

April 5, 1938.

T. F. CROCKER ET AL

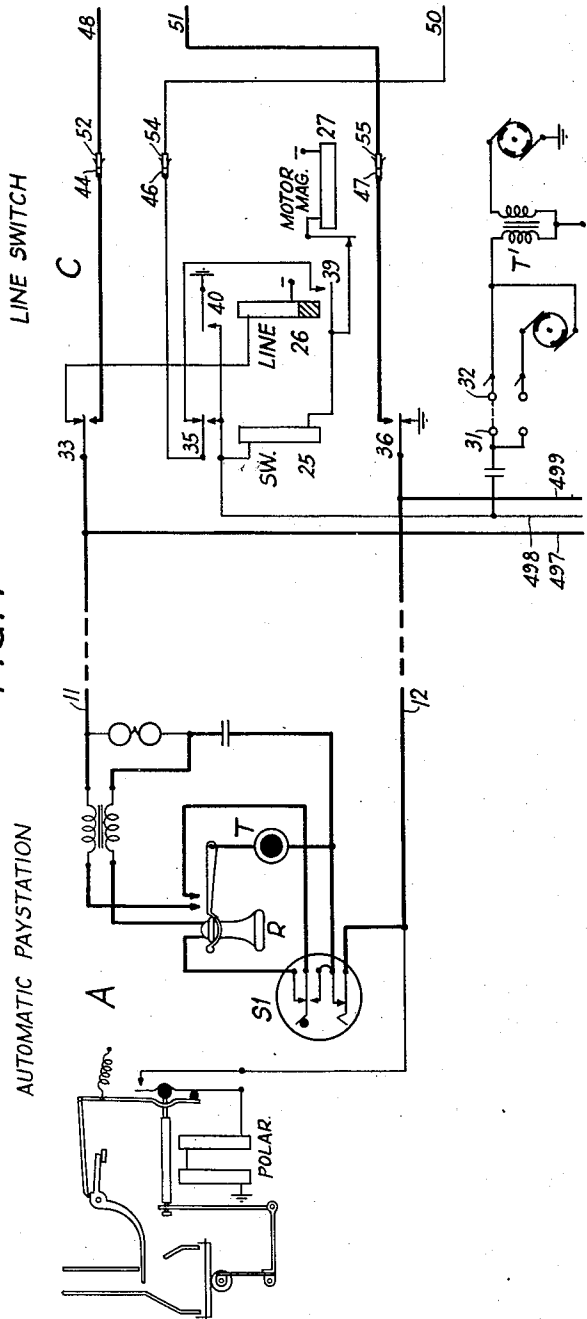
2,113,080

MEASURED SERVICE TELEPHONE SYSTEM

Filed March 7, 1936

17 Sheets-Sheet 1

FIG. 1



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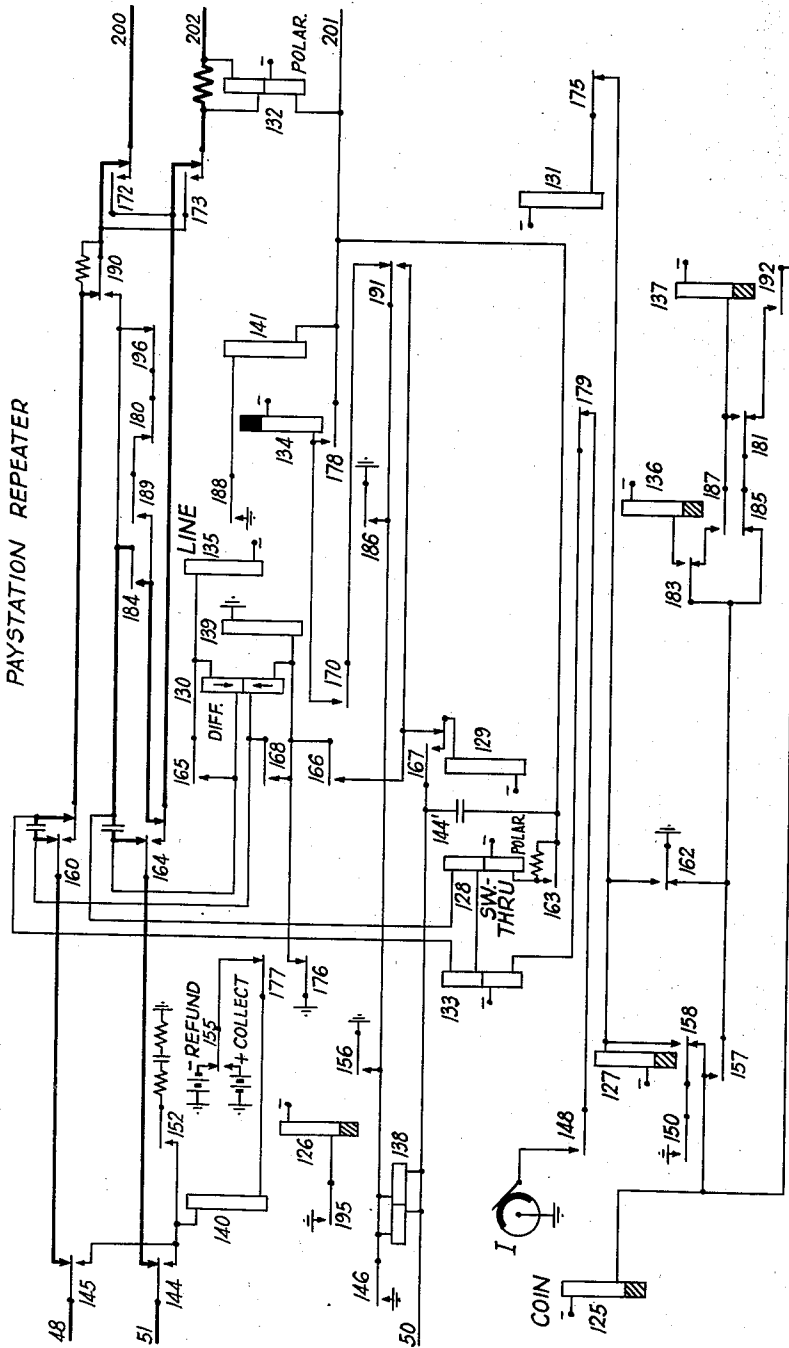
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MEASURED SERVICE TELEPHONE SYSTEM

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FIG. 2



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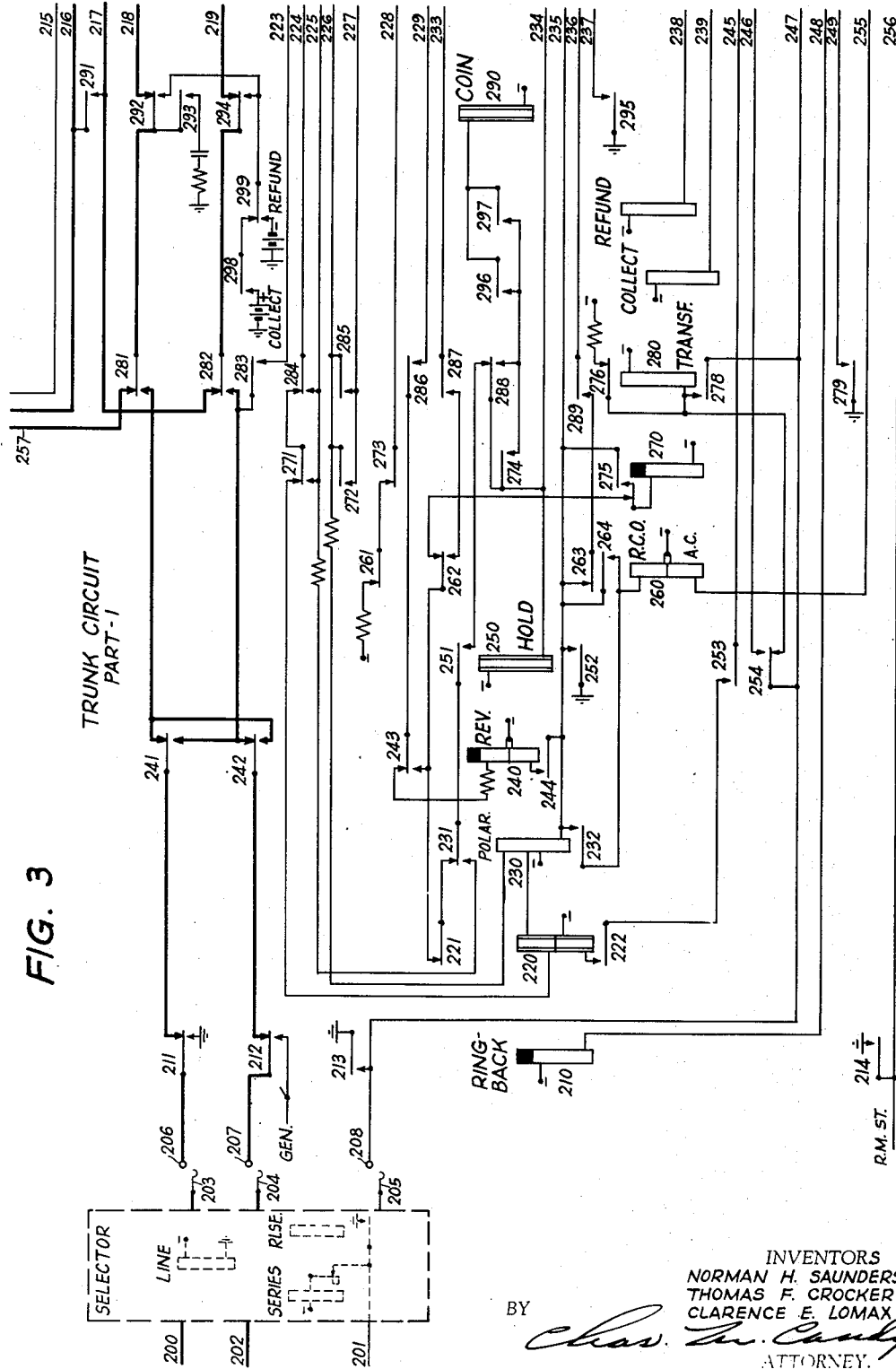
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MEASURED SERVICE TELEPHONE SYSTEM

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17 Sheets-Sheet 3



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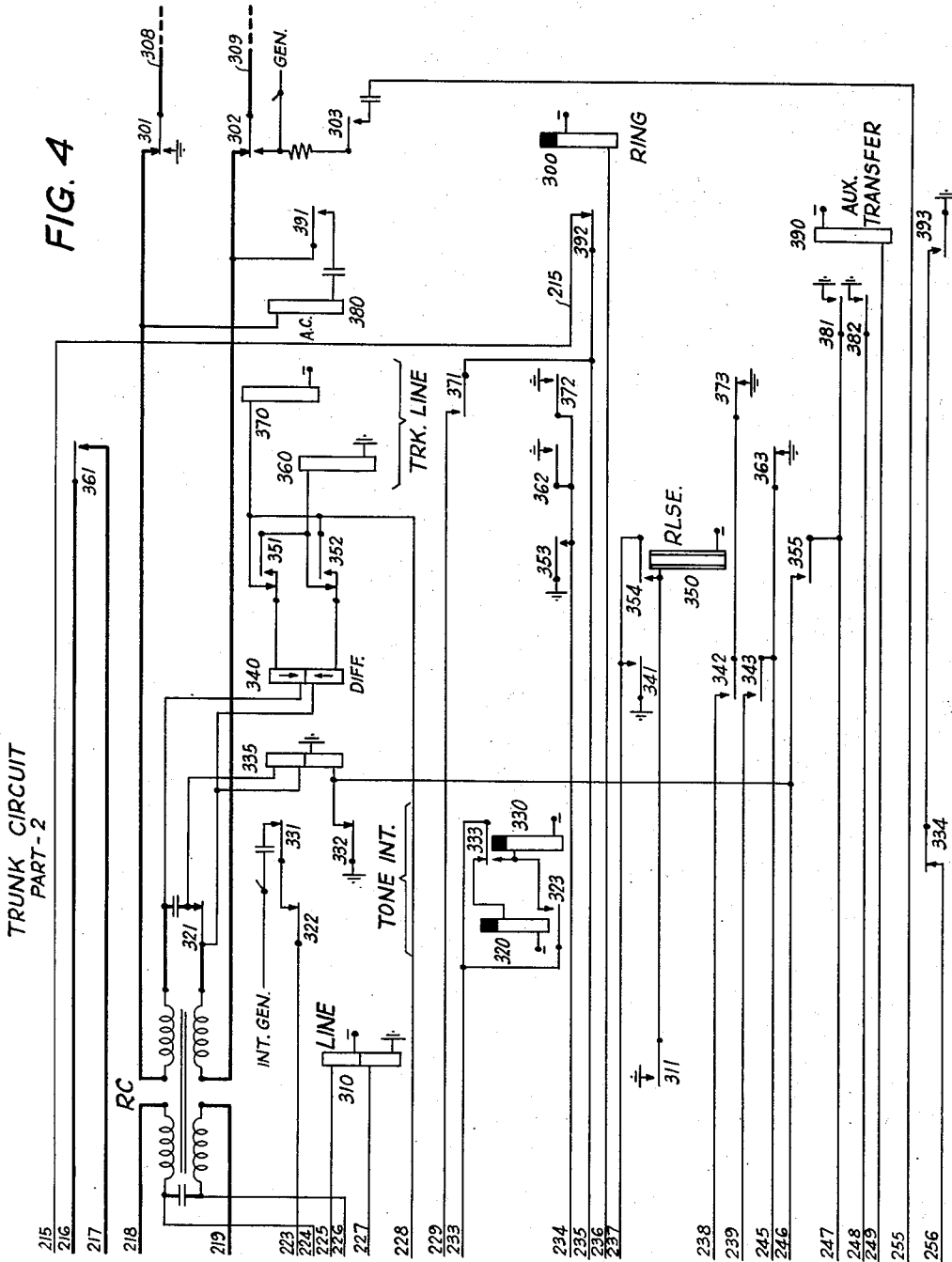
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MEASURED SERVICE TELEPHONE SYSTEM

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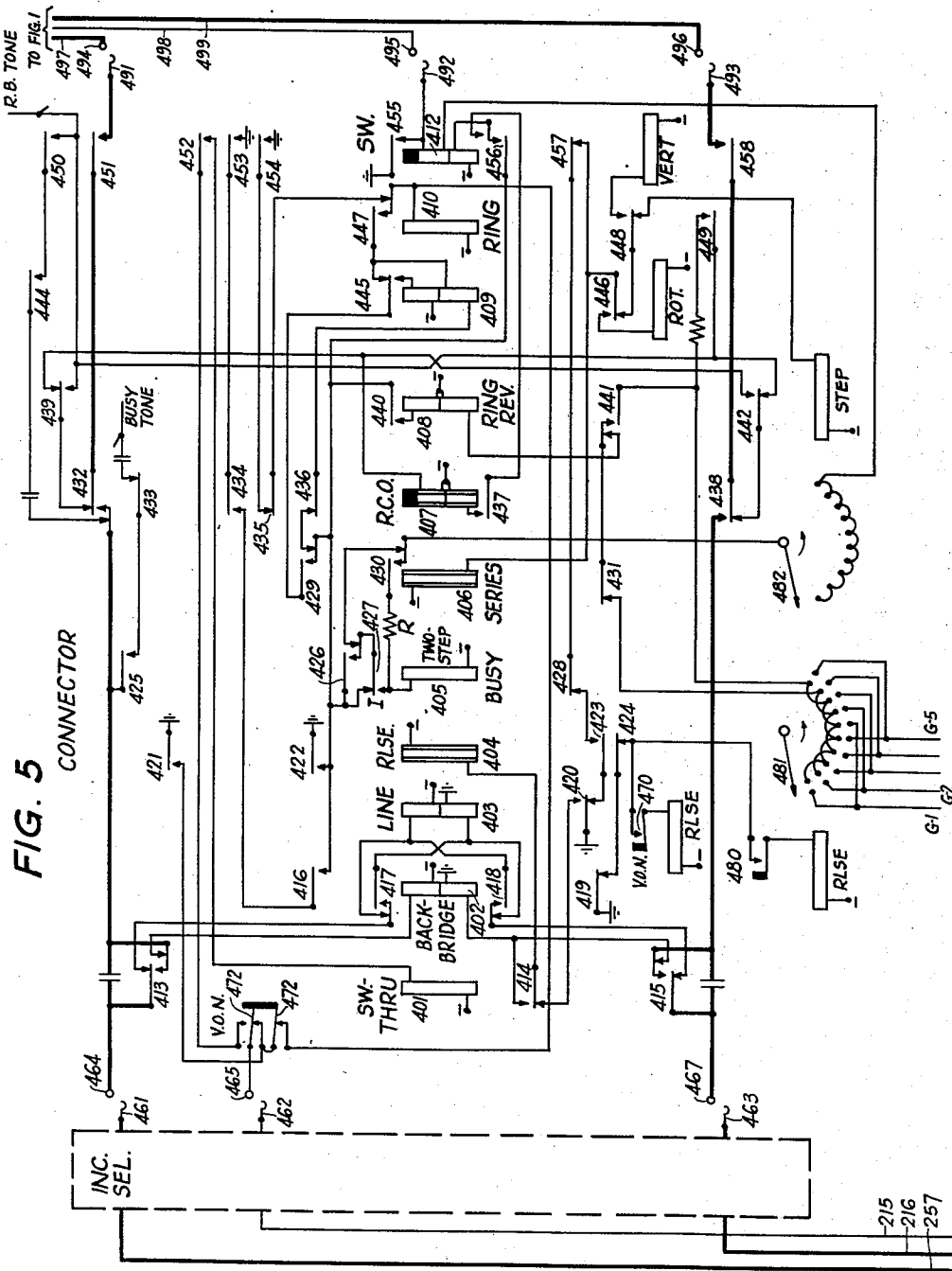
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MEASURED SERVICE TELEPHONE SYSTEM

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17 Sheets-Sheet 5



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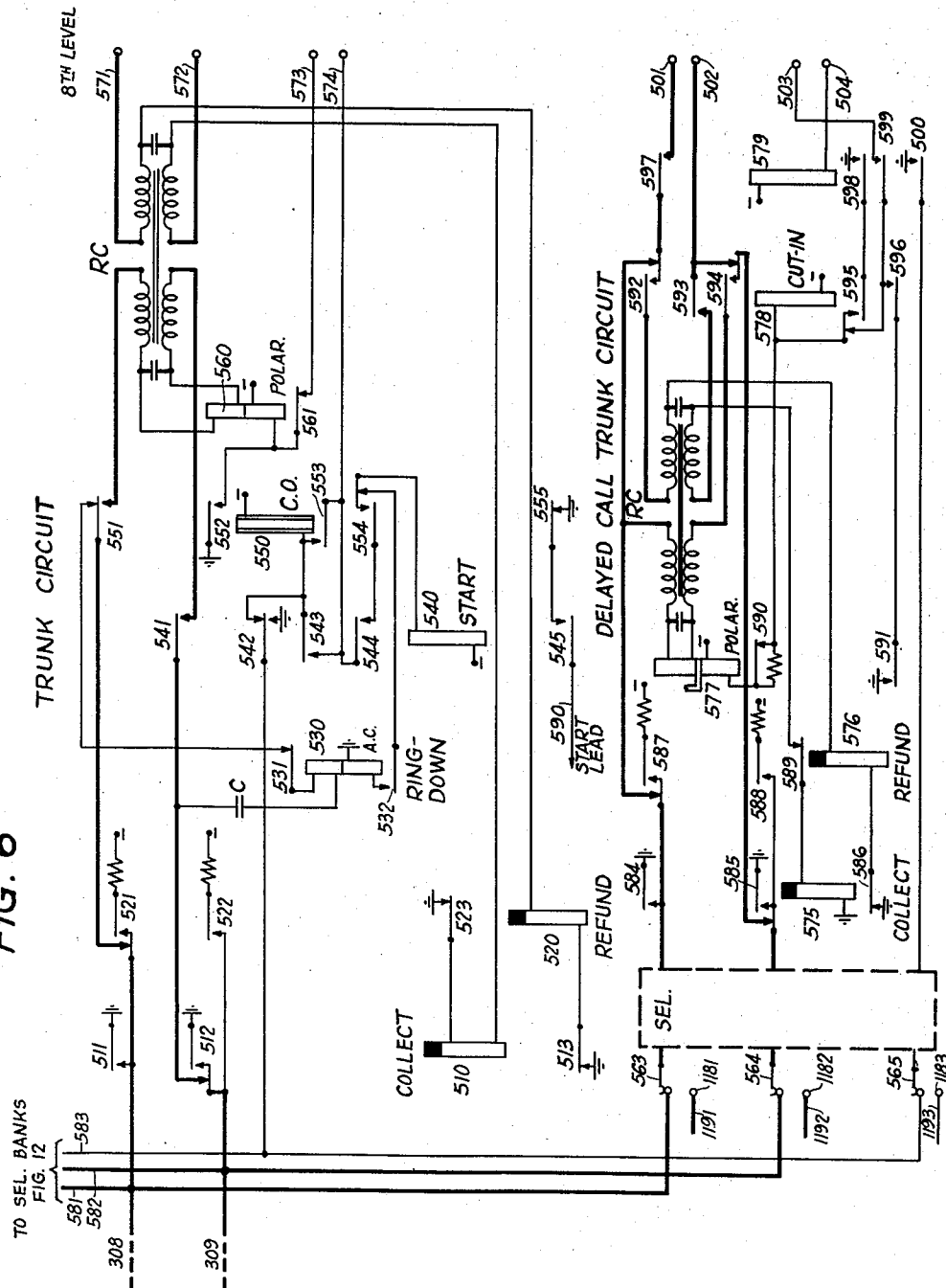
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MEASURED SERVICE TELEPHONE SYSTEM

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FIG. 6



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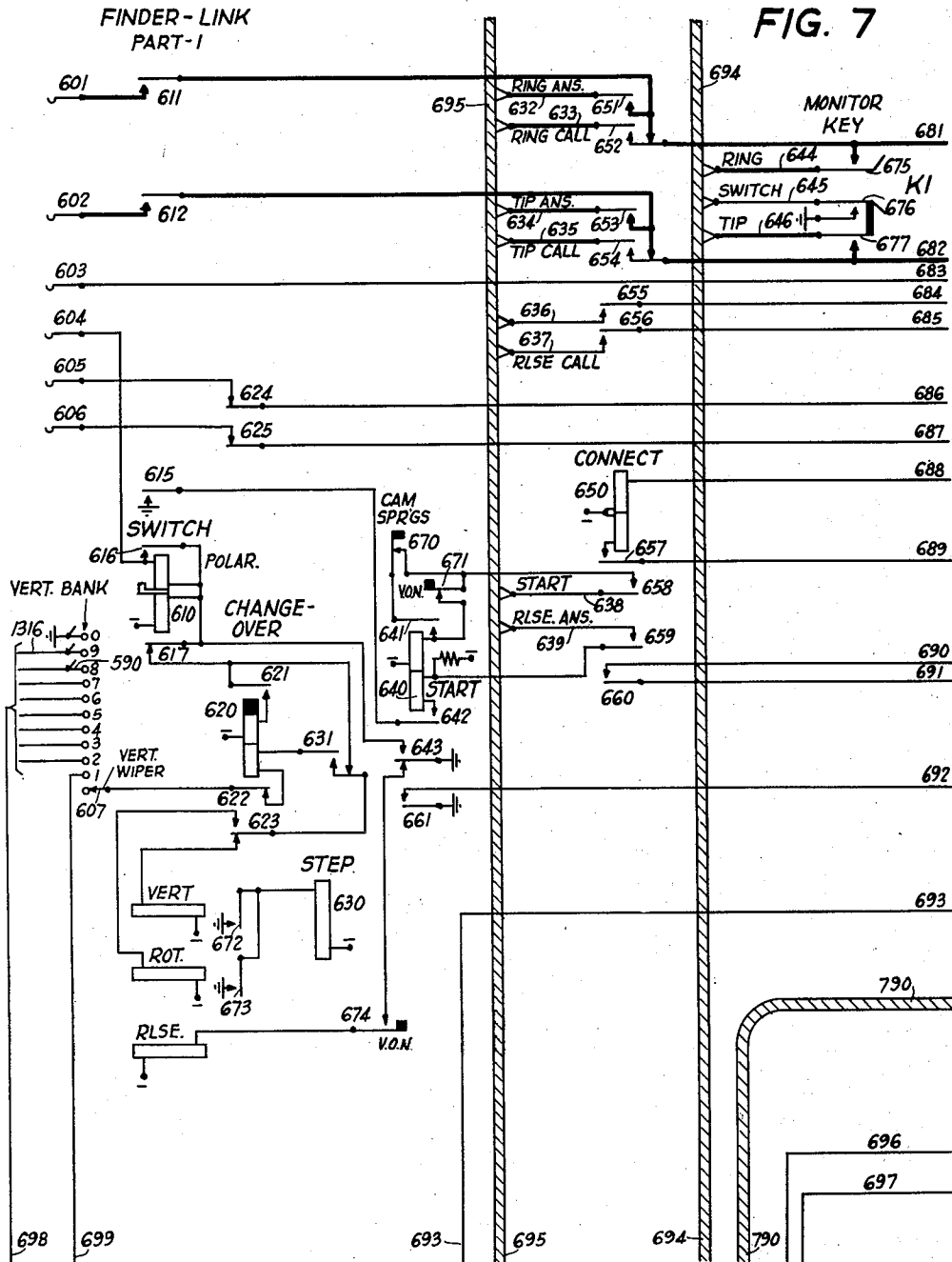
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MEASURED SERVICE TELEPHONE SYSTEM

