hereinafter be described. This circuit will be completed later, when relay 28 operates, through the outer right hand armature and front contact of relay 27 and the outer right hand armature and front contact of relay 28.

Relay 27 in operating provides a connection at its outer left hand armature and front contact from the negative terminal of a 110-volt battery, which will be connected to operate the coin magnets 5 to return coin, as will hereinafter be described. This relay 27 also provides a connection for maintaining relay 15 operated during the coin return period while the original connection to ground at the armature and front contact of relay 8 is opened. This connection will be established from the inner right hand armature and front contact of relay 10, the make-before-break contact of relay 27, left hand armature and front contact of relay 26, winding of relay 15 to battery.

The circuits are now in condition for transmitting an impulse from the 110-volt negative battery to return the coin deposited by the subscriber to enable him to call. When relay 10 operates, a circuit is closed for relay 30 as follows: battery, winding and inner left hand armature of relay 30 front contact of relay 10 to ground at the armature and front contact of relay 31. Relay 31 operates, after relay 10 is operated, over an obvious circuit when the interrupter 32 closes a connection to ground. The circuits for relays 30 and 31 are therefore alternately opened and closed under control of interrupter 32. Relay 10 also opens at its outer right hand armature and back contact the connection through the tip conductor to the calling sub-

scriber's line between the inner upper armature of relay 9 and the upper left hand winding of repeating coil 11. This is for the purpose of reducing objectionable clicks or surges in the calling subscriber's line on the subsequent operation of relay 13, as will hereinafter be described in connection with the return of the coin, at which time the circuit from battery and ground through relay 8 will be opened.

Returning now to the operation of relay 30, the first operation of this relay closes a circuit for the operation of relay 33 as follows: battery, right hand winding of relay 33, left hand armature and front contact of relay 30, outer right hand armature and back contact of relay 34, make-before-break contact of relay 35 to ground at the outer left hand armature and front contact of relay 16 through the outer left hand armature and front contact of relay 19. Relay 33 in operating extends a connection from the back contact of the right hand armature of relay 30 through the outer right hand armature and front contact of relay 33 to the winding of relay 34 and also establishes a connection from the inner right hand armature and front contact from the 110-volt negative battery to the front contacts of the inner upper and lower armatures of relay 13 preparatory to the transmission of the coin-return impulse to the magnet 5. Relay 33 provides a locking circuit for itself through its left hand winding from battery at its inner left hand armature and front contact to ground at the left hand armature and front contact of relay 16 and also closes an obvious circuit for the operation of relay 13. Relay 13 in operating opens the tip and ring conductors at the inner upper and lower armatures and back contacts of this relay and connects the 110-volt negative battery to the tip and ring conductors to the calling subscriber's line through magnet 5 to ground. The magnet is thereby operated in a direction to return the coin to the calling subscriber.

This application of the coin return current remains for a long enough period to permit the magnet 5 to fully operate and the length of this period is determined by the interrupter 32. As relay 13 operates a circuit is completed through the right hand winding of relay 10 to ground to maintain it operated as long as relay 13 is operated, as the original energizing circuit for relay 10 will presently be opened. When the interrupter 32 opens the connection to ground, which may be within a period of one-half a second, relay 31 releases, causing the release of relay 30. Relay 30 in releasing causes the operation of relay 34 over the circuit hereinbefore traced to the right hand armature and back contact of relay 30 which now is extended to ground at the outer left hand armature and front contact of relay 16. Relay 34 in operating closes a locking circuit for itself from battery through its winding and outer right hand armature and front contact, make-before-break contacts of relay 35 to ground at relay 16. It also prepares an operating circuit for relay 35 at its inner left hand armature and front contact, which will be completed when relay 33 later releases. A connection to ground is also completed for maintaining relay 13 operated through its outer left hand armature and front contact to ground at relay 16 under control of the make-before-break contacts of relay 35. Relay 13 is thereby held operated for an additional one-half second, that is, until interrupter 32 is again connected to ground. At the end of this second period the connection to ground is completed through the interrupter 32 to cause the operation of relays 31 and 30 for the second time. When relay 30 operates relay 33 releases, as it will be noted that the battery connected through its left hand winding for holding this relay operated it is now shunted through the right hand armature and front contact of relay 34 and right hand armature and front contact of relay 30 to ground at relay 16, the original energizing circuit for this relay being open at the outer right hand armature and back contact of relay 34. In releasing, relay 33 removes the coin-return battery from the magnet 5 by opening the connection through its inner right hand armature and front contact. This battery has therefore been connected to the magnet 5 for the period of one second.

