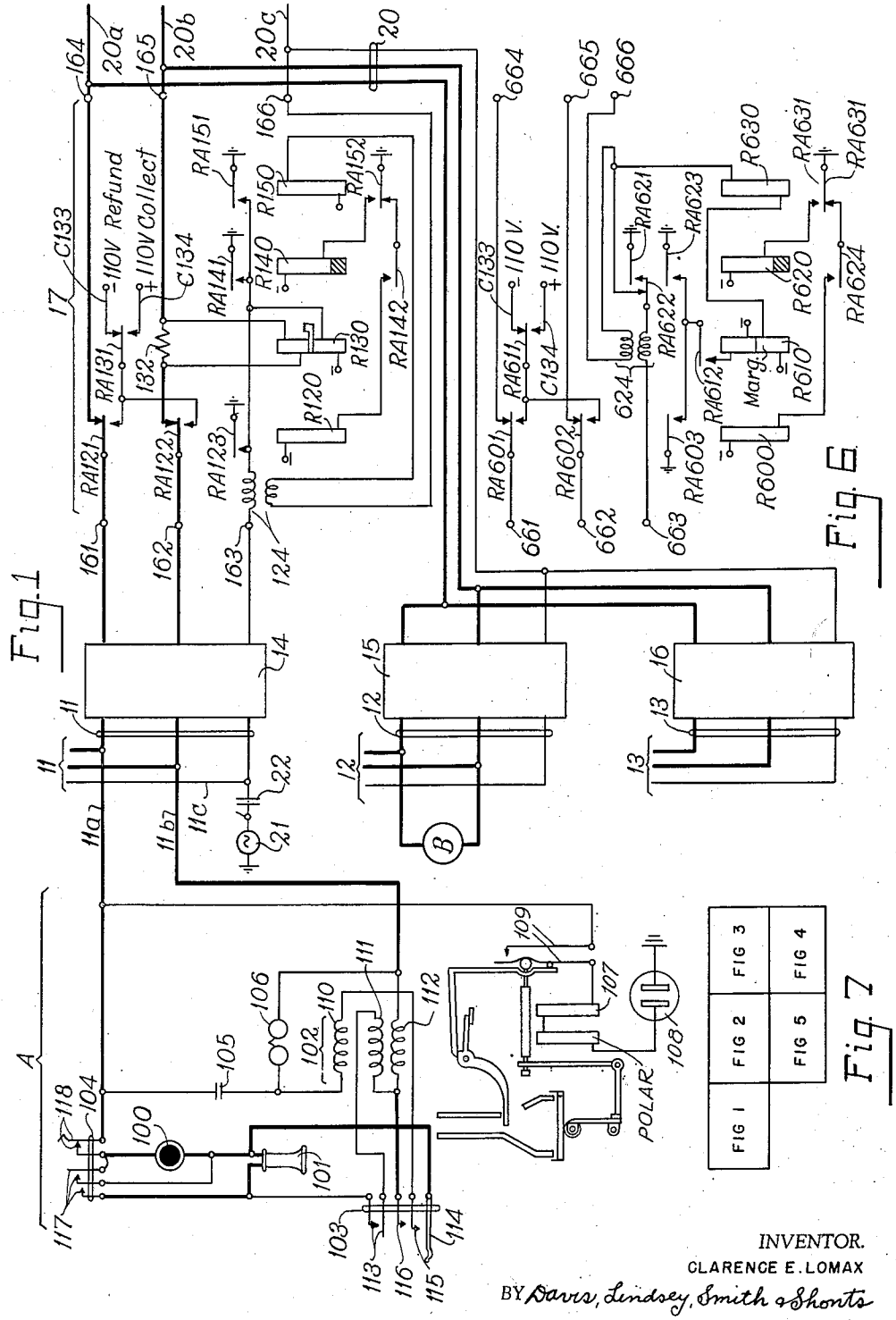
Dec. 31, 1940. C. E. LOMAX 2,226,730

TELEPHONE SYSTEM

Filed April 28, 1939 5 Sheets-Sheet 1



INVENTOR.
CLARENCE E. LOMAX
BY Davis, Lindsey, Smith & Shonts
ATTORNEYS.

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TELEPHONE SYSTEM

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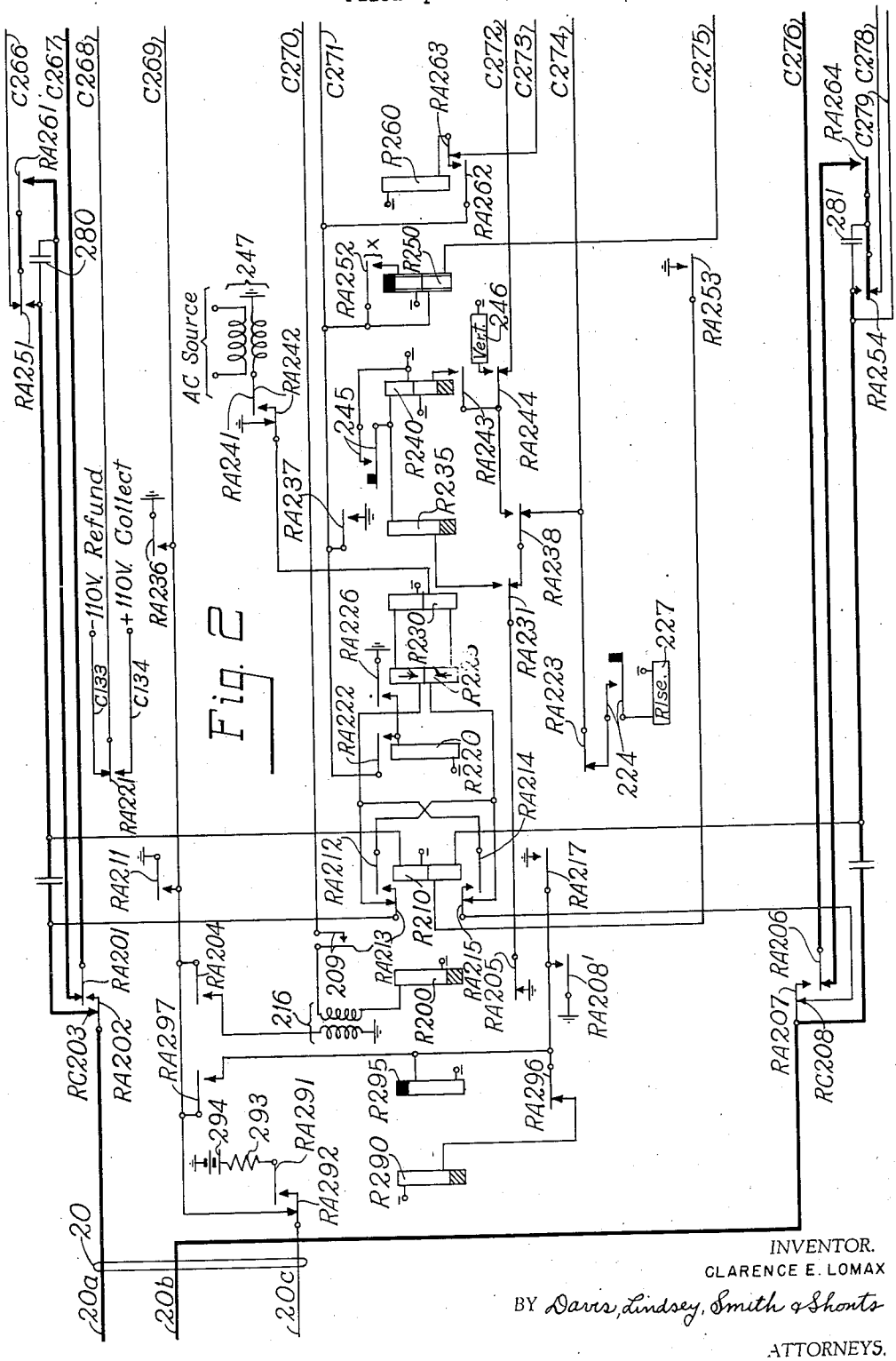


Fig. 2

INVENTOR.
CLARENCE E. LOMAX
BY Davis, Lindsey, Smith & Shorts
ATTORNEYS.