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17 Sheets-Sheet 7



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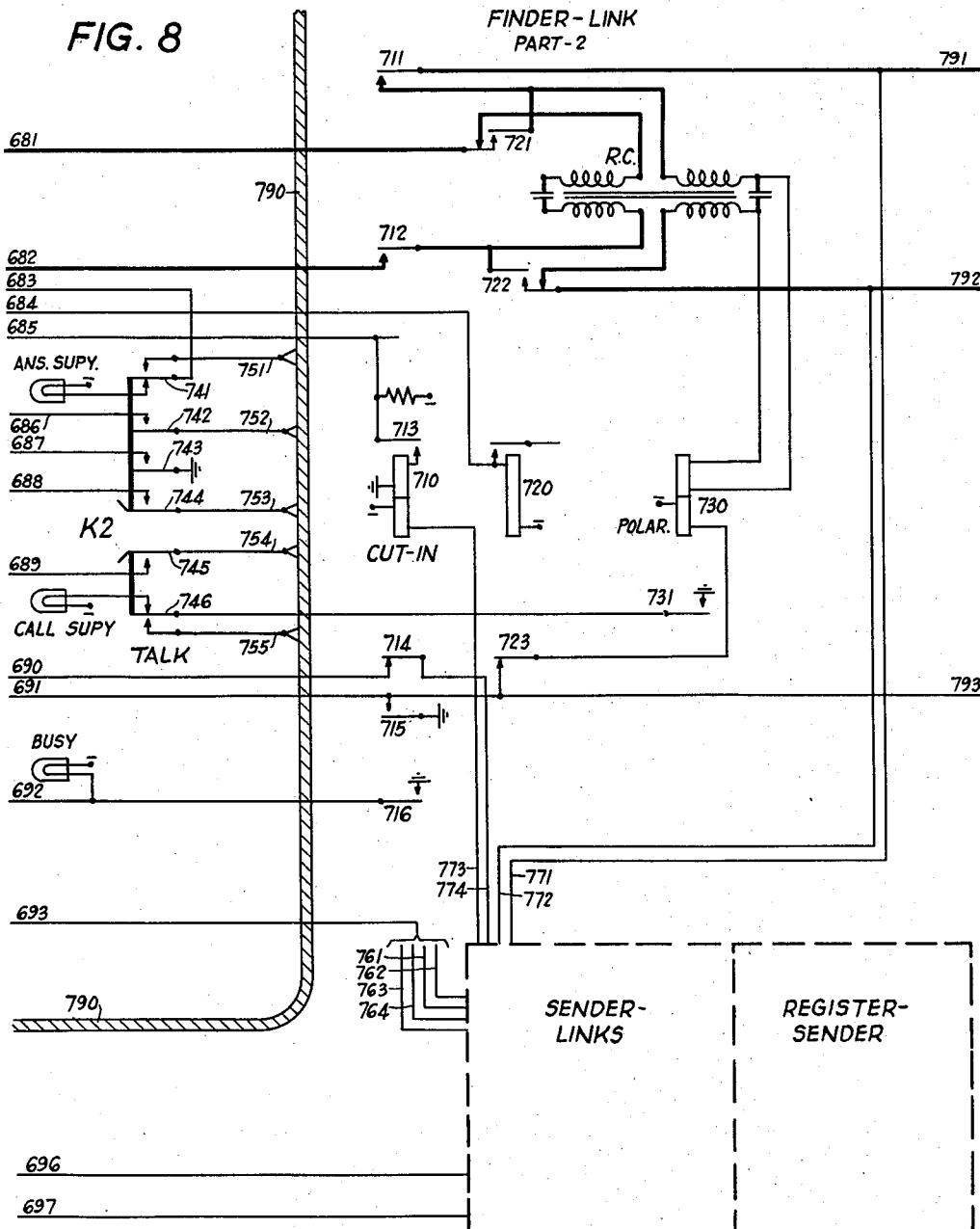
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MEASURED SERVICE TELEPHONE SYSTEM

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FIG. 8



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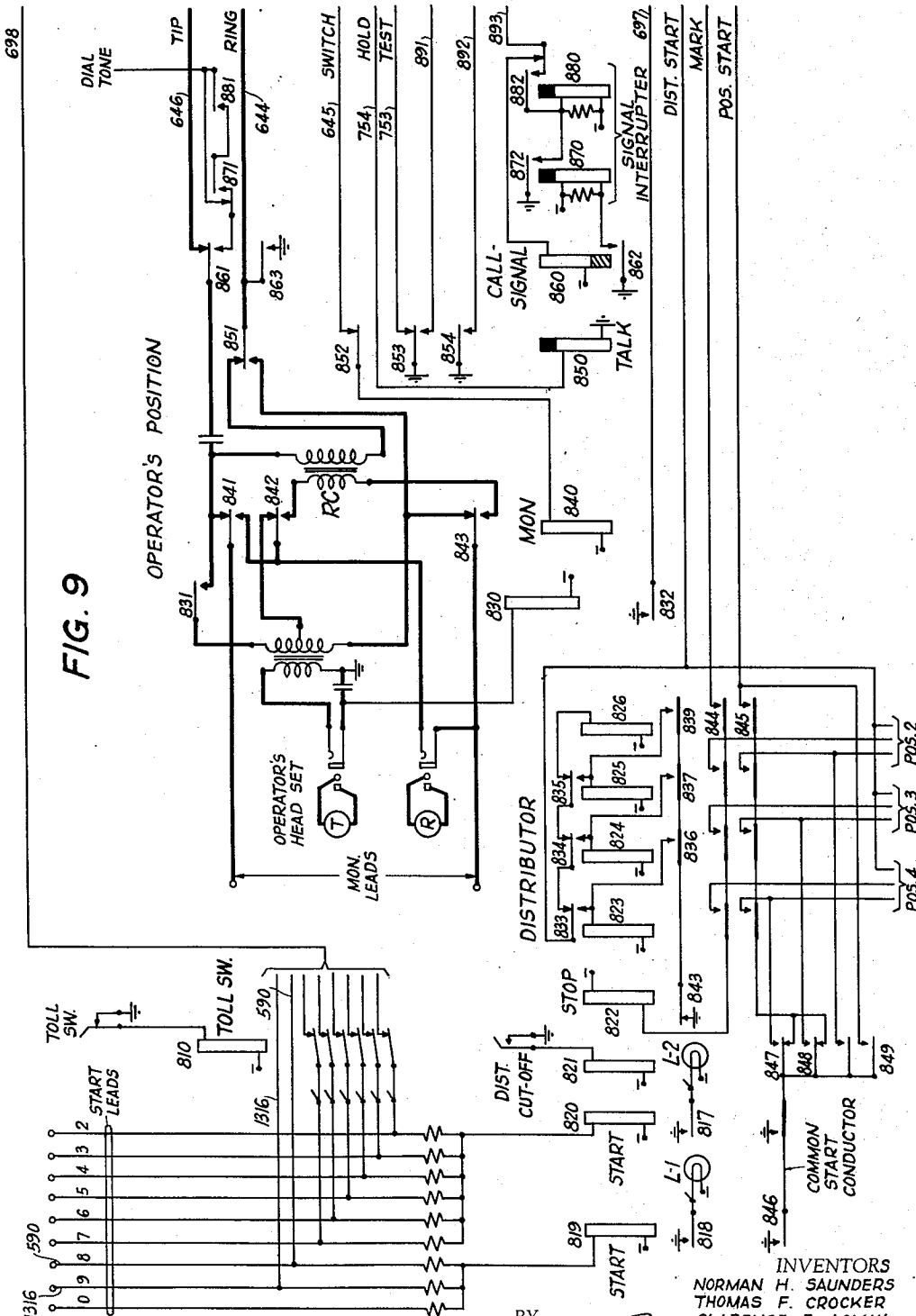
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Fig. 9



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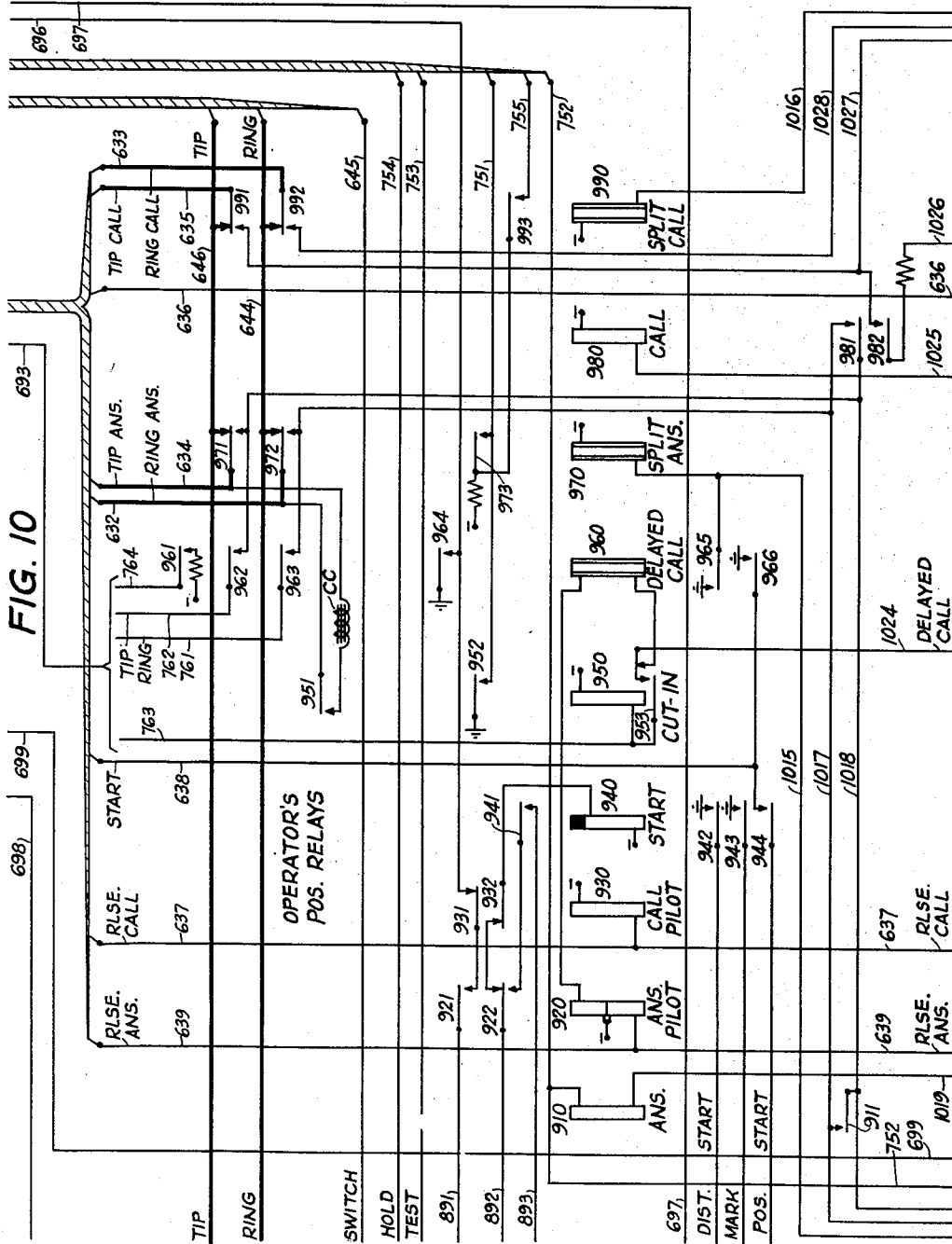
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MEASURED SERVICE TELEPHONE SYSTEM

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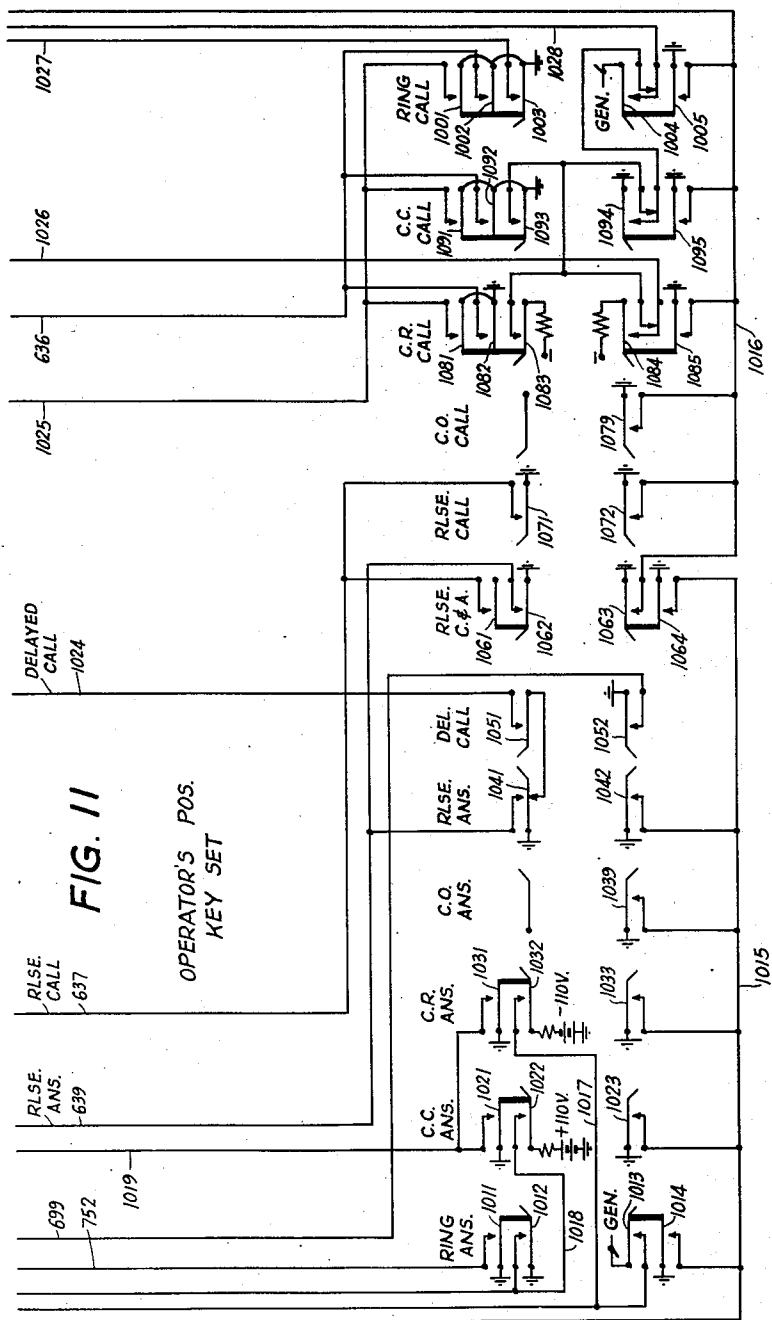
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MEASURED SERVICE TELEPHONE SYSTEM

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17 Sheets-Sheet 11



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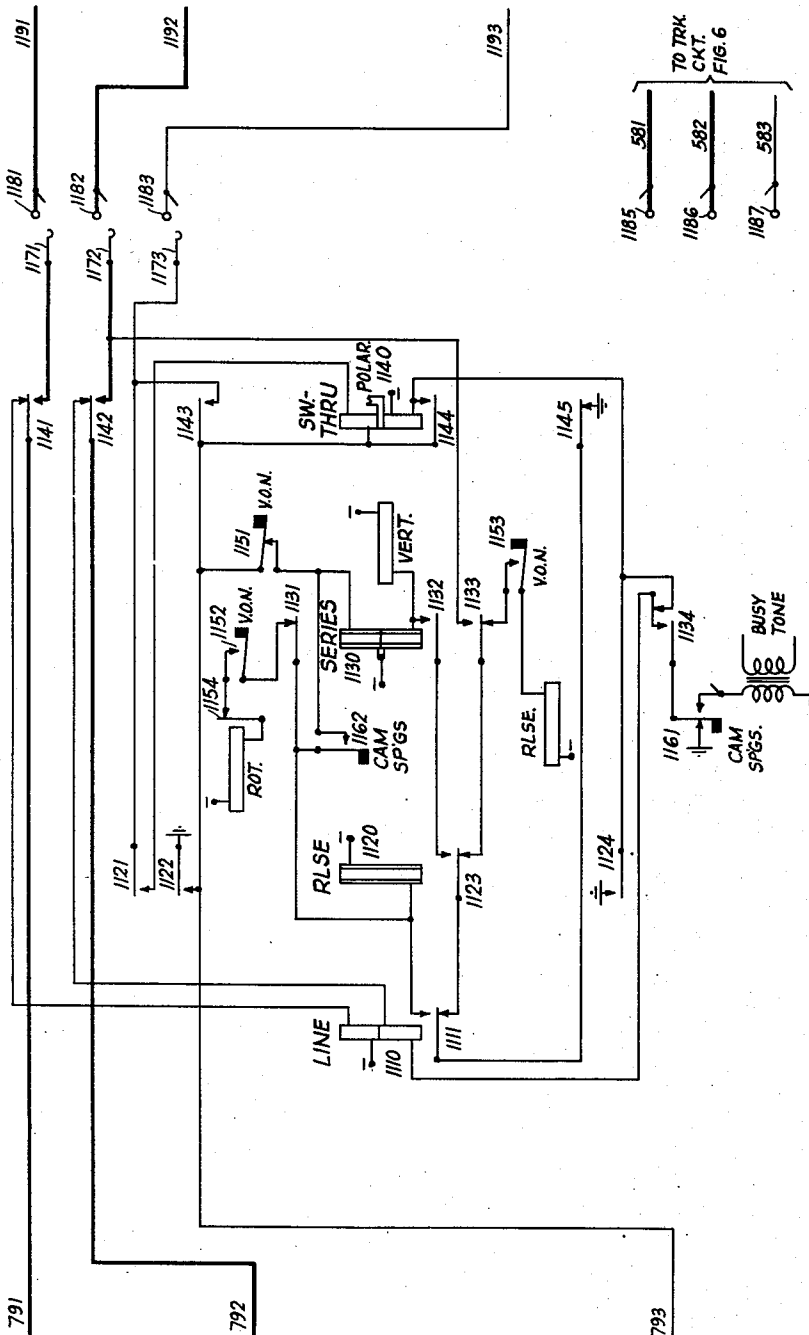
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MEASURED SERVICE TELEPHONE SYSTEM

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FIG. 12
SELECTOR



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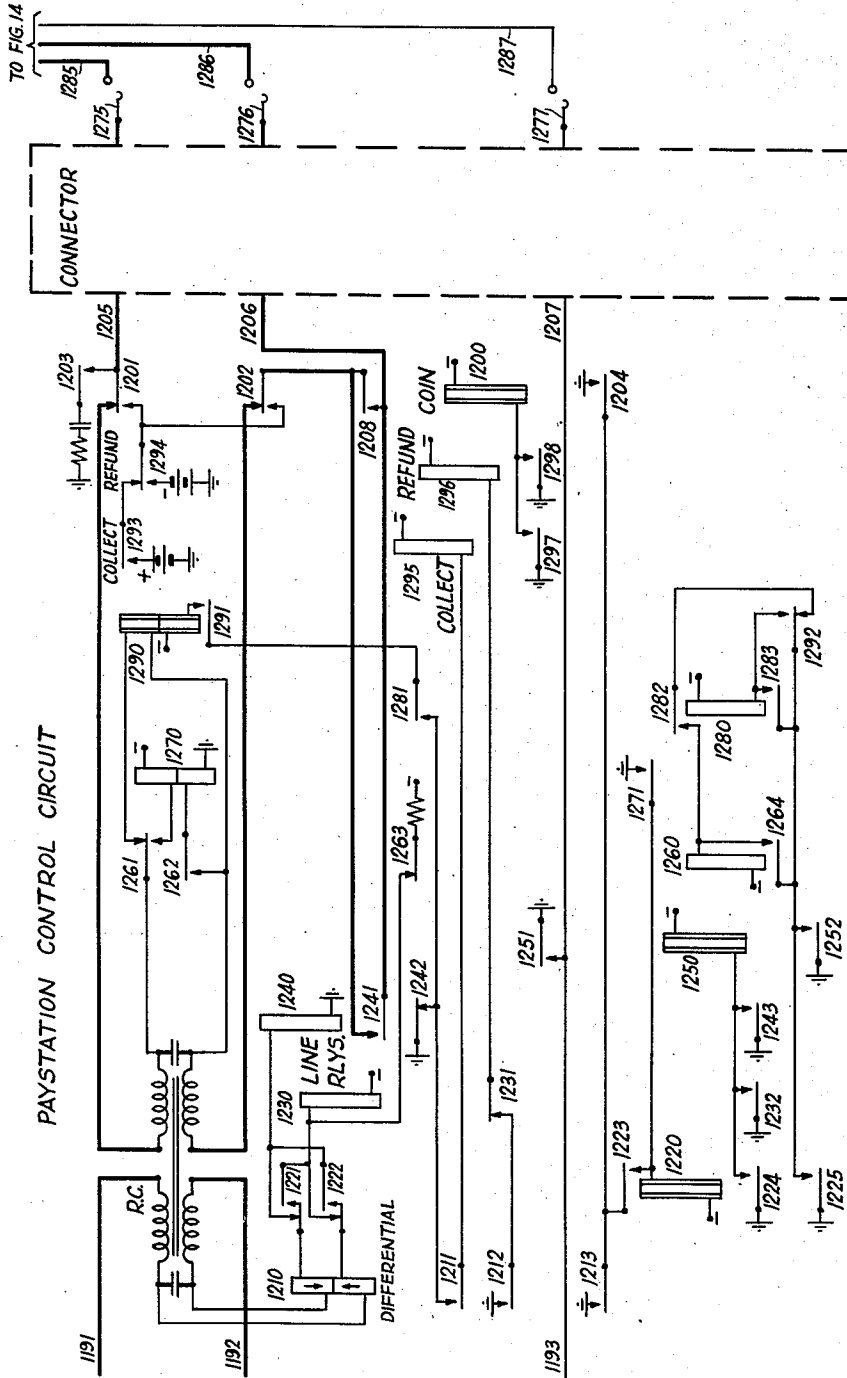
MEASURED SERVICE TELEPHONE SYSTEM

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FIG. 13

PAYSTATION CONTROL CIRCUIT



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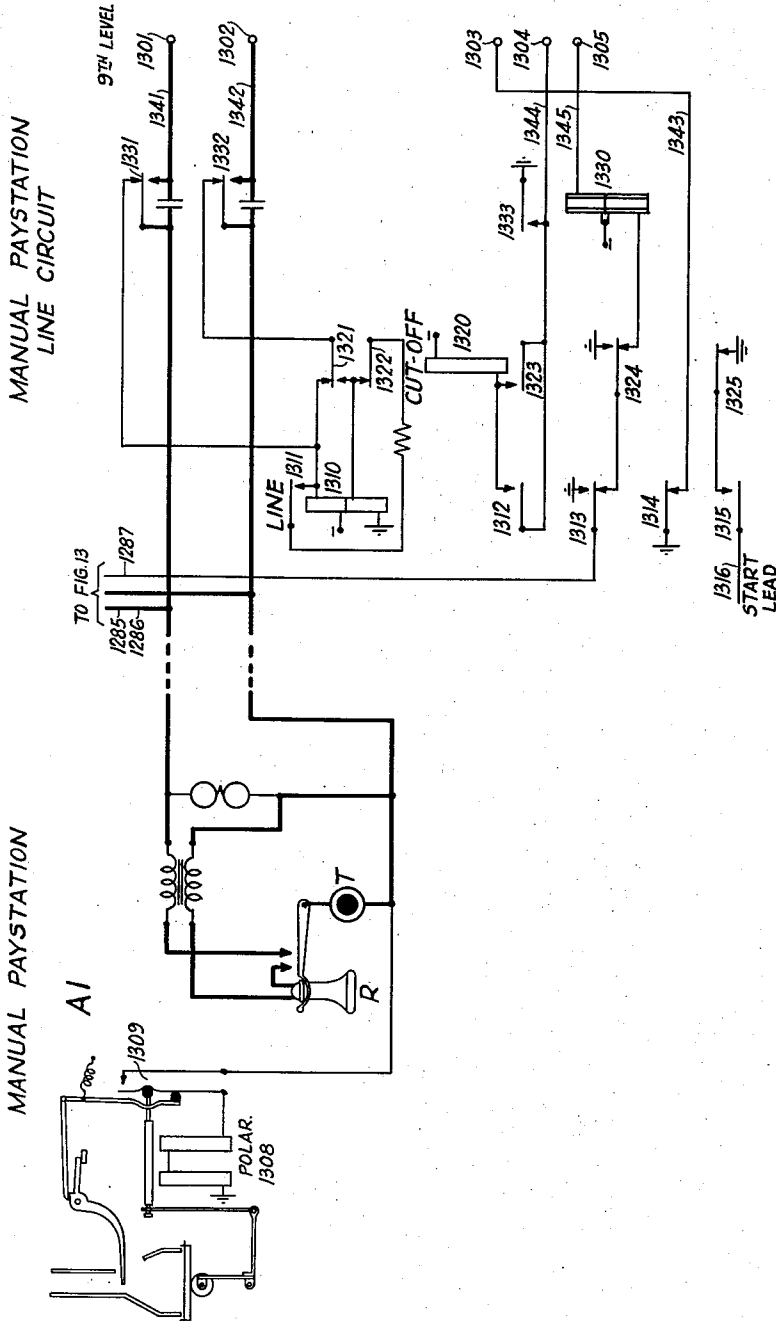
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MEASURED SERVICE TELEPHONE SYSTEM

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FIG. 14



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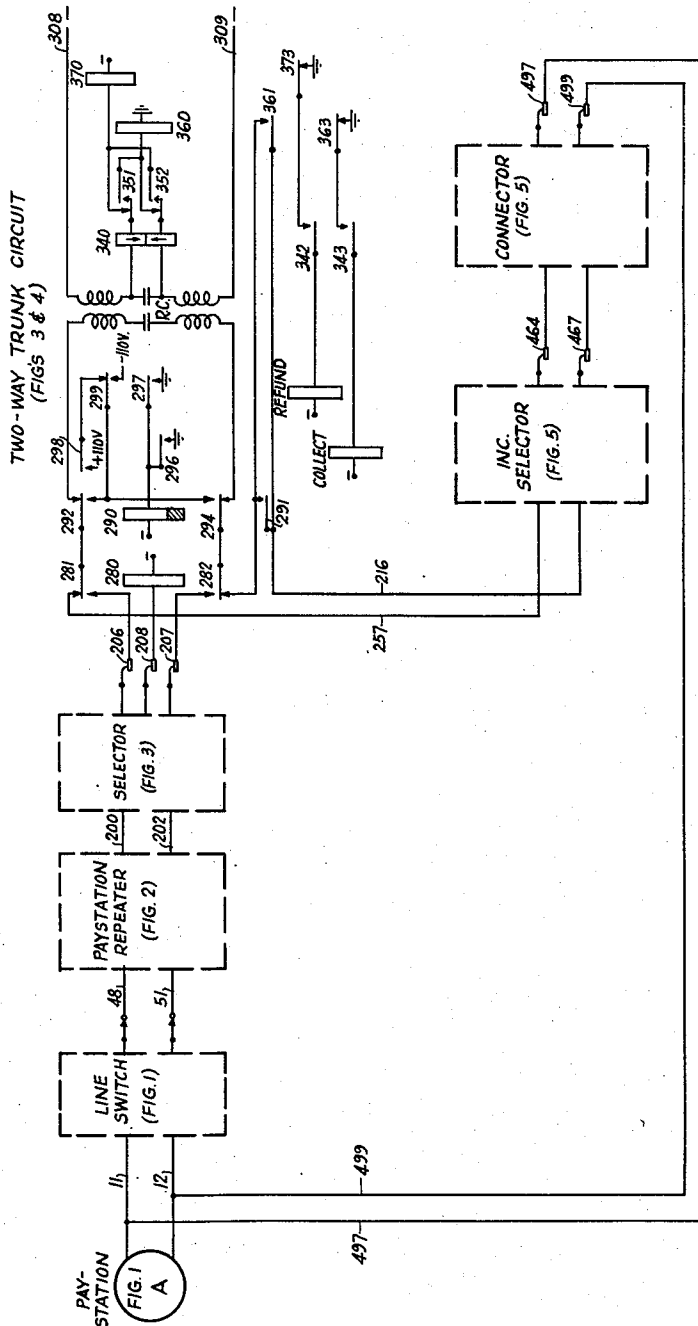
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MEASURED SERVICE TELEPHONE SYSTEM