Relay 33 in releasing opened the original operating circuit for relay 13, while the substitute circuit is maintained by relay 34. At the subsequent release of relays 31 and 30 through the removal of ground by the interrupter 32 after another one-half second interval relay 35 is operated from battery through its winding, inner left hand armature and back contact of relay 34, outer right hand armature and back contact of relay 33, right hand armature and back contact of relay 30 to ground at relay 16. Relay 35 in operating closes a locking circuit for itself through its outer right and armature and front contact to ground at relay 16 and transfers the circuit for maintaining relay 13 operated through its inner right hand armature and front contact, the outer left hand armature and front contact of relay 10, outer left hand armature and back contact of relay 28 to ground at relay 16. Relay 13 is therefore now controlled by relay 28 in place of relay 34 which is released by the operation of relay 35 by the opening of the make-before-break contacts of relay 35. Relay 34 in releasing opens the original energizing circuit for relay 35 and completes a circuit for relay 28 as follows: battery, winding of relay 28, outer left hand armature and front contact of relay 35, inner left hand armature and back

contact of relay 34 through the connection hereinbefore traced from this armature to ground at relay 16. Relay 28 in operating closes a locking circuit for itself, under control of ground at relay 16, through its inner left hand armature and front contact and outer right hand armature and front contact of the relay 35. Relay 28 also closes the hereinbefore mentioned holding circuit for relay 27 at its outer right hand armature and front contact. Relay 28 now opens the holding circuit for relay 10 at its outer left hand armature and back contact and as the holding circuit for relay 13 also passes through this contact, relay 13 will release and this relay in turn causes the release of relay 10. Relay 13 in releasing completes the talking connection from the calling subscriber through to the repeating coil 11 and when relay 10 releases the connection for the tip conductor is completed at the outer right hand armature and back contact of this relay so that battery and ground are now again fed to the calling subscriber's line.

It will be noted that this connection for opening and closing the tip conductor under control of relay 10 is such that it is opened before relay 13 is operated and closed after relay 13 is released, thus reducing the click that ordinarily would be transmitted to the subscriber's telephone on the operation and release of relay 13. The circuit is opened and closed by relay 10 between the battery and the repeating coil, it follows therefore, that no sudden discharges or charges will be felt in the line. In other words the left hand windings of the repeating coil will act as shock-absorbing or retarding means during interruptions of the circuit. Relay 10 in releasing opens the circuit for relay 31 to the interrupter 32, so that this relay 31 cannot again be operated. It also opens the supplementary holding circuit for relay 15, and this relay will now be held by ground at the armature and front contact of relay 8 which operates on the release of relay 10. With relays 35 and 28 operated and relays 34, 33, 30, 13, 10 and 31 released the coin-return circuit is prevented from again functioning until the calling subscriber and the toll operator have disconnected.

The circuit is now completed to the toll operator for talking purposes, with the talking current applied for the calling subscriber at relay 8. The calling subscriber now gives the number of the wanted subscriber to the toll operator, who as is well known in the art establishes the connection to the wanted subscriber. Conversation between the calling subscriber and the called subscriber may then begin as soon as the calling subscriber has deposited the required coins in payment for the call.

