

Dec. 31, 1940.

C. E. LOMAX

2,226,731

TELEPHONE SYSTEM

Filed April 28, 1939.

5 Sheets-Sheet 1

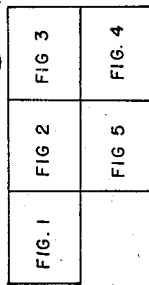
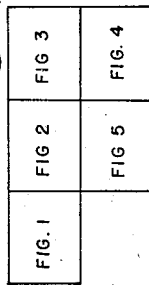
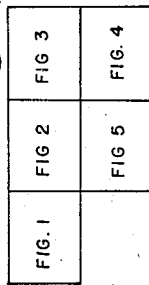
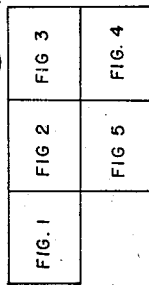
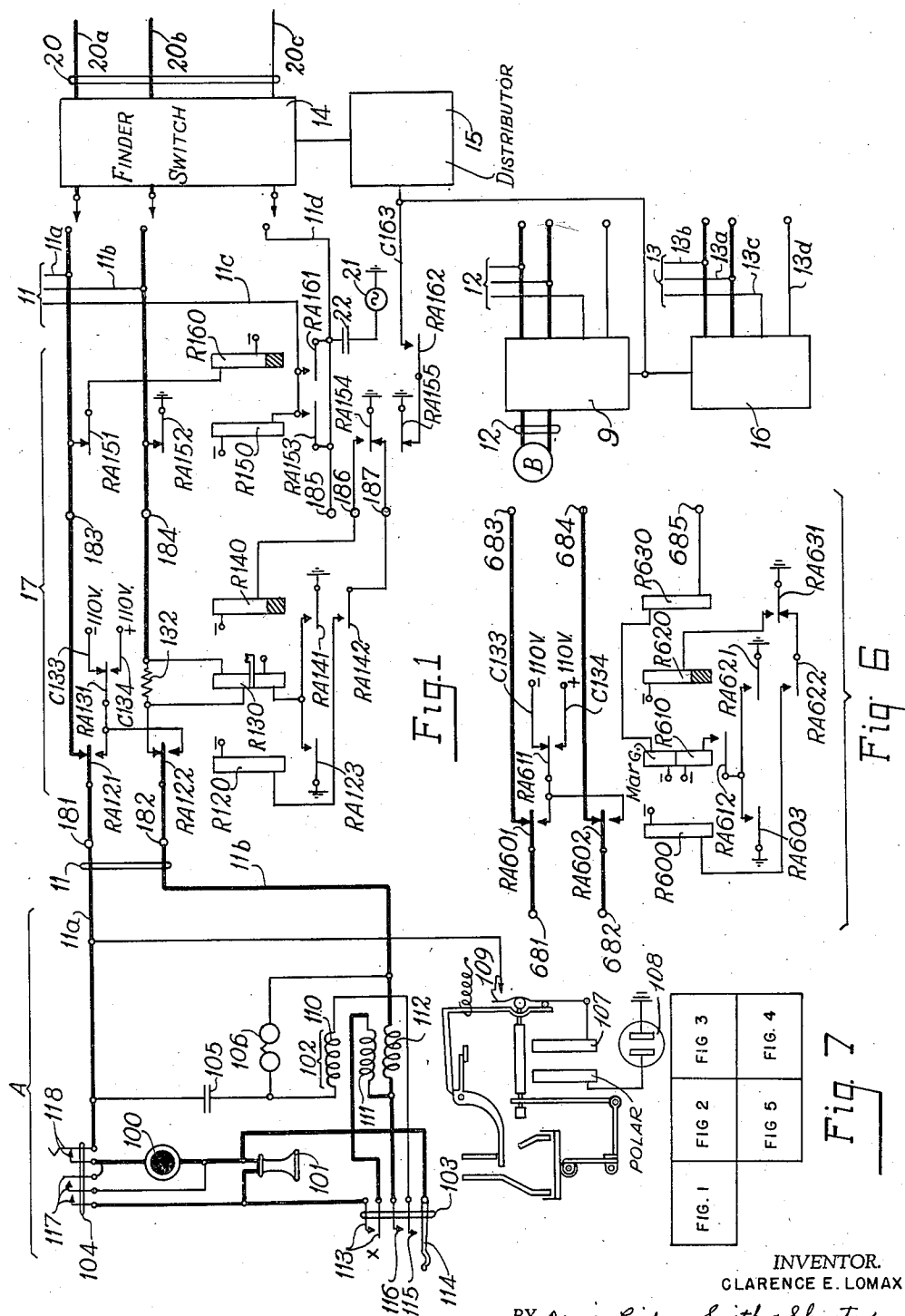


Fig. 7

Fig. 6

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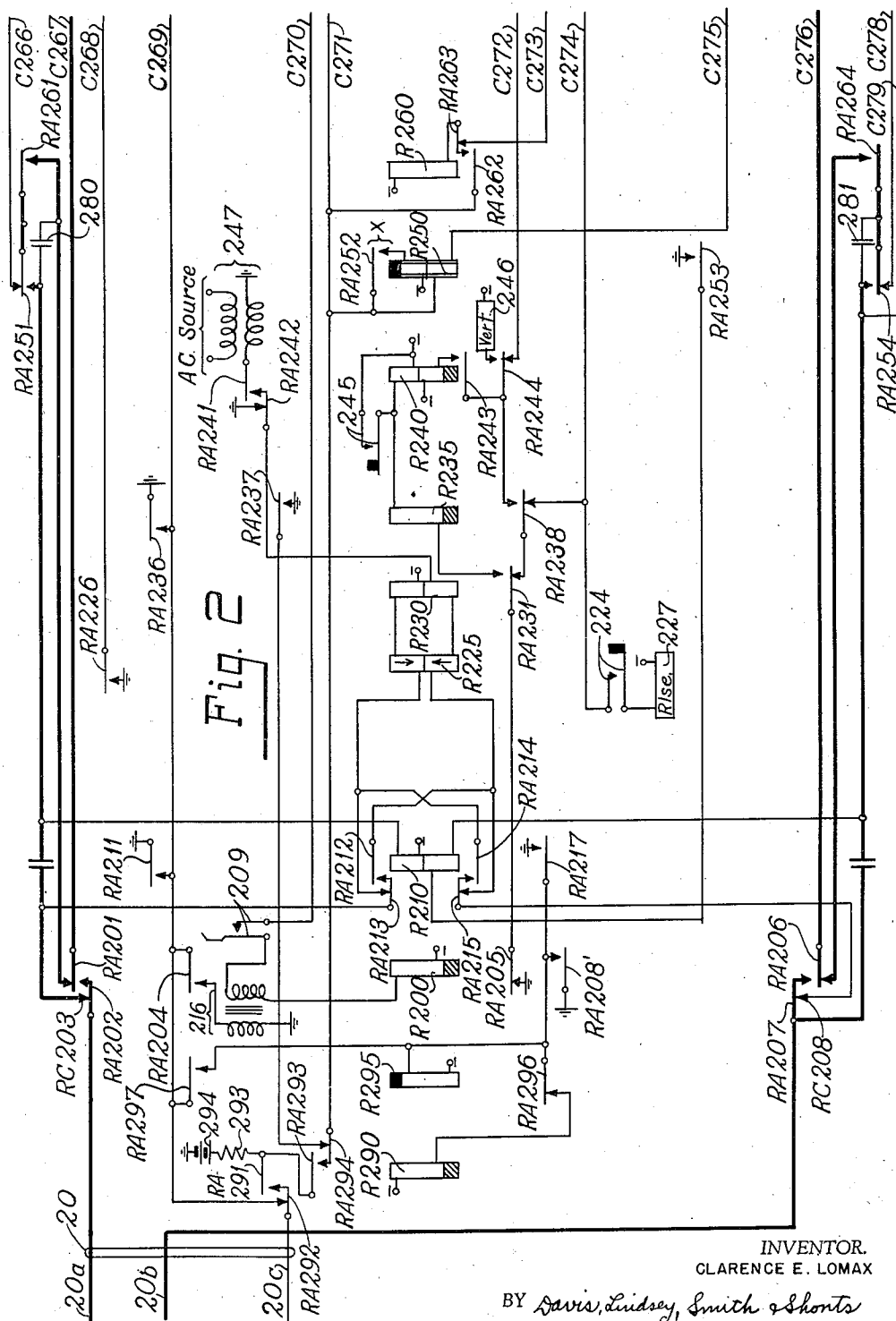
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TELEPHONE SYSTEM

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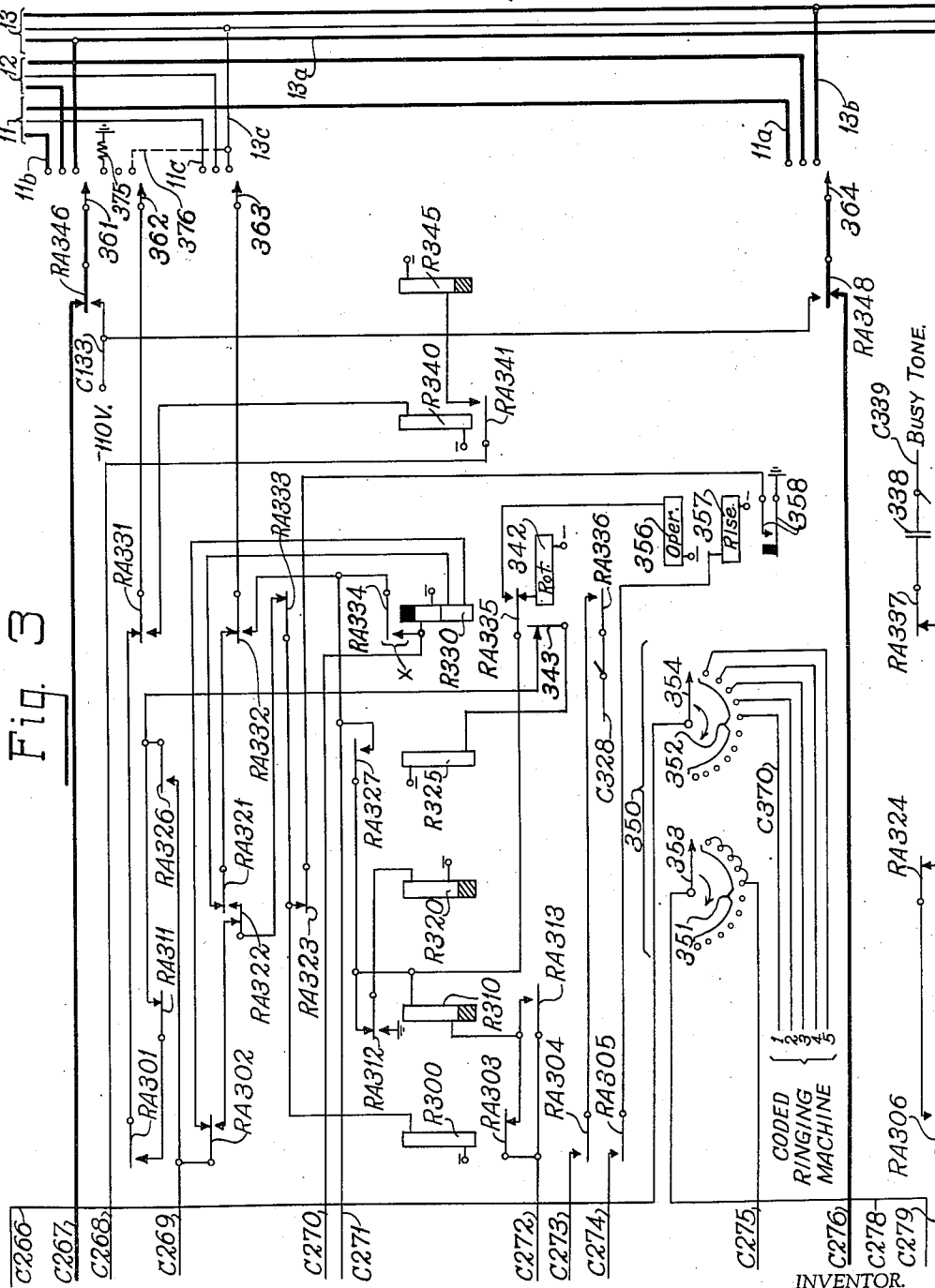
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TELEPHONE SYSTEM