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FIG. 15



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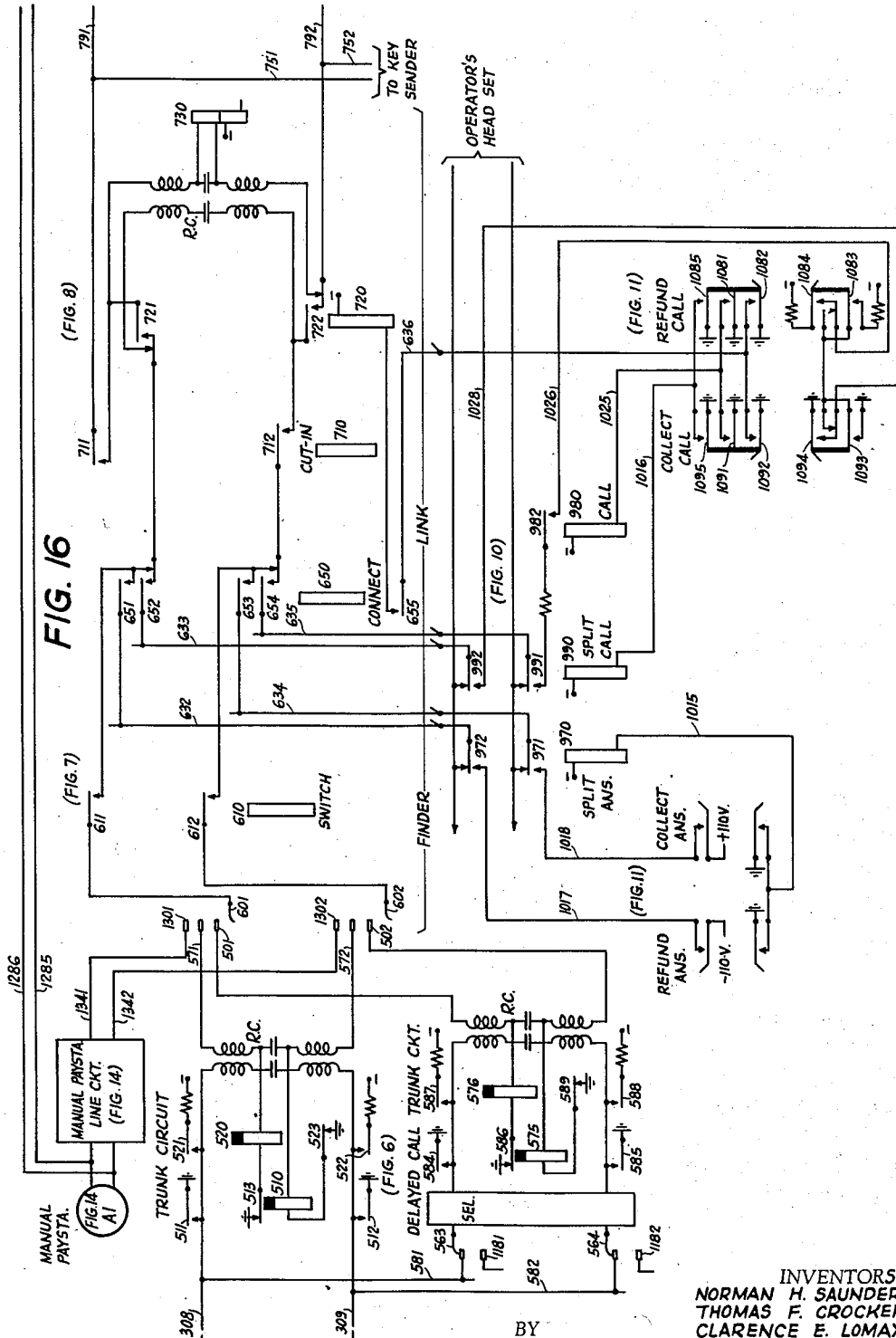
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MEASURED SERVICE TELEPHONE SYSTEM

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17 Sheets-Sheet 16



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MEASURED SERVICE TELEPHONE SYSTEM

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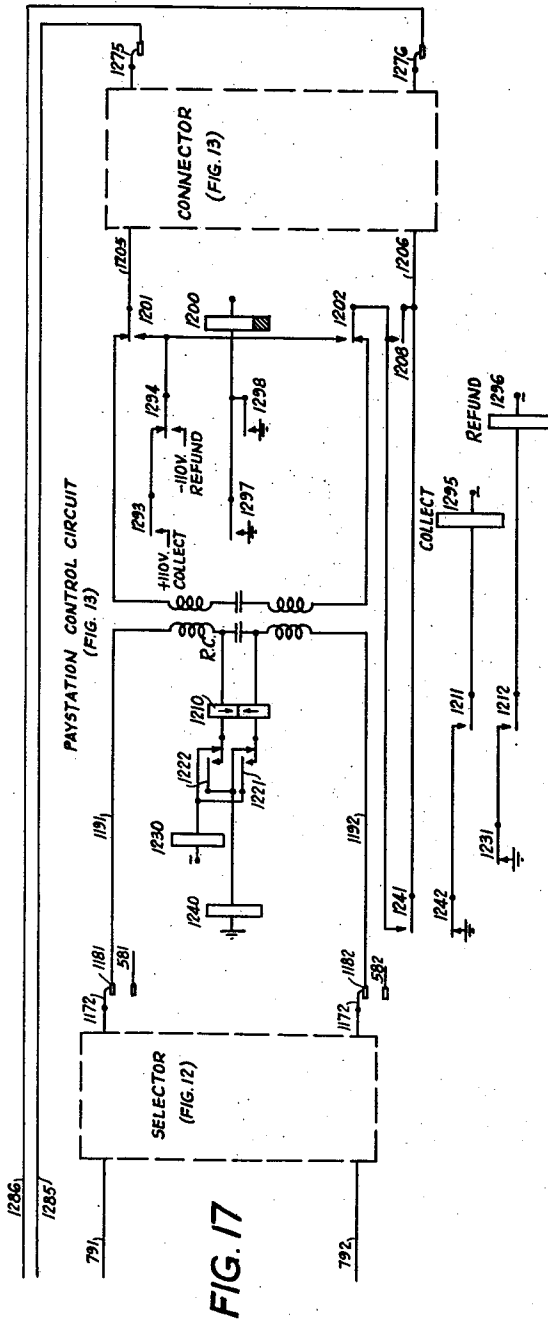


FIG. 18

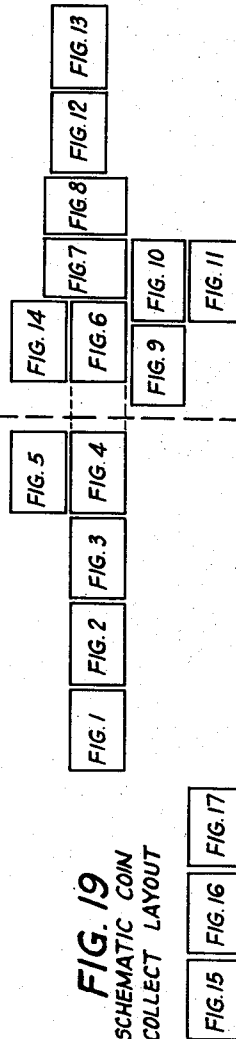
DRAWING LAYOUT

EX. #1

EX. #2

FIG. 19

SCHEMATIC COIN
COLLECT LAYOUT



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2,113,080

MEASURED SERVICE TELEPHONE SYSTEM

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Application March 7, 1936, Serial No. 67,644

25 Claims. (Cl. 179-6.3)

The present invention relates in general to measured telephone systems, and more particularly to means for controlling the collection and refunding of coins deposited in paystation apparatus.

5 The main object of the present invention is the provision of a new and novel circuit arrangement by means of which an operator can control the collection or refund of deposited coins in the local or distant exchanges.

10 Another object of the invention is the provision of a novel two-way trunk circuit connecting the local and distant exchanges which is controlled by the operator to collect or refund coins on both incoming and outgoing calls made over this trunk circuit.

15 A further object of the invention is the provision of an improved line circuit for a paystation line wherein if the operator fails to collect or refund the deposited coin the operator is automatically signalled on the release of the connection.

20 A feature of the invention relates to a novel paystation repeater individual to certain connector switches for use by the operator in completing calls to paystation lines.

25 Another feature of the invention relates to the means in the two-way trunk circuit whereby the operator may ring back over the trunk line to ring the calling paystation line.

30 A further feature relates to the operator-controlled means for completing delayed calls to paystation lines and in which a common sender is first used to control automatic switches to set up the connection to the original calling line and thereafter used to control other switches to complete the connection to the desired called line.

35 A still further feature relates to the means in the two-way trunk circuit for enabling the operator at the distant exchange to momentarily reconnect paystation tone to the trunk line conductors to verify that a paystation line is calling.

40 An additional feature relates to the means controlled by the operator whereby only certain classes of calls, such as calls from paystation lines, may be answered from an operator's position.

45 Other features of the invention not specifically mentioned will be apparent from the following description.

50 Referring now to the drawings comprising Figs. 1 to 19, inclusive, Fig. 1 shows an automatic paystation subscriber's line and a rotary lineswitch.

Fig. 2 shows one of the paystation repeaters accessible to the rotary line switches.

Fig. 3 diagrammatically illustrates the first selector individual to the paystation repeater in the upper left-hand portion, and in the remainder of the figure shows a portion of the trunk circuit connected to the distant exchange.

5 Fig. 4 shows the remainder of the trunk circuit and the two conductors extending to the distance exchange.

Fig. 5 diagrammatically illustrates an incoming selector accessible from the trunk circuit shown in Figs. 3 and 4 and which selector has access to connectors one of which is shown in the remainder of Fig. 5. The connector in Fig. 5 has access to regular subscribers' lines and also to paystation lines, one of which is shown in Fig. 1.

10 Fig. 6 in its upper portion shows the trunk circuit at the distant exchange which is accessible to the finder links, one of which is shown in Figs. 7 and 8, and to the selector switches, one of which is shown in Fig. 12. The lower portion of Fig. 6 shows a delayed call trunk circuit accessible from the first level of the finders and an associated selector switch which has access to the exchange trunk line and to paystation control circuits, one of which is shown in Fig. 13.

20 Figs. 7 and 8 show one of these finder link circuits. The finder links have access to the trunk circuits such as shown in Fig. 6, to the manual paystation line circuits and to other circuits not shown.

25 Fig. 9, in the left-hand portion, shows the manner in which the start leads of the various circuits are connected to the vertical banks of the finder links. In the lower left-hand portion is shown the distributor for allotting one of the operators' position for use on a call. The remainder of Fig. 9 discloses the operators' headset and a portion of the relays for operator's position No. 1.

30 Fig. 10 discloses the connecting relays in this operator's position for connecting with the finder links.

Fig. 11 shows the operator's key set associated with this position for controlling the desired functions.

35 Fig. 12 discloses the selector individually connected to the finder link in Figs. 7 and 8, and this selector has access to paystation control circuits, one of which is shown in Fig. 13, and to trunk circuits, one of which is shown in Fig. 6.

40 Fig. 13 shows one of the paystation control circuits accessible to the selector. This paystation control circuit is individual to the connector diagrammatically shown in the right-hand portion

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of Fig. 13. This connector has access to the manual paystation lines, one of which is shown in Fig. 14.

Fig. 14 shows a manual paystation subscriber's line and the manual paystation line circuit which terminates in the bank of the finder links.

Fig. 15 diagrammatically illustrates the coin control circuits in schematic form for the automatic exchange, while Figs. 16 and 17 diagrammatically illustrate the coin collect circuits in schematic form in the distant exchange.

Fig. 18 is a drawing layout showing the manner in which the various figures are to be assembled.

Fig. 19 is a drawing layout showing the manner in which the schematic coin collect layout figures are to be assembled.

The coin collector apparatus A shown in Fig. 1 may be of the well known type of coin collecting mechanism such as shown and described in U. S. Patent to Forsberg No. 1,043,219, granted November 5, 1912. The lineswitch shown in Fig. 1 may be of the well known rotary type of lineswitch in which the wipers have no normal position, always remaining in engagement with the bank contacts associated with the trunk line last used. At T is shown a discriminating tone machine whose function is to give a discriminating tone to a recording operator should one be called by the subscriber, in order to inform her of his status, that is whether he is entitled to certain connections or not. The paystation repeater circuit shown in Fig. 2 is somewhat similar to the paystation repeaters shown in Patent No. 1,644,968, issued to John Wicks on October 11, 1927, and the Patent No. 1,909,025, issued to V. S. Tharp on May 16, 1933. The selector switches shown in Figs. 3, 5, 6, and 12 are known as battery-searching selectors of the well known Strowger vertical and rotary type, in which the test wiper of the selector hunts for battery potential before switching through. These selectors are somewhat similar to the selector LS shown in Fig. 1 of Patent No. 1,971,505, issued to N. H. Saunders on August 28, 1934.

The connector switches shown in Figs. 6 and 13 are of the well known Strowger vertical and rotary type and are somewhat similar to the connectors shown in Fig. 3 of Patent No. 1,971,505. The finder link shown in Figs. 7 and 8 comprises the well-known Strowger vertical and rotary finder which is operated step by step in a vertical direction to the proper level under control of the vertical test wiper to find the proper group and is thereafter operated in a rotary step-by-step movement to find the calling line in the selected level. As is shown in the instant application, the finder is shown as having access to only the first, the eighth, and the ninth levels, it being understood that the remaining levels of the finder are used for other classes of service not concerned with this invention. In the lower right-hand corner of Fig. 8 is diagrammatically shown a register sender link and a register sender. This sender link and register sender is similar to the sender link and register sender shown in Figs. 22 and 23 of the Voss et al. application, Ser. No. 40,686, filed September 16, 1935. Each operator's position is provided with a set of digit keys by means of which the operator may set up the called digits in the register sender. The sender links are used to connect the register sender to the finder link in use in this operator's position. Figs. 9, 10, and 11 show one of the operator's positions in a system commonly referred to as the Strowger dial toll board. Each operator's posi-

tion has a number of finder links associated therewith by means of which the operator may extend the desired connection. Figs. 7 and 8 show only one of the finder links individual to the operator's position shown in Figs. 9, 10, and 11. The distributor shown in Fig. 9 is used to select one of the four operator's positions. In the upper left-hand corner of Fig. 9 is shown the start leads which extend from the manual paystation line circuit of Fig. 14 and the trunk circuit of Fig. 16 and the other start circuits for the other classes of lines terminating in the banks of the finder. The operator is provided with a toll switching key for controlling the circuit of relay 810 so that if desired the finder shown in Figs. 7 and 8 may be used for only certain classes of calls.

The manual paystation apparatus shown in Fig. 14 is similar in mechanical construction to the well known paystation mechanism previously referred to in Fig. 1.

In order to explain the operation of the circuits it will first be assumed that a party wishes to extend a call from the automatic paystation A to a subscriber in the distant manual exchange, and that the party attempts to do so without first depositing a coin in the coin collecting mechanism at the paystation.

When the receiver is removed at substation A, line relay 26 of the individual lineswitch C is energized over the two sides of the calling line in series. Relay 26, upon operating, at its armature 40 completes a circuit which includes the switching relay 25 and the motor magnet 27 in series, and at its armature 39 connects the test wiper 46 to the above circuit at a point midway between the switching or cut-off relay 25 and said motor magnet. The operation of the lineswitch C depends upon whether the trunk line with which its wipers 44 to 47, inclusive, are in engagement is busy or not. Assuming this line to be busy, there will be ground potential present upon the test contacts engaged by the test wiper 46, the switching relay 25 will be short circuited, and the motor magnet 27 will be supplied with direct ground by the test wiper to operate as a buzzer to advance the switch wipers step by step in search of an idle trunk line. However, it will be assumed in the present case that when the receiver is removed at substation A, the switch wipers 44 to 47, inclusive, are in engagement with the bank contacts associated with an idle trunk line. Under these conditions, immediately following the energization of line relay 26 switching relay 25, not being short circuited, will energize. Upon energizing, relay 25 disconnects the line conductors 11 and 12 of the calling substation from the winding of the line relay 26 and from ground respectively, and extends them by way of armatures 33 and 36, wipers 44 and 47, bank contacts 52 and 55, conductors 48 and 51, armatures 145 and 144 and their back contacts, armatures 160 and 164 and their back contacts, upper and lower windings of the differential relay 130, and thence through the windings of line relay 135 and the windings of the impedance coil 139, to battery and ground, respectively. The line relay 135 of the repeater shown in Fig. 2 is energized over the two sides of the calling line in series and at its armature 183 completes the circuit for slow-to-release relay 136 from ground by way of armature 162 and back contacts of relay 128. Relay 136 therefore energizes and at its armature 186 places ground on release trunk conductor 50 by way of the retardation coil 138, thereby establish-

ing a holding circuit for lineswitch C which extends by way of bank contacts 54, wiper 46, armature 35 and front contact, winding of relay 25, and thence through the winding of motor magnet 27 to battery. It will be understood that this holding circuit is completed before the slow-to-release relay 26 has had time to deenergize after its circuit was opened by relay 25. A branch of the holding circuit also extends by way of private normal conductor 498 to the multiplied test contacts in the banks of the connector switches which have access to the line of substation A, whereby that line is protected from intrusion in the well known manner. It will be remembered that ground is supplied to the release trunk conductor 50 through the retardation coil 138. This coil is of a very low resistance, of about two-and-one-half ohms, so that the multiples of the test contacts accessible to other line switches are made busy.

Relay 136, upon energizing, also completes at its armature 188 a circuit for the polarizing winding of the electro-polarized relay 132 in series with the winding of relay 141. The electro-polarized relay 132 is so adjusted that current flowing in its polarizing winding does not cause this relay to operate its armature, but after once operating, the current flow in the polarizing winding is sufficient to maintain the armature attracted. Relay 141 is, therefore, the only relay operated in this circuit. Relay 141, upon energizing, opens a point in a certain shunt circuit which will be described later.

When the line relay 135 of the repeater energizes a bridge circuit is closed across the trunk conductors 200 and 202, which may be traced as follows: conductor 200, normally closed contacts controlled by armature 172, armature 190 and back contact, normally closed contacts controlled by armature 162, upper windings of relays 133 and 128, front contact and armature 184, normally closed contacts controlled by armature 164, normally closed contacts controlled by armature 173, upper winding of relay 132, to conductor 202. Upon closure of this circuit, the line relay of the selector diagrammatically shown in Fig. 3 is energized. Upon energizing that line relay completes the circuit of a slow-acting release relay which operates to prepare the operating circuit of the selector in the usual manner and to place ground on the release trunk conductor 201. The direct ground connected to conductor 201 will short circuit relay 141 of the repeater, which relay will thereupon deenergize, and at its armature 196 and back contact close the shunt circuit around the impulsing armature 184 of line relay 135 of the repeater. It can now be seen that with the shunt circuit completed upon the impulsing armature 184, further operation of the line relay 135 will have no effect upon the selector and the call can be extended no further. In order that this shunt circuit may not be completed around the impulsing armature 184, it is necessary that the calling party deposit a coin in the coin collect mechanism at the paystation A.

The person at the substation A now deposits a coin of suitable denomination in the coin collect mechanism provided for that purpose. This mechanism is well understood and the operation need not be explained in detail. When the coin is deposited it descends past the trigger mechanism which is released by the coin with the result that the polarized magnet of the coin collecting mechanism is connected to line conductor 12. The coin is held in suspense by a trap door where

it is adapted to be either collected or refunded under control of the polarized magnet. The coin may be deposited either before or after the receiver is removed. In either case the latter operation brings about the operation of the rotary line switch C, whereupon the line is extended to an idle selector, as has been described.

Assuming that the selector in Fig. 3 is the switch to which connection is extended, the operation is the same as has already been described and will not be repeated, with one exception, however: when the line conductors 11 and 12 are connected by the operation of the lineswitch C to the windings of the line relay 135 and the impedance coil 139 the ground on line conductor 12 through the polarized magnet of the coin collect mechanism unbalances the differential relay 130 which is included in the line circuit and causes this relay to energize. It will be stated at this point that the polarized magnet at the substation is of high resistance and does not materially interfere with the transmission of operating impulses or with the talking circuit, but it is nevertheless sufficient to cause relay 130 to operate as described.

Upon attracting its armature 170 relay 130 closes a circuit for relay 134 by way of bank contact and armature 191 and armature 186 to ground. Relay 134, upon energizing, establishes a locking circuit for itself at armature 178, thereby locking itself to release trunk conductor 201. Relay 134 at armature 181 prepares a circuit which will be described subsequently, and at its armature 180 opens the shunt circuit around the impulsing armature 184, thereby obviously permitting extension of a call regardless of the operated or non-operated condition of relay 141.

The party at paystation A may now operate his calling device in accordance with the digits necessary to operate the selector to seize one of the trunk circuits connected with the distant exchange. In this case, assuming that the digit 0 is dialled by the party at substation A, the line relay 135 will be deenergized ten times and at armature 184 interrupts the circuit to the line relay of the selector ten times to cause the selector to step its wipers opposite the tenth level after which the selector is automatically rotated in the well known manner to select an idle one of the trunk circuits. When line relay 135 of the repeater deenergizes in response to the first impulse, slow-to-release relay 137 is energized over the following circuit: ground by way of armature 162 and back contact, armature 183 and back contact, armature 187, and through the winding of relay 137 to battery. This relay thereupon energizes and in operating, at its armature 191 and front contact, completes the circuit of relay 129 from ground by way of armature 186, and the normally closed contacts controlled by armature 167 of the relay. Another result of the energization of relay 137 is that at armature 190 and its front contact a direct bridge is placed across the trunk conductors 200 and 202 which does not include the upper windings of relays 133 and 128. These circuit changes are made in order to reduce the resistance and impedance of the switch control circuit to a minimum during the transmission of impulses. Relay 129, upon operating at its armature 167, locks itself to the release trunk conductor 50, while at its armatures 165 and 168 it short circuits the upper and lower windings of differential relay 130 included in the impulsing circuit of line relay 135.

Slow-to-release relay 137 deenergizes shortly after the impulsing period to again include the upper windings of relays 133 and 128 in the bridge circuit extending to the selector.

Having assumed that the trunk circuit shown in Figs. 3 and 4 is the trunk circuit seized by the selector, then at the time of seizure a circuit may be traced from ground through the winding of the switching relay in the selector by way of selector test wiper 205, bank contact 208, armature 254 and back contact, and through the winding of transfer relay 280 to battery. Relay 280, upon energizing over this circuit, at armature 279 grounds conductor 249 to energize relay 390, and at armature 278 locks energized to grounded release trunk conductor 247. At armature 276 relay 280 disconnects battery potential from conductor 247, thereby removing one of the battery potentials by means of which the trunk circuit was marked as idle. At armature 289 relay 280 prepares a point in the circuit of ringing relay 300, at armature 288 prepares a point in the circuit to coin control relay 290, at armature 287 prepares a point in the circuit to the tone interrupter relays 320 and 330, at armature 286 prepares a point in the circuit to reversing relay 240, at armatures 285 and 284 disconnects relays 220 and 230 from in bridge of the line and connects line relay 310 in place thereof. At armature 283 relay 280 connects up the ring-back tone circuit and at armatures 281 and 282 disconnects the talking conductor of the trunk circuit from the incoming selector at the back contacts of these armatures and at the front contacts completes the circuit for energizing relay 310. Auxiliary transfer relay 290, upon energizing, at armature 391 connects the A. C. relay 380 in bridge of the talking conductor, at armature 392 opens the circuit extending to the release trunk conductor 215 of the incoming selector, and at armature 393 grounds the ringing machine start conductor 256 to start the ringing machine.

The circuit for energizing relay 310 may be traced as follows: from ground and battery through the lower and upper windings of relay 310, respectively, conductors 227 and 225, armatures 285 and 284 and their front contacts, conductors 226 and 224, through the left-hand windings of the repeating coil RC, conductors 219 and 218, back contacts and armatures 294 and 292, armatures 281 and 282 and front contacts, back contacts and armatures 242 and 241, back contacts and armatures 212 and 211, bank contacts 207 and 206, wipers 204 and 203, through the selector to conductors 202 and 200, through the upper winding of polar relay 132, through the normally closed springs controlled by armatures 173 and 172, armature 190 and back contact, through the normally closed springs controlled by armatures 164 and 160, the impulsing armature 184 of line relay 135, and through the upper windings of relays 128 and 133. At armature 311 relay 310 completes the circuit for energizing release relay 350. Relay 350, upon energizing, at armatures 351 and 352 reverses battery and ground connections over the trunk conductors 308 and 309, at armature 353 grounds conductor 234 to energize relay 250, at armature 354 prepares a locking circuit for itself, and at armature 355 connects ground by way of armature 332 or the lower winding of impedance 335 to the release trunk conductor 247 to maintain this conductor grounded. Relay 250, upon energizing, at armature 252 completes the circuit through the lower polarizing winding of relay

230 and completes a circuit for energizing ringing relay 300 by way of armatures 263 and 289, and conductor 236. At armature 253 relay 250 prepares a point in the locking circuit of relay 220 and at armature 254 connects grounded conductor 246 to release trunk conductor 247.

Relay 300, upon energizing, at armatures 301 and 302 and their front contacts connects ground and generator to trunk conductors 308 and 309 for energizing the A. C. relay 530 shown in Fig. 6. At armature 303 relay 300 connects generator through the resistance, condenser, and conductor 255 to the lower winding of A. C. relay 260 to cause the latter relay to energize. At armature 261 relay 260 disconnects negative battery from the winding of relay 370, at armature 262 opens a point in the circuit to relay 270 at its back contacts, and at its front contact prepares the circuit for the tone interrupter relays 320 and 330, at armature 263 opens the circuit to ringing relay 300 and at armature 264 completes a locking circuit for itself by way of grounded armature 252. After an interval ringing relay 300 deenergizes and disconnects ground and generator from the trunk conductors 308 and 309, and opens the original energizing circuit of the A. C. relay 260 now locked in operated position.