The toll operator instructs the calling subscriber to deposit the required amount and arrangements are made in this circuit in the usual manner for refunding or collecting the deposited coins, although this circuit is also arranged for the collection of deposited coins at the end of the conversation in response to the release of the connection by the subscriber and the toll operator. In regard to the return or collection of the coins in the usual manner the procedure will be for the toll operator to call over a separate call wire between the offices and instruct an operator at office B to actuate contacts such as 41, 42 and 43 for this purpose. As this arrangement forms no part of this invention it will not be further described, except to say that the contact 42 will be controlled to close a connection to ground for the operation of relay 10; that the contact 41 actuated upwards or downwards to apply either the 110-volt negative or positive current to the tip and ring conductors leading to the calling subscriber to operate the coin magnet 5 to refund or collect coins, and that contact 43 may be correspondingly operated to apply coin return or collect tone to the toll operator. Relay 10 in operating provides a circuit for holding relay 15 operated when relay 8 is released on the operation of relay 13. Relay 13 is operated by relay 10 over a circuit from battery through the inner right hand armature and front contact of relay 35, outer left hand armature and front contact of relay 10 to ground at contact 42. The operation of relay 13 closes the circuit for holding relay 10 operated and also a circuit for the connection from contact 43 to apply the proper tone current to the toll operator. This connection may be traced from the particular tone source applied to contact 43 through the middle right hand armature and front contact of relay 28, upper outer armature and front contact of relay 13 to the tip conductor of the trunk T leading to the toll operator's position. The particular tone transmitted will indicate to the toll operator whether the coins have been refunded or collected. When the coin has been collected or refunded the ground on contact 41 is removed and relay 13 is released. When relay 13 releases, relay 10 is released and a connection is thereby established for the reoperation of relay 8 to hold relay 15 operated. It should be noted that in this case also the circuit from the battery at relay 8 is opened before relay 13 is operated and closed after relay 13 is released to reduce the click in the subscriber's receiver.

If supervision is desired from the calling subscriber to the toll operator the subscriber will manipulate his switchhook and alternately cause the release and operation of relay 8 and this in turn causes the relay 15 to be alternately released and operated. Relay 15 in releasing reverses battery and ground connection through relay 101 and this relay in turn releases relay 103, which supplies cur-

rent through its armatures and back contacts from battery and ground over the tip and ring conductors to the toll operator's cord 107, and thereby causes the supervisory lamp in this cord to be correspondingly actuated, as is well known in the art. When relay 15 is again operated this supervisory lamp is extinguished so that for each manipulation of the switchhook the lamp will be lighted and the flashing of the lamp serves as a supervisory signal to the toll operator.

It will be noted that a condenser 40 is bridged across the tip and ring conductors between the windings of relay 21 and the armatures of relay 20. This is the regular condenser usually bridging the windings of the repeating coil for talking purposes. It has been placed as indicated in order to prevent false operation of relay 21. Condenser 40 is normally charged from battery and ground through the windings of relay 21, so that when relay 15 is alternately operated and released the charge on the condenser will practically remain the same and no surges of current will pass through the windings of relay 21 under these circumstances. This relay is therefore prevented from operating falsely during supervision. If this condenser had been connected as in ordinary circuits charges and discharges therethrough at the operation and release of relay 15 might have caused false operations of relay 21, as the operating characteristics of relay 21 are marginal. In order to avoid such possibilities the condenser 40 has been placed as shown.

When the calling subscriber originates a call in the manner described above and the toll operator makes an effort to complete that call but is unsuccessful the toll operator will advise the subscriber to restore the receiver to the hook, stating that she will rering him when she is ready to complete the connection. When the connection is completed she operates the ringing key in the toll cord and thus causes the alternating current relay 110 to operate. Relay 110 causes the operation of relay 100 and this relay in turn applies alternating current from the armature and front contacts of this relay over trunk T to cause the operation of the alternating current responsive relay 25. Relay 25 in operating disconnects ground from the winding of relay 24, causing it to release. Relay 24 in releasing closes an obvious circuit for the operation of relay 12. Relay 12 in operating establishes a holding circuit for relay 26 during the release period of relay 8, as relays 15 and 21 will be released at this time. Relay 12 applies ringing current from the source associated with the front contacts of the upper and lower inner armatures to the calling subscriber's bell to rering the subscriber. When the toll operator ceases to apply ringing current, relays 110, 100 and 25 release, causing the reoperation of relay 24, and the release of relay 12.

The talking connection is held established as long as the toll operator's cord is connected to the trunk or the calling subscriber's receiver remains off the hook. At the end of the conversation when the calling subscriber replaces the receiver on the hook, relay 8 is released, causing the release of relay 15. This opens the holding circuit for relay 26 and the current through the trunk T is reversed to release relay 101, which in turn releases relay 103. This relay in releasing applies battery and ground to the toll operator's cord circuit to light the supervisory lamp as a disconnect signal. When the toll operator removes plug 107 from jack 108, relay 21 releases and this relay in turn releases relay 26.

When relay 26 releases and in case the coins deposited by the calling subscriber have not been collected manually as hereinbefore described the coin collect magnet 5 will now be actuated to collect the coins automatically.