Dec. 31, 1940. C. E. LOMAX 2,226,730

TELEPHONE SYSTEM

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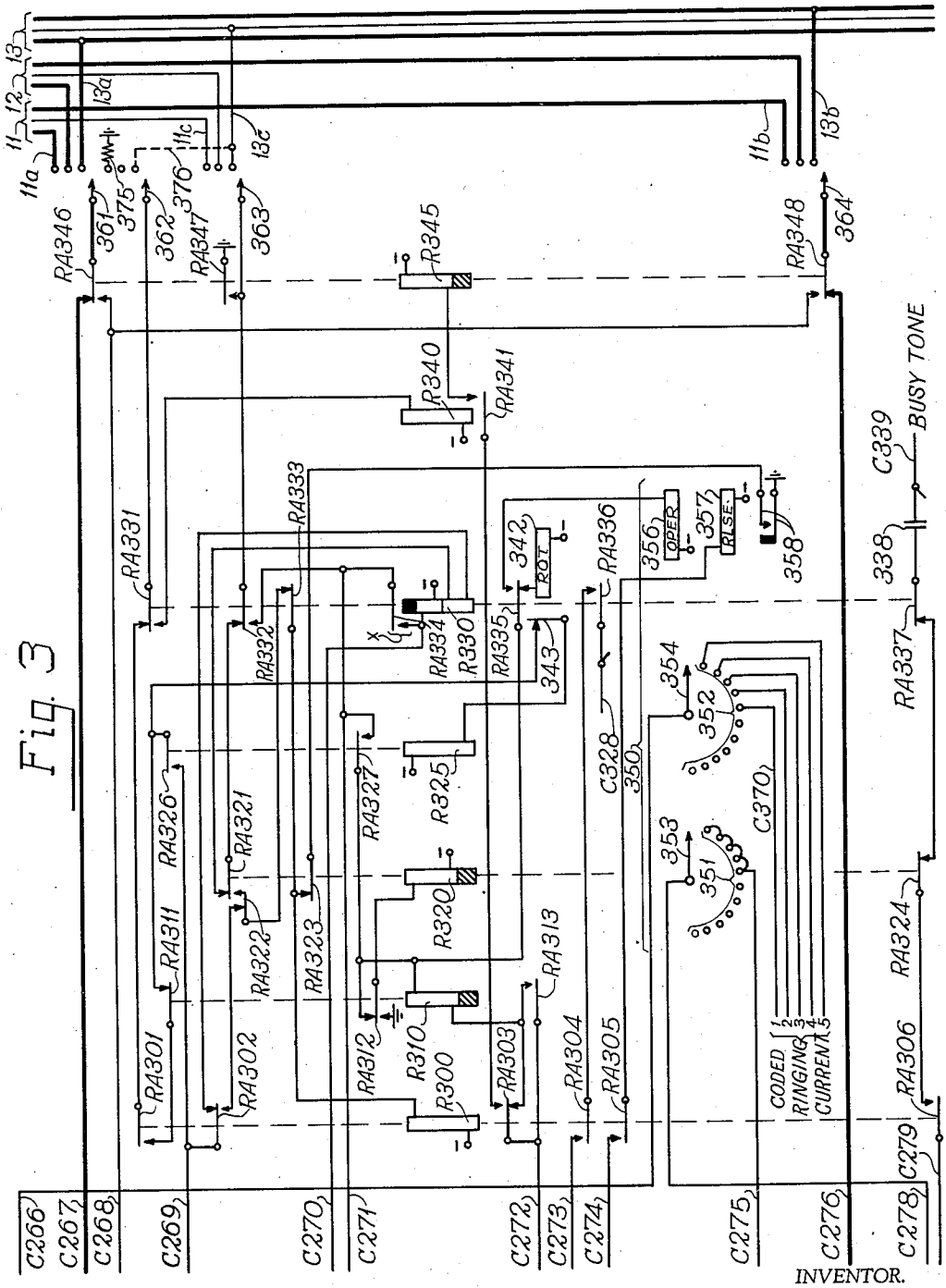


Fig. 3

INVENTOR.
CLARENCE E. LOMAX

BY Davis, Lindsey, Smith & Shontz

ATTORNEYS.

Dec. 31, 1940. C. E. LOMAX 2,226,730

TELEPHONE SYSTEM

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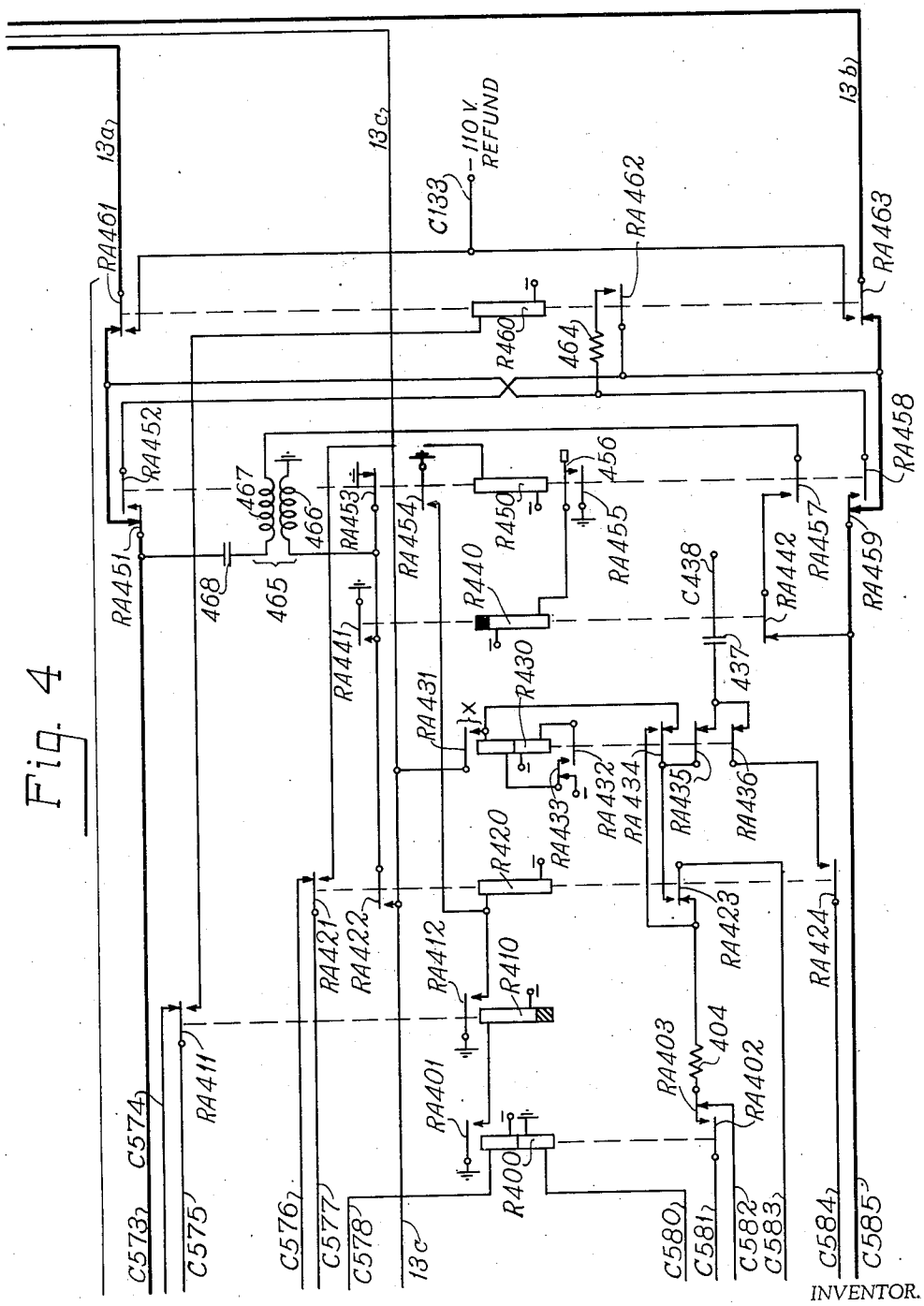