The momentary operation of ringing relay 300 causes a splash of generator to be sent out over the trunk conductors 308 and 309 to energize the A. C. relay 640 over the following circuit: from ground and generator at the automatic exchange by way of trunk conductors 308 and 309 extending to the distant manual exchange, normally closed contacts controlled by armatures 521 and 512, armature 551 and back contact, armature 531, condenser C, through the upper winding of relay 530. A. C. relay 530 energizes over the above traced circuit and at armature 532 completes a locking circuit through its lower winding in series with start relay 540. Relay 540 energizes in series with the lower winding of relay 530 and at armature 541 prepares a point in the talking circuit. At armature 542 relay 540 grounds conductor 583 extending to the selector banks to busy this trunk circuit to selectors having access thereto, at armature 543 connects battery through the winding of relay 550 to bank contact 574 in the eighth level of the finder banks to mark this trunk circuit as calling, at armature 544 prepares a new circuit for relay 540, and at armature 545 grounds the start lead 590 to energize start relay 819 in Fig. 9 and to mark the eighth level vertical bank contact of the finder to mark the group this trunk circuit is in.

Finder starting system

Referring now to Fig. 9, which shows the common start leads and the common distributor, it will be observed that there are nine start leads, having the numbers 2 to 10 applied thereto. The latter numbers indicate the levels of the finders with which the start conductors are respectively associated. Conductors 2 to 9, it will be observed, extend to correspondingly numbered contacts in the vertical test bank of the finder which are engaged by vertical test wiper 607 when the main wipers of the finders are opposite the second to the ninth levels, respectively. These leads are employed to stop the finder wipers opposite the first calling level as they move upward in answering a call. It will be observed that the tenth contact in the bank of wiper 607 is permanently grounded so as to stop the wiper invariably when the tenth or final level is reached. It

will also be noted that the start leads 2 to 7, inclusive, extend through normally closed contacts controlled by toll switching relay 810 to the vertical bank. This arrangement is provided so that if desired, one of the operator's positions may be set aside to answer and complete only certain types of calls such as paystation calls, toll calls, etc. In case the operator at position 1 desires to only answer the paystation and toll calls, the toll switch key will be operated to release relay 810 whereupon the start leads 2 to 7, inclusive, are disconnected from the vertical banks of the finders in this position. Since the start conductors 2 to 7, inclusive, are disconnected from the vertical bank, the finders individual to this position can only connect with calling lines terminating in the eighth, ninth, or tenth levels which have been reserved for special types of calls. In this case, since the common start relay 819 is energized over the grounded start conductor 590 said relay at armature 818 completes a circuit for operating lamps L1 at all of the operators' positions, and at armature 846 connects ground to the lower armatures of the selecting relays in the distributors by way of armatures 847 and 848. In case the call has originated from some other line circuit which will ground any one of the start conductors 2 to 7, inclusive, then the common start relay 280 is operated and at armature 817 operates the lamps L2 at all of the operators' positions and at armature 817 likewise grounds the lower armatures of the selecting relays in the distributors. The pre-selection of an operator's position by the distributors of Fig. 9 will now be pointed out. Each operator is instructed to operate the talking key of an idle finder link in readiness for the arrival of a call when she is not engaged. The operator is able to know which finder links are in use and which are not by the condition of the supervisory and busy lamps shown in Fig. 8.

Preselecting a finder selector link

Assuming now that the operator at position 1 is not engaged and wishes to preselect a finder or answer a call, and assuming further that the unlighted condition of the busy lamp of Fig. 8 indicates that this finder and its associated selector are not in use, the operator thereupon throws her talking key K2 in Fig. 8. In response to actuation of key K2 to talking position a circuit is closed over the associated common test conductor 753 for the upper winding of connecting relay 650. Test conductor 753 is one of the common conductors contained in the cable illustrated and this conductor is multiplied to the other finder links individual to this position and is normally grounded at armature 853 in Fig. 9. The energizing circuit for connecting relay 650 may be traced as follows: from grounded armature 853 and back contact, test conductor 753 included in the right-hand cable, key springs 744, conductor 688, and through the upper winding of connecting relay 650 to battery.

Connecting relay 650, upon energizing, at armature 657 completes a locking circuit for itself extending from ground through the winding of slow-to-operate talk relay 850, hold conductor 754 included in the right-hand cable, key springs 745, conductor 689, armature 657, and through the lower winding of connecting relay 650 to battery. Connecting relay 650, at its several contacts, completes the association between the finder link and the position equipment, which

association was partly effected by the operation of talking key K2.

Talking relay 850 energizes in series with the lower winding of the connecting relay 650, and, upon operating, disconnects ground from the test conductor 753 thereby preventing the operation of an additional connecting relay in another finder link. Talking relay 850 also disconnects the associated talking conductors from the windings of the repeating coil RC (used for monitoring purposes) and extends them to the operator's headset equipment. Talking relay 850 also extends ground potential by way of armature 854, conductor 892, and armatures 922 and 932 to the winding of distributor start relay 940 to negative battery to cause this relay to energize. Start relay 940, upon energizing, at armature 941 prepares a point in the circuit to the signal relays 860, 870, and 880, at armature 942 grounds the distributor start (Dist. start) conductor to start the operation of the selecting relays in the distributor, at armature 943 grounds the Mark conductor to mark this position as being ready to receive the call, and at armature 944 connects the Position start conductor to start conductor 638 to prepare a circuit for the start relay 640 in the finder.

Assuming that the distributor be in the normal position shown, the connection of ground potential to Dist. start lead causes the consecutive operation of relays 826, 825, 824, and 823 in which operation the relays test for the position in which a link has been pre-selected in the manner just pointed out. The preselected position, in this case position 1, is characterized by the ground now on the Mark conductor. The circuit for energizing the first of the selecting relays in the distributor may be traced from grounded Dist. start conductor by way of armatures 833, 834, and 835 and their back contacts to the winding of selecting relay 826 and negative battery. When relay 826 responds to the closure of its circuit said relay at armature 845 connects the common start conductor to the Position start conductor, at armature 844 connects the Mark conductor to the stop relay 822, and at armature 839 closes a circuit for the second selecting relay 825 by way of grounded armature of the stop relay 822. In practice, relays 823 to 826, inclusive, have a rather stiff adjustment while the stop relay 822 has a weak adjustment with the result that the stop relay will energize over the grounded Mark conductor before the next succeeding selecting relay, such as relay 825, can operate its armatures. In this instance, therefore, stop relay 822 energizes before relay 825 and at armature 843 opens the energizing circuit to relay 825 to prevent its operation.

Finding the calling trunk circuit

Assuming that the finder link in Figs. 7 and 8 has been preselected as above described, and further assuming that the trunk circuit in Fig. 6 has grounded the start lead 590 as previously described, the common start relay 819 will be energized to light the lamp L1 at all of the positions, and to ground the common start conductor by way of armature 846. A circuit may now be traced for the start relay 640 in the finder link as follows: from grounded armature 846 by way of the common start conductor, armatures 847 and 848 and back contacts, armature 845, Position start conductor, armature 944, start conductor 638 included in the left-hand cable, armature 658, through the normally closed ver-

tical off normal springs 671 and through the upper winding of start relay 640 to battery. Start relay 640 at armature 641 completes a holding circuit to its upper winding by way of cam springs 670 independent of the vertical off normal springs 671. At armature 642 relay 640 prepares a locking circuit through its lower winding, at armature 643 and back contact opens a point in the circuit to the release magnet, and at its front contact energizes the lower polarized winding of switching relay 610 and also completes a circuit for the vertical magnet, and at armature 661 grounds conductor 692 to light the busy lamp thereby indicating to the operator at this position that this finder link is busy. Polar switching relay 610 is not operated when its lower polarizing winding alone is energized, as this relay will only operate its armatures at a time when the current through its upper operating winding extends in the proper direction. The circuit for energizing the vertical magnet may be traced as follows: from ground by way of armature 643 and front contact, armature 617, normally closed contacts controlled by armature 631, armature 623 and back contact, through the winding of vertical magnet to battery. In response to each operation of the vertical magnet the wipers of the finders are operated one step in a vertical direction and at armature 672 completes a circuit for energizing the stepping relay 630. Stepping relay 630, upon energizing, at armature 631 opens the circuit to the vertical magnet and prepares a circuit through the lower winding of the change-over relay 620. The vertical magnet thereupon deenergizes and at armature 672 causes the deenergization of the stepping relay 630 whereupon the latter relay upon deenergizing again establishes the circuit for operating the vertical magnet. The vertical magnet and stepping relay 630 interact in the manner just described until such time as the vertical test wiper 607 encounters a grounded vertical bank terminating one of the grounded start leads.

In this case, since the start lead 590 is the start conductor grounded, then the wipers of the finder are stepped in a vertical direction until the vertical test wipers 607 encounter the bank contact terminating the start lead 590. At this time a circuit may be traced for energizing the change-over relay 620 in series with the vertical magnet as follows: grounded start conductor 590 and associated vertical bank contact, vertical test wiper 607, armature 622, through the lower winding of change-over relay 620, armature 631 and front contact, armature 623 and back contact, and through the winding of vertical magnet to battery. Change-over relay 620 first operates its armature 621 to complete a locking circuit through its upper winding from grounded armature 643, after which armature 622 is operated to open its original energizing circuit. Change-over relay 620, at armature 623 opens a circuit extending to the vertical magnet and at front contacts of armature 623 prepares the circuit for the rotary magnet. At armatures 624 and 625 relay 620 opens circuits to wipers 605 and 606. When the circuit to the vertical magnet is opened said magnet deenergizes and at armature 672 causes the deenergization of stepping relay 630. When stepping relay 630 deenergizes a circuit for operating the rotary magnet may be traced as follows: from grounded armature 643 and front contact, armature 617, normally closed contacts controlled by armature 631, armature 623 and front contact, and through the winding of rotary

magnet to battery. In response to the operation of the rotary magnet the wipers 601 to 606, inclusive, are rotated into engagement with the first set of bank contacts in this level and the vertical wiper 607 is disengaged from the vertical bank. At armature 673 rotary magnet operates the stepping relay 630 whereupon the stepping relay at the normally closed contacts controlled by armature 631 opens the circuit of the rotary magnet. The rotary magnet and stepping relay 630 interact in this circuit causing the wipers of the finder to be rotated step by step until the test wiper 604 encounters a bank contact having negative battery or calling potential thereon. When test wiper 604 encounters the bank contact terminating the calling potential a circuit may be traced for energizing the polar switching relay 610 and cut-off relay 550 in series as follows: from ground by way of armature 643 and front contact, through the upper winding of polar switching relay 610, test wiper 604, conductor 574, armature 543, and through the winding of slow-to-release cut-off relay 550 to battery. Polar switching relay 610, upon energizing, at armatures 611 and 612 connects the talking conductors of the trunk circuit in Fig. 6 to the tip and ring answer conductors of the operator's position by way of armatures 651 and 653, at armature 615 connects ground to the lower winding of start relay 640 to hold this relay in energized position, at armature 616 short circuits the upper winding of the polar switching relay 610 to connect direct ground to the bank contact terminating this trunk circuit to make the trunk circuit busy to other finder switches having access thereto, and at armature 617 opens the locking circuit of change-over relay 620, whereupon the latter relay deenergizes. The polar switching relay is now maintained in its operated position through its lower polarized winding alone. On the first vertical step of the finder the vertical off normal springs 671 open but the start relay is held in operated position at this time by way of cam springs 670 and start conductor 638. The vertical off normal springs 674 close on the first vertical step of the finder wipers to prepare a circuit for the release magnet which is at present open at armature 643.

Returning now to the trunk circuit and at a time when cut-off relay 550 energizes, this relay at armature 551 disconnects the A. C. relay at its back contact and at its front contact completes a loop circuit including the upper winding of relay 560 and the trunk conductors 308 and 309 extending back to the automatic exchange. At armature 552 relay 550 completes an energizing circuit through the lower polarizing winding of relay 550, at armature 553 completes a locking circuit for itself from grounded conductor 574 independent of armature 543, at armature 554 completes a new circuit for start relay 540 extending from grounded conductor 574 by way of armature 544 to maintain this relay in energized position, and at armature 555 disconnects ground from start lead 590 to remove ground from the eighth level vertical bank contacts in the finder banks and to open the circuit to the common start relay 819 in case no other call is in progress. Common start relay 619 deenergizes and disconnects ground from the Position start conductor 70 and from start conductor 638 thereby opening the original energizing circuit of the finder start relay 640, which relay, however, is now maintained in operated position by way of grounded armature 615.

When the polar switching relay 610 in the finder is operated the answer-pilot relay 920 in the operator's position is energized over the following circuit: from ground by way of armature 615, armature 642, through the lower winding of relay 640, armature 659, conductor 639, and through the lower winding of answer-pilot relay 920 to battery. When the answer-pilot relay 920 operates, it opens the previously described circuit at armature 922 for the start relay 940. The position start relay 940 is slow acting, as indicated, for which reason it remains operated for an interval after its circuit is opened. Answer-pilot relay 920 also closes a circuit by way of armature 922 and front contact and armature 841 of the still operated position start relay 920, and over conductor 893, normally closed springs controlled by armature 882 to actuate the call signal relay 860. When call signal relay operates, it disconnects the operator's headset from the tip conductor, and connects the operator's headset by way of front contact and armature 861, and normally closed springs controlled by armature 871 to dial tone. A distinctive tone current is therefore connected over contacts 861 on the call signal relay 860 and contacts on the actuated talking relay 850 to the operator's receiver. This circuit also includes the operated armature 831 of relay 830 which became energized when the operator inserted her headset into the associated jack.

Call signal relay 860 at armature 862 operates the slow-acting signal interrupter relay 870 and relay 870 at armature 872 operates the signal interrupter relay 880. Relay 870 at armature 871 momentarily interrupts the tone circuit to the operator's receiver at its normally closed contacts and at the front contacts of this armature prepares a circuit for again connecting the tone circuit to the operator's receiver when the second signal interrupter relay 880 energizes. The energization of the slow to operate signal interrupter relay 880 at armature 881 again connects the tone source to the operator's receiver, and at armature 882 opens the energizing circuit of call signal relay 860 and likewise completes a locking circuit for itself from grounded conductor 893. Call signal relay 860 deenergizes after an interval and at armatures 861 and 863 terminates the two short applications of the tone source to the operator's receiver. This connection of tone source to the operator's receiver is commonly referred to as a "zip-zip" signal. Relay 880 remains locked to conductor 893 until the slow-acting position start relay 940 deenergizes, at which time relay 880 deenergizes also.

When position start relay 940 deenergizes, it disconnects the Position start conductor from start lead 638 at armature 844 without effect at this time, because the finder start relay 640 is now maintained in operated position over its lower winding. Start relay 940 also disconnects ground from the Dist. start conductor and the Mark conductors at armatures 922 and 923 to open the circuit of relays 826 and 822.

When the upper winding of polar relay 560 is connected in bridge of the trunk conductors 308 and 309 by the operation of the cut-off relay 550 in the trunk circuit shown in Fig. 6, a circuit may then be traced for energizing trunk line relays 360 and 370 in the trunk circuit in the automatic exchange as follows: from ground through the winding of relay 360, armature 351 and front contact, upper winding of the differential relay 340, upper right-hand winding of repeating coil

RC, back contact and armature 301, conductor 308, thence through the previously traced loop circuit including the upper winding of relay 560 to conductor 309, and then by way of armature 302 and back contact, lower right-hand winding of repeating coil RC, lower winding of differential relay 340, front contact and armature 352, and through the winding of relay 370 to battery. At armatures 362 and 372 relays 360 and 370 connect ground to conductor 234 to maintain relay 520 in energized position, and relay 370 at armature 371 completes a circuit for energizing reversing relay 240 over the following circuit: from ground at armature 252, conductor 235, armature 371, conductor 229, armature 286, armature 243 and back contact, and through the winding of reversing relay 240 to battery. Differential relay 340 included in the circuit traced for relays 360 and 370 does not energize at this time because the two windings are in opposition. Relay 240, upon energizing, first operates its locking armature 244 to complete a locking circuit through its lower winding from grounded armature 252. At armatures 241 and 242 relay 240 reverses current back to the paystation repeater shown in Fig. 2 for a purpose to be described later. At armature 243 relay 240 opens its original energizing circuit and completes a circuit for energizing tone interrupter relay 320 as follows: from grounded conductor 235 by way of armature 371, conductor 239, armature 286, armature 243 and front contact, armature 262 and back contact, armature 287, conductor 233, armature 333 and back contact, and through the winding of slow-to-operate relay 320 to battery. Relays 240 and 320 are slow-to-operate relays and are thus made slow to operate in order to prevent the connection of paystation tone to the trunk until after the "zip-zip" tone at the distant manual office has been extended to the operator. Relay 320, upon energizing, at armature 321 removes the short circuit from around the upper winding of the impedance coil 335, at armature 322 opens the ring-back circuit to the calling subscriber, and at armature 323 completes the circuit of operating relay 330.

If the calling line is a paystation line, then paystation tone is superimposed on the release trunk conductor to transmit paystation tone over the trunk conductor to the distant manual operator. This paystation tone may be traced as follows: from the winding of the tone machine T, shown in Fig. 1, terminals 32 and 31, tone condenser, conductor 498, front contact and armature 35, wiper 46, bank contact 54, release trunk conductor 50, through the tone condenser 144 in Fig. 2, conductor 201, through the selector to wiper 205, bank contact 208, conductor 247, armature 254 and front contact, conductor 246, and through the lower winding of impedance coil 335 to ground. Relay 330 energizes from grounded conductor 233 by way of armature 323 and thereupon locks to grounded conductor 233 by way of armature 333 and front contact, while at the same time opening the circuit to slow-to-operate relay 320. At armature 331 relay 330 opens another point in the ring-back circuit to the calling subscriber, at armature 332 removes the shunt from around the lower winding of the impedance coil 335 so that the paystation tone may be induced into the upper winding of the impedance coil 335 before the slow-acting relay 320 has had sufficient time to deenergize. During the time the slow-acting relay 320 is still in energized position the tone induced into the

upper winding of the impedance coil 335 is transmitted through the right-hand windings of the repeating coil RC and over the trunk conductors 308 and 309 and heavy talking conductor in the distant manual exchange to the operator's headset. Relay 330 likewise opens a circuit to the ringing machine at armature 334 and when slow-to-operate relay 320 finally deenergizes the upper winding of impedance coil 335 is short circuited to disconnect the paystation tone from the trunk line.

When reversing relay 240 reverses the current flow back over the talking conductors 200 and 202 the electro-polarized relays 128 and 132 operate. Relay 128, upon operating, establishes a locking circuit for itself through its lower winding at armature 163, completes the circuit for energizing the slow-to-release relay 127 at armature 162, and at armatures 160 and 164 removes its upper winding and the upper winding of relay 133 from in bridge of the trunk conductors and also disconnects the incoming line conductors 48 and 51 from the windings of line relay 135 and the impedance coil 139 and extends them directly through the repeater to the windings of relay 310. Relay 127, upon energizing, at its armature 156 completes an additional holding circuit for the lineswitch C and at armature 155 prepares a point in the coin-collect circuit. Relay 132 is an electro-polarized relay so adjusted that it will attract its armatures when the current is reversed in its upper winding and will maintain its armatures attracted by means of its polarizing winding even if the circuit of its upper winding is later opened. However, if the current flow in its upper winding is restored to normal it will retract its armatures. Relay 132, upon operating, opens a point in the circuit of relay 131 thereby preventing the latter relay from energizing at this time. The upper winding of relay 132 is included in the talking circuit but is shunted by the non-inductive resistance which affords a path for voice currents so that the talking efficiency of the circuit is not materially affected.

Subscriber A is now connected to the operator's position over the heavy talking conductors as follows: from the substation set at substation A over the line conductors 11 and 12, 48 and 51, armatures 160 and 164 and front contacts, normally closed contacts controlled by armatures 172 and 173, trunk conductors 200 and 202, wipers 203 and 204, armatures 211 and 212 and their back contacts, armatures 241 and 242 and their front contacts, front contacts of armatures 282 and 281, armatures 294 and 292 and back contacts, conductors 219 and 218, through the left-hand windings of the repeating coil RC, the right-hand winding of repeating coil RC, back contacts and armatures 302 and 301, trunk conductors 308 and 309, normally closed contacts controlled by armatures 512 and 521, armatures 541 and 551 and their front contacts, through the repeating coil RC in Fig. 6 to conductors 572 and 571, finder wipers 602 and 601, armatures 612 and 611, armatures 653 and 651, to the tip and ring answer conductors included in cable 695, armatures 971 and 972 and back contacts, and the tip and ring conductors extending to the operator's headset. Talking battery is fed through the windings of relay 310 to the calling subscriber while talking battery to the operator extends through the winding of relay 830 and ground at the induction coil associated with the operator's headset.

Verifying the paystation tone

In case the operator fails to hear the paystation tone and wishes to verify that a paystation subscriber is calling, she may do so by operating her coin refund answer key to cause the coin to be refunded. In response to the operation of the coin refund answer CR-ANS ground at key springs 1033 completes a circuit over conductor 1015 for operating the split answering relay 970. At the key spring 1031 the circuit is prepared for the answer relay 910 which, however, is ineffective at this time, since the circuit for this relay is open at armature 613 in the finder switch. At key springs 1032 collect battery or negative 110-volts is connected to conductor 1017. Split answer relay 970, upon energizing, at armature 972 connects the refund battery extending over conductor 1017 to the ring answer conductor 632 and thence by way of armature 651, armature 611, finder wiper 601, conductor 571, through the upper right-hand winding of repeating coil RC through the winding of slow-to-operate refund relay 520 and armature 513 to ground. Relay 520, upon energizing, at armature 523 opens a point in the circuit to relay 510 and at armatures 521 and 522 connects negative battery to both trunk conductors 308 and 309. The connection of negative battery to both line conductors 308 and 309 causes the differential relay 340 to become unbalanced and to energize while relay 370 is short circuited with the result that the latter relay now deenergizes. With differential relay 340 in operated position and relay 370 in released position a circuit may be traced for operating the refund relay as follows: from grounded armature 373, armature 342, conductor 238, and through the winding of refund relay to battery. At armature 341 differential relay 340 completes a locking circuit for slow-to-release relay 350 through armature 354. At armature 371 the deenergization of relay 370 opens the locking circuit of relay 330 which accordingly deenergizes. At armature 332 relay 330, upon deenergizing, closes the shunt circuit around the lower winding of the impedance coil 335 and at armature 334 starts the ringing machine. Refund relay, upon energizing, at armature 299 connects the negative battery 110-volt refund current to the front contacts of armatures 294 and 292, and at armature 297 completes a circuit for energizing slow-to-release coin relay 290. This circuit may be traced from grounded conductor 234 by way of armature 288 and front contact, armature 297 and through the winding of coin relay 290 to battery. At armature 295 relay 290 grounds conductor 237 for maintaining relay 350 in operated position, and at armatures 292 and 294 connects the negative battery 110-volt refund current to the talking conductors extending back to the calling subscriber. This application of refund current to the talking conductors of the calling line causes the operation of the polarized magnet in the coin collect mechanism to refund the deposited coins to the calling subscriber.

The operator now restores the coin refund answer key with the result that the split-answer relay 970 deenergizes and disconnects negative battery 110-volt refund current from the ring-answer conductor 632 to deenergize relay 520. Relay 520, upon deenergizing, at armatures 521 and 522 disconnects negative battery from both trunk conductors 308 and 309, and restores the bridge including the upper winding of the polarized relay 560. When this bridge is closed across the trunk conductors 308 and 309, relay

370 again energizes and the differential relay 340 restores its armatures to normal because the two windings are equal and oppose each other. In response to the operation of relay 370 the previously traced circuit for relay 320 is again completed with the result that this relay at armature 321 opens the short circuit around the upper winding of the coil 335 so that the paystation tone connected to the lower winding of this coil may be induced into the upper winding and transmitted over the trunk conductors 308 and 309 to the operator's position. At armatures 342 and 373 the circuit to the refund relay is opened, whereupon this relay deenergizes to disconnect the refund battery from the calling line and to open the circuit to coil relay 290 at armatures 299 and 297, respectively. Relay 290, upon deenergizing after an interval, opens the bridge circuit across the calling line and again connects up the relay 310 to cause the energization of the latter relay. At armature 295 relay 290 opens the locking circuit to the slow-to-release relay 350 but this relay being slow-to-deenergize will be maintained in operated position until the relay 310 closes its armature 311 with the result that relay 350 does not release during this operation. The relays 320 and 330 are operated in the same manner as previously described to transmit the paystation tone over the trunk conductor at a time when both relays are in energized position and before relay 320 fully releases. The circuits are therefore returned to the same condition as when the call was first extended to the operator's position and the operator may now converse with the calling subscriber in order to determine the party desired. The operator may request that the calling subscriber deposit the proper amount of coins to pay for the desired connection at this time or may wait until the call is completed to the desired party at which time the request may be made. The operator listens for the paystation tone transmitted from the paystation mechanism in the well known manner in response to the deposit of the required coin.

In the lower right-hand corner of Fig. 8, the sender link and register sender shown in dotted rectangles are similar in operation to the link senders and register sender disclosed and described in the Voss et al. application Ser. No. 40,686, filed September 16, 1935. The sender links in the Voss et al. application comprise a pair of finder selector links, the finders of which are used to select the particular finder link such as shown in Figs. 7 and 8, taken into use by the operator while the selector end of these sender links selects an idle register sender. Each operator's position is provided with a set of digit keys by means of which the register sender may be set to transmit digits in accordance with the particular digit keys operated. When relay 830 is operated in response to the operator inserting her headset into the associated jack, conductor 697 is grounded at armature 832. When talking relay 850 was energized to ground conductor 891, one of the sender links shown in the dotted rectangle is operated to select the particular finder link, in this case the finder link shown in Figs. 7 and 8 for use. The circuit for grounding conductor 696 extends from grounded armature 853 and front contact, conductor 891, armature 921, and armature 831.

When the connecting relay 650 of the finder link shown in Fig. 7 was operated, said relay at armature 650 connected marking negative battery potential to conductor 774 to mark the par-

ticular finder link in Figs. 7 and 8 as the finder link to be selected by the sender link. This marking circuit may be traced as follows: from negative battery through the winding of series relay 1130, vertical off-normal springs 1151, conductor 793, armature 660, conductor 690, armature 714, to conductor 774 which terminates in the test finder bank contacts accessible to the sender links. The finder of the sender link therefore operates until this marking negative battery potential is found, whereupon the finder of the sender link switches through and when the associated switches find an idle register sender the operator may operate the digit keys in accordance with the number of the called subscriber.

