May 3, 1927. 1,626,807

J. E. GARDNER

AUTOMATIC TELEPHONE SYSTEM

Original Filed June 23, 1922 5 Sheets-Sheet 1

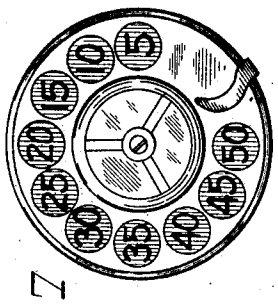


Fig: 7

Fig: 1

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AUTOMATIC TELEPHONE SYSTEM

Original Filed June 23, 1922 5 Sheets-Sheet 2

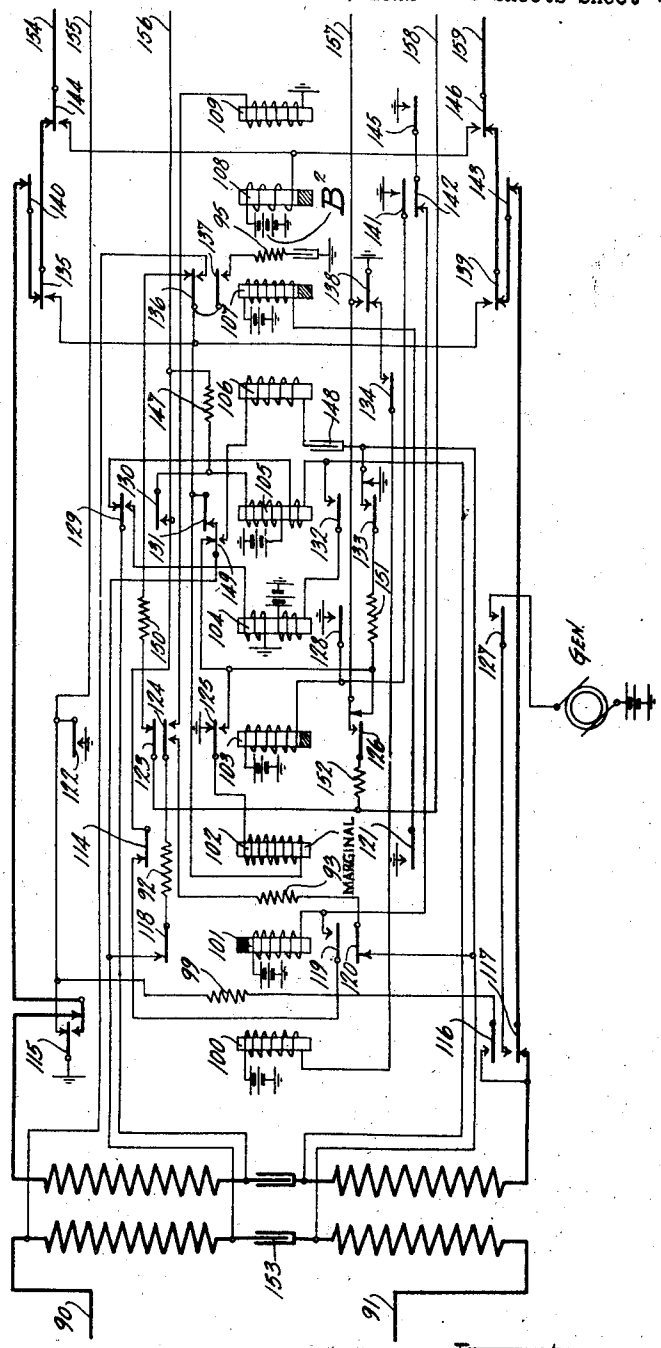


Fig. 2

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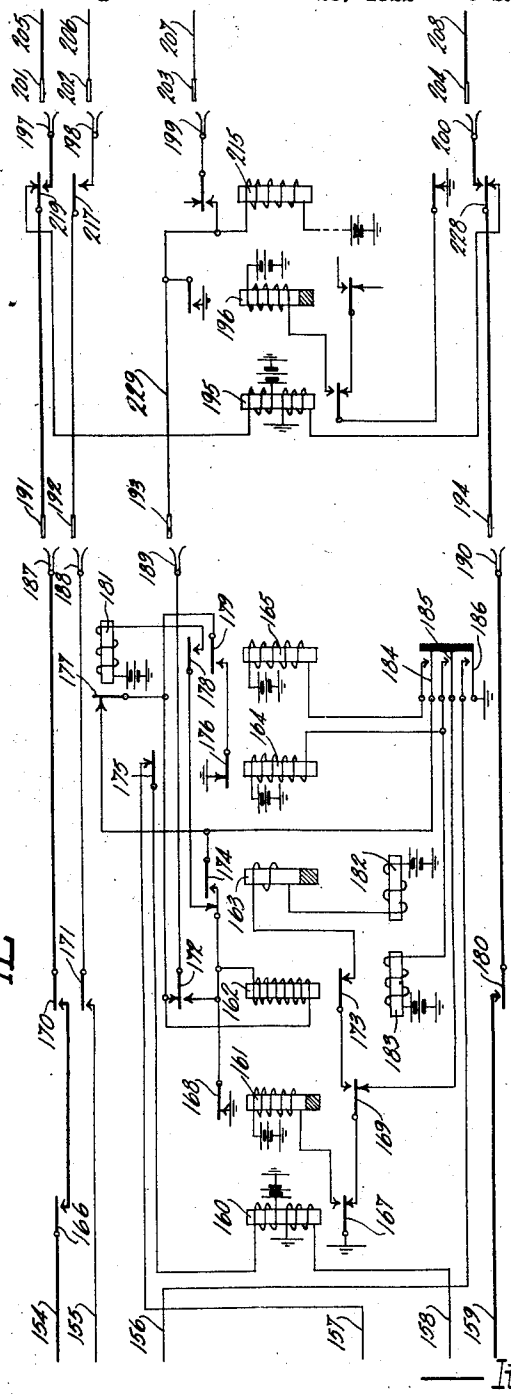


Fig. 3

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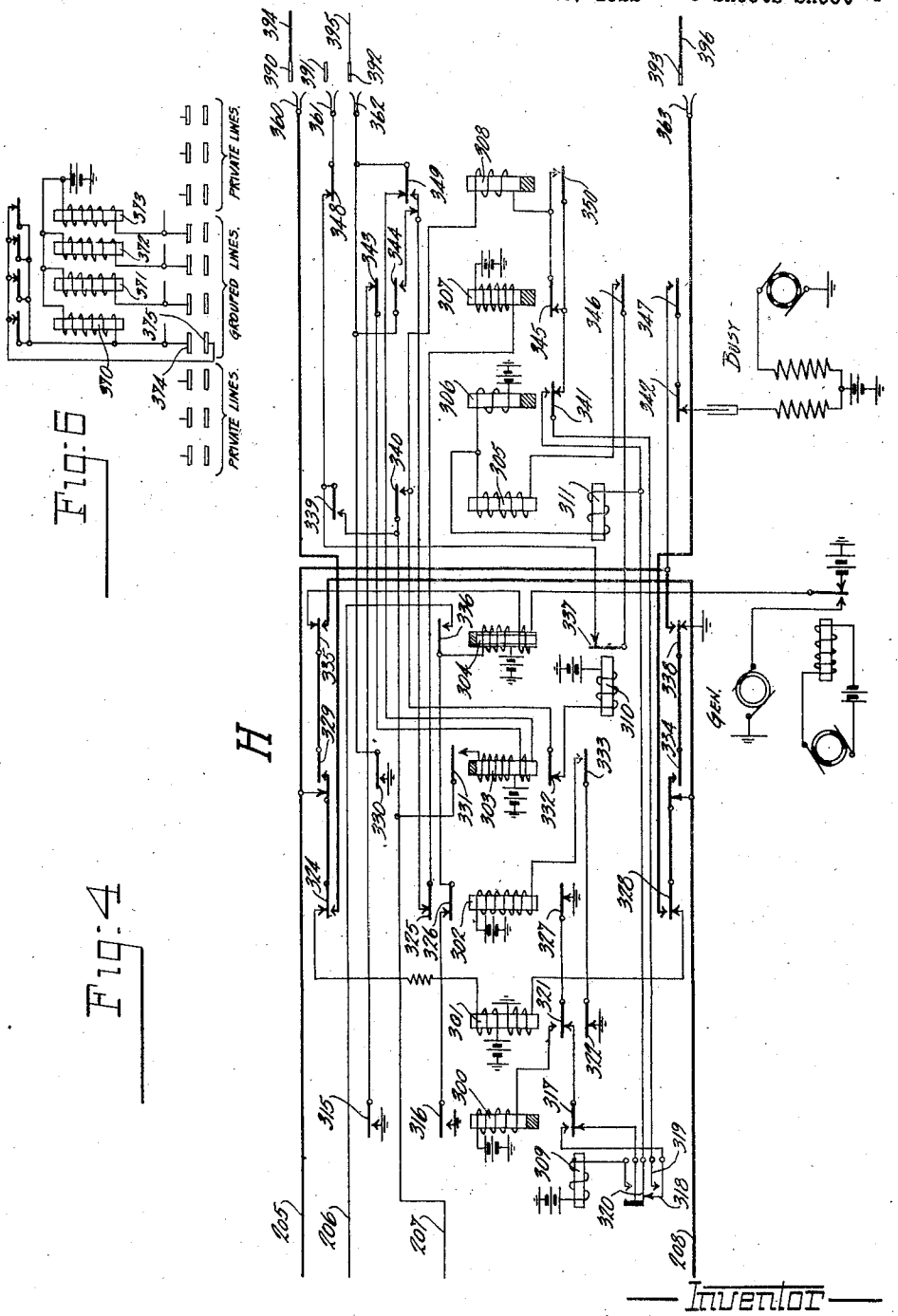