Fig. 4

INVENTOR.
CLARENCE E LOMAX

BY Davis, Lindsey, Smith & Shorts

ATTORNEYS.

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TELEPHONE SYSTEM

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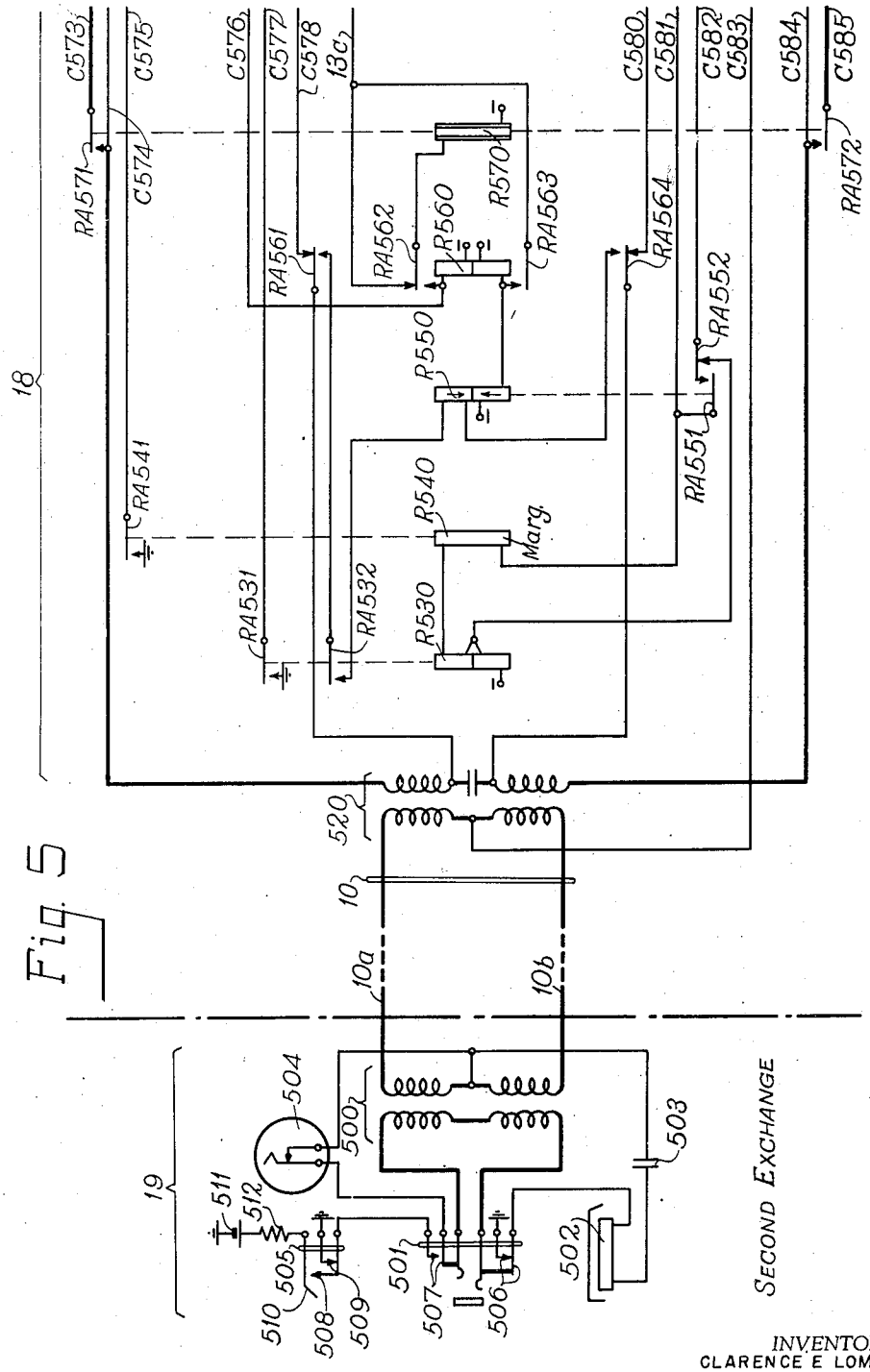


Fig. 5

INVENTOR.
CLARENCE E LOMAX

BY Davis, Lindsey, Smith & Shonts

ATTORNEYS.

Patented Dec. 31, 1940

2,226,730

UNITED STATES PATENT OFFICE

2,226,730

TELEPHONE SYSTEM

Clarence E. Lomax, Oak Park, Ill., assignor to Associated Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application April 28, 1939, Serial No. 270,538

43 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 paystations 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 paystation control mechanism 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 further object of the invention to provide for use in an automatic telephone system an improved final selector switch which is adapted to be used in completing both local and toll connections involving both regular and paystation lines and has embodied therein improved and exceedingly simple apparatus controllable from an operator's position for effecting coin collecting and refunding operations at paystations associated with certain of the lines accessible to the switch.

It is another object of the invention to provide for use in an automatic telephone system an improved two-way repeater which is adapted to be used in completing toll connections involving both regular lines and paystation lines and has embodied therein improved and simplified apparatus for effecting coin collecting and refunding operations required incident to the use of the paystations included in the system.

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 trunk lines incoming to certain of the first numerical switches of an automatic telephone system and 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 to cause coins deposited in the coin-receiving means to be refunded or collected, as desired. 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 operation of the calling device conventionally provided at the operator's position, after a connection has been routed from the operator's position to the paystation, to cause the coin collecting and refunding control means to operate in a particular manner, i. e., to refund coins deposited in the coin-receiving means. This apparatus, as embodied in each switch, is further arranged to respond 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 to operate in a different manner, i. e., to collect 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 on calls routed from the operator's position to the above-mentioned paystation. In regard to calls routed in the opposite direction, certain of the first numerical switches of the system have associated with the trunk lines incoming thereto paystation circuits which function, on toll calls routed to the operator's position, only to control the coin refunding and collecting control means in its operation to effect a coin collecting operation. These trunk circuits, on local calls originating at the paystation, are arranged to operate in a novel manner to cause both coin refunding and collecting operations to be performed. Two embodiments of this improved trunk circuit apparatus are disclosed. In one embodiment of this apparatus reverse battery control is utilized and in the other embodiment the arrangement is such that booster battery control may be utilized. For the purpose of obtaining coin refunding operations on toll calls routed to the operator's position, the repeaters individually associated with the trunk lines extending to the operator's position are provided with apparatus, arranged in an improved manner and controllable from the operator's position, for imposing upon an established connection extending back to the paystation a predetermined coin refund potential.