Series relay 1130 energizes over the above-traced circuit and at armature 1131 opens a point in the circuit to the rotary magnet, at armature 1132 prepares a point in the circuit to the vertical magnet as well as preparing a holding circuit through its lower winding, at armature 1133 opens a point in the circuit to the release magnet, and at armature 1134 connects ground by way of cam springs 1161 to the lower winding of line relay 1110. When the bridge circuit is closed across the conductors 772 and 771 in the sender, line relay 1110 is energized over conductors 771, 772, 791, and 792, armatures 1141 and 1142 and back contacts, and through the upper and lower windings of line relay 1110 to battery and ground, respectively. At armature 1111 line relay 1110 completes the circuit for energizing release relay 1120 from grounded armature 1145. At armature 1121 release relay 1120 connects the selector test wiper to the operating winding of the electro-polarized switch-through relay 1140, at armature 1122 grounds the release trunk conductor 793, at armature 1123 prepares a further point in the circuit to the vertical magnet and the lower winding of series relay 1130, and at armature 1124 completes the circuit through the lower polarizing winding of switch-through relay 1140. The electro-polarized switch-through relay 1140 will not operate its armatures at this time and will only do so when the current through its upper operating winding is in the proper direction. The operation of the selector line relay and release relay occurs responsive to the depression of the start key and the operator's digit keys, as explained in the beforementioned Voss et al. application. The register sender transmits the digits of the called number over conductors 771 and 772 until such time as the full quota of digits have been transmitted.

In response to the impulses transmitted over conductors 772, 771, and 792 and 791 by the register sender, line relay 1110 is deenergized for each impulse, and at armature 1111 completes the circuit for operating the vertical magnet and for holding the series relay in operated position as follows: from grounded armature 1145 by way of armature 1111 and back contact, armature 1123 and front contact, armature 1132, through the winding of vertical magnet to battery, and through the lower winding of series relay 1130 to battery. Vertical magnet operates the selector wipers 1171 to 1173, inclusive, one step for each impulse received to position the selector wipers opposite the desired level. Series relay 1130 being a slow-to-release relay is maintained energized during the impulsing period. Line relay 1110 is maintained in operated position after the first series of impulses and therefore opens the circuit through the low-

er winding of the series relay 1130 for a sufficient length of time to permit the deenergization of this relay.

On the first vertical step of the selector wipers the vertical off-normal springs 1151 open the original energizing circuit of the series relay, at vertical off-normal springs 1152 prepares a point in the circuit to the rotary magnet, and at vertical off-normal springs 1153 prepares a point in the circuit to the release magnet.

Series relay 1130, upon deenergizing, at armature 1134 substitutes ground at armature 1124 for ground through the cam springs 1161 for the lower winding of line relay 1110, at armature 1133 prepares another point in the circuit to the release magnet, at armature 1132 opens a point in its own circuit and the circuit to vertical magnet, and at armature 1131 completes the circuit for the rotary magnet. This circuit may be traced as follows: From grounded armature 1145, armature 1111 and front contact, armature 1131, vertical off-normal springs 1152, interrupter contact 1154 and through the winding of rotary magnet to battery. The rotary magnet energizes over this circuit and rotates the wipers of the selector one step for each energization. Near the end of its stroke the rotary magnet at its interrupter springs 1154 opens its own circuit whereupon the rotary magnet deenergizes to again complete its circuit at its interrupter contacts 1154. The rotary magnet continues to operate in the manner of a buzzer to rotate the wipers of the selector until such time as the selector test wiper 1173 encounters a test bank contact having idle battery potential thereon.

When the test wiper 1173 of the selector finds a bank contact in this level having battery potential thereon, the electro-polarized switch-through relay 1140 is operated over the following circuit: From ground by way of armature 1122, through the upper operating winding of relay 1140, armature 1121, selector test wiper 1173, to the bank contact having the negative battery potential or idle potential connected thereto. Switch-through relay 1140, upon energizing, at armatures 1141 and 1142 disconnects the windings of line relay 1110 from conductor 791 and 792, and connects these latter conductors by way of the front contacts of these armatures to the selector wipers 1171 and 1172, now in engagement with the bank contacts terminating an idle trunk. At armature 1143 switch-through relay 1140 connects the upper operating winding in a momentary short circuit and also connects the test wiper 1173 directly to the incoming release trunk conductor 793. At armature 1144 relay 1140 completes a locking circuit for itself from grounded armature 1122 as well as the circuit for maintaining itself in energized position when ground is sent back from the succeeding switch by way of the test wiper 1173, and at armature 1145 opens the circuit to the slow-to-release relay 1120. Line relay 1110, upon deenergizing, opens a further point in the circuit to release relay 1120. Release relay 1120 does not deenergize until ground has been sent back from the succeeding switch to maintain the switch-through relay 1140 in energized position as previously described due to its slow-to-release characteristics. Ground at armature 1122 is therefore not removed from the release trunk conductor 793 until the ground from the succeeding switch is fed back to this conductor by way of test wiper 1173 and armature 1143. The

remainder of the connection is established over the well known selector and connector switches in the well known manner and is therefore unnecessary to be explained in detail. In response to the last digit transmitted by the register sender the connector switch is operated to engage the contacts of the called line. If the called line is idle the connector rings the called subscriber in the well known manner and when the called subscriber answers the so-called back-bridge relay in the connector is operated to reverse battery back over the conductors of the switch train through conductors 791 and 792.

Returning now to the finder link shown in Figs. 7 and 8, and at a time when the register sender has completed the transmission of its stored digits, whereupon ground is connected to conductor 773 to operate the cut-in relay 710 through its lower winding. Cut-in relay 710, upon energizing, at armature 716 maintains the busy lamp illuminated, at armature 715 grounds the release trunk conductor 773 to the selector, at armature 714 opens the ground circuit extending into the sender link, at armature 713 completes a locking circuit for itself through its upper winding through the resistance and battery, at armature 712 connects the left-hand windings of the repeating coil RC to the talking conductors of the finder link, and at armature 711 connects the talking conductors 791 and 792 to the right-hand windings of the repeating coil RC and bridges polar relay 730 across conductors 791 and 792. When cut-in relay 710 at armature 711 connects the operating winding of the electro-polarized relay 720 across the conductors 791 and 792, this relay is energized only in case the current is in the proper direction through its upper operating winding. In this case the electro-polarized relay 730 is only operated during the time negative battery is connected to conductor 791 and positive battery to conductor 792. Relay 730, upon operating, at armature 731 prepares a circuit for lighting the call supervisory lamp through the back contacts of key springs 726. When the called subscriber answers battery is reversed over the conductors 791 and 792 in the well known manner with the result that the electro-polarized relay 730 is deenergized since the current through the operating winding is in opposition to the current through the lower winding. At armature 731 relay 730 therefore opens the prepared circuit to the call supervisory lamp, thereby providing the so-called dark supervisory board.

In case the called line was busy or the called party did not respond, then no reversal of battery takes place over conductors 791 and 792, with the result that the polarized relay 730 is maintained in its operated position and the circuit to the call supervisory light is not prepared.

The operator in extending a paystation call of this type maintains her talking key K2 in operated position until the called party answers or until busy tone is transmitted back from the connector to the toll operator.

In case the called line is busy, then busy tone will be transmitted back over the conductors of the connector to the wipers 1171 and 1172 of the selector and thence over conductors 791 and 792, armature 711, and through the right-hand winding of repeating coil RC, from which it is induced into the left-hand winding of repeating coil RC, armature 712, conductors 681 and 682, front contacts of armatures 652 and 654 of the operator's connect relay 650, over the ring call

and tip call conductors 633 and 635, armatures 992 and 991 and their back contacts, and over the ring and tip conductors 644 and 646 to the operator's headset. The operator now advises the calling paystation subscriber that the desired line is busy and proceeds to refund the deposited coin by operating the coin refund answering key CR-ANS. In response to the operation of this key the split-answer relay 970 is operated in the same manner as previously described to connect the negative 100-volts refund battery to the ring answer conductor 632 to cause the energization of relay 520. As previously described the operation of relay 520 connects negative battery through armatures 521 and 522 to the trunk line conductors 308 and 309 to cause the operation of the differential relay 340 and the deenergization of relay 370 in the trunk circuit shown in Fig. 4. As previously described, the operation of the differential relay 340 and deenergization of relay 370 causes the operation of the refund relay in Fig. 3 and the latter relay causes the operation of relay 290 which connects the negative refund battery to both conductors of the calling line to refund the deposited coin to the calling party.

Assuming now that the desired party instead of being busy has answered, then the operator will operate the coin collect answer key CC-ANS to energize the split-answer relay 970 by way of key springs 1023 and conductor 1015, at the key springs 1021 prepares a circuit for the answer relay 910 which is ineffective at this time, and at key springs 1022 connects the positive 110-volt collect battery to conductor 1018 and, since relay 970 is now energized, connects this collect battery to the tip answer conductor 634 at armature 971 and front contact, armature 653 and front contact, armature 612, wiper 602, conductor 572, through the lower right-hand winding of repeating coil RC, and collect relay 510 to grounded armature 523. Collect relay 510, upon energizing, at armature 513 opens a point in the circuit through the refund relay 520 and at armatures 511 and 512 connects ground to both trunk conductors 308 and 309 to cause the energization of the differential relay 340 and the deenergization of relay 360.

Relay 360 is deenergized because this relay is short circuited from ground extending over conductor 308 and the differential relay 340 is energized at this time because the upper winding is also shunted, thereby enabling the lower winding to operate the differential relay. At armature 341 differential relay maintains the circuit of slow-to-release relay 350 and at armature 343 completes a circuit for the collect relay in Fig. 3 by way of armature 363 of relay 360 and conductor 239. At armature 298 collect relay prepares the circuit for connecting the positive collect battery to the calling line and at armature 296 completes the circuit for relay 290. Relay 290, upon energizing this time, connects the positive collect battery to the calling line by way of the front contacts of armatures 292 and 294. The connection of positive battery to both line conductors of the calling line operates the polarized relay in the coin collect mechanism associated with the calling line to cause the mechanism to collect the coins deposited by the subscriber in the well known manner.

After collecting the coin the operator restores the talking key K2 to prepare the circuit for the answer supervisory lamp at key springs 741, opens the circuit to the connecting relay 650 at

key springs 744 and 745, and prepares the circuit to the call supervisory lamp at key springs 746. In the operator's position, the restoration of the coin collect answer key opens the circuit to the split-answer relay 970 which accordingly deenergizes and the restoration of the talking key K2 opens the circuit to the talk relay 850. Talking relay 850, upon deenergizing, at armatures 851 and 852 prepares the monitoring circuit and the circuit through the monitor relay 840, at armature 853 and front contact disconnects ground from conductor 891 and conductor 696 extending to the sender link and at the back contact of armature 863 again grounds the test conductor 753. At armature 854 relay 850 disconnects ground from conductor 892 to open the circuit to start relay 940 which accordingly deenergizes. At armature 941 relay 940 opens the locking circuit to signal interrupter relay 880 which accordingly deenergizes, at armature 942 disconnects ground from the Dist. start lead to open the circuit of the locked-up selecting relay of the distributor, at armature 943 disconnects ground from the Mark conductor to open the circuit to the stop distributor relay 822, and at armature 944 disconnects the start lead 638 from the position start conductor leading to the distributor.

The connect relay 650, upon deenergizing in response to the restoration of the talking key K2, at armatures 651 to 654, inclusive, disconnects the finder link from the operator's position and connects the calling and called subscribers over the heavy talking conductors, at armature 655 opens a point in the circuit to relay 720, at armature 656 disconnects the release call conductor 637 from the upper winding of cut-in relay 710, at armature 657 opens a point in its own locking circuit, at armature 658 disconnects the start conductor 638 from the upper winding of start relay 640, at armature 659 disconnects the release answer conductor 639 from the lower winding of start relay 640, thereby opening the circuit of the answer-pilot relay 920 in the operator's position, and at armature 660 opens a further point in the circuit connecting the selector release conductor 793 to the sender link. When the answer-pilot relay 920 deenergizes, all of the relays in the operator's position are in normal position in readiness to accept another call. Start relay 640, however, does not deenergize in response to the restoration of the connect key K2, because the start relay 640 is maintained in operated position from grounded armature 615 extending through its lower winding. The talking circuit between the calling and called subscribers includes the heavy talking conductors and the repeating coils. At any time during this conversation the operator may monitor this talking connection by operating the monitoring key K1 in Fig. 7. In response to the operation of the monitor key the ring and tip conductors 644 and 646 are connected to the talking conductors 681 and 682 by way of springs 675 and 677. At springs 676 ground connected by way of switch conductor 645 and armature 852 causes the energization of the monitor relay 840 which at armatures 841 to 843, inclusive, connects the operator's headset through the repeating coil RC in Fig. 9, to enable the operator to monitor this connection. In response to the restoration of the monitoring key in Fig. 7 relay 840 is deenergized to open the circuit to the operator's headset and at springs 675 and 677 the finder link talking circuit is disconnected from the position talking circuit.

Release supervision

After conversation and in response to the called subscriber replacing his receiver the back bridge relay in the connector is restored in the well known manner to reverse battery back over the talking conductors through the upper winding of the polarized relay 730. Polarized relay 730 in response to this reversal of current operates its armature 731 to light the call supervisory lamp by way of key springs 746, thereby notifying the operator that the called subscriber has disconnected.

When the calling subscriber replaces his receiver relay 310 in Fig. 4 deenergizes and at armature 311 opens the circuit to slow-to-release relay 350. At armatures 351 and 352 relay 350 reverses battery back over the trunk conductors 308 and 309 to cause the release of the polarized relay 560 shown in Fig. 6. At armature 353 relay 350 disconnects one of the multiple ground connections to conductor 334 and at armature 355 disconnects one of the multiple ground connections to the release trunk conductor 247. When the polarized relay 560 in the trunk circuit shown in Fig. 6 deenergizes in response to the reversal of battery over the trunk conductors 308 and 309, said relay at armature 561 connects ground by way of armature 552 to conductor 573 and thence by way of wiper 603, conductor 603, key springs 741, and through the filament of the answer supervisory lamp to battery. The answer supervisory lamp is illuminated over this circuit to call the operator's attention to the fact that the calling party has restored his receiver. If desired, the operator at this time may reoperate the talking key K2 to connect her position to the finder link and may thereafter operate the coin collect key to cause the coin to be collected in the same manner as previously described if it is desired for the operator to collect the coin when the subscribers replace their receivers.

Rering

In case the operator desires to rering the calling subscriber after replacing his receiver, the operator will operate the talking key K2 to cause the operation of the connect relay 650 to connect her position to the finder link in the same manner as previously described. The operator now operates the ring answer key to cause the operation of the split-answer relay 970 from grounded spring contacts 1014 and conductor 1015 and at springs 1012 and 1013 connects ground and generator to conductors 1018 and 1017 and thence by way of the front contacts of armatures 971 and 972 to the tip answer and ring answer conductors 634 and 632 which at this time are connected to the finder wipers 602 and 601 by way of operated armatures 653 and 651. This application of ringing current extends from the finder wipers 601 and 602 to the repeating coil RC in the trunk circuit in Fig. 6, and out over the trunk conductors 308 and 309 and through the A. C. relay 380, the associated condenser and armature 391. The A. C. relay 380 is operated by this application of ringing current to ground the release trunk conductor 247 at armature 381, and at armature 382 grounds conductor 248 to operate the ring-back relay 210. The operation of ring-back relay 210 at armature 213 grounds the release trunk conductor 247 and at armatures 211 and 212 connects ground and generator back over the existing connection to ring the bell of the calling subscriber and recall him to the tele-

phone. The operator may ring as many times as desired and after completing the ringing circuit will release the ring answer key to restore the ring-back relay 210 and disconnect ringing current from the calling line.

Releasing connection

Assuming now that the operator desires to release the established connection upon observing the lighted condition of the answer and call supervisory lamps, the operator, after operating the talking key K2 to cause the operation of the connect relay 650, thereupon operates the release call key to cause the release of the automatic switches extending to the called subscriber's line. In response to the operation of the release call key springs 1071 grounds the release call conductor 637 to operate the call-pilot relay 930 and to release the cut-in relay 710 by short circuiting the upper winding of this relay. At springs 1072 ground is connected to conductor 1016 to energize the split-call relay 990. The operation of relays 930 and 990 in the operator's position are without effect at this time. In the finder link shown in Fig. 8 cut-in relay 710 deenergizes because its upper locking winding is short circuited from ground extending from the operator's position and this relay at armature 711 opens the circuit to the automatic switches to cause the release thereof in the well known manner: at armature 713 opens a point in its own locking circuit, at armature 714 prepares a point in the circuit extending to the sender link, at armature 715 disconnects ground from the release trunk conductor 793, and at armature 716 disconnects one of the grounds from the busy lamp. When ground is removed from the release trunk conductor 793 and the automatic switches in the exchange are restored the switch-through relay 1140 in the selector shown in Fig. 12 accordingly deenergizes. At armature 1145 switch-through relay completes the circuit for energizing the release magnet as follows: from grounded armature 1145, armature 1111 and back contact, armature 1123 and back contact, armature 1133 and back contact, vertical off-normal springs 1153 and through the winding of the release magnet to battery. In response to the operation of the release magnet the wipers of the selector are restored to their normal position and the vertical off-normal springs are restored to the positions shown in the drawings. The selector in Fig. 12 is now restored to its normal condition as shown in the drawings and may be used on subsequent calls.

In order to release the connection extending from the calling line the operator operates the release answer key to ground conductor 1015 at key springs 1042, thereby causing the operation of the split-answer relay 970 and at springs 1041 grounds release-answer conductor 639 to operate the answer-pilot relay 920, and to short circuit the lower holding winding of the start relay 640. The operation of the answer-pilot relay 920 in the operator's position is without effect at this time, but the start relay 640 releases in response to its lower holding winding being short circuited. At armature 661 start relay 640 disconnects ground from the busy lamp to extinguish the same, at armature 643 and front contact disconnects ground from wiper 604 and opens the holding circuit of the switching relay 610, whereupon the latter relay deenergizes. At armature 643 and back contact start relay 640 completes a circuit by way of vertical off-normal springs 674 for op-

erating the release magnet of the finder whereupon the wipers of this finder are restored to the normal position in the well known manner. When the wipers reach their normal position the vertical off-normal springs 674 open the circuit of the release magnet and the vertical off-normal springs 671 prepares a point in the original energizing circuit for start relay 640. The deenergization of the polar switching relay 610 disconnects the wipers of the finder from the talking conductors of the link at armatures 611 and 612, at armatures 613 and 614 prepares points in the circuit for wipers 605 and 606, and at armature 617 prepares a point in the original energizing circuit for the vertical magnet. The finder of the finder link is therefore restored and may be used on subsequent calls.

In response to the disconnection of ground from wiper 604 by the restoration of the start relay 640, the locking circuit of the cut-off relay 550 in the trunk circuit is opened with the result that this relay deenergizes after an interval. At armature 551 cut-off relay 550 reconnects the A. C. relay 530 across the trunk conductors 308 and 309, at armature 552 disconnects ground from the lower polarizing winding of relay 560 and ground from conductor 573 to extinguish the answer-supervisory lamp in the finder link. The disconnection of ground from conductor 574 also opens the locking circuit of the start relay 540, whereupon the latter relay at armature 541 opens the bridge circuit extending over the trunk conductors 308 and 309, at armature 542 disconnects ground from conductor 583 to make this trunk circuit accessible to selector switches, and prepares the circuit for the cut-off relay 550. At armature 543 opens a point in the original energizing circuit of cut-off relay 559, at armature 544 opens a point in its own locking circuit, and at armature 545 opens a point to the start lead 590. The cut-off relay 550 being slow to release deenergizes after the deenergization of the start relay 540 with the result that ground is not connected to the start conductor at armature 555 because the start relay 540 is deenergized and opens the circuit to the start conductor at armature 545.

When start relay 540 deenergizes and at armature 541 opens the bridge circuit extending over the trunk conductors 308 and 309, relays 360 and 370 deenergize. Relay 360, upon deenergizing, at armature 362 disconnects one of the multiple grounds from conductor 234, and at armature 363 grounds conductor 245. Relay 370, upon deenergizing, at armature 371 opens the locking circuit of relay 330 which accordingly deenergizes and at armature 372 disconnects ground from conductor 234 to open the circuit of slow-to-release hold relay 250. Slow-to-release relay 250, upon deenergizing, at armature 252 disconnects ground from conductor 235 to open the locking circuit of the reversing relay 240, the locking circuit of the ring cut-off relay 260, and to connect negative battery through the polarizing winding of polar relay 230 to the release trunk conductor 215. At armature 254 and front contact relay 250 disconnects the grounded conductor 246 from the release trunk conductor 247, thereby opening the locking circuit of relay 280 and for releasing the selector switch (Fig. 3), the paystation repeater in Fig. 2, and the lineswitch in Fig. 1. Relay 280, upon deenergizing, at armatures 281, 282, 284, and 285 disconnects relay 310 from in bridge of the calling line and substitutes the upper windings of relays 220 and 230 in

bridge of the conductors 217 and 257 extending to the incoming selector in Fig. 5. At armature 283 transfer relay 280 opens a point in the ring-back circuit and at armature 276 connects negative battery through the resistance as well as negative battery through the winding of relay 280 to the release trunk conductor 247 by way of the back contacts of armature 254, to mark this trunk circuit as idle to other selectors having access thereto. At armature 279 ground is disconnected from conductor 249 by the restoration of relay 280 to open the circuit of auxiliary transfer relay 390. At armature 391 relay 390, upon deenergizing, opens at point in the circuit to the A. C. relay 380, at armature 392 connects the negative battery potential through the polarizing winding of polar relay 230 to the incoming selector release trunk conductor 215, and at armature 393 opens a point in the circuit to the ringing machine start lead 256. Reversing relay, upon deenergizing, at armatures 241 and 242 restores the talking conductors to normal, at armature 243 prepares a point in its original energizing circuit, and at armature 244 opens a further point in its own locking circuit. All of the relays and apparatus in the trunk circuit shown in Figs. 3 and 4 are now in normal position and may be used on subsequent calls.

In response to the disconnection of ground from release trunk conductor 247 the selector shown diagrammatically in Fig. 3 releases in the well known manner and disconnects ground from release trunk conductor 201. When ground is disconnected from release conductor 201 the circuit to the lower polarizing winding of relay 132 is opened, the locking circuit to relay 134 is opened, and the locking circuit through the lower winding of polarized relay 128 is opened, whereupon the latter relay deenergizes. Relay 134, upon deenergizing, at armature 180 prepares a point in the previously mentioned shunt circuit. Ground being removed from the release trunk conductor 201, relays 128 and 132 in the paystation repeater are deenergized. Relay 132, upon deenergizing, completes the circuit for relay 131 at armature 175. The latter relay, upon energizing, reverses the trunk conductors 200 and 202 with regard to the conductors of the calling line. Relay 128, upon deenergizing, opens the circuit of the slow-acting relay 127, but, before this relay has had time to deenergize an impulse of current is sent over the following path: ground by way of armature 162 and back contact, armature 157, and through the winding of slow-acting relay 125 to battery. Relay 125, upon energizing, places an additional ground on release trunk conductor 60 extending back to the line switch C at armature 146. Another result of the energization of relay 125 is that at armatures 145 and 144 and front contacts both sides of the line of substation A are connected to collect battery by way of armature 155 and front contact, armature 177, and winding of relay 140. Upon closure of this circuit current flows from the collect battery through the winding of relay 140 and the polarized magnet at the paystation in series to ground energizing both relay 140 and the polarized coin collect magnet. Relay 140 closes at its armature 195 the circuit for the slow-acting relay 126. Relay 126, upon energizing, at armature 150 completes a locking circuit for relay 127, which being slow-acting, has not yet deenergized, and at armature 152 connects the incoming line conductors by way of the condenser to ground. Ordinarily the polarized magnet at the substation will respond at once to

current from the collect battery and will operate to collect the deposited coin and restore the entire coin collect mechanism to normal condition instantly, at the same time disconnecting itself from line conductor 12. However, it sometimes happens that the armature of the polarized magnet will stick and relay 133 is provided to insure the collection of the coin in such case. In this particular instance, since the coin has already been collected this operation is without effect at this time but is being described so that the operation of the paystation repeater may be known when local calls are made. The interrupter I causes relay 133 to rapidly vibrate its armature and interrupt the circuit of the collect battery to insure the collection of the coin and to prevent the polarized magnet in the collect mechanism from sticking. However, should the armature of the polarized magnet continue to stick the relay 127 will remain energized. In this case since the coin has been collected previously by the operator, the circuit to the polarized magnet in the paystation mechanism is open with the result that relays 140 and 126 do not operate. Since relay 126 is not operated in this case then relay 127 is not held operated over its locking circuit with the result that the latter relay finally deenergizes. Relay 127, upon retracting its armature, opens the circuit to relay 125 at armature 157, and at armature 156 disconnects one of the ground connections to the release trunk conductor 50. Relay 125, upon deenergizing, at armature 146 disconnects ground from release trunk conductor to cause the switching relay 25 of the line 50 to deenergize and release the lineswitch in the well known manner. All of the apparatus now used in completing an outgoing call from substation A is restored and may be used on subsequent calls.

Manual to automatic paystation calls

Assuming now that the manual paystation subscriber A1 shown in Fig. 14 desires a connection with the subscriber located at the paystation equipment shown in Fig. 1. The subscriber A1 in originating a call removes the receiver from the switchhook and deposits the required coin to close springs 1309 in the well known manner. Line relay 1310 is now energized over the following circuit: from ground through the windings of the polarized coin collect magnet 1308, through the springs 1309, over the lower heavy talking conductor, and through the transmitter T, the switchhook springs, and the upper winding of the induction coil, through the upper talking conductor, and thence in multiple by way of armatures 1331 and 1332 and back contacts, armature 1321 and back contact and through the upper winding of line relay 1310 to battery. Line relay 1310 therefore energizes through its upper winding alone over the two talking conductors in parallel. At armature 1311 line relay 1310 completes a local locking circuit for itself extending from ground through its lower winding, back contact and armature 1322, armature 1311, and through the upper winding to battery. At armature 1312 line relay 1310 connects the cut-off relay 1320 to bank contact 1304 by way of conductor 1344 to thereby mark this line as calling in the finder banks. At armature 1313 line relay 1310 grounds conductor 1287 to mark this line as busy to connector switches having access thereto. At armature 1314 line relay 1310 disconnects ground from finder bank contact 1303 and at armature 1315 grounds the start lead 1316 to

energize common start relay 819 and to mark the ninth level vertical test bank contacts thereby locating the group of the calling line in the finder bank. Common start relay 819, upon energizing, at armature 818 lights all of the lamps L1 at all of the operators' positions and at armature 846 grounds the common start conductor.

In case the operator at one of the positions is idle she will then operate the key K2 of an idle finder link in the same manner as previously described. Assuming that the finder link shown in Figs. 7 and 8 is the link in which the key K2 is operated, then the connecting relay 650 is energized over the test conductor 753 in the same manner as previously described. Since the operation from now on is the same as that previously described, only a brief description will be given at this time. In response to the operation of the connecting relay 650 the operator's position is connected to the finder link and talk relay 850 is energized in series with the lower winding of relay 650. At armature 854 relay 850 completes the circuit for start relay 940, whereupon the start relay starts the distributor selecting relays over the distributor start lead at armature 942, at armature 943 marks this position as answering and at armature 944 connects the position start lead to the start conductor 638. The selecting relays in the distributor operate in the same manner as previously described until selecting relay 826 at armature 844 completes the circuit for stop relay 822. At armature 845 relay 826 connects the common start conductor grounded at armature 846 to the position start conductor which is connected to start conductor 638 thereby completing the circuit for start relay 640 in the finder link. In the same manner as previously described the start relay 640 locks itself in energized position and operates the vertical magnet. The vertical magnet of the finder operates until the vertical test wiper 607 engages the marked vertical bank contact terminating the start lead. When the finder vertical test wipers encounters the grounded vertical bank contact the change-over relay 620 is energized as before and switches the stepping circuit over to the rotary magnet.