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5 Sheets-Sheet 3



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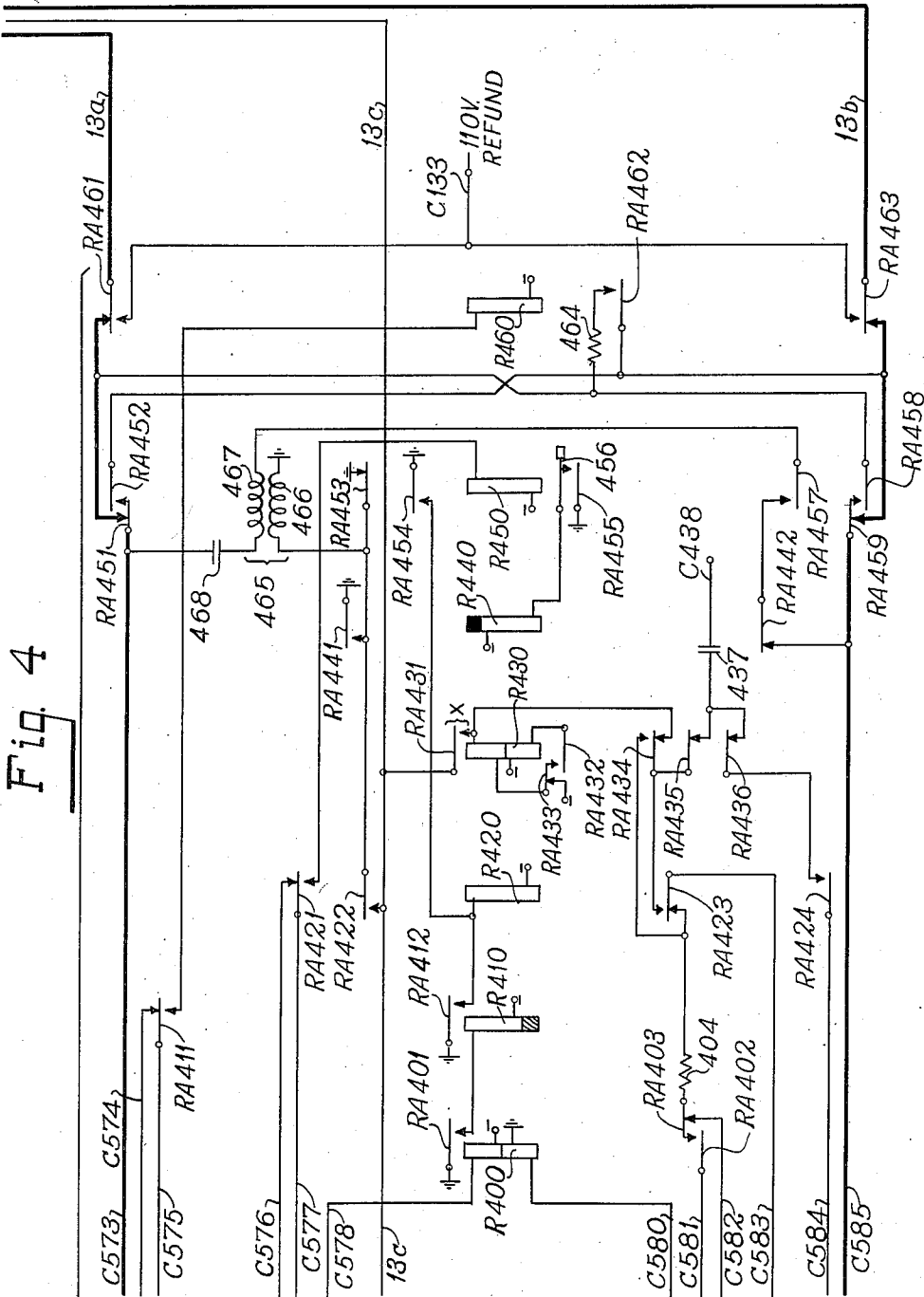
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TELEPHONE SYSTEM

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5 Sheets-Sheet 4



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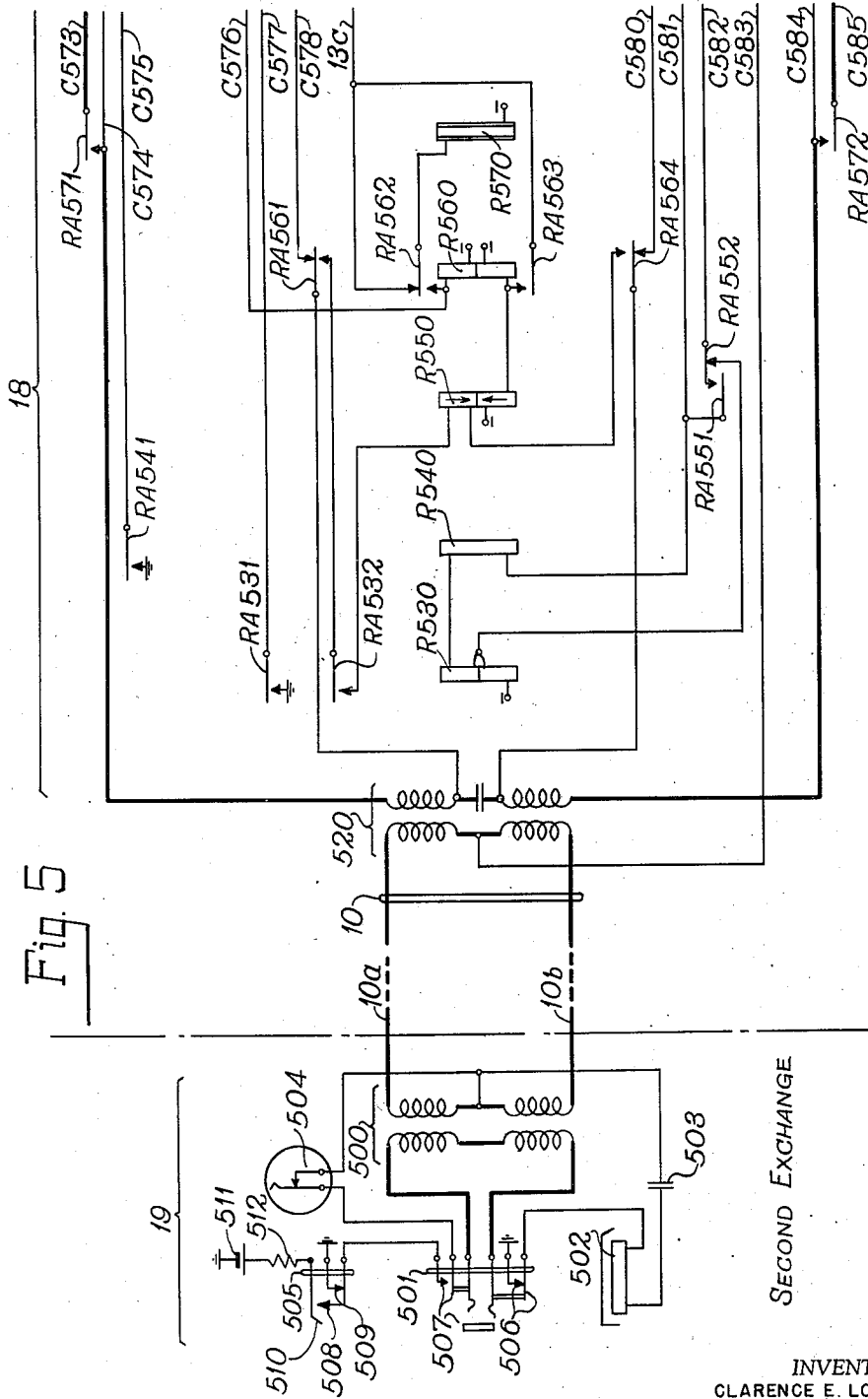
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2,226,731

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5 Sheets-Sheet 5

Fig. 5



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UNITED STATES PATENT OFFICE

2,226,731

TELEPHONE SYSTEM

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Application April 28, 1939, Serial No. 270,539

22 Claims. (Cl. 179-6.3)

The present invention relates to telephone systems and, more particularly, to improved apparatus for controlling the collecting and refunding of coins deposited in the coin-receiving means of pay stations forming a part of an automatic telephone system.

In the usual automatic telephone system, a portion of the substations are of the paystation type, each including means for receiving coins, slugs, or the like, and a coin control mechanism for controlling the coin refunding and collecting operations normally required incident to use of the station. Accordingly, the automatic switching apparatus of the system must be suitably arranged automatically to control the pay station coin control mechanisms incident to the use of local connections involving the paystations and must include apparatus for permitting operators selectively to control the mechanisms so that the proper charges and collections may be made incident to the use of toll connections involving the paystations. Prior automatic telephone systems including these paystation control features are more or less complicated in arrangement and include a large amount of equipment which is used only for the purpose of effecting proper control of the coin mechanisms provided at the paystations. For example, complicated and specially designed intermediate and final selector switches are usually provided for enabling toll operators to set up delayed call connections to the paystations and for permitting the proper coin collecting and refunding operations to be made. In the usual arrangement these special switches are used only in setting up toll call connections. Moreover, prior paystation trunk circuits, in general, require a large amount of relay equipment for effecting the proper control of the paystation coin control mechanisms.

It is an object of the present invention to provide, in an automatic telephone system, improved and exceedingly simple apparatus for controlling the coin collecting and refunding operations required incident to the use of connections involving the paystations embodied in the system.

It is another object of the invention to provide, in an automatic telephone system, improved and simplified apparatus whereby an operator can control the collecting and refunding of coins deposited at the paystations of the system at which calls originate or to which calls are routed.

It is a further object of the invention to provide improved apparatus of the character described which is so arranged that the regular automatic switching apparatus of the system

may be used in completing both local and toll connections without sacrificing any of the required paystation control features.

It is a still further object of the invention to provide improved and exceedingly simple paystation circuit apparatus adapted for use in conjunction with the individual paystation lines which is so arranged that all required paystation control operations are effected with a minimum amount of equipment.

It is a further and more specific object of the invention to provide improved paystation control apparatus of the character described wherein booster battery control is utilized in effecting coin refunding and coin collecting operations.

In the illustrated embodiment of the invention there is disclosed an automatic telephone system which includes a plurality of lines, one of which extends to a substation of the paystation type, together with automatic switching apparatus including a group of final selector switches, which apparatus is operative to establish connections between the various lines. There is also embodied in the system an operator's position to which toll calls may be routed from the substation lines and by way of which calls may be routed to the substation lines. The above-mentioned paystation comprises means for receiving coins, slugs, or the like and means for controlling the collecting and refunding of coins deposited in the coin-receiving means. In accordance with one feature of the present invention, paystation control apparatus is embodied in each of the group of final selector switches mentioned above, which apparatus is, in each case, controllable from the operator's position to control the coin refunding and collecting control means provided at the paystation only for the purpose of causing coins deposited in the coin-receiving means to be refunded. This apparatus in no way prevents the switches from being utilized in completing local call connections. On the contrary, the arrangement is such that these switches may be utilized in extending calls to and from the operator's position on calls involving any of the substations of the system and in setting up local call connections between any of the lines of the system. More particularly, this apparatus as embodied in each switch is operative in response to an unbalanced condition of an established loop circuit extending to the corresponding switch to cause the above-mentioned coin refunding and collecting control means immediately to operate to refund coins deposited in the coin-receiving means.

The above-described coin control apparatus is primarily utilized in controlling the coin collecting and refunding control means to make coin refunds on calls routed from the operator's position to the above-mentioned paystation. In regard to the collection of deposited coins, each of the paystation lines has associated therewith a paystation control circuit which functions, on toll calls routed to and from the operator's position, only to control the coin refunding and collecting control means provided at the associated paystation in its operation to effect a coin collecting operation. These paystation control circuits, on local calls originating at the associated paystations, are arranged to operate in a novel manner to cause both coin refunding and collecting operations to be performed. Two embodiments of this improved control circuit are disclosed. In one embodiment, reverse battery control is utilized and in the other embodiment the arrangement is such that booster battery control may be utilized.

Further features of the invention pertain to the particular arrangement of the various switching elements, whereby the same switches may be used in completing both local and toll connections, and the required apparatus for effecting control of the coin refunding and collecting control means is reduced to a minimum. The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings, in which Figures 1 to 5, inclusive, when combined in the manner shown in Fig. 7, illustrate a telephone system having incorporated therein the features of the invention as briefly outlined above; and Fig. 6 illustrates a modification of certain of the apparatus shown in Fig. 1.

In general, the system, as illustrated in Figs. 1 to 6, inclusive, of the drawings, comprises a relatively small community automatic exchange and a second central exchange, the two exchanges being interconnected by a plurality of two-way trunk lines, one of which is indicated at 10 in Fig. 5 as extending to an operator's position 19 provided in the central exchange. In the particular arrangement shown, the community automatic exchange is designed to serve one hundred lines or less. Two of these lines are indicated at 11 and 12 as extending respectively to the substations A and B, the substation A being of the paystation type and the substation B being of the conventional common battery type of which there are several well-known commercial embodiments. The line 12 and the other similar lines may be of the single party type or of the multiparty type, as desired. For the purpose of setting up connections between the lines terminating at the community exchange, there is provided automatic switching equipment which comprises a plurality of finder-conductor links, one of which is illustrated as comprising a finder switch 14 and the connector switch shown in Figs. 2 and 3 of the drawings. For the purpose of assigning idle ones of the finder connector switch to the use of calling lines in a definite order there is provided a distributor 15. Each of the regular subscribers' lines of the system terminates in the community exchange in a line circuit of conventional arrange-

ment, that associated with the line 12 being indicated at 9. The finder and connector switches each have access to all of the lines terminating at the community exchange and also to repeaters individually associated with the trunk lines extending to the central office. Thus, the connector switch shown in Figs. 2 and 3 has access by way of a link line 13 to a two-way repeater 18 associated with the two-way trunk line 10. Calls routed from the central exchange over the trunk line 10 and intended for a subscriber's line terminating in the community exchange may be routed through the repeater 18 and any one of the finder-conductor links provided in the community exchange to the desired subscriber's line. To this end, there is associated with the link line 13 a line circuit 16 of conventional arrangement.