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 paystation trunk circuit 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 the 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 line switches, two of which are indicated at 14 and 15, individually associated with the subscribers' lines of the system and a plurality of connector switches, one of which is illustrated in Figs. 2 and 3. These 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 connector switches provided in the community exchange to the desired subscriber's line. To this end, there is associated with the link line 13 a line switch 16 which has access to the trunk lines individually incoming to the various connector switches.

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 11_a and 11_b 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 refund chute. The 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 disengaged until the electromagnetic device 107 operates in one manner or the other. The coin collect apparatus provided at the substation A and schematically shown in Fig. 1 of the drawings may be of the well known type shown and described in Patent No. 1,043,219, granted November 5, 1912, Forsberg, although preferably this apparatus and the impulsing device 104 of the substation are arranged in the manner disclosed and claimed in copending application Serial 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 position in the distant central office, may successfully be completed without the deposit of a coin in the coin-receiving means, whereas other calls intended for the substations local to the community exchange can only successfully be completed after a coin has been deposited in the coin-receiving means. To this end, and as disclosed in the aforementioned copending application, the substation circuit is so arranged that only a predetermined number of digits, as, for example, two digits, may effectively be transmitted from the substation, a digit counter being provided for shunting the pulsing springs of this device after a predetermined number of digits has been dialed.

For the purpose of controlling the coin collecting and coin refunding operations required incident to the use of connections resulting from calls originating at the substation A, each trunk line extending to the bank contacts of the line switch 15 and incoming to one of the connector switches embodied in the community exchange is divided into two parts which are connected by paystation trunk circuit apparatus. Thus, the trunk line 20 incoming to the connector switch shown in Figs. 2 and 3 is connected to a set of bank contacts in the line switch 14 and to the other similar line switches associated with lines of the paystation type through a trunk circuit 17 which includes a group of relays for controlling the coin collecting and coin refunding operations performed incident to use of the substation A. More particularly, 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. These two additional relays also function, when operated, in the capacity of hold relays in that they impress ground potential upon the release or control conductor of the trunk line section extending to the line switch 14. The trunk circuit 17 further includes an electropolarized relay R130 which functions to determine whether a coin refund or coin collect operation is to be performed incident to operation of the relay R120. This polarized relay comprises an upper winding serially included in one side of the trunk line extending to the connector switch shown in Figs. 2 and 3 and shunted by a resistor 132 for by-passing voice frequency currents. This relay is so constructed and arranged that it only operates when its lower winding is polarized and current of a predetermined polarity is directed through its upper winding. When once operated, however, the relay R130 remains operated so long as its lower winding is energized and regardless of the polarity of the current traversing its upper winding. 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 operator's position in the central office, it is necessary that apparatus be provided for disclosing to the operator the identity of the calling station 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 11c of the line 11 through a condenser 22. In order to transmit the paystation tone voltage through the trunk circuit apparatus to the control conductor of the connector switch shown in Figs. 2 and 3 on calls routed by way of this switching equipment, there is provided a condenser 22.

Since the trunk circuit apparatus 17 is provided only for the purpose of controlling coin collecting and coin refunding operations incident to the use of substations of the paystation type on calls originating at such substations, it will be apparent that there is no need to include this or similar apparatus in the trunk lines extending between the line switches associated with the regular substation lines and the connector switches. Accordingly, the trunk line 20 extending to the connector switch shown in Figs. 2 and 3 is terminated directly in the bank contacts of the line switch 15 associated with the subscriber's line 12 and in the corresponding bank contacts of the line switch 16 associated with the link line 13 extending to the repeater 18.

Each of the line switches embodied in the automatic switching apparatus provided in the community exchange is preferably of the well-known rotary type of which several commercial embodiments are known. The connector switches of this exchange are all of identical arrangement. In brief, the connector switch shown in Figs. 2 and 3 comprises 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 contacts in a selected level; a release magnet 227; three sets of off-normal springs 209, 224 and 245; and a plurality of control relays connected 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 ring cut-off relay R250, a ringing control relay R260, a pair of booster battery control relays R290 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 cooperate with a trunk hunting relay R325 to control the operation of the wipers 361 to 364, inclusive, when the connector switch is functioning to search for an idle one of the trunk lines extending to the central office. The control apparatus of the connector switch further includes four additional relays R220, R225, R340 and R345 which are provided for the purpose of controlling coin refunding and coin collecting operations performed incident 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_c of the trunk line 20 incoming to the connector 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 associated with the multiparty 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 comprises two sets of bank contacts 351 and 352 of eleven points each; wipers 353 and 354 individually associated with the contact sets; means comprising an operating magnet 356 and a ratchet 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 repeating 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 repeater. 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_c 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 and collecting control key 505 of the non-locking 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 for initiating the operation of the line switch 14. This loop circuit may partially be traced as extending by way of the line conductor 11_a, the pulsing springs 118, the transmitter 100, the switchhook 114 and associated contacts 115 and 116, and the induction coil winding 112 to the opposite line conductor 11_b. When the hook switch 103 is operated to its off-normal position the contact 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 switch 14 responds to the completion of the above-traced loop circuit by operating in a well-known manner to select a trunk line extending to an idle one of the con-

nector switch to which it has access. Assuming, for example, that the connector switch illustrated in Figs. 2 and 3 is the first available idle switch accessible to the line switch 14, when the trunk line extending to this connector switch is found, the line switch 14 operates to extend the calling loop circuit to this connector switch, so that the line relay R230 is energized. 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 20_b, the upper winding of R130, RA122, the conductor 11_b, the winding 112, the contacts 116 and 115, the switchhook 114, the transmitter 100, the pulsing springs 118, the conductor 11_a, RA121, the conductor 20_a, 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 RA238, 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 147 to the receiver 101 provided in the calling substation.

At RA236, the hold relay R235, upon operating, impresses ground potential upon the control conductor 20_c of the trunk line 20, thereby to mark the connector switch of Figs. 2 and 3 as busy in the bank contacts of the various line switches having access thereto. 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 20_c, the secondary winding of the transformer 124 and the winding of R150 to battery. When energized over this circuit, the relay R150 operates to complete, at RA151, an obvious path for impressing ground potential upon the control conductor of the trunk line section extending to the bank contacts of the line switch 14, thereby to maintain this line switch operated. At RA152, the relay R150 completes an obvious circuit for energizing the slow-to-release relay R140, causing the last-mentioned relay to operate and complete, at RA141, an obvious multiple path for impressing ground potential upon the last-mentioned control conductor. At RA142, the relay R140 prepares a circuit for energizing the relay R120. The operation of the two relays R140 and R150 also results in the energization of the lower winding of the electropolarized 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. 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 11_a and ground. At this time the voltage of the exchange battery as impressed between the line conductor 11_a 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 impulsing. 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 impulsing 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 RA285 by way of RA231, RA232, RA244, C272, RA333, 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 impulsing 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 RA 305, 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 interdigit 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 con-