The release of relay 26 causes the release of relay 19 and also opens the operating path for relay 15, so that this relay cannot be again operated as long as this connection remains. The release of relay 19 opens the holding circuit for relays 35 and 28 and the operating circuit from relay 27. Relays 35 and 28 release immediately but relay 27 is held operated until after the release of relay 28. Relay 19 also opens the operating circuit for relay 16 and this relay is now under control of the holding circuit established through the left hand armature and front contact of relay 18. Relay 35 in releasing applies ground through the resistance associated with the contacts for the inner upper and lower armatures of relay 13 to serve as a discharge absorbing circuit, as will hereinafter appear. Relay 35 also opens the original operating circuit for relay 28 at its outer left hand armature and front contact. Another circuit opened by the release of relay 35 is that through its inner left hand armature and front contact to the manual coin collect and refund circuit arrangement controlled through contact 42, so that the automatic coin collection cannot be interfered with by manual coin operations. Relay 28 in releasing opens the holding circuit for relay 27. Relay 27 is held operated in this manner to insure that relays 28 and 35 are released on the release of relay 19.

Relay 28 in releasing restores the operating circuit for relay 10, so that this relay will now operate from ground at the relay 16. The circuit for relay 10 in this case is completed to ground at relay 16 through the outer right hand armature and back contact of relay 27. Relay 28 also opens the connections for contact 42 to further prevent interference with the automatic coin collecting means from the manual means. Relay 27 in releasing also opens the original energizing circuit for re-

lay 18, but this relay is held operated through a substitute path established through the inner right hand armature and back contact of relay 27 to ground at the inner right hand armature and front contact of relay 10, so that the relay 18 will remain operated until the coin collect circuits have functioned. Relay 27 in releasing substitutes the positive 110-volt coin collecting current connection for the 110-volt negative coin return current connection at its upper left hand armature and front contact. The operation of relay 10 closes the circuit for relay 31 through to interrupter 32 when ground connection is established therethrough. Relay 31 in turn causes the operation of relay 30 so that these relays will now operate and release under control of the interrupter 32, as hereinbefore described. Relays 33, 34, 35, 13 and 28 will now function as hereinbefore described, except that the coin collect current from the positive source at the outer left hand armature and back contact of relay 27 is sent to the subscriber's station instead of the coin return current. To review these operations briefly, the first operation of relay 30 causes relay 33 to operate. Relay 33 in turn prepares the circuit for relay 34; extends the connection from the 110-volt positive coin collect battery to the contacts of relay 13; provides a locking circuit for itself which in this case is extended through the outer right hand armature and back contact of relay 27 to ground at relay 16, and closes the circuit for the operation of relay 13.

Relay 13 applies 110-volt positive current to magnet 5 to operate it to collect the coins. When the interrupter 32 opens the circuit for relay 31 at the end of the first half-second period, relays 31 and 30 release, causing the operation of relay 34, which in turn establishes a locking circuit for itself, prepares a circuit for relay 35, and provides a holding circuit for relay 13 under control of relay 10. When the interrupter 32 again completes a connection to ground relays 31 and 30 are operated. Relay 33 is thereby released, causing the 110-volt positive battery connection to be opened to release magnet 5. At the subsequent release of relays 31 and 30 relay 35 operates to close a locking circuit for itself; to transfer the circuit of relay 13 to be under the control of relay 10 and to release relay 34. Relay 34 in releasing opens the original circuit for relay 35 and causes relay 28 to operate. Relays 35 and 28 are now under control of relay 16. Relay 28 causes the release of relay 13, which in turn causes the release of relay 10. With relays 35 and 28 operated and relay 10 released the holding ground for relay 18 is removed, causing it to release. Relay 18 in releasing removes the ground from the sleeve circuit to the calling subscriber for switch S, causing the switches S and LF to release the calling subscriber's line from trunk T. Relay 18 also causes the release of relays 9, 16, and 20. The release of relay 16 in turn releases relays 35 and 28 and the circuits of the trunk T are therefore now in their normal condition. It should therefore be noted that the arrangements of the circuit of trunk T are such that in case the toll operator neglects to collect the coins deposited by the calling subscriber in payment for the call these circuits function automatically to operate magnet 5 to collect deposited coins. It should be understood, however, that the equipment for collecting coins manually by a toll operator may be dispensed with as the circuits of trunk T will always function to automatically collect coins before the connection is finally released.