Any desired number of the subscribers' lines terminating at the community exchange may be arranged to serve substations of the paystation type and such substations may each be of the form illustrated in Fig. 1 for the substation A. In brief, the apparatus provided at this substation comprises a transmitter 100, a receiver 101 and an induction coil 102 arranged to be interconnected through operation of a hook switch 103 to form a substation circuit of the well-known anti-side-tone type. For the purpose of audibly indicating the presence of incoming calls on the line 11, there is also provided at the substation A a signal device in the form of a ringer 106 which is bridged across the conductors 11a and 11b of the line 11 in series with a condenser 105. In order to transmit switch control impulses by way of the line 11 to the automatic switching equipment provided in the line terminating exchange, there is embodied in the substation apparatus a calling or impulsing device 104. The substation further comprises coin-receiving means, not shown, which includes a coin deposit chute, a coin collect chute and a coin refund chute, together with apparatus for selectively directing a deposited coin into the correct one of the coin collect and coin refund chutes. This apparatus includes a coin-directing door, not shown, which is arranged to be operated by a polarized electromagnetic device 107 having windings adapted to be connected between the line conductors 11a and ground in series with a glow discharge device in the form of a neon tube 108. The electromagnetic device 107 is so arranged that when its windings are energized by current of one polarity the associated coin-directing door is rocked in one direction to direct deposited coins into the coin collect chute and when its windings are energized by current of the opposite polarity the associated coin-directing door is rocked in another direction to direct deposited coins into the coin refund chute. The neon tube 108 has the well-known characteristic of being non-conductive until a predetermined voltage is impressed across the terminals thereof. Following ionization of the gas contained therein the voltage required to maintain the tube conductive is substantially less than that required for initiating ionization. Also, the resistance of the device is substantially lessened after the device is rendered conductive. The series circuit including the tube 108 and the windings of the device 107 also includes a pair of contact springs 109 which are only operated into engagement in response to the deposit of a coin in the coin deposit chute of the coin-receiving means. When once operated

into engagement, the springs 109 are not dis-
 engaged until the electromagnet device 107 op-
 erates in one manner or the other. The coin
 collect apparatus provided at the substation A
 and schematically shown in Fig. 1 of the draw-
 ings may be of the well-known type shown and
 described in Patent No. 1,043,219, granted No-
 vember 5, 1912, Fosberg, although preferably
 this apparatus and the impulsing device 104 of
 the substation are arranged in the manner dis-
 closed and claimed in copending application Se-
 rial No. 265,459, filed April 1, 1939, Clarence E.
 Lomax. As thus arranged, certain calls, such,
 for example, as trunk calls to an operator's po-
 sition in the distant central office, may success-
 fully be completed without the deposit of a coin
 in the coin-receiving means, whereas other calls
 intended for the substations local to the com-
 munity exchange can only successfully be com-
 pleted after a coin has been deposited in the
 coin-receiving means. To this end, and as dis-
 closed in the aforementioned copending applica-
 tion, the substation circuit is so arranged that
 only a predetermined number of digits, as, for
 example, two digits, may effectively be trans-
 mitted from the substation, a digit counter be-
 ing provided for shunting the pulsing springs of
 this device after a predetermined number of dig-
 its has been dialed.

For the purpose of controlling the coin col-
 lecting and coin refunding operations required
 incident to the use of connections resulting from
 calls originating at the substation A, the line
 11 is divided into two parts which are connected
 by a combined paystation control and line cir-
 cuit 17. This trunk circuit comprises a coin
 control and line switching relay R120 arranged
 to be controlled by a pair of additional relays
 R140 and R150, the first of which is of the slow-
 to-release type. The relay R150 also functions
 in the capacity of a cut-off relay. The circuit
 17 further includes a slow-to-release line relay
 R160 and an electro-polarized relay R130 which
 functions to determine whether a coin refund
 or coin collect operation is to be performed in-
 cident to operation of the relay R120. This po-
 larized relay comprises an upper winding seri-
 ally included in one side of the line 11 and
 shunted by a resistor 132 for by-passing voice
 frequency currents. This relay is so construct-
 ed and arranged that it only operates when its
 lower winding is polarized and current of a pre-
 determined polarity is directed through its up-
 per winding. When once operated, however, the
 relay R130 remains operated so long as its lower
 winding is energized and regardless of the po-
 larity of the current traversing its upper wind-
 ing. Several embodiments of this type of relay
 are commercially available.

On a call originating at a paystation, such, for
 example, as the station A, and routed to an op-
 erator's position in the central office, it is nec-
 essary that apparatus be provided for disclosing
 to the operator the identity of the calling sta-
 tion in order that the proper charges may be
 assessed and the proper collection made. For
 this purpose there is provided a tone generator
 21 which is arranged to impress its alternating
 voltage output upon the control conductor 11
 of the line 11 through a condenser 22.

Each of the finder switches embodied in the
 automatic switching apparatus provided in the
 community exchange is preferably of the well-
 known Strowger type of which several commer-
 cial embodiments are known. The distributor

15 may be of any desired commercial construc-
 tion. The connector switches of this exchange
 are all of identical arrangement. In brief, the
 connector switch shown in Figs. 2 and 3 com-
 prises a plurality of bank contacts arranged in
 levels; a wiper carriage structure including the
 wipers 361 to 364, inclusive; means comprising
 a vertical magnet 246 for elevating the wiper
 carriage structure to bring the wipers opposite
 a desired level of contacts; means comprising a
 rotary magnet 342 for rotating the indicated
 wipers until they engage a desired set of con-
 tacts in a selected level; a release magnet 227;
 three sets of off-normal springs 209, 224 and
 245; and a plurality of control relays connect-
 ed and arranged in the manner illustrated. More
 particularly, the control relays of the connector
 switch include a line switching relay R200 of
 the slow-to-release type, a called party answer
 or back-bridge relay R210, a line relay R230, a
 slow-to-release hold relay R235, a slow-to-release
 digit transfer relay R240, a slow-acting ring cut-
 off relay R250, a ringing control relay R260, a
 pair of booster battery control relays R280 and
 R295, a busy test relay R300, a pair of slow-to-
 release pulse responsive relays R310 and R320,
 and a slow-to-operate line switching relay R330.
 The slow-acting relay R320 is arranged to co-
 operate with a trunk hunting relay R325 to con-
 trol the operation of the wipers 361 to 364, in-
 clusive, when the connector switch is function-
 ing to search for an idle one of the trunk lines
 extending to the central office. The control ap-
 paratus of the connector switch further includes
 three additional relays R225, R340 and R345
 which are provided for the purpose of control-
 ling coin refunding operations performed in-
 cident to the completion of calls routed from an
 operator's position in the central office to the
 paystation lines terminating at the community
 exchange. In order to transmit paystation tone
 voltage impressed upon the control conductor
 20 of the trunk line 20 incoming to the con-
 nector switch to the control conductor of a link
 line extending to one of the repeaters selected
 through operation of the connector switch, there
 is also embodied in the connector switch a signal
 voltage repeating transformer 216.

The connector switch is arranged to provide
 selective code ringing of the substations associ-
 ated with the multi-party subscribers' lines of
 the system. To this end there is embodied in
 the connector switch an impulse responsive code
 selecting switch 350 of the well-known minor
 type. In brief, this code selecting switch com-
 prises two sets of bank contacts 351 and 352
 of eleven points each; wipers 353 and 354 indi-
 vidualy associated with the contact sets; means
 comprising an operating magnet 356 and a ratch-
 et and pawl mechanism, not shown, for stepping
 the wipers over the contacts of their respective
 associated contact sets; a release magnet 357;
 and off-normal springs 358 for controlling the
 energization of the release magnet.

The two-way repeater 18 associated with the
 trunk line 10 extending between the community
 exchange and the central office comprises a re-
 peating transformer 520 and a plurality of relays
 for controlling the signaling and line switching
 operations required incident to the extension of
 connections in either direction through the re-
 peater. More particularly, the relay equipment
 of this repeater comprises a line relay R400, a
 slow-to-release hold relay R410, a ringing relay
 R420, a ring cut-off relay R430, and a pair of

relays R440 and R450 which function to control the transmission of the paystation tone signal voltage over the trunk line 10 to the operator's position 19. The relay R440 is of the slow-to-operate type and the relay R450 is of the well-known pendulum type. The relays just described are utilized primarily in the extension of connections from the apparatus provided in the community exchange to the operator's position 19. On calls routed in the other direction, that is, from the operator's position 19 to the automatic switching apparatus provided in the community exchange, the relay equipment shown in Fig. 5 primarily controls the line switching operations. This equipment comprises a line relay R530, a back-bridge relay R550, a slow-acting line switching relay R570, and a control relay R560. Two additional relays R540 and R460 are embodied in the repeater 18 for the purpose of controlling coin refunding operations required incident to the use of paystations associated with the paystation lines terminating at the community exchange. For the purpose of transmitting paystation tone signals over the trunk line 10, there is embodied in the repeater a transformer 465 which includes a primary winding 466, bridged between the control conductor 13 of the link line 13 and ground, and a secondary winding 467 which is adapted to be bridged across the line conductors of the repeater in series with a condenser 468.

The trunk line 10 terminates in the central exchange in a repeater transformer 500, one side of which is connected to the tip and ring contacts of a call and answer jack 501 located at the operator's position 19. The apparatus provided at the operator's position 19 also includes a signal device in the form of a drop 502 which includes a winding normally bridged between ground and the junction point of the secondary windings of the transformer 500 in series with a condenser 503. For the purpose of transmitting switch control impulses from the operator's position 19 over the trunk line 10 to the repeater 18, there is provided a calling or impulsing device 504. The apparatus provided at this operator's position further includes a coin refunding control key 505 of the nonlocking type which is operative to impress the positive potential of a booster battery current source 511 upon a simplex circuit including the trunk line 10, thereby to control the two relays R540 and R460 embodied in the repeater 18. The apparatus provided at the operator's position 19 also includes an operator's cord circuit, not shown, which may be of any desired commercial arrangement.

As explained above, the arrangement of the apparatus provided at each of the substations of the paystation type is such that a local call initiated at any one of these substations can only be completed if the correct coin deposit is made in the coin-receiving means provided at the calling substation. Assuming, for example, that a party at the substation A desires a connection with the substation B, the call is initiated in the usual manner by removing the receiver 101 from the supporting hook 114 of the hook switch 103. In response to this operation a loop circuit is completed over which the line relay R160 is energized. This loop circuit extends from battery by way of the winding of R160, RA151, RA121, the line conductor 11a, the pulsing springs 118, the transmitter 100, the switch-

hook 114 and associated contacts 115 and 116, the induction coil winding 112, the line conductor 11b, RA122, the upper winding of R130 and RA152 to ground. When the hook switch 103 is operated to its off-normal position the contact 5 springs 113 are also closed so that the induction coil 102, the transmitter 100 and the receiver 101 are properly interconnected for the reception and transmission of voice frequency currents. The line relay R160 responds to the completion 10 of the above-traced loop circuit by operating to complete, at RA161, a path extending through the winding of the cut-off relay R150 for marking the line 11 in the bank contacts of the finder switches having access thereto. At RA162, the relay R160 completes a path including RA155 for impressing ground potential upon the distributor start conductor C163. The distributor 15 responds to the last-mentioned operation by initiating the operation of an idle one of the finder switches to search for the calling line. Assuming, for example, that the link comprising the finder switch 14 is assigned by the distributor 15 to the use of the line 11, this switch operates in a well-known manner to seize the line 11, as marked in the bank contacts of the finder switch 14 over the above-traced marking path, and to extend the calling loop circuit to the connector switch shown in Figs. 2 and 3. The line relay R230 is energized over this loop circuit and operates. More particularly, the circuit for energizing the line relay R230 may be traced as extending from ground by way of RA242, the lower winding of R230, the lower winding of R225, RA215, RC208, RA207, the line conductor 20b, the upper winding of R130, RA122, the conductor 11b, the winding 112, the contacts 115 and 116, the switchhook 114, the transmitter 100, the pulsing springs 118, the conductor 11a, RA121, the conductor 20a, RA202, RC203, RA213, the upper winding of R225 and the upper winding of R230 to battery. The relay R225, being of the differential type, does not operate when its two windings are energized over the loop circuit just traced. The relay R230, however, operates to complete, at RA231, a circuit extending from ground at RA205 for energizing the winding of R235 in series with the upper winding of the relay R240. The relay R235, upon operating, prepares, at RA237, various circuits, traced hereinafter, for energizing certain of the other relays shown in Figs. 2 and 3. At RA238, the relay R235 opens a point in the circuits, traced hereinafter, for energizing the release magnets 227 and 357. At RA239, the relay R235 also prepares pulsing circuits, traced hereinafter, for respectively energizing the vertical magnet 246, the rotary magnet 342 and the operating magnet 356 of the minor switch 350. The relay R240, upon operating, prepares, at RA243, a holding circuit for itself and prepares, at RA244, the above-mentioned circuit for energizing the vertical magnet 246. At RA241 and RA242, the relay R240 substitutes ground through the secondary winding of the transformer 247 for ground derived from the contact associated with RA242 in the above-traced loop circuit including the two windings of the line relay R230. When the secondary winding of the transformer 247 is included in this loop circuit, the usual dial tone signal is transmitted through the transformer 247 to the receiver 101 provided in the calling substation.

At RA236, the hold relay R235, upon operating - 76

ing, impresses ground potential upon the control conductor 20 of the trunk line 20. This ground is extended to the private conductor 11a of the calling line 11 through the finder switch 14. When ground potential is impressed upon the indicated control conductor, the relay R150 is energized over a circuit which may be traced as extending by way of the grounded conductor 11a, RA161, and the winding of R150 to battery.

When energized over this circuit, the relay R150 operates to complete, at RA153, an obvious holding circuit for itself and in so doing completes an obvious path for impressing ground potential upon the private conductor 11a, thereby to mark the line 11 as busy. At RA154, the relay R150 completes an obvious circuit for energizing the slow-to-release relay R140, causing the last-mentioned relay to operate and prepare, at RA142, a circuit for energizing the relay R120.

The operation of the relay R140 also results in the energization of the lower winding of the electro-polarized relay R130 in an obvious manner. The direction of current flow through the upper winding of this polarized relay is, however, such that the relay does not operate at this time. At RA155, the relay R150 opens the above-traced path for impressing ground potential upon the distributor start conductor C163. At RA151 and RA152, the relay R150 opens two points in the above-traced operating circuit for the line relay R160, thereby to clear the line 11 of the shunt impedance represented by the exchange battery and the winding of R160 and to cause the release of R160. Upon restoring, the relay R160 opens, at RA161, a point in the operating circuit for the cut-off relay R150 and opens at RA162, a further point in the above-traced path for impressing ground potential upon the start conductor C163. Following the above-described operations, the connector switch, as shown in Figs. 2 and 3, is conditioned to respond to the impulses of the first digit to be dialed at the calling substation A.