Fig. 5

Fig. 4

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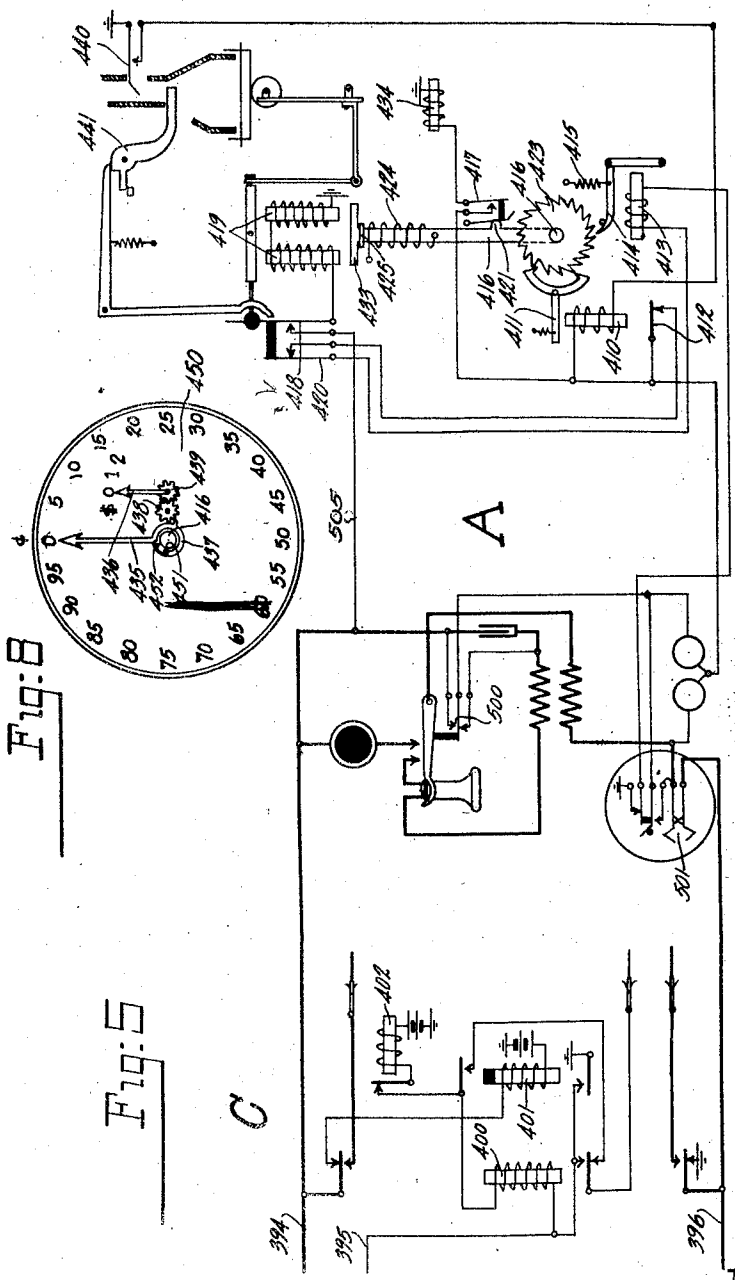


Fig: 8

Fig: 5

C

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UNITED STATES PATENT OFFICE.

JOHN E. GARDNER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

AUTOMATIC TELEPHONE SYSTEM.

Application filed June 23, 1922, Serial No. 570,494. Renewed September 24, 1926.