ductor 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 switch 15. 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 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 R358, RA323 and the winding of R300 to battery. Upon operating, the relay R300 prepares, at RA303, the circuit for energizing the relay R345. 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 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 350. 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, RA348, C276, RA206, RA264, RA254, C278, the wiper 353, the fifth contact of the set 351, C275, the lower winding of R250, 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, RA256, 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_c of the trunk line 20. At its armatures RA212 to RA214, 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_c, 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_c. After this path is completed the control conductor 20_c is disconnected from ground at RA292 and its associated resting contact. 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 and RA292 after an interval, thereby to disconnect the conductor 20_c from the booster battery source and to reconnect this conductor to ground. Thus, it will be apparent that booster battery potential is impressed upon the control conductor 20_c 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 the conductor 20_c is without effect other than to increase the energization of the relay R150. 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_c 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_c of the trunk line 20 may also be utilized to control the paystation trunk circuit apparatus 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_a 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 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 101 upon the switchhook 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, RA223, 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 destoration 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 he windings of the cut-off relay embodied in the line switch 15, 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 20c of the trunk line 20, thereby to deenergize the relay R150. When ground potential is removed from the private conductor 20c of the trunk line 20, the connector switch shown in Figs. 2 and 3 is marked as idle in the bank contacts of the line switches having direct access thereto. Upon restoring, the relay R150, at RA152, opens the operating circuit for the relay R140 and completes a circuit extending by way of RA142 for energizing the relay R120. At RA151, the relay R150 opens one of the multiple paths for impressing ground potential upon the private conductor extending to the bank contacts of the line switch 14. The relay R120, upon operating, completes, at RA121 and RA122, the above-mentioned path for impressing a positive or coin collect potential of 110 volts upon the line conductors 11a 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 11a, 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, the second multiple path for impressing ground potential upon the private conductor extending from the trunk circuit apparatus 17 to the bank contacts of the line switch 14. 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 disconnects ground from the private conductor extending from the apparatus 17 to the bank contacts of the line switch 14 and, in so doing, interrupts the circuit for energizing the lower windings of 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. When ground potential is removed from the private conductor extending between the apparatus 17 and the bank contacts of the line switch 14, this switch is released in the usual manner and battery potential is substituted for ground upon the private conductor 11c of the calling line 11, thereby to identify this line as idle in the bank contacts of the connector switches having access thereto. Thus, the apparatus involved in establishing the connection between the substations A and B is fully released.

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 trunk circuit 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 R235, 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 relay R150 is deenergized 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 disconnect ground from the private conductor extending from the trunk circuit apparatus 17 to the line switch 14, whereby the line switch 14 is caused 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 fur-

ther that the line 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 energizating 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_c 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 engagement with the contact terminating the private conductor 13_c 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_c, this path extending by way of the grounded conductor C271, RA332 and the wiper 363 to the conductor 13_c. 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 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_c of the trunk line 20, thereby to maintain 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 the conductor 20_c. 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_a and 20_b 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_c 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_c, 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 13_c; 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 13_c. 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 10_a and 10_b 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 complete 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 11c of the calling line 11 by the alternating current source 21. This potential is impressed by means of the transformer 124 upon the private conductor 20c 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 operator's 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 operating, 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 11a, 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 20c of the trunk line 20, thus causing the restoration of the relay R150 followed by the operation 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. With the three relays R120, R140 and R150 all released, the private conductor extending from the apparatus 17 to the bank contacts of the line switch 14 is disconnected from ground, permitting the line switch 14 to release and remove ground potential from the private conductor 11c of the calling line. 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 13c 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 line 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 reoperate to extend a connection through the line switch 16 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 switch 16 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 switch 16. 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 switch 16 operates to select an idle one of the connector switches to which it has access. Assuming, for example, that the connector switch illustrated in Figs. 2 and 3 is the first available idle connector switch accessible to the line switch 16, when this connector switch is found the line switch 16 operates in the usual manner to switch the above-mentioned loop circuit through thereto, 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 20c of the trunk line 20, which ground potential is applied through the line switch 16 to the private conductor 13c of the link 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 13c 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.

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 16, 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.

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 again operates the calling device 504 to dial the digit 1 so that the line relay R530 restores and then reoperates. Upon restoring, the relay R530 opens, at RA532, the loop extending by way of the link line 13 and the line switch 16 to the connector switch shown in Figs. 2 and 3 so that the line relay R230 is caused momentarily to restore. The relay R230, upon restoring, completes, at RA231, the previously mentioned circuit for energizing the relay R345, this circuit extending from ground at RA285 by way of RA231, RA238, RA244, C272, RA383, RA341 and the winding of R345 to battery. At the end of the digit, the relays R530 and R230 sequentially reoperate in an obvious manner to interrupt the circuit just traced. Upon operating, the slow-to-release relay R345 completes, at RA347, an obvious multiple path for impressing ground potential upon the private wiper 363 of the connector switch and 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, RA221, C268, RA346, wiper 361 and to the line conductor 11a and the other path extending by way of the conductor C268, RA348 and the wiper 364 to the conductor 11b. When the negative coin refund potential is impressed upon the conductor 11a, the magnet 187 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 line relay R230 at the end of the additional or coin refund digit dialed at the operator's position, the relay R345 restores to open the two paths just traced, to disconnect, at RA347, multiple ground from the private wiper 363, and to recomplete the talking circuit between the called substation and the operator's position 19.

In order to condition the apparatus so that coins deposited in the coin-receiving means pro-

vided at the called substation A will be collected, the operator attending the position 19 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. Upon operating, the relay R225 completes, at RA226, an obvious circuit for energizing the relay R220, which latter relay, in turn, operates to complete, at RA222, an obvious holding circuit for itself. Thus, the relay R220 is held in its operated position after the key 505 is restored to normal to cause the sequential restoration of the relays R540 and R225. Upon operating, the relay R220 opens, at RA223, a point in the previously traced circuit for energizing the release magnet 227. At RA221, the relay R220 disconnects the conductor C268 from the negative terminal of the 110 volt coin refund current source and connects this conductor to the positive terminal of the 110 volt coin collect current source. Following the operation of the relay R220, the operator may cause the coins deposited in the coin-receiving means provided at the substation A to be collected before the desired conversational circuit between another substation of the system and the substation A is established, or, alternatively, permit the deposited coins to be collected during the release of the established switch train. In the event the operator desires to collect the coins before the connection is set up, the calling device 504 is operated to again interrupt the circuit for energizing the relay R530, causing this relay and the line relay R230 of the connector switch sequentially to restore in the order named. Upon restoring, the relay R230 completes the previously traced circuit for energizing the relay R345, whereby the last-named relay is caused to operate to connect the positive terminal of the 110 volt coin collect current source to each side of the called line 11 over the paths traced above. The magnet 107 of the coin control mechanism provided at the station A is, in this case, energized by current of the proper polarity to cause the deposited coins to be routed from the coin deposit channel of the coin-receiving means into the coin collect channel.

As indicated above, the following operation of the relay R220, the coins deposited in the coin-receiving means provided at the called substation A will also automatically be 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 and the relay R345 reoperates to cause the coin collecting operation to be performed at the substation A in the manner pointed out above. Shortly following the operation of the relay R345, the hold relay R235 restores to open, at RA237, the holding circuit for the relay R220 and to remove, at RA236 and RA237, ground potential from the private conductors 20_c and 13_c. The relay R220, upon restoring, disconnects, at RA221, the line conductors of the called line from the coin collect current source and completes, at RA223, 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. 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 13_c of the link line 13, the relays R550 and R560 are deenergized and restore. 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.

From the foregoing explanation, it will be apparent that on local calls originating at one of the pay stations served by the automatic switching equipment of the community exchange, the coin refunding and coin collecting operations are performed under the control of trunk 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 pay stations 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 collect operations being controlled by trunk circuit apparatus, such, for example, as the apparatus 17, terminating the trunk line extending to the connector switch in use. Finally, on delayed calls originating at the operator's position 19 and routed to substations of the pay station type served by the automatic switching apparatus located at the community exchange, coin refunding and coin collecting operations may both 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 calling device 504 and the key 505 and the resulting operation of the control apparatus provided in the repeater and the connector switch in use.