After removing the receiver 101 from its supporting hook, the calling party should deposit the coin representing the charge for local calls in the coin-receiving means provided at the substation A. Following this operation, the calling party may proceed to dial the digits of the directory number designating the desired substation B. When a coin is deposited in the coin deposit channel of the coin-receiving means, the coin controlled mechanism operates to move the contact springs 109 into engagement, thereby to connect the windings of the polarized magnet 107 and the serially related discharge lamp 108 between the line conductor 11a and ground. At this time the voltage of the exchange battery as impressed between the line conductor 11a and ground through the windings of the two relays R230 and R225 is insufficient to cause current flow through the discharge device 108. Accordingly, the windings of the electromagnetic device 107 are not energized at this time. During the dialing operation and each time the dial of the calling device 104 is moved off normal, the shunt springs 117 of this device are moved into engagement to complete obvious paths for short-circuiting the transmitter 100 and the receiver 101. Also, during each return movement of the dial, the pulsing springs 118 are opened and closed a number of times depending upon the numerical value of the digit dialed. At the end of each return movement of the dial, the shunt

springs 117 are opened in the usual manner to interrupt the above-mentioned short-circuiting paths.

The line relay R230 responds to the impulses of the first digit dialed at the calling substation by completing the above-mentioned operating circuit for the vertical magnet 246 one or more times. Assuming, for example, that the directory number designating the desired substation B is 775, the line relay R230 restores and reoperates seven times during the impulses of the first digit so that seven current pulses are transmitted to the vertical magnet 246. The circuit for energizing this vertical magnet may be traced as extending from ground at RA205 by way of RA231, RA238, RA244 and the winding of the magnet 246 to battery. A branch of this circuit extends by way of RA243 and the lower winding of the slow-to-release relay R240 to battery. Each time the vertical magnet 246 is energized, the wipers 361 to 364, inclusive, are elevated one step so that, at the end of the first digit of seven impulses, these wipers are left standing opposite the seventh level of bank contacts. As the indicated wipers are operated to the first vertical off-normal position, the off-normal springs 245 are moved into engagement to complete an obvious path for short-circuiting the upper winding of the relay R240. By virtue of the completion of the above-mentioned branch circuit including the lower winding of the relay R240 and the slow-to-release characteristic of this relay, it remains operated until shortly following the end of the first digit. Due to its slow-to-release characteristic, the hold relay R235 also remains operated during pulsing. At the end of the first digit and during the interdigit pause between the first and second digits, the line relay R230 remains operated for a sufficiently long time interval to cause the restoration of the relay R240. Upon restoring, the relay R240 opens, at RA243, a point in the circuit for energizing its lower winding and opens, at RA244, the above-traced pulsing circuit including the winding of the vertical magnet 246. At RA241 and RA242, the relay R240 removes the secondary winding of the transformer 247 from the loop circuit extending to the calling substation, thereby to terminate the dial tone signal being transmitted to the calling subscriber.

The impulses of the second digit dialed at the calling substation are repeated through operation of the line relay R230 to the rotary magnet 342. More particularly, as the line relay restores at the beginning of each impulse of the second digit, a circuit is completed for energizing the rotary magnet 342 in series with the slow-to-release relay R310, this series circuit extending from ground at RA205 by way of RA231, RA238, RA244, C272, RA303, the winding of R310, RA335 and the winding of the magnet 342 to battery. Each time the magnet 342 is energized over this circuit it steps the wipers 361 to 364, inclusive, one step in the rotary direction so that, at the conclusion of the second digit of seven impulses, these wipers are left standing in engagement with the contacts terminating the conductors of the called line 12.

Upon operating, at the beginning of the first impulse of the second digit, the relay R310 completes, at RA313, a path in multiple with the armature RA303, thereby to prevent the pulsing circuit extending through the winding of the rotary magnet 342 from being interrupted

through operation of the busy relay R300 as the wipers 361 to 364, inclusive, are moved over contacts terminating the conductors of busy lines. At RA311, the relay R310 opens a point in the circuit, traced hereinafter, for energizing the trunk hunting relay R325. At RA312, the relay R310 completes an obvious circuit for energizing the slow-to-release relay R320, causing the last-mentioned relay to operate. Due to the slow-to-release characteristics thereof, the relays R310 and R320 remain operated throughout the second and each succeeding series of impulses. Upon operating, the relay R320 opens, at RA323, a point in an alternative circuit, traced hereinafter, for energizing the busy relay R300. At RA321 and its associated resting contact, the relay R320 opens a point in the circuit, traced hereinafter, for energizing the lower winding of the line switching relay R330. At RA321 and RA322, the relay R320 completes the line test circuit including the winding of the busy relay R300, whereby this busy relay is energized each time the wipers 361 to 364, inclusive, encounter a set of contacts terminating a busy line. At RA324, the relay R320 opens a point in the path, traced hereinafter, for impressing busy tone voltage upon the loop circuit extending to the calling substation.

Immediately the wipers 361 to 364, inclusive, are moved into engagement with the contacts terminating the called line 12, this line is tested over the above-mentioned test circuit including the winding of the busy relay R300. Assuming the called line to be busy at the time it is thus selected, the busy relay is energized over this circuit which extends by way of the grounded private conductor of the called line, the wiper 363, RA332, RA321, RA322, RA333 and the winding of R300 to battery. Upon operating, the relay R300 opens, at RA303, a point in the initially traced circuit for energizing the rotary magnet 342. At RA304, the relay R300 prepares a circuit, traced hereinafter, for energizing the ringing control relay R260. At RA305, the relay R300 prepares a point in the above-mentioned circuit for energizing the release magnet 357. At RA306, the relay R300 prepares the above-mentioned path for impressing busy tone voltage upon the calling loop circuit. At RA301, the relay R300 prepares a circuit, traced hereinafter, for energizing the trunk hunting relay R325. At RA302, the relay R300 opens another point in the operating circuit for the line switching relay R330 and prepares a holding circuit for itself. Shortly following the end of the second digit the relays R310 and R320 sequentially restore in the order named and in an obvious manner. Upon restoring, the relay R320 completes the above-mentioned holding circuit for the busy relay R300 and thereafter opens the operating circuit for the busy relay. The holding circuit for the busy relay extends by way of the grounded release conductor C269, RA302, RA322 and its associated resting contact, RA333 and the winding of the relay R300 to battery. At RA324, the relay R320 completes the above-mentioned path for impressing busy tone voltage upon the calling loop circuit. This path may partially be traced as extending from the ungrounded terminal of the busy tone source by way of C339, the condenser 338, RA337, RA324 and RA306 to the lower side of the loop circuit extending to the calling substation. When this path is completed busy tone current is caused to flow over the calling loop circuit in the usual manner. This current is reproduced by the receiver 101 so that

the calling party is informed that the desired connection cannot be obtained. It is pointed out that following operation of the busy relay R300 the dialing of the third digit at the calling substation is without effect since with the relay R300 operated the pulsing circuit for the rotary magnet 342 is held open at the armatures RA303 and RA313 and the circuit for energizing the operating magnet 356 of the minor switch 350 is also interrupted at these two points. Hence, if the calling party continues the dialing operation and dials the third digit, the only response to the impulses of this digit is the alternate restoration and operation of the line relay R230. Following the operation of the busy relay R300, in the manner just explained, no further operation of the apparatus occurs until the connection is cleared out at the calling substation. The manner in which the switch train is released when the calling subscriber replaces the receiver 101 upon its supporting hook 114 is explained in detail hereinafter.

Assuming the called line 12 to be idle at the time it is selected, battery potential is present upon the private or control conductor thereof so that the busy relay R300 is not energized over the previously traced test circuit. Shortly following the selection of the line and during the inter-digit pause between the second and third digits, the two relays R310 and R320 sequentially restore in the manner pointed out above. The relay R320, upon restoring, completes the above-mentioned circuit for energizing the slow-to-operate line switching relay R330, this circuit extending by way of the grounded release conductor C269, RA302, the lower winding of R330, RA321, RA332 and the wiper 363 to the negative battery terminal as connected to the private conductor of the called line 12 through the windings of the cut-off relay conventionally embodied in the line circuit 9. When its lower winding is energized over this circuit, the relay R330 first completes, at the "X" contacts associated with RA334, a holding circuit for itself, this holding circuit extending by way of the grounded release conductor C271, RA334 and the upper winding of R330 to battery. Thereafter the relay R330 opens, at RA333, a point in the above-traced test circuit including the winding of the busy relay R300, interrupts, at RA332, its own operating circuit as traced above, and completes, at RA332, a path for impressing ground potential upon the private conductor of the called line for the purpose of marking this line as busy in the bank contacts of the other connector switches having access thereto. This path extends by way of the grounded conductor C271, RA332 and the private wiper 363 to the private conductor of the called line. At RA331, the relay R330 opens a point in the above-mentioned circuit for energizing the trunk hunting relay R325 and prepares a circuit, traced hereinafter, for energizing the coin refund control relay R340. At RA335, the relay R330 prepares the above-mentioned circuit for energizing the operating magnet 356 of the minor switch 350 in accordance with the impulses of the third and final digit of the directory number designating the called substation B. At RA336, the relay R330 prepares a point in the circuit for energizing the ringing control relay R260. Finally, at RA337, the relay R330 opens a point in the above-traced path for impressing busy tone voltage upon the calling loop circuit. Following operation of the relay R330, the operating magnet 356 is conditioned to respond to the impulses of

the third digit of the directory number designating the called substation.

Each time the line relay R230 restores during the impulses of the third digit, the above-mentioned circuit is completed for energizing the magnet 356, this circuit extending from ground at RA205 by way of RA231, RA238, RA244, C272, RA303, the winding of R310, RA335 and the winding of the magnet 356 to battery. When energized over this circuit at the beginning of the first impulse of the third digit, the relay R310 operates to complete the operating circuit for the relay R320, which latter relay, in turn, operates to open, at RA323, the above-mentioned alternative circuit for energizing the busy relay R300. The two slow-to-release relays R310 and R320 remain operated throughout the impulses of the third digit. Each time the operating magnet 356 is energized during the impulses of the third digit, it functions to advance the wipers 353 and 354 one step so that, at the conclusion of the third digit of five impulses, these wipers are left standing in engagement with their respective associated fifth contacts. When the indicated wipers are stepped to their respective first off-normal positions, the off-normal springs 358 are moved into engagement to prepare the alternative circuit for energizing the busy relay R300. This circuit is completed shortly following the end of the third digit and in response to the sequential restoration of the two slow-to-release relays R310 and R320. Specifically, this circuit extends from ground by way of the springs 358, RA323, and the winding of R300 to battery. At RA305, the relay R300 prepares the above-mentioned circuit for energizing the release magnet 357. At RA304, the relay R300 prepares the circuit for energizing the ringing control relay R260. The last-mentioned circuit is completed shortly following the operation of the busy relay R300 and at the beginning of the next cycle of operation of the ringing interrupter switch forming a part of the ringing apparatus conventionally provided in the community exchange in common association with the various connector switches of the exchange. This circuit may be traced as extending from ground by way of the pickup conductor C328, RA336, RA304, C273, RA263 and the winding of R260 to battery. When energized over this circuit the relay R260 operates to complete a holding circuit for itself, which holding circuit extends from ground at RA237 by way of RA294, RA262, RA263 and the winding of R260 to battery. Following the completion of this circuit the relay R260 opens, at RA263 and its associated resting contact, a point in its operating circuit as traced above. At RA261 and RA264, the relay R260 completes a circuit for projecting over the called line 12 coded ringing current of the particular character corresponding to the called substation B, as selected by the minor switch 359. More particularly, the circuit traversed by the ringing current may, in the present case, be traced as extending from one terminal of the ringing current generator by way of contacts controlled by the above-mentioned interrupter switch, not shown, C370, the fifth contact of the set 352, the wiper 354, C266, RA251, RA261, RA201, C267, RA346, the wiper 361, one side of the line 12, the ringer and condenser bridged between the conductors of the line 12, the other side of the line 12, the wiper 364, RA349, C276, RA206, RA264, RA254, C278, the wiper 353, the fifth contact of the set 351, C275, the lower wind-

ing of R250, RA294, RA237 and the exchange battery to the other side of the ringing current source. The resulting operation of the signal device provided at the called substation B serves to signal the subscriber at this substation that his substation is being called to the exclusion of other substations associated with the line 12. A portion of the ringing current is by-passed by way of the condensers 280 and 281 and the calling loop circuit to energize the receiver provided at the calling substation, thereby to signal the calling party that the called substation is being rung.

The desired conversational circuit between the calling and called substations is completed when the call is answered at the called substation B. More particularly, when the receiver at the called substation is removed from its supporting hook, the hook switch embodied in this substation operates to connect a direct current bridge across the conductors of the line 12, thereby to complete a circuit, substantially similar to that traced above and traversed by the ringing current, for energizing the lower winding of the slow-acting cut-off relay R250. When energized by direct current traversing this circuit, the relay R250 operates to complete, at the "X" contacts associated with RA252, a circuit, extending from ground at RA237, for energizing its upper winding. Following the completion of this circuit, the relay R250 completes its operation to open, at RA251 and RA254, two points in its operating circuit and two points in the above-traced circuit traversed by the ringing current, thus arresting the ringing operation and terminating the ring-back tone signal. At these same armatures and their respective associated working contacts, the relay R250 completes the desired conversational circuit between the calling and called substations and, in so doing, completes a loop circuit extending to the called substation. This loop circuit includes the windings of the back-bridge relay R210 and may be traced as extending from ground at RA253 by way of the lower winding of R210, RA254, RA264, RA206, C276, RA348, the wiper 364, one side of the called line 12, the direct current bridge connected between the conductors of the line 12, the other side of the line 12, the wiper 361, RA346, C267, RA201, RA261, RA251 and the upper winding of R210 to battery. Current for energizing the transmitter provided at the called substation is conducted to the transmitter over the circuit just traced. Current for energizing the transmitter 100 provided at the calling substation is conducted to this transmitter through the windings of the line and differential relays R230 and R225 and over the calling loop circuit. When energized over the loop circuit extending to the called substation, the relay R210 operates to complete, at RA211, an obvious multiple path for impressing ground potential upon the control conductor 20 of the trunk line 70. At its armatures RA212 to RA215, inclusive, the relay R210 reverses the direction of current flow over the calling loop circuit in the usual manner.