The above described circuit arrangements should be considered merely as illustrative of one embodiment of the invention and it should be understood that many other arrangements may be employed without departing from the spirit of the invention.

What is claimed is:

1. In a telephone system, two stations, a coin collect and refund device associated with one of said stations, means for establishing a connection between said stations, means responsive to the establishing of said connection for actuating said device to refund coins deposited therein, and means responsive to the release of said connection for actuating said device to collect coins deposited therein.

2. In a telephone system, a calling subscriber's line, a coin collect and refund device associated therewith, a trunk, means for connecting said line and device to said trunk at one end thereof under control of the calling subscriber, an operator's cord circuit for association with said trunk at the opposite end thereof, and means responsive to the release of an established connection by the calling subscriber and to the removal of the cord from the trunk for actuating said device to collect coins deposited therein.

3. In a telephone system, a calling subscriber's line, a coin collect and refund device associated therewith, a trunk, means for connecting said line and device to said trunk at one end thereof under control of the calling subscriber, an operator's cord circuit for association with said trunk at the opposite end thereof, a source of current, an interrupter, and means responsive to the release of an established connection by the calling subscriber and removal of the cord from the trunk for applying current from said source to said device under control of said interrupter to actuate said device to collect coins deposited therein.

4. In a telephone system, a line, a source of current, a first relay, a second current reversing relay, the tip and ring conductors of said line being connected from the source of current through the windings of the first re-

lay and the contacts of the current reversing relay, and a condenser bridging said conductors between the two relays.

5. In a telephone system, a line, a repeating coil, a source of current, a first relay, a second current reversing relay, the tip and ring conductors of said line being connected respectively through windings of said repeating coil, contacts of the current reversing relay and windings of the first relay to the source of current, and a condenser bridging said conductors and placed between the contacts of the current reversing relay and the windings of the first relay.

6. In a telephone system, a line, a supervisory relay having two windings, and normally having one winding connected between ground and the incoming end of one of the conductors in said line, and means responsive to the seizure of the outgoing end of said line for connecting the other winding of said relay between battery and the incoming end of the other conductor of said line.

7. In a telephone system, a line, a relay associated with one end of the line in one manner to be non-responsive to currents of a certain value, and means responsive to the seizure of the other end of said line for associating said relay in another manner with said line to be responsive to currents of substantially the same value.

8. In a telephone system, a line, a source of current, a supervisory relay associated with the incoming end of said line and connected to said source of current in one manner to have certain marginal operating characteristics, and means responsive to the seizure of the outgoing end of said line for connecting said relay to said source in a different manner for decreasing the marginal characteristics of said relay by increasing the ampere turns thereon without materially increasing the resistance.

9. In a telephone system, a line, a source of current, a repeating coil connected between the source of current and the line, means for opening the connection between the repeating coil and the source of current for thereafter opening and closing the connection between the line and the repeating coil and finally for closing the first mentioned connection.

10. In a telephone system, a line, a source of current therefor, a repeating coil connected between the source of current and the line, means for interrupting the connnection between the line and the repeating coil, and means responsive to said interrupting means for opening the connection between the repeating coil and the source of current before said interruptions take place and closing it after the interruptions have ceased.

11. In a telephone system two stations, a coin collect and refund device associated with one of said stations, means for establishing connection between said stations, a relay actuated in response to the establishing of said connection, means responsive to the actuation of said relay for actuating said device to refund coins deposited therein, means responsive to the release of said connection for releasing said relay, and means responsive to the release of said relay for actuating said device to collect coins deposited therein.

12. In a telephone system two stations, a coin collect and refund device associated with one station, means for establishing a connection between said stations, two relays actuated in response to the establishing of said connection and a third relay actuated in response to the actuation of one of the first mentioned relays, means responsive to the actuation of said third relay for actuating said device to refund coins deposited therein, means responsive to the release of the connection from one station for releasing one of said first mentioned relays and responsive to the release of the connection from the other station for releasing the other of said first mentioned relays to cause the release of the third relay, and means responsive to the release of said third relay for actuating said device to collect coins deposited therein.

In witness whereof, I hereunto subscribe my name this 9th day of May, 1928.

THOMAS V. CURLEY.