The finder rotary magnet is now operated step by step to rotate the wipers until the test wiper 604 finds the marked finder bank contact having calling potential thereon. When finder test wiper 604 engages the finder bank contact 1304 the cut-off relay 1320 and the switching relay 610 energize in series as follows: from ground by way of armature 643 and front contact, through the upper operating winding of switching relay 610, wiper 604, bank contact 1304, conductor 1344, armature 1312, and through the winding of cut-off relay 1320 to battery. At armatures 611 and 612 relay 610 completes a point in the talking circuit between the calling subscriber and the operator's position, at armature 615 completes the locking circuit through the lower winding of start relay 640, at armature 616 grounds finder wiper 604 to completely energize the cut-off relay 1320 and to mark this line as busy in the finder banks, and at armature 617 opens the locking circuit of the change-over relay 620 which accordingly deenergizes.

At armature 1321 cut-off relay 1320 connects the lower or positive conductor of the calling line to the lower winding of line relay 1310, at armature 1322 opens the local loop around relay 1310, at armature 1323 completes a locking circuit for itself, at armature 1324 opens the circuit to lower winding of relay 1330 and prepares a point for

later on grounding the release trunk conductor 1287, and at armature 1325 disconnects ground from start lead 1316 to deenergize the common start relay 819 in case no other call has been originated.

The operator now converses with the subscriber at substation A1 over the following talking circuit: line conductors 1341 and 1342, bank contacts 1301 and 1302, wipers 601 and 602, armatures 611 and 612, armatures 651 and 653, conductors 632 and 634, armatures 971 and 972 and back contacts, to the tip and ring conductors 646 and 644 associated with the operator's headset. Talking battery for the calling subscriber is supplied through the windings of the line relay 1310.

Assuming now that subscriber A1 informs the operator that a connection is desired to subscriber A in the distant automatic exchange, and accordingly the operator operates the digit keys in her key-set to set up the number in the sender, after which the sender is started to transmit the digits of the called number. Impulse transmission from the register sender is transmitted over conductors 772 and 771 to conductors 791 and 792, as previously described. The selector shown in Fig. 12 is operated in the same manner as previously described, but in this case, since the call is to be extended to the distant automatic exchange the selector is operated to select one of the trunk circuits terminating an idle trunk in this exchange. Assuming that the trunk circuit in Fig. 6 is the trunk circuit selected by the selector, then the switch-through relay 1140 of the selector is energized over the following circuit: from grounded armature 1122 by way of the upper operating winding of switch-through relay 1140, armature 112, wiper 1173, bank contact 1187, conductor 583, armature 542 and back contact, and through the winding of cut-off relay 660 to battery. At armatures 1141 and 1142 switch-through relay 1140 connects the link talking conductors 791 and 792 to conductors 581 and 582, normally connected to conductors 308 and 309. At armature 1143 relay 1140 grounds wiper 1173 to completely energize cut-off relay 550 and to mark this trunk line as busy to other selectors having access thereto. Cut-off relay 550, upon energizing, at armature 551 disconnects the upper winding of A. C. relay from in bridge of the trunk conductors, at armatures 553 grounds conductor 574 to mark this trunk circuit as busy, at armature 554 opens a point in the circuit to start relay 540, and at armature 555 disconnects ground to prevent grounding of start lead 590.

When the selector switches through and bridges the impulse springs in the register sender across the trunk conductors 308 and 309 trunk line relays 360 and 370 are energized as follows: from ground through the winding of trunk line relay 360, normally closed contacts controlled by armature 352, through the lower winding of differential relay 340, lower right-hand winding of repeating coil RC, back contact and armature 302, conductor 309, conductor 582, wiper 1172, front contact and armature 1142, conductor 792, conductor 772, by way of the impulse springs in the register sender to conductor 771, conductor 791, armature 1141 and front contact, wiper 1171, conductors 581 and 308, armature 301 and back contact, upper right-hand winding of repeating coil RC, through the upper winding of differential relay 340, normally closed springs controlled by armature 351, and through the winding of trunk line relay 370 to battery.

Relay 370, upon energizing, at armature 372 grounds conductor 234 to energize hold relay 250. Relay 360, upon energizing, at armature 362 likewise grounds conductor 234, and at armature 361 connects the upper winding of relays 220 and 230 in bridge of the windings of the line relay (not shown) in the incoming selector in Fig. 5. This selector is similar to the selector shown in Fig. 12 and need not therefore be described in detail. Hold relay 250, upon energizing, at armature 251 prepares a point in the circuit to slow-to-operate relay 270, and at armature 252 grounds conductor 235 to energize the polarizing winding of relay 230 and to connect ground to release trunk conductor 215 to operate the series relay in the incoming selector in Fig. 5 by way of armature 392 and conductor 215. At armature 253 relay 250 prepares a point in the holding circuit for slow-to-release relay 220 effective during the impulsing period, and at armature 254 opens the circuit to transfer relay 280 and grounds release trunk conductor 247 by way of armature 332 and conductor 246 to mark this trunk circuit as busy to selectors having access thereto.

The closure of the bridge circuit in this trunk circuit at armature 361 causes the energization of relay 220 as follows: from ground and battery through the windings of the line relay in the incoming selector, conductors 257 and 216, armature 361, back contacts and armatures 281 and 282, armatures 292 and 294 and back contacts, conductors 218 and 219, thence through the left-hand windings of repeating coil RC to conductors 224 and 226, armatures 284 and 271 and back contacts, and through the upper windings of relay 220 and polar relay 230. Polar relay 230 does not energize over this circuit because the flow of current is in the wrong direction and since the upper and lower windings now oppose each other. Relay 220, however, is energized over this circuit to open a point in the circuit to relay 270 at armature 221 before this slow-to-operate relay can fully operate its armatures, and at armature 222 prepares a holding circuit for its lower winding.

In the incoming selector the release relay is energized in response to the operation of the line relay and the incoming selector is ready for receipt of impulses. In response to the next series of impulses transmitted from the sender, trunk line relays 360 and 370 deenergize once for each impulse. At armatures 362 and 372 trunk line relays 360 and 370 momentarily open the circuit to slow-to-release relay 250, but this relay is held in operated position during the impulsing period due to its slow-to-release characteristic. At armature 363 relay 360 immediately closes the circuit through the lower winding of relay 220 during the impulsing period to maintain relay 220 in operated position. At armature 361 trunk line relay 360 repeats the impulses to the line relay in the incoming selector, thereby causing this line relay to deenergize once for each impulse received. In the incoming selector and responsive to the operation of the line relay the vertical magnet is operated to step the wipers of the incoming selector opposite the level corresponding to the first digit, after which the selector series relay deenergizes and completes the self-interrupting circuit to the rotary magnet. The rotary magnet thereupon rotates the wipers of the incoming selectors 461 to 463, inclusive, in the selected level until the test wiper 462 finds an idle connector switch, which switch will have negative battery as indicating an idle condition on its corresponding bank contact in the selector banks.

When the test wiper 462 finds this idle potential the polarized switching relay in the selector switches through in the well known manner.

Assuming now that the connector shown in Fig. 5 is the first idle connector accessible to the selector in this level, then the switching relay of the selector energizes from ground through its operating winding, wiper 462, bank contact 465, vertical off-normal springs 472 and back contact, vertical off-normal springs 471, and through the winding of relay 410 to battery. Relay 410, upon energizing, at armature 447 prepares a point in its own locking circuit, at armature 448 prepares a point in the impulsing circuit to the vertical magnet, and at armature 449 prepares a point in the ringing circuit. Line relay 403 is energized over the following circuit: from ground and battery through the lower and upper windings of line relay 403, normally closed contacts controlled by armatures 418 and 417, back contacts and armatures 415 and 413, selector bank contacts 467 and 464, wipers 463 and 461, through the selector to conductors 257 and 216 and the previously traced bridge circuit including the upper windings of relays 220 and 230 and armature 361. At armature 420 line relay 403 completes a circuit for energizing slow-to-release relay 404 by way of armature 414 and back contact. Release relay 404, upon energizing, at armature 421 grounds bank contact 465 by way of vertical off normal springs 472 to supply an additional ground for marking this selector as being busy, the other ground extending from the trunk circuit by way of grounded armature 252, conductor 235, armature 392, conductor 215, and through the operated contacts on the selector switching relay to the selector wiper 462. At armature 422 relay 404 completes the locking circuit for relay 410 by way of the normally closed springs controlled by armature 429, armature 436, the lower winding of relay 409, and by way of armature 447 and front contact. Relay 409 does not energize in this circuit because ground is connected to both of the winding terminals of the lower winding. At armature 423 relay 404 prepares a point in the impulsing circuit and at armature 424 opens a point in the circuit to the connector release magnet and the ringing switch release magnet.

Relay 360, at armature 361, repeats the next series of impulses causing the line relay 403 to deenergize once for each impulse received. Each time line relay 403 falls back armature 420 completes a circuit for operating the connector vertical magnet and the series relay 406, as follows: from ground by way of armature 420 and back contact, armature 423, armature 428, armature 457, where the circuit divides, one branch extending through the winding of series relay 406 to battery and the other extending by way of armature 446 and back contact, armature 448 and front contact, through the winding of the connector vertical magnet to battery. Series relay 406, being of the slow-to-release type, maintains its armature attracted during the impulsing period, and at armature 429 opens the previously traced locking circuit for relay 410 and substitutes a new locking circuit by way of armature 445 and back contact for holding relay 410 in operated position. At armature 430 relay 406 prepares a point in the circuit to the busy relay 405, and at armature 431 opens a point in the ringing circuit. The vertical magnet is operated to step the wipers of the connector opposite the level corresponding to the digit transmitted. On the first vertical step of the

connector wipers the vertical off-normal springs 470, 471, and 472 operate. Vertical off-normal springs 471 opens the original energizing circuit of relay 410, and removes one of the ground connections shorting the lower winding of relay 409. At vertical off-normal springs 472 and front contact the circuit for reversing relay 401 is prepared and at vertical off-normal springs 470 a circuit is prepared for the connector release magnet.

Shortly after this series of impulses series relay 406 deenergizes and at armature 429 connects the lower winding of relay 409 in series with relay 410, thereby causing the energization of relay 409 while relay 410 is maintained in energized position. This circuit may be traced as follows: from ground by way of armature 422, normally closed contacts controlled by armature 429, armature 436, through the lower winding of relay 409, armature 447 and front contact, and through the winding of relay 410 to battery. At armature 445 relay 409 prepares a point in its own locking circuit through its upper winding, and at armature 446 connects the rotary magnet of the connector to the impulsing circuit, as well as disconnecting the connector vertical magnet.

In response to the next series of transmitted impulses trunk line relay 360 again repeats the impulses to line relay 403, which again energizes series relay 406 and this time operates the rotary magnet as follows: from grounded armature 420 and back contact, armatures 423, 428, and 457, and by way of armature 446 and front contact to the connector rotary magnet. Series relay 406, upon reenergizing, at armature 429 completes the locking circuit through the upper winding of relay 409 and opens the circuit through the lower winding of relay 409 and the locking circuit of relay 410 to cause the latter relay to deenergize. Relay 410, upon deenergizing, at armature 447 prepares a new operating circuit for itself and at armature 448 prepares a point in the impulsing circuit to the stepping magnet of the ringing switch. The rotary magnet of the connector is operated once for each impulse received to step the connector wipers into engagement with the bank contacts of the called line. When relay 406 deenergizes after the impulsing period said relay at armature 429 opens the locking circuit of relay 409 with the result that it now deenergizes and at armature 446 prepares a further point in the circuit to the stepping magnet of the ringing switch.

In the same manner as previously described the connector line relay 403 is operated in response to the transmitted ringing digit to step the wipers 481 and 482 of the ringing switch. This stepping circuit may be traced as follows: ground by way of armature 420 and back contact, armatures 423, 428, and 457, and by way of armatures 446 and 448 and back contacts, through the winding of the stepping magnet of the ringing switch to battery. When wiper 482 of the ringing switch engages its first bank contact a circuit is prepared for the busy test relay 405.

If the called line is busy, then connector test wiper 492 is in engagement with a busy grounded bank contact with the result that the busy relay 405 is energized in its first step over the following circuit: from the grounded connector bank terminal of the busy line, wiper 492, through the upper winding of switching relay 412, through the multiple bank contacts engaged by wiper 482, front contact and armature 430 of the series relay 406, through the resistance R and the winding of busy relay 405 to battery. On account of the re-

istance in this circuit just traced the busy relay 405 is operated to close only its armature 427 to prepare a circuit for fully energizing the busy relay when the slow-acting series relay 406 de-energizes shortly after the impulsing period. Switching relay 412 is marginal and will not energize in series with the busy relay 405 and resistance R. When series relay 406 deenergizes after the impulsing period said relay at armature 430 opens the original energizing circuit of busy relay 405 and substitutes a new circuit including the normally closed contacts controlled by armature 426 and the operated armature 427, thereby causing the busy relay 405 to operate its remaining armatures. Busy relay 405, upon energizing, in its second step, at armature 425 connects the busy tone to the upper talking conductor to transmit the busy tone back to the operator over the heavy talking conductors, at armature 426 completes a locking circuit for itself from grounded armature 422, and at armature 428 opens a point in the impulsing circuit.

Returning now to the operation of the sender and at a time when the last digit is finally transmitted, the cut-in relay 710 in the finder link is operated in the same manner as previously described to prepare the talking circuit and to bridge the upper winding of polar relay 730 across the conductors 791 and 792. Since no reversal of battery has taken place over trunk conductors 308 and 309 the current flow through the upper operating winding of the polar relay 730 is in the proper direction to operate this relay with the result that this relay at armature 731 prepares the circuit for illuminating the call supervisory lamp which, however, is only completed when the talking key K2 in the finder link is restored. When the operator hears the busy tone such operator will inform the subscriber at substation A1 that the line is busy and therefore advises such subscriber to replace his receiver and that she will complete the call later on.

The operator now refunds the deposited coin by operating the coin refund answer key CR-ANS to operate springs 1031, 1032, and 1033. At springs 1031 the circuit is completed for energizing the answer relay 910 in the operator's position and relay 1330 in the calling line circuit in series as follows: from grounded springs 1031, conductor 1019, through the winding of answer relay 910, conductor 752, key springs 742, conductor 686, armature 624, wiper 605, bank contact 1305, conductor 1345 and through the upper winding of relay 1330 to battery. At springs 1033 ground is connected to conductor 1015 to energize the split answer relay 970, and at springs 1032 the negative 110-volt refund battery is connected to conductor 1017. Answer relay 910, upon energizing, at armature 911 connects the negative 110-volt battery to conductor 1018 and relay 970 upon energizing at armatures 971 and 972 connects the negative 110-volt refund battery to the finder wipers by way of conductors 632 and 634.

Relay 1330, upon energizing, at armatures 1331 and 1332 disconnects the line relay 1310 from the calling line at their back contacts, and at their front contacts bridges the associated condensers to permit the 110-volt refund battery to be transmitted from the finder wipers over conductors 1341 and 1342 through the windings of the polarized collect magnet 1308. At armature 1333 relay 1330 maintains the cut-off relay 1320 in operated position. The connection of 110-volt refund battery to the polar relay 1308 causes this magnet to operate its armature in the direc-

tion to refund the deposited coin, after which the coin springs 1309 return to their normally open position. Line relay 1310, upon deenergizing, at armature 1313 and back contact connects the grounded armature 1324 to release trunk conductor 1287 to maintain this line busy and at armature 1314 grounds conductor 1343 to prepare a circuit for the call supervisory lamp in the finder link. When the operator restores the coin refund answer key relays 910, 970, and 1330 de-energize.

Returning now to the operation of the connector shown in Fig. 5 and assuming that the called line is idle instead of busy, then the busy relay 405 is not energized and when series relay 406 deenergizes after the impulsing period the switching relay 412 is energized over the following circuit: from ground by way of armature 422, back contact and armature 427, normally closed springs controlled by armature 430, wiper 482 of the ringing switch, upper winding of switching relay 412, test wiper 492, bank contact 495, conductor 498, through the winding of switching relay 25, and through the winding of motor magnet 27 to battery. Switching relay 412 operates to close its armature 456 and switching relay 25 operates to disconnect the line relay 26 and ground from the called subscriber's line. Switching relay 412 first operates armature 456 to complete a locking circuit through its lower winding from ground at armature 422 and to cause the operation of its remaining armatures.

Relay 412, upon fully operating, at armatures 451 and 458 prepares a point in the talking and ringing circuits, at armature 452 completes the circuit for operating the reversing relay 401, at armature 454 completes a new circuit for energizing relay 410, at armature 455 grounds wiper 492 and conductor 498 to make the called line busy to other connectors having access thereto, and at armature 457 opens a point in the local impulsing circuit.

The reversing relay 401 is energized over the following circuit: from grounded release trunk conductor 215 extending through the incoming selector to wiper 462, bank contact 465, off-normal spring 472 and front contact, armature 452, and through the winding of reversing relay 401 to battery. At armatures 413 and 415 relay 401 short circuits the associated talking condensers, and disconnects the windings of relays 402 and 403 from the talking conductors of the connector, at armatures 414 and back contact opens a point in the circuit to release relay 404, while at the front contact thereof completes a circuit for energizing the back bridge relay 402 through its lower winding in series with release relay 404 which relay is maintained in its operated position.

The circuit for energizing relay 410 may be traced from grounded armature 454, armature 435, normally closed springs controlled by armature 447 and through the winding of relay 410 to battery. Relay 410, upon energizing, at armature 447 locks itself in energized position through the lower winding of relay 409, and at armature 440 prepares a point in the ringing circuit. Relay 409 is energized in series with relay 410. Relay 409 at armature 444 completes the ring-back circuit. Relay 402, upon energizing, at armature 419 opens a point in the circuit to the connector release magnet and the ringing switch release magnet.

Ring reversing relay 408 is only energized in case the ringing digit is an odd digit, that is, assuming that the ringing digit was 1, then wiper

481 completes the following circuit for energizing relay 408: from generator G1, first bank contact and wiper 481, through the multiple contacts to armature 431, normally closed springs controlled by armature 441, and through the lower winding of ring-reversing relay 408 to battery. At armatures 439 and 442 relay 408 reverses the ringing leads, at armature 440 locks itself through the upper winding of grounded armature 422, and at armature 441 opens its original energizing circuit and completes the ringing circuit. The ringing circuit in this case may be traced as follows: from generator G1, first bank contact, wiper 481, multiple contacts, armature 431, front contact and armature 441, armature 449, front contact and armature 439, back contact and armature 432, thence over the heavy talking conductor through the ringer at the substation back to armature 438 and back contact, armature 442 and front contact, and through the upper winding of ring-cut-off relay 407 to battery.

In case the ringing digit is an even number, then ring-reversing relay 408 does not energize and the ringing circuit will then extend from the generator lead over wiper 481 and the multiple bank contacts, armature 449, back contact and armature 442, back contact and armature 438, armature 458, wiper 493, conductor 499, over the subscriber's line circuit through the ringer and back to conductor 497, wiper 491, armature 451, armature 432 and back contact, armature 439 and back contact, and through the upper winding of ring-cut-off relay 407 to battery.

When the called subscriber answers ring-cut-off relay 407 is energized over the previously traced ringing circuit to operate armature 437, thereby completing a locking circuit through its lower winding for operating its remaining armatures. This circuit may be traced from grounded armature 422, by way of armature 456 and the two make contacts, armature 437, and through the lower winding of ring-cut-off relay to battery. At armatures 432 and 438 and back contacts relay 407 disconnects the ringing circuit, and at their front contacts completes the talking circuit. At armature 434 relay 407 connects grounded armature 453 to the hold conductor by way of armature 416, at armature 435 opens the original energizing circuit of relay 410, at armature 436 opens the circuit of relays 409 and 410 which relays accordingly deenergize.

Returning to the trunk circuit in Figs. 3 and 4, and at a time when reversing relay 401 disconnects its line relay 403 from in bridge of conductors 257 and 216, the circuit for energizing relay 220 was thereupon opened, whereupon the latter relay deenergizes. At armature 221 relay 220 completes a circuit for energizing relay 270 as follows: from grounded conductor 234 by way of armature 288 and back contact, armature 251, armature 231 and back contact, armature 221, armature 262 and back contact, normally closed springs controlled by armature 275, and through the winding of relay 270 to battery. At armature 271 relay 270 opens the circuit through the upper windings of relays 220 and 230, at armatures 271 and 272 switches the upper and lower windings of line relay 310 across the conductors 257 and 216 and therefore across the called line conductors, at armature 273 disconnects the battery potential from in shunt of relay 370, at armature 274 prepares a point in the circuit to coin relay 290, and at armature 275 completes a locking circuit for itself from grounded armature 252. Line relay 310 is now connected across the line con-

ductors of the called line and when the called subscriber answers line relay 310 energizes. At armature 311 relay 310 completes a circuit for relay 350. Relay 350, upon energizing, at armatures 351 and 352 reverses battery over trunk conductors 308 and 309. This reversal of battery back over the trunk conductors 308 and 309 causes the deenergization of the polar relay 730 in the finder link and this polar relay upon deenergizing opens the previously prepared circuit for the call supervisory lamp.

The operator may collect the deposited coin now or after the termination of the conversation. In order to collect the coin the operator operates the coin collect answer key CC-ANS to close springs 1021, 1022, and 1023. Key springs 1021 grounds conductor 1019 to energize relays 910 and 1330 over the circuit previously traced. At the key springs 1023 grounds conductor 1015 to operate split answer relay 970 and at key springs 1022 connects the positive 110-volt collect battery to conductor 1018. Relay 910, upon energizing at armature 911 connects the 110-volt battery on conductor 1017 to conductor 1018 with the result that when relay 970 is energized to operate armatures 971 and 972 this 110-volt collect battery is connected to both the finder wipers. In the same manner as previously described relay 1330 at armatures 1331 and 1332 short circuits the associated condenser and opens the circuit to line relay 1310 and at armature 1333 holds relay 1320 in operated position. At armatures 1331 and 1332 and front contacts the 110-volt collect battery is connected over the substation circuit to operate the polarized collect magnet 1308 to cause the coin to be collected. When the operator restores the coin collect answer key relays 1330, 910, and 970 deenergize as before.

After the called subscriber answers the operator restores the talking key K2 in the finder link to connect the calling and called subscribers over the following talking circuit: through the transmitter and receiver at substation A1 over the heavy talking conductors, the talking condensers, conductors 1341 and 1342, wipers 601 and 602, armatures 611 and 612, normally closed springs controlled by armatures 652 and 654 of the deenergized connect relay, which relay deenergizes when the key K2 is restored by the operator, and thence by way of conductors 681 and 682, through the windings of the repeating coil RC, conductors 791 and 792, wipers 1171 and 1172, conductors 581 and 582, trunk conductors 308 and 309, armatures 301 and 302 and back contacts, through the repeating coil RC, conductors 218 and 219, back contacts and armatures 292 and 294, back contacts and armatures 281 and 282, conductor 217, armature 361, conductors 257 and 216, wipers 461 and 463, armatures 413 and 415 and front contacts, front contacts and armatures 432 and 438, armatures 451 and 458, wipers 491 and 493, conductors 497 and 499, conductors 11 and 12 and through the substation circuit of the called station. Talking battery to the calling subscriber is furnished through the windings of line relay 1310, while talking battery for the called subscriber is furnished through the windings of the line relay 310.

When the called subscriber replaces his receiver line relay 310 deenergizes and at armature 1311 opens the circuit of relay 350 which accordingly deenergizes. Relay 350, upon deenergizing, at armatures 351 and 352 reverses battery back over the trunk conductors 308 and 309, thereby causing the energization of the polar relay 730 in

the finder link. Relay 730, upon energizing, at armature 731 completes the circuit for lighting the call supervisory lamp, thereby indicating to the operator that the called party has replaced his receiver.

When the calling subscriber at substation A1 replaces his receiver line relay 1310 deenergizes and at armature 1314 grounds conductor 1343 to light the answer supervisory lamp as follows: ground by way of armature 1314, conductor 1434, finder bank contact 1303, wiper 603, conductor 683, key springs 741 and back contact, and through the answer supervisory lamp to battery. By the lighting of the answer supervisory lamp the operator is informed of the fact that the calling party has replaced his receiver. The operator now operates key K2 to cause the reoperation of connecting relay 650. After the operation of key K2 the operator will then operate the release call key to ground conductors 637 and 1016 at key springs 1071 and 1072. The call pilot relay 930 is maintained energized in response to grounding conductor 637, and at the same time the upper locking winding of cut-in relay 710 is short-circuited from ground on release call conductor 637 by way of armature 656, conductor 685, armature 713 and through the upper winding of relay 710 to ground. Cut-in relay 710 thereupon deenergizes and at armature 711 opens the circuit of polar relay 730 and trunk line relays 360 and 370. At armature 712 opens a point in the talking circuit, at armature 713 opens a further point in its own locking circuit, at armature 715 disconnects ground from release trunk conductor 793, and at armature 716 disconnects one of the ground connections from the busy lamp. Relay 730, upon deenergizing, at armature 731 opens the previously traced circuit to the called supervisory lamp. The disconnection of ground from release trunk conductor 793 by the deenergization of cut-in relay 710 at armature 715, releases the switch-through relay 1140 in the selector and also releases the cut-off relay 550 in the trunk circuit shown in Fig. 6. Switch-through relay 1140 in the selector, upon deenergizing, releases the selector in the same manner as previously described. Cut-off relay 550, upon deenergizing, at armature 551 reconnects the upper winding of the A. C. ring-down relay 530, at armature 552 disconnects ground from the polarizing winding of relay 560 and from conductor 573, whereupon the trunk circuit shown in Fig. 6 is now in normal position.

Trunk line relays 360 and 370, upon deenergizing, at armature 361 opens a point in the talking circuit, at armature 362 removes one of the ground connections from hold relay 250, and at armature 372 disconnects the remaining ground from holding relay 250 to cause the latter relay to deenergize. Relay 250, upon deenergizing, at armature 252 disconnects ground from conductor 235 and conductor 215 to release the incoming selector and to deenergize the reversing relay 401 in the connector. At armature 252 relay 250 opens the locking circuit to relay 270 and disconnects ground from the polar winding of relay 230. At armature 254 relay 250 disconnects ground from release trunk conductor 247 and reconnects negative battery potential through the winding of transfer relay 280 to mark this trunk circuit as idle in the banks of the selector switches. Relay 270, upon deenergizing, at armatures 271 and 272 disconnects line relay 310 and at armature 271 reconnects the upper windings of relays 220 and 230 to conductors 218 and 219.