The back-bridge relay R210, upon operating, also completes, at RA217, an obvious circuit for energizing the slow-to-operate relay R295 in parallel with the slow-to-release relay R290. The relay R290 now operates to complete a path for impressing booster battery potential upon the control conductor 20, this path extending from the positive terminal of the booster battery current source 294 by way of the resistor 293, RA291

and RA292 to the conductor 20. At RA293 and RA294, the relay R290 completes a similar path for impressing booster battery potential upon the release conductor C271. After these paths are completed the control conductor 20. and the conductor C271 are disconnected from ground at RA292 and RA294 and their respective associated resting contacts. Shortly following the operation of R290, the relay R295 operates to complete, at RA297, an obvious holding circuit for itself. At RA296, the relay R295 opens the operating circuit for the relay R290. The relay R290 restores its armatures RA291, RA292, RA293 and RA294 after an interval, thereby to disconnect the conductors 20. and C271 from the booster battery source and to reconnect these conductors to ground. Thus, it will be apparent that booster battery potential is impressed upon the conductors 20. and C271 for a short time interval immediately following the completion of the desired talking circuit between the calling and called substations. In the present case the application of positive booster potential to these conductors is without effect other than to increase the energization of the relays R150, R250, R260 and R330. On calls originating at regular substations of the system, however, and routed through the connector switch of Figs. 2 and 3, the application of booster potential to the conductor 20. may be utilized, in a well-known manner, to control call metering devices associated with the calling lines. The application of booster potential to the control conductor 20. of the trunk line 20 and to the release conductor C271 may also be utilized to control the paystation control circuit shown in Fig. 6 in the manner described hereinafter.

When the relay R210 operates to reverse the direction of current flow over the calling loop circuit, the electropolarized relay R130 operates to prepare, at RA131, a path, traced hereinafter, for impressing a positive or coin collecting potential of 110 volts upon the line conductor 11. in order to cause the electromagnetic device 107 to operate and collect the coin deposited in the coin-receiving means provided at the calling substation. As explained previously, the relay R130 is of the type such that when once operated it remains in its operated position so long as its lower winding is energized regardless of the direction of current flow through its operating or upper winding.

The arrangement of the connector switch shown in Figs. 2 and 3 is such that the release of a switch train including this switch is entirely under the control of the calling party. Thus, following the completion of the connection between the calling substation A and the called substation B, if the called party replaces his receiver upon its hook before the connection is cleared out at the calling substation, the only resulting operation is the release of the back-bridge relay R210 to reverse the direction of current flow over the calling loop circuit. When, however, the calling party replaces the receiver upon the switch-hook 114, the calling loop circuit is interrupted at the springs 115 and 116, and the line relay R230 restores to interrupt the circuit for energizing the hold relay R235. The hold relay, upon restoring, completes, at RA238, the above-mentioned circuits for energizing the release magnets 227 and 357. The circuit for energizing the magnet 227 extends from ground at RA205 by way of RA231, RA238, the off-normal springs 224 and the winding of the magnet 227 to battery. When thus energized, the magnet

227 operates to cause the restoration of the wipers 361 to 364, inclusive, to rotary and vertical normal in the usual manner. If the back-bridge relay R210 is operated at the time the release magnet 227 is energized, the loop circuit extending to the called substation is interrupted during the release of the switching mechanism, thus causing the restoration of the back-bridge relay. Upon restoring, the relay R210 opens, at RA217, a point in the operating circuit for the relays R290 and R295. When the enumerated switch wipers are returned to their respective normal positions, the off-normal springs 224 are opened to deenergize the magnet 227. The circuit for energizing the release magnet 357 extends from ground at RA205 by way of RA231, RA238, C274, RA305 and the winding of the magnet 357 to battery. When this circuit is completed, the magnet 357 operates to cause the wipers 353 and 354 of the minor switch 350 to be returned to their respective home positions, at which time the off-normal springs 358 are opened to interrupt the above-traced alternative circuit for energizing the busy relay R300, causing this relay to restore and open, at RA305, the operating circuit for the release magnet 357.

When the hold relay R235 restores, in the manner explained above, it also interrupts, at RA237, a point in the common portion of the holding circuits for the relays R250, R260 and R330, causing all of these relays to restore. At this time ground potential is also removed from the private conductor of the called line 12, permitting battery potential to be impressed upon this private conductor through the windings of the cut-off relay embodied in the line circuit 9, thereby to mark the line 12 as idle. At RA236, the relay R235 opens the holding circuit for the relay R295, causing the last-named relay to restore. Following the restoration of the indicated relays and switching apparatus, the connector switch is fully released.

When the two relays R210 and R235 restore during the release of the connector switch, ground potential is removed from the private conductor 20. of the trunk line 20, thereby to deenergize the relay R150. When ground potential is removed from the private conductor 20. of the trunk line 20, the finder switch 14 is released in the usual manner and the finder-connector link illustrated is marked as idle in the bank contacts of the distributor 15. Upon restoring, the relay R150, at RA154, opens the operating circuit for the relay R140 and completes a circuit extending by way of RA142 for energizing the relay R120. At RA153, the relay R150 opens the path for impressing ground potential upon the private conductor 11. and a point in its own holding circuit. The relay R120, upon operating, completes, at RA123, an obvious multiple holding circuit for the relay R130. At RA121 and RA122, the relay R120 completes the above-mentioned paths for impressing a positive or coin collect potential of 110 volts upon the line conductors 11. and 11b of the calling line 11. More particularly, the 110 volt source is connected across the discharge device 108 over a circuit which extends from the ungrounded terminal of the source by way of C134, RA131, RA121, the conductor 11., the springs 109, the windings of the magnet 107 and through the discharge device 108 to the grounded terminal of the source. The magnitude of this voltage is such that the gas contained in the discharge device 108 is ionized to permit the flow of current therethrough, so that the windings of the magnet 107 are energized.

The polarity of the current traversing the above-traced circuit following ionization of the device 108 is such that the armature associated with the magnet 107 is pivoted in a direction to cause the coin deposited in the coin deposit channel of the coin-receiving means to be directed into the coin collect channel in the usual manner. Operation of the armature associated with the magnet 107 also results in disengagement of the contact springs 109 to interrupt the series circuit including the windings of the magnet 107 and the discharge device 108. Thus, the deposited coin is collected during the release of the operated switch train and after the conversation held over the established connection is terminated. Shortly following the energization of the magnet 107 the slow-to-release relay R140 restores to open, at RA141, one of the multiple holding circuits for the relay R130. At RA142, the relay R140 opens the operating circuit for the relay R120, causing the last-mentioned relay to restore. When the relay R120 restores it interrupts the remaining holding circuit for the electropolarized relay R130, causing the latter relay to restore. At its armatures RA121 and RA122, the relay R120, upon restoring, also opens the above-traced path for impressing the positive coin collect potential upon the conductors 11a and 11b of the line 11.

In the event the called line 12 is busy at the time it is selected by the connector switch illustrated in Figs. 2 and 3, the back-bridge relay R210 embodied in this switch does not operate. Accordingly, the two booster battery control relays R290 and R295 are not caused to operate. Also, the direction of current flow over the calling loop circuit is not reversed and the polarized relay R130 of the apparatus 17 remains in its restored position. When the usual busy tone signal is transmitted to the calling substation, the calling party is expected to abandon the call by replacing the receiver 101 upon its supporting hook 114. In response to this operation, the calling loop circuit is interrupted and the relays R230, R235 and R300, which are the only operated relays in the connector switch, are caused sequentially to restore in an obvious manner. The hold relay R335, upon restoring, functions to remove ground potential from the control conductor 20c and to complete, at RA238, the previously traced operating circuits for the release magnets 227 and 357, thus causing the minor switch 350 and the switching mechanism of the connector switch to be restored to normal in the manner previously explained. When ground potential is removed from the control conductor 20c of the trunk line 20, the finder switch 14 is released and the relay R150 is de-energized and restores to complete the previously traced circuit for energizing the relay R120. Upon operating, the relay R120 completes, at RA121 and RA122, paths for impressing the negative potential of the 110 volt coin refund current source upon both conductors of the calling line 11. More particularly, the voltage of this source is impressed across the electrodes of the discharge tube 108 over a circuit extending from the negative terminal of the coin refund current source by way of C133, RA131, RA121, the conductor 11a, the springs 109, the windings of the magnet 107 and through the device 108 to the positive terminal of the coin refund current source. The magnitude of this voltage is such that the discharge device 108 is rendered conductive, so that the windings of the magnet 107 are energized by current traversing the circuit just traced. The direction of current flow over this circuit is such

that the magnet 107 pivots its associated armature in a direction to cause the coin deposited in the coin deposit chute of the coin-receiving means to be directed into the coin refund channel of this means. Operation of the armature controlled by the magnet 107 also results in disengagement of the contact springs 109, whereby the circuit serially including the discharge device 108 and the windings of the magnet 107 is broken. Shortly thereafter the relays R140 and R120 are caused to restore in the order named and in the manner previously explained, the last-mentioned thereof functioning to open the holding circuit for the relay R130 causing the latter relay to release. Thus, the operated switch train is fully released and the coin deposited by the calling party, incident to initiation of the call, is refunded.

Referring now to the operation of the apparatus to extend a connection to the operator's position 19 in the central office, if it be assumed, for example, that the above-described call initiated at the substation A is a trunk call and further that the finder switch 14 and the connector switch shown in Figs. 2 and 3 are utilized in completing the desired connection, the calling party, after removing the receiver 101 from its supporting hook 114, dials the two digits of the directory number designating the operator's position 19. As explained above, the arrangement of the apparatus provided at the substation A is such that two digit numbers may be dialed without the deposit of a coin in the coin-receiving means. In response to the impulses of the first digit, the wipers 361 to 364, inclusive, of the connector switch are elevated to a position opposite the level of bank contacts terminating the link lines extending to the repeaters associated with the trunk lines extending to the central office, all in the exact manner previously described with reference to the call routed to the substation B. In this connection, it is pointed out that the uppermost level or levels of bank contacts embodied in the connector switch are utilized to terminate the indicated link lines. During the vertical movement of the wipers and when the wipers are moved to a position opposite the first of the contact levels terminating link lines extending to the two-way repeaters, the off-normal springs 209 are moved into engagement to prepare a circuit, traced hereinafter, for energizing the slow-to-release switching-through relay R200. When a second digit of one impulse is dialed at the calling substation, the rotary magnet 342 is energized and operates to rotate the wipers 361 to 364, inclusive, into engagement with the first set of contacts in the selected contact level. Assuming that the link line 13 extending to the repeater 18 is terminated at the third set of contacts in the selected level and further that the trunk line 10 is the first available idle trunk line extending to the central office, the three relays R300, R320 and R325 cooperate with the rotary magnet 342 to cause the wipers to be rotated until they encounter the third set of contacts in the selected level. Thus, the private conductors of the link lines extending to the repeaters associated with the respective first and second interoffice trunk lines both have ground potential thereon by virtue of the busy condition of the associated repeaters. Accordingly, when the wiper 363 encounters the grounded contact of the first contact set during the first step taken by the wipers 361 to 364, inclusive, the previously traced circuit is completed for energizing the busy relay R300, it being pointed

out that the two slow-acting relays R310 and R320 are operated at this time. When the relay R310 restores shortly following the operation of the busy relay R300, it completes the previously mentioned circuit for energizing the trunk hunting relay R325, this circuit extending by way of the grounded private conductor of the first link line, the strap 376 between the private and extra control contacts of the first contact set in the selected level, the wiper 362, RA331, RA301, RA311, the armature 343 and the winding of R325 to battery. When this circuit is completed, the relay R325 operates to complete, at RA326, a holding circuit for itself, which holding circuit extends from ground at RA236 by way of C269, RA326, the armature 343 and the winding of R325 to battery. At RA327, the relay R325 completes a circuit for energizing the relay R320 and the rotary magnet 342 in parallel, one branch of this circuit extending by way of the grounded release conductor C271, RA327, RA312 and the winding of R320 to battery, and the other branch extending by way of C271, RA327, RA335, and the winding of the magnet 342 to battery. By virtue of the completion of this circuit, the slow-to-release relay R320 is maintained in its operated position. The rotary magnet 342, when energized over the above-traced circuit, operates to step the wipers 361 to 364, inclusive, into engagement with the second set of contacts of the selected contact level and to open, at the armature 343, the holding circuit for the relay R325. The relay R325 now restores to open, at RA326, a further point in its holding circuit and to interrupt, at RA327, the above-traced circuit for energizing the relay R320 and the magnet 342 in parallel. As a result, the magnet 342 restores its armature 343 to recomplete the previously traced test circuit including the winding of the relay R325. Since, in the assumed case, the link line terminated at the second set of contacts of the selected contact level is also associated with a busy interoffice trunk line, ground potential is present upon the private and extra control contacts of the second contact set and the trunk hunting relay R325 is again energized over the test circuit as traced above. Accordingly, this relay reoperates to recomplete, at RA326, its holding circuit and to recomplete, at RA327, the circuit for energizing the relay R320 in parallel with the rotary magnet 342. As a result, the wipers 361 to 364, inclusive, are operated into engagement with the third set of contacts of the selected level, which contacts are assumed to terminate the conductors of the link line 13 associated with the idle interoffice trunk line 10. It will be understood, in view of the foregoing explanation, that in any case the interrelated operation of the relay R325 and the rotary magnet 342 continues until the wipers 361 to 364, inclusive, are advanced into engagement with a set of contacts terminating an idle one of the link lines or until all of the link lines have been tested. Since, in the present case, the third link line 13 is assumed to be idle, negative battery potential as derived through the winding of the relay R570 is present upon the control or private conductor 13, so that the trunk hunting relay R325 is not energized over the previously traced test circuit when the wipers 361 to 364, inclusive, encounter the contacts terminating the conductors of the line 13. Accordingly, the relay R325 remains in its restored position and the step-by-step operation of the wipers is arrested. Immediately the wiper 363 is moved into engage-

ment with the contact terminating the private conductor 13, having negative battery potential thereon, the busy relay R300 restores to prepare the previously traced circuit for energizing the lower winding of the line switching relay R330. Shortly thereafter the relay R320 restores to complete the last-mentioned circuit. The relay R330 now operates to complete, at RA334, its holding circuit, as traced above, and to open, at RA333, a further point in the circuit for energizing the busy relay R300. At RA331, the relay R330 prepares the circuit for energizing the relay R340. At RA332, the relay R330 opens a point in its operating circuit and completes a path for impressing ground potential upon the private or control conductor 13, this path extending by way of the grounded conductor C271, RA332 and the wiper 363 to the conductor 13. At RA334, the relay R330 also completes a circuit for energizing the switching-through relay R200, this circuit extending from ground at RA237 by way of RA294, C271, RA334, C270, the off-normal springs 209, the secondary winding of the transformer 216 and the winding of R200 to battery. Upon operating, the relay R200 completes, at RA204, a multiple path including the primary winding of the transformer 216 for impressing ground potential upon the private conductor 20, of the trunk line 20, thereby to maintain the finder switch 14 operated and the relay R150 energized. At RA208, the relay R200 completes the circuit for energizing the relays R290 and R295, thereby to cause the sequential operation of these two relays followed by the restoration of the relay R290, in the manner previously explained. During the interval when the relay R290 is operated positive booster battery potential is substituted for ground potential upon each of the conductors 20, and C271. The relay R295, upon operating, completes a holding circuit for itself, this holding circuit extending from ground by way of the left winding of the transformer 216, RA204, RA297 and the winding of R295 to battery.