Referring now more particularly to Fig. 6 of the drawings, the trunk 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 trunk circuit apparatus 17. In brief, the apparatus shown in Fig. 6 comprises a pay station tone repeating transformer 624, 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 161 to 166, inclusive, may be disconnected from the trunk circuit 17 and connected to the terminals 661 to 666, respectively.

With the apparatus of Fig. 6 connected in the manner just explained, if a connection is routed through the line switch 14 to the connector switch of Figs. 2 and 3, the application of ground

potential to the control conductor 20c 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 terminals 166 and 666, the secondary winding of the transformer 624, the winding of R630 and the lower 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 RA624, a circuit for energizing the relay R600, prepares, at RA623, a holding circuit for the relay R610 and completes, at RA621 and RA622, a path extending through the primary winding of the transformer 624 for impressing ground potential upon the control conductor terminal 663, thereby to maintain the line switch 14 operated.

In the event the call as routed from the substation A over the line 11 and through the line switch 14, the apparatus of Fig. 6 and 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 conductor 20c, 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 paystation line. The magnet 107 provided at the calling substation responds in the manner previously explained by operating to cause the coin or coins deposited in the coin-receiving means of this substation to be refunded. Shortly following the operation of the relay R500, the relay R620 restores to open, at RA624, the operating circuit for the relay R600 and to open, at RA621 and RA622, the path for impressing ground potential upon the control terminal 663. As a result, the line switch 14 is released and the relay R600 restores to disconnect the negative refund potential from the conductors of the calling line.

In the event the call as routed from the line 11 through the line switch 14, the apparatus of Fig. 6 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 lower 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 RA623, in response to the restoration of the relay R620. 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 to the operator's position 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 trunk calls 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 trunk circuit apparatus included in the trunk circuit extending to the connector switch in use.

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 and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, an operator's position, automatic switching apparatus including a selector switch having line terminating contacts, a line extending to said substation and terminating in the contacts of said selector switch, said automatic switching apparatus being controllable from said operator's position to route a connection from said operator's position to said substation, and means including in said selector switch and controllable from said operator's position for controlling said coin refunding and collecting control means over said line to cause coins deposited in said coin-receiving means to be refunded.

2. 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, an operator's position, automatic switching apparatus including a selector switch having line terminating contacts, a line extending to said substation and terminating in the contacts of said selector switch, said automatic switching apparatus being controllable from said operator's position to route a connection from said operator's position to said substation, and means included in said selector switch and controllable from said operator's position for controlling said coin refunding and collecting control means over said line to cause coins deposited in said coin-receiving means to be collected.

3. 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, an operator's position, automatic switching apparatus including a selector switch having line terminating contacts, a line extending to said substation and terminating in the contacts of said selector

switch, said automatic switching apparatus being controllable from said operator's position to route a connection from said operator's position to said substation, and means included in said selector switch and selectively controllable from said operator's position for controlling said coin refunding and collecting control means over said line to cause coins deposited in said coin-receiving means selectively to be collected or refunded.

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 refunding and collecting control means being operative to refund coins deposited in said coin-receiving means in response to application of a predetermined potential to one of the conductors of said line and to collect coins deposited in said coin-receiving means in response to application of a different predetermined potential to said one line conductor, an operator's position, automatic switching apparatus including a selector switch having line terminating contacts at which said line is terminated, said automatic switching apparatus being controllable from said operator's position to route a connection from said operator's position over said line to said substation, and means included in said selector switch and controllable from said operator's position for selectively impressing 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 second telephone station, a calling device at said second station, automatic switching apparatus operative in response to operation of said calling device to route a connection from said second station to said substation, and means responsive to operation of said calling device after said connection is extended to said substation for causing operation of said coin refunding and collecting control means.

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 second telephone station, a calling device at said second station, automatic switching apparatus including a selector switch, said automatic switching apparatus being operative in responsive to operaiton of said calling device to route a connection from said second station to said substation, and means included in said selector switch and operative in response to operation of said calling device after said connection is extended to said substation for causing operation of said coin refunding and collecting control means.

7. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like, a second telephone station, a calling device at said second station, automatic switching apparatus operative in response to operation of said calling device to route a connection from said second station to said substation, and means responsive to operation of said calling device after said connection is routed to said substation for causing a coin deposited in said coin-receiving means to be refunded.

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 refunding of coins deposited in said coin-receiving means, a second telephone station, a calling device at said second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being operative in response to operation of said calling device to route a connection from said second station to said substation, and means included in said selector switch and operative in response to operation of said calling device after said connection is routed to said substation for causing the operation of said coin refunding control means.

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 second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being controllable from said second telephone 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 interrupting said loop circuit, and means included in said selector switch and operative in response to interruption of said loop circuit for causing the operation of said coin refunding and collecting control means.

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 second telephone station, a calling device at said second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being operative in response to operation of said calling device to route a connection from said second station to said substation, said connection comprising a loop circuit extending to said selector switch, means responsive to operation of said calling device or to a release operation performed at said second station for interrupting said loop circuit, and means included in said selector switch and operative in response to interruption of said loop circuit for causing the operation of said coin refunding and collecting control means.

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 second telephone station, a calling device at said second telephone station, automatic switching apparatus including a selector switch, said automatic switching apparatus being operative in response to operation of said calling device to route a connection from said second station to said substation, said connection comprising a loop circuit extending to said selector switch, a line relay included in said selector switch and energized over said loop circuit, means responsive to operation of said calling device or to a release operation performed at said second station for interrupting said loop circuit, thereby to cause the release of said line relay, and means responsive to the release of said line relay for

causing the operation of said coin refunding and collecting control means.

12. 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, an operator's position, a calling device at said operator's position, a connector switch having access to said line, automatic switching apparatus including a repeater and said connector switch operative in response to operation of said calling device to route a connection from said operator's position to said line, said connection comprising a loop circuit extending from said repeater to said connector switch, a line relay included in said repeater and operative to interrupt said loop circuit in response to operation of said calling device or in response to a release operation performed at said operator's position, a line relay in said connector switch having windings included in said loop circuit, whereby it is released in response to interruption of said loop circuit, and means included in said connector switch and operative in response to the release of said last-named line relay after said connection to said line is established for causing the operation of said coin refunding and collecting control means.

13. 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, and means responsive to the unbalancing of said loop circuit for conditioning said coin collecting and refunding control means to operate in a particular manner.

14. 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 responsive to the unbalancing of said loop circuit for conditioning said coin collecting and refunding control means to operate in a particular manner, and means controllable from said second station for causing the operation of the coin collecting and refunding control means in the particular manner determined by operation of said last-named means.

15. 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 responsive to the unbalancing of said loop circuit for conditioning said coin collecting and refunding control means to operate in a particular manner, means controllable from said second station for interrupting said loop circuit, and means responsive to interruption of said loop circuit for causing said coin collecting and refunding control means to operate in said particular manner.

16. 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 the coins deposited in said coin-receiving means, a line extending to said substation, an operator's position, a calling device at said operator's position, a connector switch having access to said line, means including a repeater and said connector switch operative in response to operation of said calling device for routing a connection from said operator's position to said line, said connection comprising a loop circuit extending from said repeater to said connector switch, means included in said repeater and controllable from said operator's position for unbalancing said loop circuit, means included in said connector switch and responsive to the unbalancing of said loop circuit for conditioning said coin collecting and refunding control means to operate in a particular manner, means included in said repeater and responsive to operation of said calling device or to a release operation performed at said operator's position for interrupting said loop circuit, and means included in said connector switch and operative in response to interruption of said loop circuit following the completion of said connection for causing said coin collecting and refunding control means to operate in said particular manner.