When ground is disconnected from release trunk conductor 215 by the deenergization of relay 250 reversing relay 401 deenergizes and at armature 414 opens the circuit of relays 402 and 404. Relay 402, upon deenergizing, at armature 419 prepares a point in the circuit to the release magnets of the connector and ringing switch. Relay 404, upon deenergizing, at armature 422 disconnects ground from the hold conductor to release switching relay 412 and relay 407 and relays 409, 410, 408, and 405 if energized. At armature 424 relay 404 completes the circuit for energizing the connector release magnet and the release magnet of the ringing switch from grounded armature 419 through the off-normal springs of the respective switches. In response to the operation of the release magnet of the ringing switch the wipers 481 and 482 are restored to normal position at which time the off-normal springs 480 opens the circuit to the release magnet of the ringing switch. In response to the operation of the connector release magnet the wipers of the connector are restored to their normal position in the well known manner at which time the vertical off-normal springs 470 of the connector opens the circuit to the connector release magnet, while at vertical off-normal springs 471 and 472 the battery potential through the winding of relay 410 is connected to the selector bank contact 465 to mark this conductor as idle in the incoming selector banks. Switching relay 412, upon deenergizing, at armature 455 disconnects ground from conductor 498 to deenergize switching relay 25 in the line switch C and when this latter relay deenergizes all of the apparatus used in extending the connection to the called line is now in normal position ready for use on other calls.

In order to release the connection to the calling party the operator operates the release answer key RLSE.ANS thereby grounding conductors 1015 and 639 by way of key springs 1042 and 1041. The connection of ground to conductor 1015 causes the operation of the split-answer relay 970 and the connection of ground to conductor 639 short circuits the start relay 640 whereupon the latter relay deenergizes in the same manner as previously described. Relay 640, upon deenergizing, at armature 643 and front contact disconnects ground from finder wiper 604 to deenergize switching relay 610 and cut-off relay 1320. At armature 643 and back contact relay 640 operates the finder release magnet to release the finder wipers as previously described, and at armature 661 extinguishes the busy lamp. Cut-off relay 1320, upon deenergizing, at armature 1321 reconnects the upper winding of line relay 1310 to the lower talking conductor of line A1 by way of armature 1332 and at armature 1324 connects the lower winding of relay 1330 to release trunk conductor 1287 to mark this line as idle in the connectors having access thereto. All of the apparatus now used in establishing a previous connection is restored and may be used on other calls.

One of the novel features of the line circuits shown in Fig. 14 is that in case the operator fails to refund or collect the deposited coin on the release of a connection, then the circuits are arranged to cause a false call to come in to the operator's position and when the operator answers and receives no response she is instructed to collect the coin. For this purpose, it will be assumed that the operator fails to collect the coin at substation A1. Therefore, when the con-

nection is released line relay 1310 is still held operated over the following circuit: from ground through the windings of the polarized magnet 1308, through the coin controlled springs 1309, at this time closed since the coin has not been collected, over the lower heavy talking conductor, armature 1332 and back contact, armature 1321 and through the upper winding of line relay 1310 to battery. Since line relay 1310 is held energized after the subscriber replaces his receiver, the deenergization of cut-off relay 1320 on the release of the connection grounds the start lead 1316 causing a call to come in to one of the operator's positions as previously described. The operator in answering causes a finder to find this line and when the operator receives no response she knows that some operator has failed to collect or refund the deposited coin, and therefore operates the coin collect answer key to cause the coin to be collected as previously described.

The operation of the trunk circuit in Figs. 3 and 4 is somewhat different for an incoming call over the trunk conductors 308 and 309 when a subscriber other than a paystation subscriber is being called. As previously described, the special connector in Fig. 5 was used because the previous call was for a paystation, but in case a regular subscriber is called, then a regular connector is seized by way of the incoming selector banks. This regular connector instead of cutting off battery and switching straight through, reverses battery back over conductors 257 and 216 in the well known manner. This reversal of battery causes a slightly different operation of the trunk circuit, in that polar switching relay 230 is now operated whereas in the previous description, the circuit to relays 230 and 220 was opened. At this time relays 350, 370, 250, and 220 are in operated position, and the reversal of current over conductors 257 and 261 operates the polar relay 230. Since relay 220 does not deenergize in this type of call relay 270 is not operated. Relay 230, upon deenergizing, at armature 231 and back contact, opens a further point in the circuit of relay 270, and at its front contact completes the circuit for operating line relay 310, and at armature 232 also completes the circuit for energizing relay 260. Relay 260, upon energizing, at armature 262 opens a further point in the circuit to relay 270, and at armature 261 disconnects the negative battery from in shunt of relay 370. The circuit for energizing relay 310 may be traced as follows: from grounded conductor 234, armature 288 and back contact, armature 251, armature 231 and front contact, conductor 225, and through the upper winding of line relay 310 to battery. At armature 311 relay 310 completes a circuit for energizing relay 350, and the latter relay at armatures 351 and 352 reverses battery back over conductors 308 and 309 to give the operator answer supervision, as previously described. In response to the called subscriber replacing his receiver battery is reversed back over conductors 257 and 216 to release the polarized relay 230. Relay 230, upon deenergizing, at armature 231 opens the circuit of relay 310 and the latter relay at armature 311 opens the circuit of relay 350. Relay 350, upon deenergizing, at armatures 351 and 352 reverses battery over trunk conductors 308 and 309 to give the operator disconnect supervision. The operator now releases the connection in the same manner as previously described.

Delayed calls

It will now be assumed that the operator wishes to complete the delayed call from subscriber A to subscriber A', because in a previous desired connection the operator was unable to complete the call to substation A1. The operator first operates the delayed call key to close springs 1051 and 1052. Key springs 1052 grounds the first level vertical bank contacts of the finders over conductors 699 and at key springs 1051 grounds conductor 1024 to energize the delayed call relay 960 and the answer pilot relay 920 by way of the normally closed contacts controlled by armature 953. Relay 960, upon energizing, at armature 961 connects negative battery marking potential to conductor 764 to mark this position as making a delayed call in the banks of the finder associated with the sender link. At armatures 962 and 963 relay 960 prepares a point in the impulsing circuit from the sender, at armature 964 grounds conductor 696 to start the finder of the sender link searching for this position or the position marked over conductor 764, at armature 965 operates the split-answer relay 970, and at armature 966 grounds the start conductor 638 in order to energize the start relay 640 in the finder link when the talking key K2 is operated. The finder of the sender link is thereupon operated and hunts for the marked bank contact or the contact terminating conductor 764. When the finder of the sender link finds the marked bank contact the sender link switches through and associates the sender with this position. Relay 920 is energized in series with delayed-call relay 960, and at armature 921 prepares another circuit for later on starting the finder of the sender link to associate the sender with the selector end of the finder link, at armature 922 opens a point in the circuit to start relay 940 to prevent the operation of this relay when the key K2 is operated. Relay 970, upon energizing, at armatures 971 and 972 prepares another point in the impulsing circuit extending from the sender link.

The operator now operates the talking key K2 of an idle finder link to operate the connecting relay thereof and associate her position to such link. Assuming that the key K2 in the finder link in Figs. 7 and 8 is operated, then connecting relay 650 is energized over its upper winding by way of the grounded test conductor 753 and the key springs 744. Connect relay 650, upon energizing, at its upper armatures associates the link circuit to the operator's position, at armature 657 locks itself over its lower winding in series with talk relay 850, and at armature 658 connects the grounded start lead 638 to the upper winding of start relay 640 to cause the latter relay to energize. Start relay 750, upon energizing, causes the operation of the finder as previously described but in this case since the first level in the vertical test bank has been marked as calling by way of grounded conductor 699, then the sender wipers take one vertical step at which time the circuit to the change-over relay 620 may be traced as follows: from grounded conductor 699, the first level vertical bank contact, vertical wiper 607, armature 622, through the lower winding of change-over relay 620, armature 631 and front contact, armature 623 and back contact, and through the winding of vertical magnet to battery. In the same manner as previously described the operation of the change-over relay 620 causes the wipers of the finder to be rotated in the first level until an

idle delayed call trunk circuit is reached, at which time the polar switching relay 610 energizes to connect the finder link to the selected delayed call trunk circuit. Assuming that the delayed call trunk circuit shown in the lower portion of Fig. 6 is the first idle delayed call trunk circuit in this level, then the circuit for energizing switching relay 610 of the finder link may be traced as follows: from grounded armature 643 through the upper operating winding of the polar switching relay 610, test wiper 604, bank contact 504, and through the winding of relay 579 to battery. Relay 579 energizes in series with the switching relay 610 and the latter relay switches the call through to this delayed call trunk. Relay 579, upon energizing, at armature 597 connects the windings of the line relay in the selector shown in the lower portion of Fig. 6 across the sender conductors 761 and 762, at armature 598 prepares a locking circuit for relay 578 and a circuit for polarizing the lower winding of polar relay 577, at armature 599 prepares a point in the circuit to relay 578, and at armature 500 grounds the release trunk of the selector to operate the series relay therein and prepare such selector for operation.

The operator now operates the digit keys of the key sender in accordance with the digits in the called number of substation A, and thereafter operates the start key to cause the sender to transmit the digits of substation A. The impulsing circuit from the sender may be traced as follows: from the impulse springs in the sender, conductors 761 and 762, armatures 963 and 962, front contacts and armatures 972 and 971, conductors 632 and 734, armatures 651 and 653, armatures 611 and 612, finder wipers 601 and 602, bank contacts 601 and 502, armature 597, normally closed springs controlled by armatures 592 and 594, normally closed springs controlled by armatures 587 and 585, and through the upper and lower windings of line relay (not shown) in the selector to battery and ground. The selector line relay is operated over this circuit and deenergizes for each transmitted impulse to cause the selector to select an idle trunk circuit extending to the distant automatic exchange. Assuming that the trunk circuit shown in Figs. 3 and 4 is the trunk circuit selected by the selector in Fig. 6, then when this selector switches through the trunk line relays 360 and 370 are energized over the impulsing circuit extending from the sender through the selector and over trunk conductors 308 and 309. In response to the remaining impulses transmitted by the sender the trunk line relay 360 at armature 361 repeats these impulses to the incoming selector and to the connector shown in Fig. 5 to cause the relays in the trunk circuit, the incoming selector, and the connector, to operate in the same manner as previously described for an incoming trunk call to substation A.

After the sender has transmitted the complete number of substation A, the cut-in-lead 763 is grounded in the sender to cause the operation of the cut-in relay 950. Cut-in relay 950, upon energizing, at armature 951 closes a bridge including the choke coil CC across the conductors 632 and 634 to maintain the trunk line relays 360 and 370 in operated position, at armature 952 completes a circuit for energizing relays 578 in the delayed trunk circuit, and at armature 953 opens the circuit to delayed call relay 960 and likewise completes a locking circuit from grounded conductor trunk 1024. Relay 960, upon

deenergizing, at armature 961 disconnects the marking potential from the sender finder banks, at armatures 962 and 963 opens a point in the impulsing circuit of the sender and at armature 964 removes one of the ground connections from conductor 696 which latter conductor, however, is maintained grounded at armature 853 by the operated talk relay 850. At armature 965 relay 960 opens the circuit of relay 970 to cause the latter relay to deenergize and at armature 966 disconnects ground from start conductor 638. Relay 920 does not deenergize when the circuit of delayed call relay 960 is opened because relay 920 is held energized through its lower winding in series with the lower winding of start relay 640 of the finder link.

The circuit for energizing relay 578 may be traced as follows: from grounded armature 952 on the cut-in relay 950, conductor 751, front contact and key springs 741, conductor 683, wiper 603, bank contact 503, armature 599, normally closed springs controlled by armature 595, and through the winding of relay 578 to battery. Relay 578, upon energizing, at armatures 592, 593, and 594 cuts in the repeating coil RC, and at armature 594 and front contact bridges the upper operating winding of polar relay 570 across the trunk conductors 308 and 309 to maintain the trunk line relays 360 and 370 in operated position. At armature 595 relay 578 completes a locking circuit for itself and also completes a circuit for energizing the polarizing lower winding of polar relay 577, and at armature 596 prepares a point in the supervisory circuit. Polar relay 577 operates since the current flow over the trunk conductors 308 and 309 are in the proper direction to assist the polarizing winding. At armature 590 relay 577 includes a resistance in its polarizing winding and at armature 591 grounds finder wiper 603 by way of armatures 596 and 599 to prepare a circuit for the answer supervisory lamp.

When the call is extended to substation A and the subscriber thereat answers, line relay 310 in Fig. 4 is energized over the called subscriber's loop in the same manner as previously described. At armature 311 relay 310 completes the circuit for relay 350 and the latter relay at armatures 351 and 352 reverses the flow of current over the trunk conductors 308 and 309 to cause the deenergization of the polar relay 577 in the delayed call trunk circuit. Relay 577, upon deenergizing, at armature 591 disconnects ground from wiper finder 603 to open the prepared circuit to the answer supervisory lamp.

The operator may now restore the delayed call key and in response thereto springs 1052 removes ground from conductor 699 to remove the ground from the first level vertical bank contact, and at springs 1051 restores the cut-in relay 950. Relay 950, upon deenergizing, at armature 951 opens the previously mentioned bridge for holding trunk line relays 360 and 370 but these latter relays are now held through the operating winding of polar relay 577, and at armature 952 disconnects ground from conductor 751 over which relay 578 was originally energized.

When the delayed call relay 960 deenergized and removed marking potential at armature 961 from conductor 764, the finder in the sender link was released and when the connecting relay 650 in the finder link connected marking potential over conductor 774 to the bank of the sender finder, then the sender finder is reoperated to search for and contact the sender link to the

finder link in the same manner as previously described. The operator now operates the digit keys corresponding to the digits in the called number of substation A1, after which she operates the start key. In the same manner as previously described, the sender transmits impulses over conductors 772 and 771 to cause the selector in Fig. 12 to be operated in the same manner as previously described. In this case, the first digit transmitted by the sender causes the selector to select an idle paystation control circuit, one of which is shown in Fig. 13.

Assuming that the paystation control circuit in Fig. 13 is the circuit seized by the selector, then switch-through relay 1140 is energized in series with the ringing relay in the connector in Fig. 13, which ringing relay corresponds to relay 410 of the connector shown in Fig. 5. The circuit for energizing switch-through relay 1140 may be traced as follows: from ground by way of armature 1122, through the upper operating winding of polar switch-through relay 1140, armature 1121, wiper 1173, bank contact 1183, conductor 1193, conductor 1207, and through the vertical off-normal springs and winding of ringing relay in the connector to battery. Line relays 1230 and 1240 are now energized over the impulsing circuit from the sender as follows: from the impulse springs in the sender by way of conductors 771 and 772, conductors 791 and 792, armatures 1141 and 1142 and front contacts, wipers 1171 and 1172, conductors 1191 and 1192, through the left-hand windings of the repeating coil RC, through the upper and lower windings of differential relay 1210, normally closed springs controlled by armatures 1221 and 1222, and through the windings of relays 1240 and 1230 to ground and battery, respectively. Relay 1230, upon energizing, at armature 1231 opens a point in the circuit to refund relay 1296, and at armature 1232 energizes relay 1250. Relay 1240, upon energizing, at armature 1243 likewise completes the circuit for energizing relay 1250, and at armature 1241 bridges the upper winding of relay 1290 across the talking conductors 1205 and 1206 to energize the line relay in the connector. Relay 1250, upon energizing, at armature 1251 grounds release trunk conductor 1193 to maintain the switch-through relay 1140 in the selector in operated position and at armature 1252 prepares a point in the circuit for energizing relay 1280. The line relay in the connector and relay 1290 in the paystation control circuit operate over the following circuit: from ground and battery through the windings of the line relay in the connector, through contacts controlled by the back bridge relay and reversing relay, conductors 1206 and 1205, armature 1241, armatures 1202 and 1201 and back contacts, through the right-hand windings of repeating coil RC, armature 1261 and back contact, and through the upper winding of relay 1290. At armature 1291 relay 1290 prepares a circuit for holding itself in operated position during the impulsing period, and at armature 1292 completes a circuit for energizing relay 1280 from grounded armature 1252. Relay 1280, upon energizing, at armature 1281 prepares a further point in the circuit for maintaining relay 1290 operated during the impulsing period, at armature 1282 prepares a point in the circuit to relay 1260, and at armature 1283 completes a locking circuit for itself from grounded armature 1252. In the connector switch the operation of the ring relay and the line relay prepares the

connector for operation in the same manner as described for Fig. 5.

In response to the next series of impulses from the sender, line relays 1230 and 1240 deenergize once for each impulse. At armatures 1232 and 1243 the circuit to slow-to-release relay 1250 is momentarily interrupted but this relay is maintained in its operated position during the impulsing period due to its slow-to-release characteristics. At armature 1242 the circuit through the lower winding of relay 1290 is completed by way of armature 1281 to maintain this latter relay in operated position, and at armature 1241 relay 1240 repeats the impulses to the line relay in the connector. The operation of the line relay in the connector operates the vertical magnet to raise the wipers of the connector one vertical step for each impulse received. After this series of impulses the circuit for the rotary magnet of the connector is prepared and in response to the next series of impulses transmitted from the sender the line relay and the rotary magnet cause the wipers of the connector to be rotated into engagement with the contacts of the called line. In response to the last or ringing digit transmitted from the sender relay 1240 at armature 1241 again repeats the impulses to cause the line relay in the connector and the stepping magnet of the ringing switch to operate its wipers to select the desired generator in the same manner as described for the connector in Fig. 5.

In response to this last digit the switching relay in the connector is energized in case the line is idle, and causes the connector to switch through thereby disconnecting the line relay from the connector conductors 1205 and 1206, thereby causing relay 1290 to deenergize after the impulsing period. Relay 1290, upon deenergizing, at armature 1292 and back contact, completes the circuit for energizing relay 1290 as follows: from grounded armature 1252, armature 1292 and back contact, armature 1282, and through the winding of relay 1260 to battery. Relay 1260, upon energizing, at armature 1261 and back contact opens a further point in the circuit through the upper winding of relay 1290, and at the front contacts of armatures 1261 and 1262 connects the upper and lower windings of relay 1270 in bridge of the talking conductors of the called line. At armatures 1263 relay 1260 removes a partial shunt circuit from around the winding of relay 1230, and at armature 1264 completes a locking circuit for itself from grounded armature 1252.

When the sender has completed transmitting the final ground is connected to conductor 737 to operate the cut-in relay 710, as previously described. Relay 710, at armatures 711 and 712 cuts in the repeating coil, completes the talking circuit, and connects the upper winding of polar relay 730 in bridge of conductors 791 and 792 to cause this relay to energize from battery and ground through the windings of relays 1230 and 1240. At armature 731 relay 730 prepares a point in the circuit for lighting the call supervisory lamp.

When the called subscriber answers and operates the connector ring cut-off relay the called line is bridged across the windings of relay 1270 to cause these latter relays to energize. This circuit may be traced as follows: from battery and ground through the windings of relay 1270, armatures 1261 and 1262 and front contacts, right-hand winding of the repeating coil RC, back contacts and armatures 1202 and 1201, armature 75

1241, conductors 1206 and 1205, through the operated contacts in the connector, wipers 1276 and 1275, conductors 1286 and 1285, and through the substation switchhook springs, transmitter and induction coil at the called substation. At armature 1271 relay 1270 completes the circuit for energizing relay 1220. Relay 1220, upon energizing, at armatures 1221 and 1222 reverses battery back over conductors 1191 and 1192 to cause the deenergization of the polar relay 730 in the finder link, at armature 1223 prepares a point in its own holding circuit, at armature 1224 prepares another holding circuit for relay 1250, and at armature 1225 prepares a holding circuit for maintaining relay 1260 and 1280 energized. The talking circuit from substation A1 to the operator's position is now complete over the heavy talking conductors through the repeating coil RC in Fig. 13, the repeating coil RC in Fig. 8, and thence by way of armatures 652 and 654 to the operator's headset.

The operator may now operate the coin collect answer key CC-ANS to collect the deposited coin. In response to the operation of the coin collect answer key, springs 1023 grounds conductor 1015 to energize relay 970, and key springs 1022 connects positive 110-volt collect battery to conductor 1018, and thence by way of front contact and armature 971 of the operated split-answer relay 970, conductor 634, armature 653, armature 612, wiper 602, bank contact 502, armature 593, lower right-hand winding of repeating coil RC in the delayed call trunk circuit, armature 589, and through the winding of collect relay 575 to ground. Relay 575 is energized over this circuit and at armatures 584 and 585 grounds both trunk conductors 308 and 309 by way of the selector wipers 563 and 564 to cause the energization of the differential relay 340 and the deenergization of trunk line relay 360 in the same manner as previously described. Differential relay 340, upon energizing, and trunk line relay 360, upon deenergizing, at armatures 363 and 343 completes a circuit for energizing the collect relay in Fig. 3 by way of conductor 239. At armature 298 collect relay connects the positive 110-volt collect battery to the front contacts of armatures 292 and 294, and at armature 296 completes the circuit for operating the coin relay 290. The circuit for the latter relay may be traced from grounded conductor 234 by way of armatures 274 and 296. At armatures 292 and 294 coin relay 290 connects the positive 110-volt collect battery to conductors 257 and 216 by way of armature 291. At armature 295 coin relay 290 completes a circuit for holding relay 350 in operated position, since the circuit of line relay 310 is open at armatures 292 and 294 and back contacts. The connection of positive 110-volt collect battery to conductors 257 and 216 causes the deposited coins at substation A to be collected in the well known manner over the heavy talking conductors.

The operator now restores the talking key K2 to disassociate her position from the finder link and to connect the calling and called subscribers' lines together over the following talking circuit: from the substation A over conductors 11 and 12, conductors 497 and 499, connector wipers 491 and 493, armatures 451 and 458, armatures 432 and 438, armatures 413 and 415, wipers 461 and 463, conductors 257 and 216, armature 361 and conductor 217, back contacts and armatures 281 and 282, armatures 292 and 294, conductors 218 and 219, through the repeating coil RC, back

contacts and armatures 301 and 302, trunk conductors 308 and 309, conductors 581 and 582, wipers 563 and 564, normally closed springs controlled by armatures 587 and 585, armature 594, through the repeating coil RC in the delayed call trunk circuit, armatures 592 and 593, armature 597, bank contacts 501 and 502, finder wipers 601 and 602, armatures 611 and 612, normally closed springs controlled by armatures 652 and 654, conductors 681 and 682, armature 712, and normally closed springs controlled by armature 721, through the repeating coil RC in the finder link, armature 711 and the normally closed springs controlled by armature 722, conductors 791 and 792, armatures 1141 and 1142 and front contacts, wipers 1171 and 1172, conductors 1191 and 1192, through the repeating coil RC in the paystation control circuit, back contacts and armatures 1201 and 1202, armature 1241, conductors 1205 and 1206, through the operated contacts in the connector to wipers 1275 and 1276, conductors 1285 and 1286, and through the substation circuit at the manual paystation A1. Talking battery for substation A is supplied through the windings of relay 310 and talking battery for substation A1 is supplied through the windings of relay 1270.

If, for some reason, the operator desires to refund the coin instead of collecting the same, she may do so by operating the coin refund answer key CR-ANS, while the talking key K2 in the finder link is still operated. The operation of springs 1033 grounds conductor 1015 to energize relay 970, and the operation of springs 1032 connects negative 110-volt refund battery to conductor 1017 and thence by way of armature 972 and front contact of operated relay 970, conductor 632, armature 651, armature 611, wiper 601, bank contact 501, armature 597, front contact and armature 592, upper right-hand winding of the repeating coil RC in the delayed call trunk circuit, through the winding of refund relay 576 to grounded armature 586. Refund relay 576 energizes over this circuit and at armatures 587 and 588 connects battery to both trunk conductors 308 and 309 by way of selector wipers 563 and 564 and conductors 581 and 582.

The connection of battery to both conductors 308 and 309 causes the energization of differential relay 340 and the deenergization of trunk line relay 360. At armatures 373 and 342 relays 370 and 340 grounds conductor 238 to operate the refund relay which at armature 297 completes the circuit for energizing coin relay 290, and at armatures 299 connects the negative 110-volt refund battery through the front contacts of armatures 292 and 294 of operated coin relay 290, over the previously traced circuit to the polarized collect magnet at substation A to cause this polarized magnet to refund the deposited coin.

Assuming now that for some reason the charges on this delayed call are to be reversed, then if the subscriber at substation A1 agrees to this the operator will request the deposit of the proper coin after which the operator will operate the collect call key CC-CALL. In response to the operation of this key springs 1091 grounds conductor 1025 to energize call relay 980, springs 1092 grounds conductor 635 to energize relay 720, springs 1093 grounds conductor 1026 to prepare a circuit to ground conductor 792, key springs 1094 grounds conductor 1028 to prepare the circuit to ground conductor 791 and key springs 1095 grounds conductor 1016 to energize relay 990. The circuit for energizing relay 720 may be

traced as follows: from grounded key springs 1092, conductor 636, armature 655, conductor 684, and through the winding of relay 720 to battery. At armatures 721 and 722 relay 720 cuts out the finder link repeating coil RC, and connects conductors 791 and 792 directly to conductors 681 and 682. At armature 723 relay 720 opens a point in the polarizing winding of polar relay 730. Relay 980, upon energizing, at armature 982 connects the grounded conductor 1026 to conductor 1027. Relay 990, upon energizing, at armatures 991 and 992, connects ground on conductors 1027 and 1028 to conductors 791 and 792 by way of conductors 635 and 633, armatures 654 and 652, conductors 681 and 682, armatures 712 and 711, and front contacts of armatures 721 and 722. Since conductors 791 and 792 are both grounded, then this ground continues by way of wipers 1171 and 1172 to conductors 1191 and 1192 and thence through the windings of the differential relay 1210 and line relays 1230 and 1240. Differential relay 1210 becomes unbalanced over this circuit and thereupon operates its armature while relay 1240 is short circuited, thereby causing it to deenergize. With differential relay 1210 energized and line relay 1240 deenergized the following circuit is completed for energizing collect relay 1295; ground by way of armature 1242, armature 1211, and through the winding of collect relay 1295 to battery. At armature 1213 relay 1210 completes the holding circuit for relay 1220 through its operated armature 1223, and relay 1240 at armature 1241 momentarily opens the circuit of relay 1270 which is without effect at this time since relay 1220 is held in operated position over grounded armature 1213. Collect relay 1295, upon energizing, at armature 1297 completes the circuit for operating coin relay 1200 and at armature 1293 connects positive 110-volt collect battery to the front contacts of armatures 1201 and 1202. Relay 1200, upon energizing, at armature 1204 completes another circuit for holding relay 1220, at armature 1208 bridges the now open contacts of armature 1241, and at armatures 1201 and 1202 connects the positive 100-volt collect battery to conductors 1205 and 1206. This collect battery extends through the operated contacts of the connector to wipers 1275 and 1276, and thence over conductors 1285 and 1286 through the substation set at substation A1 over the coin springs 1309 and through the windings of the polar collect magnet 1308 to ground. This application of collect battery through the windings of the collect relay 1308 causes the coin to be collected in the well known manner.