At RA201 and RA206 and their respective associated armatures RA202 and RA207, the relay R200, upon operating, connects the trunk line conductors 20, and 20, to the link line conductors C267 and C276, thereby to switch the calling loop circuit through to the repeater 18. At RA202 and RA207 and their respective associated contacts RC203 and RC208, the relay R200 opens two points in the loop circuit as initially established and including the windings of the relays R225 and R230, thereby to cause the sequential restoration of the relays R230 and R235. Before the hold relay R235 restores to remove ground potential from the respective release conductors C269 and C271, however, multiple ground potential is impressed upon the conductor C271 in the repeater 18 for the purpose of maintaining the relays R200, R295 and R330 operated. Thus, when ground potential is impressed upon the private conductor 13, of the link line 13, this line is marked as busy in the bank contacts of the other connector switches having access thereto and a circuit is completed for energizing the slow-acting relay R570. This circuit extends by way of the grounded conductor 13, RA562 and the winding of R570 to battery. Upon operating, the relay R570, at RA571 and RA572, extends the calling loop circuit through the windings of the repeating coil 520 and the windings of the line relay R400 so that the last-mentioned relay is energized thereover. Upon operating, the relay

R400 prepares, at RA402 and RA403 a circuit, traced hereinafter, for energizing the relays R530 and R540 in series. At RA401, the relay R400 completes an obvious circuit for energizing the slow-to-release hold relay R410. The last-mentioned relay, in turn, operates to prepare, at RA411, a circuit for energizing the relay R460 and to complete, at RA412, an obvious circuit for energizing the relay R420. When the relay R420 operates, it completes, at RA422, two multiple paths for impressing ground potential upon the private conductor 13c; one of these paths extending from ground at RA453, the other path extending from ground through the winding 466 and both thereof extending by way of RA422 to the private or control conductor 13c. The completion of these paths prevents the release of the operated relays R330, R295 and R200 in the manner indicated above. The relay R420, upon operating, opens, at RA421, a point in the circuit, traced hereinafter, for energizing the relay R560. At this same armature, the relay R420 prepares a circuit for energizing the pendulum-type relay R450. At RA423, the relay R420 prepares a circuit for energizing the ring cut-off relay R430 and, in so doing, completes a circuit for transmitting ringing current over both sides of the trunk line 10 to energize the signal device 502 provided at the operator's position 19. The circuit traversed by the ringing current extends from one terminal of the ringing current source by way of C438, the condenser 437, RA435, RA423, C583, an obvious simplex path including the line conductors 10a and 10b of the line 10, the condenser 503, the winding of the signal device 502, the contact springs 506, and the exchange battery to the other terminal of the ringing current source. The resulting operation of the signal device 502 indicates to the operator that an incoming call on the line 10 should be answered. At RA424, the relay R420 completes a circuit for transmitting the usual ring-back tone signal current to the calling substation. More particularly, the high potential terminal of the ringing current source is connected to one side of the calling loop circuit over a path including the conductor C438, the condenser 437, RA436, RA424 and C584. When this path is completed, ringing current is caused to traverse the calling loop circuit to energize the receiver provided at the calling substation A, whereby the calling party is informed that the operator is being signaled. Following the operations just described no further operation of the apparatus occurs until the operator answers the call.

To answer the call the operator attending the position 19 inserts the plug terminating her telephone set in the call and answer jack 501, thus completing the desired conversational circuit between the calling substation A and the operator's telephone set. When this operation is performed, the contact springs 506 are disengaged to open the above-traced circuit for energizing the signal device 502. Simultaneously the springs 507 are moved into engagement to complete the circuit for energizing the relay R430, this circuit extending from ground by way of the switch springs 509 and 508, the springs 507, the pulsing springs of the calling device 504, the simplex loop including both sides of the line 10, C583, RA423, RA434, the upper winding of R430 and RA433 to battery. When energized over this circuit, the relay R430 closes the "X" contacts associated with RA431 to complete an obvious holding circuit for itself. Thereafter the relay R430 fully operates to com-

plete a circuit for energizing its two windings in series, this circuit extending from ground at RA453 by way of RA422, RA431, the upper winding of R430, RA433, RA432 and the lower winding of R430 to battery. Following the completion of this circuit, the relay R430 opens, at RA433 and its associated resting contact, a point in its initially completed operating circuit. At RA435 and RA436, the relay R430 opens the above-traced circuits for transmitting ringing current over the line 10 to the operator's position 19 and back over the calling loop circuit to the calling substation A, thus terminating the ring-back tone signal. At RA434, the relay R430 completes the previously mentioned circuit for energizing the two relays R530 and R540 in series, this circuit extending by way of the grounded conductor C583, RA423, RA434, the resistor 404, RA403, RA402, C581, the winding of R540 and the two windings of R530 to battery. Due to the relatively high resistance of the series connected windings of R530, the relay R540 does not operate when this circuit is completed. The relay R530, however, operates to complete, at RA531, the circuit for energizing the pendulum-type relay R450, this circuit extending from ground by way of RA531, C577, RA421 and the winding of R450 to battery. When energized over this circuit, the relay R450 attracts its associated armature RA455 to initiate vibration of the weighted armature 456. At RA454, the relay R450 completes an obvious holding circuit for the relay R420. At RA453, the relay R450 opens one of the previously traced multiple paths for impressing ground potential upon the private conductor 13c and, in so doing, removes the short circuit from the transformer winding 466 so that paystation tone current is caused to traverse this winding. More particularly, paystation tone voltage is impressed, through the condenser 22, upon the control conductor 11a of the calling line 11 by the alternating current source 21. This voltage is impressed, through the finder switch 14, between the private conductor 20c and ground and is thus applied to the primary winding of the transformer 216. The transformer 216, in turn, impresses the paystation tone potential upon the conductor C270, the last-mentioned conductor being connected through the private wiper 363 to the control conductor 13c of the link line 13. Thus, the voltage across the secondary winding of the transformer 216 is impressed across the primary winding 466 of the transformer 465. When the relay R450 operates, the induced voltage developed in the secondary winding 467 of the transformer 465 is impressed upon the line conductors C573 and C585 of the repeater 18 over a path including the condenser 468 and the two armatures RA457 and RA442. As a result, paystation tone current is caused to traverse the windings of the repeater 520 so that the usual paystation tone signal is transmitted by way of the trunk line 10 and the repeater 500 to the receiver of the operator's telephone set. Through reproduction of this voltage, the operator is informed that the calling substation is of the paystation type. A predetermined time interval following energization of the relay R450, the vibrating armature 456 settles into resting engagement with its associated armature RA455 to hold completed an obvious circuit for energizing the slow-to-operate relay R440. The relay R440 operates after an interval to complete, at RA441, an obvious path for short-circuiting the winding 466 of the transformer 465, thereby to terminate the paystation tone signal

and to complete a multiple path for maintaining ground potential upon the control conductor 13c. At RA442, the relay R440 disconnects the secondary winding 467 of the transformer 465 from the line conductor C585.

The relay R450, upon operating, also functions to reverse, at its armatures RA451, RA452, RA458 and RA459, the direction of current flow over the calling loop circuit in an obvious manner. As a result of this current reversal, the relay R130 included in the trunk circuit apparatus 17 is caused to operate to prepare, at RA131, the previously traced paths for impressing the positive potential of the 110 volt coin collect current source upon the line conductors 11a and 11b of the calling line 11.

If the operator desires to recall the paystation tone signal she may do so by momentarily withdrawing from the jack 501 the plug terminating her telephone set. When the call and answer plug is withdrawn from the jack 501, the springs 507 are disengaged to interrupt the previously traced circuit for energizing the two relays R530 and R540 in series. Accordingly, the relay R530 restores to open, at RA531, the previously traced operating circuit for the relay R450. The last-named relay, in turn, restores to open, at RA455 and its associated weighted armature 456, the operating circuit for the relay R440, causing the last-named relay to restore. Upon restoring, the relay R450 also reverses, at its armatures RA451, RA452, RA458 and RA459, the direction of current flow over the calling loop circuit. Since the relay R130 of the trunk circuit 17 is now operated, the last-mentioned reversal of the direction of current flow over the calling loop circuit is without effect. When the operator reinserts the plug terminating her cord circuit in the jack 501, the previously traced operating circuit for the relay R530 is recompleted, causing this relay and the relay R450 sequentially to operate in the order named. As a result, paystation tone current is again caused to traverse the winding 466 of the transformer 465 and the secondary winding 467 is again connected between the line conductors C573 and C585. After a predetermined time interval required for vibration of the weighted armature 456 to cease, the slow-to-operate relay R440 operates to terminate the signal in the manner explained above.

After the connection between the operators position 19 and the calling substation A is established in the manner just explained, the operator, upon ascertaining the party or substation desired by the calling party, may instruct the calling party to make the appropriate coin deposits. It may occur that an improper coin deposit is made by the calling party, in which case the operator may desire to refund all of the deposited coins and request a second deposit of the coins representing the assessed charge. A refunding operation of this character may be performed under the control of the operator at any time. To this end, the operator momentarily operates the key 505 to its off-normal position. In response to this operation, the contact springs 508 and 510 are closed and the springs 508 and 509 are disengaged. As a result, the booster battery current source 511 and the resistor 512 are serially included in the previously traced circuit for energizing the windings of the two relays R530 and R540 in series. The increased current flow over this circuit causes operation of the relay R540. Upon op-

erating, the relay R540 completes, at RA541, the previously mentioned circuit for energizing the relay R460, this circuit extending from ground by way of RA541, C575, RA411 and the winding of R460 to battery. Upon operating, the relay R460 completes, at RA462, a local loop circuit including the resistor 464 for maintaining the line relay R400 operated. At RA461 and RA463, the relay R460 opens two points in the calling loop circuit. At these same armatures and their respective associated working contacts, the relay R460 impresses the negative 110 volt potential of the coin refund current source upon both sides of the calling loop circuit. As a result, the discharge device 108 is rendered conductive and current flows through the windings of the magnet 107 over a circuit extending from the positive terminal of the 110 volt source by way of the discharge device 108, the windings of the magnet 107, the contact springs 109, the conductor 201a, RA121, the conductor 20a, RA202, RA201, C267, RA346, the wiper 361, the conductor 13a, RA461 and C133 to the negative terminal of the 110 volt source. The direction of current flow over this circuit is such that the armature controlled by the polarized magnet 107 is pivoted in a direction to cause the deposited coin or coins to be refunded to the calling party through the coin refund chute of the coin-receiving means. When the key 505 is released and allowed to restore to its normal position, the springs 508 and 510 are disengaged and the springs 508 and 509 are moved into engagement. Accordingly, the booster battery source 511 is excluded from the series circuit including the windings of the relays R530 and R540, causing the last-mentioned relay to restore. Upon restoring, the relay R540 opens the previously traced operating circuit for the relay R460. The relay R460, in turn, restores to disconnect the line conductors 13a and 13b from the negative terminal of the coin refund current source and to extend the calling loop circuit to the line terminals of the line relay R400. At RA462, the relay R460 also interrupts the local loop circuit including the windings of the line relay R400.

After the correct coin deposits have been made by the calling party, the operator attending the position 19 may extend the connection to the desired substation and complete the desired conversational circuit between the calling and called substations in the manner conventionally employed in manual office practice. During the release of the connection and when the operator withdraws the plug terminating her cord circuit from the jack 501, the contact springs 507 are disengaged to open the series circuit including the windings of the relays R530 and R540. Thus, the relays R530, R450 and R440 are caused sequentially to restore in the manner previously explained. When the calling subscriber thereafter replaces the receiver 101 upon the supporting hook 114 to interrupt the calling loop circuit, the relays R400, R410, R420, R430 and R570 are caused sequentially to restore in an obvious manner and in the order named. The relay R420, upon restoring, disconnects the private conductor 13c from ground, thus interrupting the holding circuit for the operated relays R330, R295 and R200 of the connector switch shown in Figs. 2 and 3. The relay R200, upon restoring, completes, at RA205, the previously traced circuit for energizing the release magnet 227, thus causing the wipers 361 to 364, inclusive to be restored to rotary and vertical normal in the

usual manner. When these wipers are returned to their respective home positions, the operating circuit for the release magnet is opened at the off-normal springs 224. In addition, the off-normal springs 209 are disengaged to open a further point in the operating circuit for the relay R200. At RA204, the relay R200, upon restoring, disconnects ground potential from the private conductor 20 of the trunk line 20, thus causing the release of the finder switch 14 and the restoration of the relay R120. When the relay R120 operates, it connects the line conductors 11a and 11b of the calling line 11 to the positive terminal of the 110 volt coin collect current source so that the magnet 107 is energized by current of the proper polarity to cause the armature associated with this magnet to operate in the manner required to pass the deposited coins into the coin collect chute of the coin-receiving means. Shortly following the operation of the relay R120, the relay R140 restores to cause the sequential restoration of the relays R120 and R130 in the manner previously explained. Thus, the connection is fully released and the apparatus involved therein is conditioned for further use.