17. 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 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 controllable from said second station for interrupting said loop circuit, and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, said last-named means being operative in one manner in response to interruption of said loop circuit in the event said loop circuit is not unbalanced before it is interrupted, and in a different manner in the event said loop circuit is unbalanced before it is interrupted.

18. In an automatic telephone system, a substation of the paystation type including means for receiving coins or the like, a second telephone station, a calling device and a manually operable switch at said second station, automatic switching apparatus operative in response to operation of said calling device to route a connection from said second station to said substation, means responsive to operation of said calling device or to a release operation performed at said

second station after said connection is routed to said substation for causing a coin deposited in said coin-receiving means to be refunded, and means responsive to operation of said manually operable switch for conditioning said last-named means to cause a coin deposited in said coin-receiving means to be collected incident to operation of said calling device or to a release operation performed at said second station after said connection is established.

19. 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, a line relay and a differential relay included in said selector switch, said relays having windings serially included in said loop circuit, whereby said differential relay is caused to operate when said loop circuit is unbalanced and said line relay is released when said loop circuit is interrupted, means controllable from said second station for unbalancing said loop circuit, means controllable from said second station for interrupting said loop circuit, means responsive to the release of said line relay for causing said coin collecting and refunding control means to operate in one manner, and means responsive to operation of said differential relay and release of said line relay for causing said coin collecting and refunding control means to operate in a different manner.

20. 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, a connector switch having access to said line, said coin collecting and refunding means being operative to collect coins deposited in said coin-receiving means in response to 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 application of a different predetermined potential to said one line conductor, a second telephone station, means including said connector switch for routing a connection from said second station to said line, said connection comprising a loop circuit, a line relay and a differential relay included in said connector switch, said relays having windings serially included in said loop circuit, whereby said differential relay is caused to operate when said loop circuit is unbalanced and said line relay is released when said loop circuit is interrupted, means controllable from said second station for unbalancing said loop circuit, means controllable from said second station for interrupting said loop circuit, and means jointly controlled by said relays for selectively applying said predetermined potentials to said one line conductor.

21. 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, a connector switch having access to said line, said coin collecting and refunding being operative to collect coins deposited in said coin-receiving means in response to 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 application of a different predetermined potential to said one line conductor, a second telephone station, means including said connector switch for routing a connection from said second station to said line, said connection comprising a loop circuit, a line relay and a differential relay included in said connector switch, said relays having windings serially included in said loop circuit, whereby said differential relay is caused to operate when said loop circuit is unbalanced and said line relay is released when said loop circuit is interrupted, means controllable from said second station for unbalancing said loop circuit, means controllable from said second station for interrupting said loop circuit, means responsive to the release of said line relay unaccompanied by operation of said differential relay for impressing one of said predetermined potentials upon said one line conductor, and means responsive to the release of said line relay preceded by operation of said differential relay for impressing the other of said predetermined potentials upon said one line conductor.

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, an operator's position, automatic switching apparatus for setting up connections between said lines and between said operator's position and said lines, said automatic switching apparatus including selector switches connected and arranged for utilization in completing connections between said lines and also in completing connections between said operator's position and said lines, and means included in said selector switches for controlling said coin collecting and refunding control means incident to the use of connections established between said operator's position and said substation.

23. 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, an operator's position, automatic switching apparatus for setting up connections between said lines and between said operator's position and said lines, said automatic switching apparatus including selector switches connected and arranged for utilization in completing connections between said lines and also in completing connections between said operator's position and said lines, means included in said selector switches for controlling said coin collecting and refunding control means incident to the use of connections established between said operator's position and said substation, and means independent of said last-named means for controlling said coin collecting and refunding control means incident to the establishment and use of connections extending between said one line and others of said lines.

24. In an automatic telephone system a plurality of lines, a substation of the paystation type associated with one of said lines, said sub-

station including means for receiving coins or the like and means for controlling the collecting and refunding of coins deposited in said coin-receiving means, an operator's position, automatic switching apparatus for setting up connections between said lines and between said operator's position and said lines, said automatic switching apparatus including selector switches connected and arranged for utilization in completing connections between said lines and also in completing connections between said operator's position and said lines, means included in said selector switches for controlling said coin collecting and refunding control means incident to the use of connections routed from said operator's position to said substation, additional means for controlling said coin collecting and refunding control means incident to the use of connections routed from said one line to others of said lines, and means including said additional means for controlling said coin collecting and coin refunding means incident to the use of connections routed from said one line to said operator's position.

25. 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, an operator's position, means including an automatic switch train for routing a connection from said one line to another of said lines, said switch train including at least one numerical switch, means associated with said connection at a point preceding the first numerical switch of said switch train for controlling the operation of said coin collecting and refunding control means incident to the use of said connection, means including said switch train for routing another connection from said operator's position to said substation, and means included in one of the numerical switches of said switch train for controlling the operation of said coin collecting and refunding control means incident to the use of said other connection.

26. 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, an operator's position, means including an automatic switch train for routing a connection from said one line to another of said lines, said switch train including at least one numerical switch, trunk circuit apparatus associated with said connection at a point preceding the first numerical switch of said switch train for controlling the operation of said coin collecting and refunding control means incident to the use of said connection, means including said switch train for routing a second connection from said substation to said operator's position, means including said trunk circuit apparatus for controlling the operation of said coin collecting and refunding control means incident to the use of said second connection, means including said switch train for routing a third connection from said operator's position to said substation, and means included in one of the numerical switches of said switch train for controlling the operation of said coin collecting and refunding control means incident to the use of said third connection.

27. 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, an automatic switch having access to said lines and including outlet contacts at which said one line is terminated, said switch including circuit means for controlling said coin collecting and refunding control means over a circuit comprising at least a portion of said outlet contacts and means responsive to operation of said switch to seize said one line on a call routed through said switch to said one line for conditioning said circuit means for operation.

28. 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, an automatic switch having access to said lines and including circuit means for controlling said coin collecting and refunding control means, a trunk line incoming to said switch, line and differential relays including windings connected in series circuit relation with the conductors of said trunk line, circuit means jointly controlled by said line and differential relays for controlling said coin collecting and refunding control means, and means operative in response to operation of said switch to seize said one line for rendering said circuit means effective to control said coin collecting and refunding control means.

29. 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, said coin collecting and refunding control means being operative to refund coins deposited in said coin-receiving means in response to application of one predetermined potential to one of the conductors of said one line and to collect coins deposited in said coin-receiving means in response to application of another predetermined potential to said one line conductor, an automatic switch having access to said lines, a trunk line incoming to said switch, line and differential relays including windings connected in series circuit relation with the conductors of said trunk line, circuit means jointly controlled by said relays for impressing either of said predetermined potentials upon said one line conductor, and means operative in response to operation of said switch to seize said one line for rendering said circuit means operative to impress said potentials upon said one line conductor.

30. 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, an automatic switch having access to said lines and including circuit means for controlling said coin collecting and refunding control means, said switch including control contacts one of which is individual to said one line, a relay, an operating circuit for said relay, said circuit including said contacts and being com-

pleted in response to operation of said switch to seize said one line, and means controlled by said relay for rendering said circuit means operative to control said coin collecting and refunding control means.