If for some reason the coin should be refunded to such subscriber at substation A1, then the coin refund call key CR-CALL is operated. Key springs 1081 grounds conductor 1025 to energize relay 980, key springs 1083 grounds conductor 636 to energize relay 720. Key springs 1083 connects negative battery potential to conductor 1028, key springs 1084 connects battery potential to conductor 1026, and key springs 1085 grounds conductor 1016 to energize relay 990. Relay 980, upon energizing, at armature 982 connects the negative battery potential on conductor 1026 to conductor 1027. Relay 990, upon energizing, at armatures 991 and 992 connects the negative battery potential on conductors 1027 and 1028 to the finder conductors 681 and 682 over the previously traced circuit. Relay 720 energizes over the same circuit as previously traced and at armatures 721 and 722 cuts out the repeating coil RC and

connects the conductors 681 and 682 to conductor 791 and 792. Negative battery potential is now connected over conductors 1191 and 1192 to energize differential relay 1210, to deenergize relay 1230, and to hold relay 1240 in operated position. At armatures 1212 and 1231 the circuit for energizing refund relay 1296 is completed by the energization of the differential relay 1210 and the deenergization of line relay 1230. Refund relay 1296, upon energizing, at armature 1298 completes the circuit for energizing coin relay 1200 and at armature 1294 connects the negative 110-volt refund battery to the front contacts of armatures 1201 and 1202. Relay 1200, upon energizing, at armatures 1201 and 1202 and back contacts disconnects relay 1270, and at armature 1204 completes the holding circuit for relay 1220, while relay 1270 is in deenergized position. At armatures 1201 and 1202 relays 1200 connects the negative 110-volt refund battery back over the heavy talking conductor to operate the polar collect magnet 1308 in the proper direction to refund the deposited coin. After releasing the refund call key the operator restores the key K2 to complete the talking circuit between the subscribers in the same manner as previously described.

After conversation and in response to the subscriber at substation A replacing his receiver line relay 310 deenergizes, and at armature 311 opens the circuit of relay 350 which, upon deenergizing, at armatures 351 and 352 reverses battery back over the trunk conductors 308 and 309 to cause the energization of polar relay 577 in the delayed call trunk circuit. Relay 577, upon energizing, at armature 591 operates the answer supervisory lamp over the following circuit: from ground by way of armature 591, armatures 596 and 599, bank contacts 503, finder wiper 603, conductor 683, spring 741 and back contact, and through the filament of the answer supervisory lamp to battery. When the subscriber at substation A1 replaces his receiver the circuit to relay 1270 is opened with the result that this relay deenergizes and at armature 1271 opens the circuit of relay 1220. Relay 1220, upon deenergizing, at armatures 1221 and 1222 reverses battery back over conductors 1191 and 1192 to operate the polar relay 730 in the finder link. The polar relay 730 at armature 731 completes the previously traced circuit for operating the call supervisory lamp in the finder link.

In response to the operation of the call and answer supervisory lamps the operator will reoperate the key K2 of this finder link to again energize the connecting relay 650 as previously described. The operator now operates the release call and answer key RLSE-C and A. Key springs 1061 grounds conductor 637 to short circuit the upper winding of cut-in relay 710 to cause this relay to deenergize as previously described. Key springs 1062 grounds conductor 639 to short circuit the lower winding of start relay 640 to cause this relay to deenergize as previously described. Cut-in relay 710, upon deenergizing, at armature 711 opens the circuit to relays 1230 and 1240, thereby causing the latter relays to deenergize. At armatures 1232 and 1243 relays 1230 and 1240 open the circuit of relay 1250 which accordingly deenergizes after an interval. At armature 1251 relay 1250 disconnects ground from conductors 1193 and 1207 to release the selector in Fig. 12 and the connector in Fig. 13 as previously described. At armature 1252 relay 1250 opens the locking circuits of relays 1280 and 1260, whereupon the

latter relays deenergize. All of the apparatus included in the connection to substation A1 is now restored and may be used on other calls.

Start relay 640, upon deenergizing, releases the finder in the same manner as previously described, and disconnects ground from wiper 604 and bank contact 504 to cause the deenergization of relay 579. Relay 579, upon deenergizing, at armature 500 releases the selector associated with the delayed call trunk circuit, and at armature 598 opens the locking circuit of relay 578, whereupon the latter relay deenergizes. At armature 594 relay 579 opens the bridge across the trunk conductors 308 and 309 to cause the trunk line relays 360 and 370 to deenergize and release the apparatus in the connection to substation A in the same manner as previously described.

Delayed call from A1 to A

A brief description of a delayed call from substation A1 to substation A will now be described, and it will therefore be assumed that the operator in order to complete this call first operates the delayed call key to close springs 1051 and 1052. Delayed call springs 1052 grounds conductor 699 to mark the first level in the vertical bank of the finder and at armature 1051 completes the circuit for energizing relays 960 and 920 over conductor 1024. Relay 960, upon energizing, at armature 961 marks the finder bank in the sender finder, at armature 964 grounds conductor 696 to start the sender finder searching for the marked bank contact, at armature 962 and 963 prepares a point in the impulsing circuit from the sender, at armature 965 operates relay 970, and at armature 966 grounds the start conductor 638 to energize start relay 640 when the key K2 of an idle finder link is operated. The sender finder hunts for and finds the marked bank contact, thereby connecting the sender to conductors 761 to 764, inclusive. Relay 920, upon energizing, at armature 921 prepares another point in a start circuit to the sender, and at armature 922 prevents the energization of start relay 940 when K2 is operated. Relay 970 at armatures 971 and 972 prepares another point in the sender impulsing circuit.

The operator now operates the key K2 of an idle finder link to operate the connecting relay thereof to associate her position to such link circuit. Assuming that key K2 in the finder link in Figs. 7 and 8 is operated, then the connecting relay 650 is energized over its upper winding as previously described. Connect relay 650, upon energizing, at its upper armatures associates the finder link to the operator's position, at armature 657 maintains itself energized in series with talk relay 850, and at armature 658 completes the circuit for energizing the start relay 640 over grounded start conductor 638. Start relay 640 energizes and causes the operation of the finder as previously described to select an idle delayed call trunk circuit, whereupon the switch relay 610 and relay 579 are operated. Switch relay 610 operates in the same manner as previously described, and switches the finder through to the delayed call trunk circuit and locks itself in operated position. Relay 579, upon energizing, at armature 500 grounds the release trunk of the selector to prepare the same for operation as previously described, and at armature 597 connects the windings of the line relay of the selector across the impulse springs in the sender.

The operator now operates the digit keys in

accordance with the number of substation A1 and thereafter operates the start key to cause the sender to transmit the digits of the numbers registered. In response to the first digit, the selector in Fig. 6 is operated to select an idle paystation control circuit in the well known manner. Assume that the paystation control circuit in Fig. 13 is the circuit selected, then relays 1230 and 1240 are energized over the following circuit: from ground and battery through the windings of relays 1240 and 1230, normally closed springs controlled by armature 1221 and 1222, through the winding of the differential relay 1210 and the left-hand windings of the repeating coil RC in Fig. 13, conductors 1191 and 1192, multiples of bank contacts 1182 engaged by selector wipers 563 and 564, normally closed springs controlled by armatures 586 and 585, normally closed springs controlled by armatures 592 and 594, armature 597, finder bank contacts 501 and 502, finder wipers 601 and 602, armatures 651 and 653, conductors 632 and 634, armatures 972 and 971 and front contacts, armatures 963 and 962, to the impulse conductors 761 and 762 extending to the sender. The paystation control circuit and the connector in Fig. 13 are now operated in the same manner as previously described in response to the digits transmitted from the sender to complete the connection to the line of substation A1.

When the sender has completed sending the final digit, the cut-in relay 950 is energized in the same manner as previously described in response to the sender grounding conductor 763. At armature 951 relay 950 closes a bridge to hold relays 1230 and 1240 energized, at armature 952 grounds conductor 751 to energize relay 578, as previously described, and at armature 953 completes a locking circuit for itself and at the same time opens the circuit to delayed call relay 960 which thereupon deenergizes. Delayed call relay 960, upon deenergizing, removes the control from the sender. Relay 578, upon energizing, at armatures 592, 593, and 594 cuts in the delayed call repeating coil RC and bridges the upper winding of the polar relay 577 across the trunk conductors 1191 and 1192 to maintain relays 1023 and 1240 operated and to operate the polar relay 577. At armature 595 relay 578 locks itself to grounded armature 598 and completes the circuit for grounding the polarizing winding of polar relay 577. Polar relay 577, upon energizing, at armature 591 prepares a point in the circuit to the answer supervisory lamp.

When the subscriber at substation A1 answers relay 1270 is energized over the called subscriber's loop in the same manner as previously described, and at armature 1271 operates relay 1220. Relay 1220, at armatures 1221 and 1222, reverses battery back over conductors 1191 and 1192 to cause the deenergization of the polar relay 577 in the delayed call trunk circuit.

The operator now restores the delayed call key, thereby removing the marking from the first level of the vertical finder bank, and likewise releases cut-in relay 950 by disconnecting ground from conductor 1024.

The finder of the sender link is now operated to find the bank contacts terminating in conductors 771 to 774, inclusive, and associates the sender with the selector end of the finder link in the same manner as previously described. The operator now operates the digit keys corresponding to the number of substation A and starts the

sender as before. The operation from here on is the same as previously described and therefore only a brief description will be given. The first digit transmitted from the sender operates the selector in Fig. 12 to seize a trunk circuit, for example, the trunk circuit in Fig. 6, the second digit operates the incoming selector in Fig. 5 and the remaining digits operate the connector in Fig. 5 to select and ring substation A. Cut-in relay 710 energizes when the sender is through sending to cut in the repeating coil RC and bridge the upper winding of polar relay 730 across the trunk conductors 308 and 309 to cause this relay to energize as previously described.

When subscriber A answers relay 310 is energized over the subscriber's loop to in turn energize relay 350 which reverses battery back over conductors 308 and 309 to deenergize the polar relay 730 for supervisory purposes, as previously described.

In order to collect the coins at substation A1 the operator operates the coin collect answer key CC-ANS. Key springs 1021 grounds conductor 1019, key springs 1023 grounds conductor 1015 to energize relay 970, and key springs 1022 connect the positive 110-volt collect battery to conductor 1018. Relay 970, upon energizing, at armature 971 connects the positive 110-volt collect battery to conductor 634 and thence by way of finder wiper 602, bank contact 502, armature 593, lower right-hand winding of repeating coil RC, armature 589 to ground through the winding of the collect relay 575. Collect relay 575 energizes over this circuit and at armatures 584 and 585 grounds both conductors 1191 and 1192 by way of the selector wipers 563 and 564. When ground is connected to conductors 1191 and 1192 differential relay 1210 is energized, and relay 1240 is deenergized, while relay 1230 is held in operated position. Differential relay 1210, upon energizing, at armature 1211 prepares a point in the circuit to the collect relay 1205, and at armature 1213 holds relay 1220 in operated position. Relay 1240, upon deenergizing, at armature 1242 completes the circuit for energizing the collect relay 1295. Relay 1295, upon energizing, at armature 1293 prepares a point in the circuit for connecting collect battery to the talking conductors, and at armature 1297 completes the circuit for energizing relay 1200. Relay 1200, upon energizing, at armature 1204 holds relay 1220 in operated position, at armature 1208 shunts armature 1241 to prevent the release of the connection, and at armatures 1201 and 1202 connects the positive 110-volt collect battery to line conductors 1285 and 1286 of substation A1 by way of the connector wipers 1275 and 1276 to operate the coin collect magnet 1308 to collect the deposited coin.

In case the operator desires to refund the coin to the subscriber at substation A1, then the coin refund answer key CR-ANS key is momentarily operated instead of the coin collect answer key to energize relay 970 and connect the negative 110-volt refund battery to conductor 1017. Relay 970 at armature 972 connects the negative 110-volt refund battery to conductor 632 to energize the refund relay 576 in the delayed call trunk circuit over the following circuit: from grounded armature 586 through the refund relay 576, upper right-hand winding of the repeating coil RC in the delayed call trunk circuit, armature 592 and front contact, armature 597, bank contact 501, finder wiper 601, armature 611, armature 651, conductor 632, armature 972, conductor 1017, to negative 110-volt collect battery.

Refund relay 576, upon energizing, at armatures 587 and 588 connects negative battery potential to conductors 1191 and 1192 by way of selector wipers 563 and 564 to energize the differential relay 1210 and deenergize relay 1230. In response to the energization of differential relay 1210 and the deenergization of relay 1230, armatures 1212 and 1231 complete the circuit for energizing refund relay 1296. At armature 1298 relay 1296 energizes coin relay 1200 and the latter relay at armatures 1201 and 1202 connects the negative 110-volt refund battery by way of front contact of armature 1294 and front contacts of armatures 1202 and 1201, and armature 1208 to conductors 1205 and 1206, and from thence over the connector wipers 1275 and 1276, and conductors 1285 and 1286 to substation A1 through the coin control springs 1309 and the winding of the polar collect magnet 1308 to ground. The polar collect magnet 1308 is operated over this circuit to refund the deposited coin in the well known manner.

After completing the connection between the two subscribers the operator restores the key K2, thereby completing the talking circuit between the two subscribers. After conversation and when subscriber A replaces his receiver relay 310 deenergizes and releases relay 350 which at armatures 351 and 352 reverses battery back over trunk conductors 308 and 309 to operate the polar relay 730, in the same manner as previously described. At armature 731 relay 730 operates the call supervisory lamp. When the subscriber at substation A1 replaces his receiver relay 1270 deenergizes, and at armature 1271 opens the circuit of relay 1220 which latter relay, upon deenergizing, at armatures 1221 and 1222 reverses battery back over conductors 1191 and 1192 to cause the polar relay 577 in the delayed call circuit to energize. At armature 591 relay 577 completes the circuit for lighting the answer supervisory lamp, as previously described. The operator now reoperates the key K2 and the release call and answer key RLSE-C and A to release cut-in relay 710 and start relay 640, as previously described. Relay 710 at armature 711 opens the circuit to the trunk line relays 360 and 370 to cause the release of the apparatus in the distant automatic exchange as previously described. Start relay 640, upon deenergizing, causes the release of the finder as previously described, and opens the circuit to relay 579. Relay 579, upon deenergizing, at armature 500 releases the associated selector, and at armature 598 releases relay 578. Relay 578, upon deenergizing, at armature 594 opens the circuit of relays 1230 and 1240 as previously described, and in response to the deenergization of these latter relays the connection to the line of substation A1 is released as previously described.

Since Figs. 1 to 14 have been described in detail, it is thought unnecessary to describe the schematic circuits shown in Figs. 15 to 17, inclusive, as the apparatus and circuits therein have the same reference characters as the corresponding apparatus and circuits in Figs. 1 to 14, inclusive, and therefore the detailed description may be readily applied to the schematic figures. Figs. 15 to 17, inclusive, show in schematic form only the essential circuits for collecting and refunding coins, all other detail circuits relating to the establishment and supervision of the various connections being omitted. It is thought that the showing of the refund and collect control circuits in this schematic form will greatly

assist in understanding and appreciating the invention as well as assisting in applying the claims to the disclosure.

What is claimed is:

1. In a telephone system, a two-way two-conductor trunk circuit for completing incoming and outgoing telephone calls, a first relay connected to the first of said conductors, a second relay connected to the other of said conductors, a third relay connected to both said conductors, coin collect means controlled by said first and third relays, coin refund means controlled by said second and third relays, and means for controlling said relays over said conductors on both incoming or outgoing calls to collect or refund deposited coins.
2. In a two-way two-conductor trunk circuit for competing incoming and outgoing telephone calls, a pair of line relays each connected to a different one of said conductors, a third relay connected to both of said conductors, and means controlled by said relays for controlling the collection or refunding of deposited coins on both incoming and outgoing calls.
3. In a telephone system, a local exchange, subscribers' lines terminating in said exchange, paystation equipment on said lines, a two-way trunk circuit in said local exchange, means for completing incoming and outgoing calls over said trunk circuit to and from said lines, means in said trunk circuit for collecting or refunding coins deposited in the paystation equipment on both incoming and outgoing calls to and from said lines, and means in said trunk circuit for relaying ringing current to rering on the connected line after the replacement of the receiver thereon.
4. In a two-way trunk circuit for completing incoming and outgoing telephone calls, a pair of line relays, and a third relay connected to the line conductors of said trunk circuit, means controlled by said relays for controlling the collection or refunding of deposited coins on both incoming and outgoing calls, and means controlled by one of said line relays for repeating impulses received over the line conductors on incoming calls.
5. In a two-way trunk circuit for completing incoming and outgoing trunk calls, means for connecting a splash of current to the outgoing end on outgoing trunk calls, means for repeating impulses received on incoming trunk calls, means for repeating ringing current received at the outgoing end to the incoming end on outgoing trunk calls, means for reversing battery back over both the incoming and outgoing ends for supervisory purposes, and coin collect and refund means for controlling the collection and refunding of coins deposited in both incoming and outgoing trunk calls.
6. In a telephone system, a two-conductor trunk circuit for completing telephone calls, a first relay connected to the first of said conductors, a second relay connected to the second of said conductors, a third relay connected to both conductors, coin collect means controlled by said first and third relays, coin refund means controlled by said second and third relays, and means for controlling said relays over said conductors on telephone calls to collect or refund deposited coins.
7. In a trunk circuit for completing telephone calls, coin collect means for controlling the collection of deposited coins, coin refund means for controlling the refund of deposited coins, a first

relay and a differential relay for controlling said coin collect means, and a second relay and said differential relay for controlling said coin refund means.

8. In a trunk circuit having two incoming line conductors and two outgoing line conductors inductively connected, a first line relay and a differential relay connected to one of the incoming line conductors, a second line relay and said differential relay connected to the other incoming line conductor, a collect relay controlled by said first line relay and said differential relay, a refund relay controlled by said second line relay and said differential relay, a source of collect current, a source of refund current, means controlled by said collect relay for connecting collect current to both outgoing line conductors, and means controlled by said refund relay for connecting refund current to both outgoing line conductors.

9. In a telephone system, a local exchange, a distant exchange, a calling paystation line in the local exchange, a trunk circuit connecting the two exchanges, a paystation repeater for controlling the collection and refunding of deposited coins on calls from said line to other lines in the local exchange, means responsive to said line originating an outgoing call to the distant exchange for including said repeater and trunk circuit in a connection to the distant exchange, means in the trunk circuit for reversing battery back to said repeater in response to the call being answered at the distant exchange, means in said repeater responsive to this reversal for switching the line conductors of the repeater straight through to the trunk circuit to render said repeater ineffective for collecting or refunding coins, means in said trunk circuit for thereafter controlling the collection and refunding of coins at the calling line independent of said repeater, and means in said trunk circuit controlled from the distant exchange for controlling said last means.

10. In a telephone system, a local exchange, a paystation subscriber's line terminating in said exchange, a distant exchange, a two-way trunk circuit connecting said exchanges, an operator's position at the distant exchange, means responsive to said line originating an outgoing trunk call for seizing said trunk circuit and for signalling the operator at the distant exchange, a paystation tone source associated with said line, tone interrupter relays in said trunk circuit for momentarily connecting a tone from said source to the conductors of said trunk circuit to transmit a paystation tone to the operator in response to the operator answering the trunk call, and operator controlled means for reoperating said tone interrupter relays to again momentarily connect said tone to the trunk conductors for verification.

11. In a telephone system, a subscriber's line having paystation equipment, a finder switch having access to said line, means responsive to the deposit of a coin in said equipment and the initiation of a call by the subscriber on said line for operating said finder to find and connect with said line, means for collecting the deposited coin, means for releasing said finder after a completed telephone connection, and means for automatically reoperating said finder to reconnect with said line in case of failure to collect the deposited coin.

12. In a telephone system, an operator's position, a subscriber's line having paystation equip-

ment, a line relay individual to said line, means for operating said relay in response to a subscriber on said line depositing a coin in said equipment and initiating a call, means responsive to the operation of said relay for signalling the operator at said position, a circuit for maintaining said relay in operated position after the release of an established connection as long as said coin is maintained in deposited condition, means responsive to the release of an established connection in case said relay is maintained in operated position by the deposited coin for automatically resignalling the operator, and means for collecting said deposited coin to open said circuit and release said relay.

13. In a telephone system, an operator's position, a subscriber's line having paystation equipment, means responsive to the deposit of a coin in said equipment and the initiation of a call on said line for signalling the operator at said position, and means responsive to the release of an established connection in case the operator fails to collect the deposited coin for such connection for automatically resignalling the operator.

14. In a telephone system, an operator's position, a subscriber's line having paystation equipment, means responsive to the deposit of a coin in said equipment and the initiation of a call on said line for signalling the operator at said position, means responsive to the release of an established connection in case the operator fails to collect the deposited coin for such connection for automatically resignalling the operator, and means for thereafter permitting the operator to collect said coin.

15. In a telephone system, an operator's position, a plurality of finder links controlled from said position by the operator for completing telephone calls, a plurality of different classes of lines accessible to said finders, means controlled by the operator for selecting one of said finders for use, means responsive to a subscriber on any of said lines initiating a call for marking such line in the finder banks, means also responsive to the subscriber's call for operating the selected finder to find the marked calling line and connect such line to the operator's position, and operator controlled means for preventing calling lines in certain of said classes from marking the finder banks to prevent said finders to find and connect with said certain lines.

16. In a telephone system, an operator's position, a plurality of finder links controlled from said position by the operator for completing telephone connections, a plurality of different classes of calling lines accessible to the finders of said finder links, and operator controlled means for at will restricting the connection of said finders to only certain classes of said calling lines.

17. In a telephone system, a paystation subscriber's line, an operator's link circuit extending between an answering switch and a calling switch, incoming circuits accessible to said answering switch, means effective when there is a call on any one of said incoming circuits for operating the answering switch to find and connect with the calling circuit, operator controlled means for operating the calling switch to further extend the connection, delayed call trunk circuits for use in completing delayed connections, means operative under control of the operator for operating said answer switch to connect with said delayed call trunk circuit and complete a connection to said paystation line, and means in said delayed call trunk circuit controlled by the opera-

tor for collecting or refunding coins deposited at said paystation line.

18. In a telephone system, a plurality of operator's link circuits associated with an operator's switchboard, an answering switch on the answering end of each said link circuit, a calling switch on the calling end of each said link circuit, a register sender common to all said links, means responsive to taking one of said link circuits into use for automatically associating said sender to the calling switch of such link circuit, and means responsive to taking one of said link circuits into use for making a delayed call for first associating said sender with the answering switch and thereafter with said calling switch of such link circuit.

19. In a telephone system, a calling paystation subscriber's line and a called paystation subscriber's line, a link circuit, a first and a second paystation repeater, an established connection between said lines including said first repeater, said link circuit, and said second repeater in serial relation, a source of collect current and a source of refund current in each repeater, means in said first repeater for connecting said collect source or said refund source to the calling subscriber's line, means in said second repeater for connecting said collect source or said refund source to the called subscriber's line, and operator controlled means associated with said link circuit for selectively operating said means in said repeaters to collect or refund deposited coins at either the calling or called subscriber's paystation equipment dependent upon the source connected to such subscriber's line.

20. In a telephone system, subscribers' lines having paystation equipment, automatic connector switches having access to said lines, a paystation repeater individual to each connector, automatic selector switches having access to said repeaters, means for directively and automatically operating one of said selectors to select and seize an idle repeater in response to a transmitted digit comprising a series of impulses, means in the seized repeater for repeating received impulses to directively operate the associated connector to connect with a desired one of said lines, and coin collect and refund means in said repeater for controlling the collection and refund of coins deposited in the paystation equipment of the connected line.

21. In a telephone system, subscribers' lines having paystation equipment, a two conductor trunk line for completing telephone calls for said lines, a source of direct current associated with said trunk line, means for connecting one or the other pole of said current to both conductors of said trunk line, a pair of line relays and a differential relay connected to the conductors of said trunk line, said differential relay and one of said pair of relays operated in case said one pole of current is connected to said trunk line conductors, said differential relay and the other of said pair of relays operated in case said other pole of current is connected to said trunk line conductors, coin collect means controlled by said differential relay and said one relay of the pair to collect coins deposited in the paystation equipment of a connected line, and coin refund means controlled by said differential relay and said other relay of said pair to refund coins deposited in the paystation equipment of a connected line.

22. In a telephone system, subscribers' lines having paystation equipment, a trunk line having two line conductors for completing calls for

said lines, a source of direct current associated with said trunk line, a first relay for connecting one pole of said current to both line conductors of said trunk line, a second relay for connecting the other pole of said current to both said line conductors, operator controlled means for operating the first or second of said relays, a differential relay and a trunk line relay connected to one of said line conductors and operated in response to the connection of said one pole to both said line conductors by the operation of said first relay, a second trunk line relay and said differential relay connected to the other of said line conductors and operated in response to the connection of said other pole to both line conductors by the operation of said second relay, coin collect means controlled in response to the operation of said differential relay and the first trunk line relay for collecting coins deposited in the paystation equipment of a connected line, and coin refund means controlled in response to the operation of said differential relay and the second trunk line relay for refunding coins deposited in the paystation equipment of a connected line.

23. In a telephone system, an operator's position, a finder associated with said position for extending telephone connections under the control of the operator, a subscriber's line terminating in the banks of said finder, paystation equipment on said line, operator controlled means for conditioning said finder for operation, means responsive to the deposit of a coin in said equip-

ment and the initiation of a call on said line for operating said finder to find and connect said line to said position, operator controlled means for collecting the deposited coin, means for releasing said finder after a completed telephone connection, and means for automatically reoperating said finder to reconnect said line to said position in case of failure to collect the deposited coin.

24. In a telephone system, a calling paystation subscriber's line and a called paystation subscriber's line, a link circuit, a first and a second paystation repeater, means including said first repeater, said link circuit, and said second repeater in serial relation for completing a connection between said lines, and operator controlled means associated with said link circuit for controlling said repeaters to collect and refund deposited coins at either the calling or called subscriber's paystation equipment.

25. In a telephone system, subscribers' lines having paystation equipment, a directly controlled automatic connector switch for connection to said lines, a paystation repeater individual to said connector, a directly controlled selector switch for connecting with said repeater, and coin collect and refund means in said repeater for controlling the collection and refund of coins deposited in the paystation equipment of a called subscriber's line.

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