In the event the connection is released at the calling substation before it is cleared out at the operator's position 19, the relays R400, R410, R420, R430, R570, R450 and R440 are all caused to release in an obvious manner. When these relays are restored to normal, ground potential is removed from the private conductor 13 of the link line 13 so that the connector switch shown in Figs. 2 and 3 is released in the manner pointed out above. Also, the trunk circuit apparatus 17 operates to cause the coin collecting operation to be performed, after which it releases to initiate the release of the finder switch 14. During the release of the indicated relay equipment embodied in the repeater 18 and when the relay R420 restores, an alternative circuit, traced hereinafter, is completed for energizing the relay R530, whereby this relay, the relay R560, the relay R570 and the relay R550 are caused to re-operate to extend a connection to an idle one of the connector switches provided in the community exchange, all in the manner pointed out immediately hereinafter.

To initiate, at the operator's position 19, a call intended for one of the substations associated with a line terminating at the distant community exchange, the operator inserts the plug terminating her cord circuit in the jack 501 and dials the directory number of the desired substation. If, for example, the substation A is being called from the operator's position 19, the operator dials the directory number designating this station. When the operator inserts the call and answer plug in the jack 501, the previously mentioned circuit is completed for energizing the relay R530, this circuit extending from ground by way of the springs 509 and 508, the jack springs 507, the pulsing springs of the calling device 504, the simplex loop including the conductors 10a and 10b of the line 10, C583, RA423, the resistor 404, RA403, C582, RA552 and the lower winding of R530 to battery. The relay R530, upon operating, prepares, at RA532, a loop circuit to the line circuit 18 associated with the link line 13. At RA531, the relay R530 completes a circuit for energizing the upper winding of the relay R560, this circuit extending from ground at RA531 by way of C577,

RA421, C576 and the upper winding of R560 to battery. The relay R560, upon operating, completes, at RA562, a circuit for energizing the slow-acting relay R570, this circuit extending from ground at RA531 by way of C577, RA421, C576, RA562 and the winding of R570 to battery. At RA563, the relay R560 prepares a circuit, traced hereinafter, for energizing the relay R550. At RA561 and RA564, the relay R560 prepares two additional points in the above-mentioned loop circuit extending by way of the line 13 to the line circuit 18. This loop circuit is completed in response to operation of the relay R570 and may partially be traced as extending by way of the line conductor 13a, RA461, RA451, C573, RA571, the upper right winding of the transformer 520, RA561, RA532, the upper winding of R550, RA564, the lower right winding of the transformer 520, RA572, C585, RA459 and RA463 to the opposite line conductor 13b. Due to the relatively low resistance of the upper winding of the relay R550, this relay does not operate at this time. When the above-traced loop circuit is completed, the line relay in the line circuit 18 operates to impress ground potential upon the distributor start conductor C163 and to mark the line 13 in the bank contacts of the finder switches. Assuming, for example, that the finder-connector link illustrated is the link assigned to the use of the calling line 13, when ground potential is impressed upon the conductor C163, the finder switch 14 is started in operation to search for the marked line 13. When the calling line is found the finder switch 14 operates in the usual manner to switch the above-mentioned loop circuit through to the connector switch of Figs. 2 and 3, causing the relays R230, R235 and R240 sequentially to operate in the order named and in the manner explained previously with reference to the call initiated at the substation A. When the hold relay R235 operates, it functions to impress ground potential upon the private conductor 20 of the link line 20, which ground potential is applied through the finder switch 14 and the line circuit 18 to the private conductor 13 of the trunk line 13. When the last-mentioned private conductor is grounded, the relay R560 is energized over a circuit including this conductor, RA563 and the lower winding of R560. Thus, a holding circuit is established for the relay R560. When ground potential is impressed upon the conductor 13, the lower winding of the relay R550 is energized over an obvious circuit. Since the currents respectively traversing the upper and lower windings of R550 are at this time in opposition the relay R550 does not operate when its lower winding is energized.

The connector switch illustrated in Figs. 2 and 3 responds to the three digits of the directory number designating the substation A by operating to select the line 11, to test the idle or busy condition of this line, to return busy tone to the calling operator in the event the line is busy, and to project ringing current of the proper code over the called line in the event the line is idle, all in the manner set forth above with reference to the call routed to the substation B. In this regard it will be noted that during each operation of the calling device 504, the above-traced circuit for energizing the relay R530 is interrupted a number of times depending upon the particular digit dialed. Thus, the relay R530 follows the dialed impulses and, through operation of RA532, repeats the impulses to the connector switch shown

in Figs. 2 and 3. When the wipers 361 to 364, inclusive, of the connector switch are moved into engagement with the contacts terminating the conductors of the called line 11, a circuit including the resistor 375 is prepared for energizing the relay R340. Assuming the line 11 to be idle at the time it is selected, this circuit is completed in response to operation of the line switching relay R330 and may be traced as extending from ground by way of the resistor 375, the wiper 362, RA331 and through the winding of R340 to battery. The relay R340, upon operating, prepares a circuit for energizing the slow-to-release relay R345.

Upon operating, the line switching relay also completes, at RA334 and RA332, a path extending by way of the private wiper 363 for impressing ground potential upon the private conductor 11a of the called line 11, thereby to mark the line 11 as busy and to energize the cut-off relay R150. The relay R150, upon operating, disconnects the winding of the line relay R160 from the line 11 and completes the operating circuit for the relay R140. The relay R140, in turn, completes the circuit for energizing the polarizing winding of the relay R130 and prepares the operating circuit for the relay R120.

When the call is answered at the called substation A, the desired conversational circuit extending from the operator's telephone set to the called substation is completed in the manner previously explained. At this time the back-bridge relay R210 is caused to operate, in the manner previously explained, to cause the operation of the booster battery control relays R290 and R295 and a reversal of the direction of current flow over the loop circuit extending to the repeater 18. The resulting operation of the indicated booster battery control relays is without effect. Reversal of the current flow over the loop extending to the repeater 18 causes the two windings of the relay R550 to be cumulatively energized. Accordingly, the relay R550 operates to complete, at RA551 and RA552, the previously traced circuit for energizing the relays R530 and R540 in series. Following the completion of this circuit the relay R550 opens, at RA552 and its associated resting contact, the initially completed operating circuit for the relay R530. If desired, the arrangement just described, wherein the back-bridge relay R550 and the line relay R400 are arranged to control the resistance of the simplex circuit including the two sides of the line 10, may be utilized to control a supervisory signal control relay of the marginal type provided at the operator's position 19 for purposes of call supervision. An arrangement of this character is disclosed in the copending application of John H. Voss, Serial No. 215,786, filed June 25, 1938.

When the call is answered at the called substation A, a loop circuit is completed between this substation and the connector switch shown in Figs. 2 and 3, this loop circuit serially including the operating winding of the relay R130. The direction of current flow over this loop circuit is such that the polarized relay R130 operates to prepare, at RA131, the previously traced paths for impressing the positive potential of the coin collect current source upon the conductors 11a and 11b of the line 11.

Following the completion of the talking circuit in the manner just explained, the operator may desire to make coin refunds to the called party. For example, if the call routed from the operator's position to the substation A is a delayed

call and the party at the substation A desires to pay for the call, a coin refund operation may be required incident to the use of the connection. To this end, the operator momentarily operates the key 505 to cause the operation of the relay R540 in the manner previously described. Upon operating, the relay R540 completes, at RA541, a path including the conductors C575 and C574 for impressing ground potential upon both sides of the loop extending by way of the line 13 and the line switch 16 to the connector switch shown in Figs. 2 and 3. As a result, the differentially wound relay R225 is unbalanced and operates. The relay R225, upon operating, completes the previously mentioned circuit for energizing the relay R345, this circuit extending from ground at RA226 by way of C268, RA341 and the winding of R345 to battery. When the key 505 is restored to normal the relays R540 and R225 sequentially restore to interrupt the circuit just traced. Upon operating, the slow-to-release relay R345 opens, at RA346 and RA348, two points in the established talking circuit extending to the called substation. At these same armatures and their respective associated working contacts, the relay R345 completes paths for connecting the negative terminal of the 110 volt coin refund current source to each side of the called line 11, one of these paths extending by way of C133, RA346 and the wiper 361 to the line conductor 11b and the other path extending by way of RA348 and the wiper 364 to the conductor 11a. When the negative coin refund potential is impressed upon the conductor 11a, the magnet 107 is caused to operate, in the manner previously explained, to refund the deposited coin or coins to the called party. Shortly following the restoration of the relay R225 in response to release of the key 505, the relay R345 restores to open the two paths just traced and to recomplete the talking circuit between the called substation and the operator's position 19.

As indicated previously, coins deposited in the coin-receiving means provided at the called substation A are automatically collected during the release of the operated switch train. The release of the switch train is entirely under the control of the operator attending the position 19. More particularly, when the connection is cleared out at the operator's position 19, the relays R530 and R230 sequentially restore. Shortly following the release of the relay R230, the hold relay R235 restores to remove, at RA236 and RA237, ground potential from the private conductors 20a and 13a. The relay R230, upon restoring, completes the previously traced circuits for energizing the release magnets 227 and 357, thus causing the wipers 361 to 364, inclusive, to be restored to rotary and vertical normal and the minor switch 350 to be released. From this point on, the release of the connector switch shown in Figs. 2 and 3 and of the line switch 16 is accomplished in the exact manner described previously. When ground potential is removed from the private conductor 13a of the link line 13, the relays R550 and R560 are deenergized and restored. The relay R570 is deenergized and restores shortly following the restoration of the line relay R530 to open the operating circuit for R570 as traced above. Thus, the repeater 18 is fully released and all of the apparatus utilized in setting up the connection is conditioned for further use.

During the release of the connector switch and when ground potential is removed from the pri-

vate conductor 11c of the called line 11, the cut-off relay R150 restores to interrupt the operating circuit for the relay R140 and to complete the operating circuit for the relay R120. The resulting operation of the relay R120 causes the magnet 107 to operate in a manner such that the coins on deposit in the coin-receiving means at the substation A are collected, all in the manner previously explained. The relay R140, upon restoring, causes the sequential restoration of the relays R120 and R130 in the exact manner described above.

From the foregoing explanation, it will be apparent that on local calls originating at one of the paystations served by the automatic switching equipment of the community exchange, the coin refunding and coin collecting operations are performed under the control of paystation control circuit apparatus, such, for example, as the apparatus 17, after the calls are terminated and during the release of the switch trains through which the calls are routed. On trunk calls routed from the paystations to the operator's position 19, on the other hand, coin refunding operations may be performed at any time after a connection to the operator's position is established under the control of the operator and through operation of the apparatus provided in the repeater associated with the interoffice trunk line in use. On such trunk calls, however, coin collect operations are only performed after the connection in use is cleared out and during the release of the operated switch train, the coin collecting operations being controlled by paystation control circuit apparatus, such, for example, as the apparatus 17, associated with the paystation line in use. Finally, on delayed calls originating at the operator's position 19 and routed to substations of the paystation type served by the automatic switching apparatus located at the community exchange, coin refunding operations may be performed under the control of the operator at any time after a connection is set up between the operator's position and the called substation, these coin refunding and coin collecting operations being obtained through appropriate manipulation of the key 505 and the resulting operation of the control apparatus provided in the repeater and the connector switch in use. Here again, the paystation control circuit apparatus associated with the called paystation line is utilized to control the coin collecting operations.

Referring now more particularly to Fig. 6 of the drawings, the paystation control circuit apparatus there illustrated is arranged for booster battery control and may be substituted in the system of Figs. 1 to 5, inclusive, for the relays R120, R130 and R140 of the apparatus 17. In brief, the apparatus shown in Fig. 6 comprises a line switching relay R600, a coin collect control relay R610 of the marginal type, and a pair of control relays R620 and R630 arranged to control the energization of the line switching relay R600. In order to substitute this apparatus for the apparatus 17 in the system shown in Figs. 1 to 5, inclusive, the terminals 181, 182, 183, 184, 186 and 187 may be disconnected from the circuits controlled by the relays R120, R130 and R140 and the terminals 181 to 185, inclusive, connected to the terminals 681 to 685, respectively.

With the apparatus of Fig. 6 connected in the manner just explained, if a connection is routed by way of the line 11 through the finder switch 14 to the connector switch of Figs. 2 and

3, the application of ground potential to the control conductor 20, resulting from the operation of the relays R230 and R235 causes the series connected windings of the relays R610 and R630 to be energized. The circuit, including these windings, may be traced as extending by way of the grounded conductor 20c, the conductor 11d, the terminals 185 and 685, the winding of R630 and the upper winding of R610 to battery. The marginal relay R610 does not operate when this circuit is completed. The relay R630, however, operates to complete, at RA631, an obvious circuit for energizing the slow-to-release relay R620. The relay R620, upon operating, prepares, at RA622, a circuit for energizing the relay R600 15 and prepares, at RA621, a holding circuit for the relay R610.

In the event the call as routed from the substation A over the line 11 and through the connector switch of Figs. 2 and 3 is not successfully completed, the back-bridge relay R210 does not operate and hence the booster battery control relays R290 and R295 are not caused to operate. Accordingly, the relay R610 remains in its restored position. During the release of the connection and when ground potential is removed from the control conductors 20c and 11a, the relay R630 restores to complete, at RA631, the circuit for energizing the line switching relay R600. The relay R600, upon operating, completes, at RA601 and RA602, paths extending by way of RA611 for impressing the negative potential of the 110 volt coin refund current source upon the line conductors of the calling line 11. At RA603, the relay R600 prepares a multiple holding circuit for the relay R610. The magnet 107 provided at the calling substation now operates in the manner previously explained, by operating to cause the coin or coins deposited in the coin-receiving means of the substation to be refunded. Shortly following the operation of the relay R600, the relay R620 restores to open, at RA622, the operating circuit for the relay R600 and to open, at RA621, the prepared multiple holding circuit for the relay R610.