31. 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, an automatic switch having access to said lines, a trunk line incoming to said switch, line and differential relays including windings connected in series circuit relation with the conductors of said trunk line, circuit means jointly controlled by said line and differential relays for controlling said coin collecting and refunding control means, said switch including control contacts one of which is individual to said one line, a relay, an operating circuit for said relay, said circuit including said contacts and being completed in response to operation of said switch to seize said one line, and means controlled by said relay for rendering said circuit means operative to control said coin collecting and refunding control means.

32. 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, said coin collecting and refunding control means being operative to refund coins deposited in said coin-receiving means in response to application of one predetermined potential to one of the conductors of said one line and to collect coins deposited in said coin-receiving means in response to application of another predetermined potential to said one line conductor, an automatic switch having access to said lines, a trunk line incoming to said switch, line and differential relays including windings connected in series circuit relation with the conductors of said trunk line, circuit means jointly controlled by said relays for impressing either of said predetermined potentials upon said one line conductor, said switch including control contacts one of which is individual to said one line, a relay, an operating circuit for said relay, said circuit including said contacts and being completed in response to operation of said switch to seize said one line, and means controlled by said relay for rendering said circuit means operative to impress said predetermined potentials upon said one line conductor.

33. A selector switch for use in an automatic telephone system and including an incoming trunk line, said switch comprising line and differential relays having windings connected in series circuit relation with the conductors of said trunk line, and apparatus including said relays for selectively impressing coin refund and coin collect potentials upon one conductor of a selected line extending to a substation of the paystation type.

34. 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, an operator's position, means including an automatic switch train for routing a connection from said substation to said operator's position, said switch train comprising a numerical switch, a repeater and a trunk line connected in tandem in the order named, a relay included in said repeater, a simplex circuit including both sides of said trunk line and the winding of said relay, means controllable from said operator's position to energize said circuit sufficiently to cause the operation of said relay, means responsive to operation of said relay for causing said coin collecting and refunding control means to operate in one manner, and additional means operative in response to the release of said connection for causing said coin collecting and refunding control means to operate in a different manner.

35. 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, an operator's position, means including an automatic switch train for routing a connection from said substation to said operator's position, said switch train comprising a numerical switch, a repeater and a trunk line connected in tandem in the order named, a relay included in said repeater, a simplex circuit including both sides of said trunk line and the winding of said relay, means controllable from said operator's position to energize said circuit sufficiently to cause the operation of said relay, means responsive to operation of said relay for causing said coin collecting and refunding control means to refund a coin deposited in said coin-receiving means, and additional means operative in response to the release of said connection for causing said coin collecting and refunding means to collect a coin deposited in said coin-receiving means.

36. 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, an operator's position, means including an automatic switch train for routing a connection from said substation to said operator's position, said switch train comprising a numerical switch, a repeater and a trunk line connected in tandem in the order named, line and marginal relays included in said repeater, a simplex circuit serially including the windings of said relays and both sides of said trunk line, means at said operator's position for completing said circuit to cause the operation of said line relay, means responsive to operation of said line relay for impressing upon said trunk line a signal voltage identifying the character of said substation, means controllable from said operator's position for increasing the current flow over said simplex circuit, thereby to cause the operation of said marginal relay, means responsive to operation of said marginal relay for causing said coin collecting and refunding control means to operate in one manner, and additional means operative in response to the release of said connection for causing said coin collecting and refunding control means to operate in a different manner.

37. 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, an operator's position, a repeater having a trunk line extending thereto, means including said trunk line and said repeater for routing a connection from said operator's position to said substation, line and mar-

ginal relays included in said repeater, a circuit serially including the windings of said relays and said trunk line, means at said operator's position for completing said circuit to cause the operation of said line relay, means controllable from said operator's position for increasing the current flow over said circuit, thereby to cause the operation of said marginal relay, means responsive to release of said line relay without operation of said marginal relay for causing said coin collecting and refunding control means to operate in one manner, and means responsive to operation of said marginal relay followed by release of said line relay for causing said coin collecting and refunding control means to operate in a different manner.

38. 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, an operator's position, a repeater having a trunk line extending thereto, means including said trunk line and said repeater for routing a connection from said operator's position to said substation, line and marginal relays included in said repeater, a circuit serially including the windings of said relays and said trunk line, means at said operator's position for completing said circuit to cause the operation of said line relay, means controllable from said operator's position for increasing the current flow over said circuit, thereby to cause the operation of said marginal relay, means responsive to release of said line relay without operation of said marginal relay for causing said coin collecting and refunding control means to operate in one manner, means responsive to operation of said marginal relay followed by release of said line relay for causing said coin collecting and refunding control means to operate in a different manner, means including said repeater and said trunk line for routing another connection from said substation to said operator's position, and means responsive to operation of said marginal relay after said other connection is established for causing said coin collecting and refunding control means to operate in said one manner.

39. 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, an operator's position, a repeater having a trunk line extending thereto, means including said trunk line and said repeater for routing a connection from said operator's position to said substation, line and marginal relays included in said repeater, a circuit serially including the windings of said relays and said trunk line, means at said operator's position for completing said circuit to cause the operation of said line relay, means controllable from said operator's position for increasing the current flow over said circuit, thereby to cause the operation of said marginal relay, means responsive to release of said line relay without operation of said marginal relay for causing said coin collecting and refunding control means to operate in one manner, means responsive to operation of said marginal relay followed by release of said line relay for causing said coin collecting and refunding control means to operate in a different manner, means including said repeater and said trunk line for routing another connection from said substation to said operator's position, means responsive to each operation of said line relay following the completion of said other connection for impressing upon said trunk line a signaling voltage identifying the character of said substation, and means responsive to operation of said marginal relay after said other connection is established for causing said coin collecting and coin refunding control means to operate in said one manner.

40. A two-way repeater comprising line and marginal relays having windings connected in series circuit relation, means responsive to operation of said marginal relay on a call routed through said repeater in one direction for impressing a paystation coin control potential upon one of the conductors of the trunk line incoming to said circuit, means responsive to operation of said marginal relay on a call routed through said repeater in the other direction for unbalancing a loop circuit established by way of said incoming trunk line, and means including said line relay for interrupting said loop circuit.

41. In a paystation trunk circuit, a pair of line conductors, paths for impressing either of two paystation coin control potentials upon one of said conductors, a polarized relay operative only in response to current of one polarity traversing said conductors, said relay including contacts for selectively preparing said paths, and means operative during the release of a connection including said circuit for completing the prepared one of said paths.

42. A paystation trunk circuit adapted to be interposed in a trunk line extending to a numerical switch of an automatic telephone system and comprising, in combination, a pair of line conductors and a control conductor, paths for impressing either of two paystation coin control potentials upon one of said conductors, means controlled by the application of booster battery potential to said control conductor for selectively preparing said paths, a pair of relays connected and arranged to operate in one order in response to the application of ground potential to said control conductor and to release in the same order in response to the subsequent removal of ground potential from said control conductor, and means controlled by said relays for completing the prepared one of said paths.

43. A paystation trunk circuit adapted to be interposed in a trunk line extending to a numerical switch of an automatic telephone system and comprising, in combination, a pair of line conductors and a control conductor, paths for impressing either of two paystation coin control potentials upon one of said conductors, a pair of relays connected and arranged to operate in one order in response to the application of ground potential to said control conductor and to release in the same order in response to the subsequent removal of ground potential from said control conductor, a third relay including a winding energized in series with the first of said pair of relays to operate, said third relay only being operative in response to the application of booster battery potential to said control conductor, contacts controlled by said third relay for selectively preparing said paths, and means responsive to the release of the first of said pair of relays to operate for completing the prepared one of said paths.

CLARENCE E. LOMAX.