In the event the call as routed from the line 11 through the finder switch 14 and the connector switch of Figs. 2 and 3, is successfully completed, the relays R290 and R295 function in the manner set forth above to impress, for a short time interval, the potential of the booster battery source 294 upon the control conductor 20c. The resulting increased current flow over the circuit including the upper winding of R610 and R630, is such that the relay R610 operates to complete, at RA612, an obvious holding circuit for itself. At RA611, the relay R610 prepares paths for impressing the positive potential of the 110 volt coin collect current source upon the conductors of the calling line. Thereafter, and when the connection is released, the relays R630 and R600 cooperate to complete these paths so that the magnet 107 is caused to operate to perform a coin collecting operation. During the release of the apparatus shown in Fig. 6, the holding circuit for the relay R610 is interrupted, at RA603, in response to the restoration of the relay R600. Aside from the release of the relay R610, the other relays of Fig. 6 are caused to restore in the exact sequence described above.

Since the booster battery control relays R290 and R295 are caused to operate to cause the operation of the relay R610 in extending connections both to and from the operator's posi-

tion 19 as well as during the completion of local call connections, it will be understood that the desired coin collecting operation will be performed at the calling substation through operation of the apparatus shown in Fig. 6 during the release of trunk call connections as well as during the release of local call connections. In this regard, it will be recalled from the previous description that on calls routed through the connector switch of Figs. 2 and 3 and incoming to the line 11, booster battery potential is impressed upon the control conductor 11a, in response to operation of the relays R290 and R295, over a path extending by way of the resistor 293, RA293, RA294, C271, RA334, RA332, the wiper 363 and RA153. It will further be recalled that on trunk calls routed from the operator's position 19 through the connector switch of Figs. 2 and 3 to the paystation A, coin refunding operations at the station A are achieved through operation of the apparatus included in the connector switch independently of the paystation control circuit apparatus associated with the line 11. It will also be recalled that on trunk calls routed from the paystation A to the operator's position 19, coin refunding operations at the calling paystation are achieved through operation of the apparatus embodied in the repeater 18 independently of the paystation control circuit apparatus associated with the line 11.

While there has been described what are at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like, a second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second station to route a connection to said substation, said connection comprising a loop circuit extending to said selector switch, means controllable from said second station for unbalancing said loop circuit, and coin collecting and refunding control means at said substation operative in response to the unbalancing of said loop circuit.

2. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like, a second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second station to route a connection to said substation, said connection comprising a loop circuit extending to said selector switch, a differential relay comprising windings serially included in said loop circuit, means controllable from said second station for unbalancing said loop circuit, thereby to cause operation of said differential relay, and coin collecting and refunding control means at said substation operative in response to operation of said relay.

3. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like, a second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second station to route a connection to said substation,

said connection comprising a loop circuit extending to said selector switch, a differential relay comprising windings serially included in said loop circuit, means controllable from said second station for unbalancing said loop circuit, thereby to cause operation of said differential relay, a slow-to-release relay operative in response to operation of said differential relay, and coin collecting and refunding control means at said substation operative in response to operation of said slow-to-release relay.

4. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, a line extending to said substation, said coin collecting and refunding control means being operative to collect coins deposited in said coin-receiving means in response to the application of one predetermined potential to one of the conductors of said line and to refund coins deposited in said coin-receiving means in response to the application of a different predetermined potential to said one line conductor, a second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second station to route a connection from said second station to said line, said connection comprising a loop circuit extending to said selector switch, means controllable from said second station for unbalancing said loop circuit, and means operative in response to the unbalancing of said loop circuit for impressing one of said predetermined potentials upon said one line conductor.

5. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, a line extending to said substation, said coin collecting and refunding control means being operative to collect coins deposited in said coin-receiving means in response to the application of one predetermined potential to one of the conductors of said line and to refund coins deposited in said coin-receiving means in response to the application of a different predetermined potential to said one line conductor, a second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second station to route a connection from said second station to said line, said connection comprising a loop circuit extending to said selector switch, a differential relay comprising windings serially included in said loop circuit, means controllable from said second station for unbalancing said loop circuit, thereby to cause operation of said differential relay, and means responsive to operation of said relay for impressing one of said predetermined potentials upon said one line conductor.

6. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, a line extending to said substation, said coin collecting and refunding control means being operative to collect coins deposited in said coin-receiving means in response to the application of one predetermined potential to one of the conductors of

said line and to refund coins deposited in said coin-receiving means in response to the application of a different predetermined potential to said one line conductor, a second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second station to route a connection from said second station to said line, said connection comprising a loop circuit extending to said selector switch, a differential relay comprising windings serially included in said loop circuit, means controllable from said second station for unbalancing said loop circuit, thereby to cause operation of said differential relay, and a slow-to-release relay operative to impress one of said predetermined potentials upon said one line conductor in response to operation of said differential relay.

7. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, a second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second station to route a connection from said second station to said substation, said connection comprising a loop circuit extending to said selector switch, means controllable from said second station for unbalancing said loop circuit, means operative in response to the unbalancing of said loop circuit for causing said coin collecting and refunding control means immediately to operate in a particular manner, and additional means individual to said substation and operative during the release of said connection for causing said coin collecting and refunding control means to operate in a different manner.

8. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, a second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second station to route a connection from said second station to said substation, said connection comprising a loop circuit extending to said selector switch, a differential relay comprising windings serially included in said loop circuit, means controllable from said second station for unbalancing said loop circuit, thereby to cause operation of said relay, means operative in response to operation of said relay for causing said coin collecting and refunding control means immediately to operate in a particular manner, and additional means individual to said substation and operative during the release of said connection for causing said coin collecting and refunding control means to operate in a different manner.

9. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, a line extending to said substation, said coin collecting and refunding control means being operative to collect coins deposited in said coin-receiving means in response to the application of one predetermined potential to one of the conductors of said line and to refund coins deposited in said coin-receiving means in response to the applica-

tion of a different predetermined potential to said one line conductor, a second telephone station, automatic switching apparatus including a final selector switch having access to said line, said automatic switching apparatus being controllable from said second station to route a connection through said switch to said line, means included in said selector switch and controllable from said second station for impressing one of said predetermined potentials upon said one line conductor, and a paystation control circuit individual to said line and operative to impress the other of said predetermined potentials upon said one line conductor in response to the release of said connection.

10. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, a line extending to said substation, said coin collecting and refunding control means being operative to collect coins deposited in said coin-receiving means in response to the application of one predetermined potential to one of the conductors of said line and to refund coins deposited in said coin-receiving means in response to the application of a different predetermined potential to said one line conductor, a second telephone station, automatic switching apparatus including a final selector switch having access to said line, said automatic switching apparatus being controllable from said second station to route a connection through said switch to said line, means included in said selector switch and controllable from said second station for impressing one of said predetermined potentials upon said one line conductor, a normally incomplete path for impressing the other of said predetermined potentials upon said one line conductor, a polarized relay comprising an operating winding connected in series circuit relation with the conductors of said line, said relay being operative to prepare said path in response to seizure of said line by said switch, and means operative to complete said path in response to the release of said connection.

11. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, a line extending to said substation, said line including a control conductor, said coin collecting and refunding control means being operative to collect coins deposited in said coin-receiving means in response to the application of one predetermined potential to one of the conductors of said line and to refund coins deposited in said coin-receiving means in response to the application of a different predetermined potential to said one line conductor, a second telephone station, automatic switching apparatus including a final selector switch having access to said line, said automatic switching apparatus being controllable from said second station to route a connection through said switch to said line, means included in said selector switch and controllable from said second station for impressing one of said predetermined potentials upon said one line conductor, a normally incomplete path for impressing the other of said predetermined potentials upon said one line conductor, a marginal relay comprising a winding connected to be energized over a circuit including said control conductor, means included in said selector switch for impressing a booster

potential upon said control conductor, thereby to cause operation of said relay, said relay being operative to prepare said path, and means operative to complete said path in response to the

5 release of said connection.

12. In an automatic telephone system, a plurality of subscribers' lines each including a control conductor, substations of the paystation type associated with certain of said lines, each of said
10 substations including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, automatic switching apparatus for setting up connections between said
15 lines, said automatic switching apparatus including connector switches having access to said lines and each having a trunk line incoming thereto which includes a control conductor, each of said connector switches including means for impressing
20 a booster potential upon the control conductor of its incoming trunk line and upon the control conductor of a selected one of said subscribers' lines, and paystation control circuits individual to the lines extending to said substations
25 of the paystation type, said paystation control circuits being controlled by the application of said booster potential to the control conductors of the respective associated lines and being operative individually to control the coin collecting
30 and refunding control means of the respective associated substations.

13. In combination with a telephone line adapted to extend to a substation of the paystation type, a combined line and paystation control circuit comprising line and cut-off relays,
35 normally incomplete paths for impressing predetermined coin collecting and refunding potentials upon one of the conductors of said line, a relay and means controlled thereby for selectively preparing said paths, and means controlled by said
40 cut-off relay for completing the prepared one of said paths.

14. In combination with a telephone line adapted to extend to a substation of the paystation type, a combined line and paystation control circuit comprising line and cut-off relays,
45 normally incomplete paths for impressing predetermined coin collecting and refunding potentials upon one of the conductors of said line, a relay and means controlled thereby for selectively preparing said paths, and means responsive
50 to the operation and subsequent restoration of said cut-off relay for completing the prepared one of said paths.

15. In combination with a telephone line adapted to extend to a substation of the paystation type, a combined line and paystation control circuit comprising line and cut-off relays,
55 normally incomplete paths for impressing predetermined coin collecting and refunding potentials upon one of the conductors of said line, a polarized relay including an operating winding connected in series circuit relation with the conductors of said line, whereby said last-named relay
60 is caused to operate when current of a predetermined polarity traverses said line, means controlled by said last-named relay for selectively preparing said paths, and means responsive to the operation and subsequent restoration of said
65 cut-off relay for completing the prepared one of said paths.

16. In combination with a telephone line adapted to extend to a substation of the paystation type, a combined line and paystation control
75 circuit comprising line and cut-off relays, nor-

mally incomplete paths for impressing predetermined coin collecting and refunding potentials upon one of the conductors of said line, a relay and means controlled thereby for selectively preparing said paths, an additional relay operative
5 to complete the prepared one of said paths, an operating circuit for said additional relay, a slow-to-release relay operative to prepare said operating circuit in response to operation of said cut-off relay, and means responsive to the subsequent
10 release of said cut-off relay for completing said operating circuit.

17. In combination with a telephone line adapted to extend to a substation of the paystation type, a combined line and paystation control circuit comprising line and cut-off relays,
15 normally incomplete paths for impressing predetermined coin collecting and refunding potentials upon one of the conductors of said line, an electropolarized relay including a polarizing winding and an operating winding connected in series circuit relation with the conductors of said line, whereby said electropolarized relay is caused
20 to operate when its polarizing winding is energized and current of a predetermined polarity traverses said line, a first circuit for energizing said polarizing winding, means controlled by said electropolarized relay for selectively preparing said paths, an additional relay operative to complete the prepared one of said paths, a second
25 circuit for energizing said additional relay, a slow-to-release relay operative to complete said first circuit and to prepare said second circuit in response to operation of said cut-off relay, and means responsive to the subsequent release of said
30 cut-off relay for completing said second circuit.

18. In combination with a telephone line adapted to extend to a substation of the paystation type and including a control conductor, a combined line and paystation control circuit comprising line and cut-off relays, normally incomplete paths for impressing predetermined coin
40 collecting and refunding potentials upon one of the conductors of said line, a marginal relay operative in response to application of a predetermined booster potential to said control conductor, means controlled by said marginal relay for selectively preparing said paths, and means controlled by said cut-off relay for completing the prepared one of said paths.
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19. In combination with a telephone line adapted to extend to a substation of the paystation type and including a control conductor, a combined line and paystation control circuit comprising line and cut-off relays, normally incomplete paths for impressing predetermined coin
55 collecting and refunding potentials upon one of the conductors of said line, a marginal relay operative in response to application of a predetermined booster potential to said control conductor, means controlled by said marginal relay for selectively preparing said paths, and means responsive to the operation and subsequent restoration of said cut-off relay for completing the prepared one of said paths.
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20. In combination with a telephone line adapted to extend to a substation of the paystation type and including a control conductor, a combined line and paystation control circuit comprising line and cut-off relays, normally incomplete paths for impressing predetermined coin
70 collecting and refunding potentials upon one of the conductors of said line, a marginal relay operative in response to application of a predetermined booster potential to said control conductor,
75

tor, means controlled by said marginal relay for selectively preparing said paths, a holding circuit for said marginal relay, an additional relay operative to complete the prepared one of said paths, an operating circuit for said additional relay, a slow-to-release relay operative to prepare said circuits in response to operation of said cut-off relay, said holding circuit being completed in response to operation of said marginal relay, and means responsive to the release of said cut-off relay for completing said operating circuit.

21. In an automatic telephone system, a plurality of lines, a substation of the paystation type associated with one of said lines, said substation including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, automatic switching apparatus including nonnumerical and numerical switches for setting up connections between said lines, said automatic switching apparatus being controllable from said substation to route a connection to another of said lines, said connection extending through at least one of said nonnumerical

switches, and means associated with said connection at a point preceding the first nonnumerical switch through which said connection extends for controlling said coin collecting and refunding control means.

22. In an automatic telephone system, a plurality of lines, a substation of the paystation type associated with one of said lines, said substation including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, automatic switching apparatus including nonnumerical and numerical switches for setting up connections between said lines, said automatic switching apparatus being controllable over another of said lines to route a connection from said other line to said substation, said connection extending through at least one of said nonnumerical switches and at least one of said numerical switches, and means associated with said connection at a point following the last numerical switch through which said connection extends for controlling said coin collecting and refunding control means.

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