The present invention relates in general to automatic telephone systems, but is more particularly concerned with methods of handling long distance calls in such systems; and the general object of the invention is to provide a new and improved toll service trunking system for connecting local subscribers in automatic exchanges with long distance lines either as calling or called subscribers.

More specifically, the invention is concerned with a toll service trunking system containing improved circuit arrangements whereby the toll operators can connect with desired calling or called automatic lines which are equipped with paystations, and whereby such operators can thereafter collect or refund deposited coins as the occasion requires.

A special object of the invention is the provision of novel mechanism and circuit arrangements whereby the subscriber is automatically notified of the required amount of toll and whereby it is unnecessary for the toll operator after notifying the subscriber of the required amount of toll, to supervise the depositing of coins. Mechanism is provided by which the toll operator may complete the established connection and need pay no further attention to it unless it is necessary for her to give it special attention. However, the subscribers are not connected together until the proper amount of toll is deposited at the paystation apparatus, whereupon the connection is completed and the toll operator is notified that the correct amount has been placed in the coin box.

In addition to the above, there are a number of other improvements not now specifically mentioned which together with the foregoing will be explained hereinafter with reference to the accompanying drawings.

Referring to the drawings, comprising Figs. 1–8, inclusive, Figs. 1–5, inclusive, show by means of the usual circuit diagrams the apparatus required to establish a complete connection from a toll line terminating in the jack J, Fig. 1, to a local subscriber's station A, Fig. 5. This apparatus comprises the cord circuit O, Fig. 1, located at the toll operator's position in a toll switching station or office; the two conductor trunk line extending from jack J′ in the toll switching office through the relay group D, this relay group being provided for controlling the coin collecting and other circuits under certain conditions, to the transmission repeater R, Fig. 2, in the main exchange of the system: the toll first selector 1E, and a toll second selector 2E, Fig. 3; and the toll rotary connector H, Fig. 4. The repeater, first selector, second selector and connector mentioned are all in the same office or exchange, which as indicated above may be one of the main offices or exchanges of a large multi-office system.

Fig. 6 shows certain connections of the test contacts in a certain level of the connector H which are necessary in order to enable this connector to give rotary service, the test contacts of the fourth to the seventh contacts, inclusive, being those associated with a group of lines. When it is desired to connect with a line in this group the connector H will be operated until its wipers are brought into connection with the first set of contacts. Should the line associated with the first set of contacts in the group be busy the connector will be automatically operated until connection is made with an idle line in the group. If all the lines in the group are busy the connector will not operate but will maintain itself associated with the first set of bank contacts, transmitting a busy signal to the calling party, and as soon as one of the grouped lines become idle the connector will then operate to select it.

Fig. 7 shows a certain type of calling device which is associated with the trunk lines leading out from the operator's position and which control certain toll assessing circuits as will be explained.

Fig. 8 shows a detail view of the dial of the registering device, the mechanism of which is indicated in Fig. 5, associated with the subscriber's paystation apparatus, which is used for indicating to the subscriber the required amount to be deposited.

As has been indicated hereinbefore, a feature of the invention is the provision of suitable arrangements whereby the toll operator can collect or refund coins deposited to pay for a toll connection, and it should be explained that the subscribers' stations, or some of them at least, are provided with coin collecting devices, or paystations, of the well known type which is described in the U. S. patent to Forsberg, No. 1,043,219. Paystation equipment of this type is shown diagrammatically in connection with the

substation A, Fig. 5. While the paystation coin collecting and refunding mechanism is substantially the same as shown in the above cited patent, certain additions have been made whereby the operator is enabled to visually indicate to the subscriber the amount to be deposited and does not have to supervise the depositing of coins. The additions to the paystation mechanism comprises a rotatable shaft 416 attached to the ratchet wheel 423. The shaft 416 is movable rotatably and longitudinally and rests on suitable bearings, one of these being shown at 425. At the upper end the shaft 416 is provided with an armature 433 which is controlled by the magnet 419. The ratchet wheel 423 is adapted to be rotated by the operating magnet 413 through the medium of the pawl 414 against the tension of the spring 424. As soon as the shaft leaves the off normal position the cam 421 thereon allows the spring 417 to engage its working contact. The shaft and ratchet wheel are restored to normal either by the operation of the escapement, which is operated by the magnet 410, or by the operation of the magnet 419. If the magnet 419 is operated the ratchet wheel 423 is pulled out of engagement with the escapement and operating mechanism and restores to normal under the influence of spring 424. When the magnet 419 is deenergized, the spring 424 causes the shaft 416 carrying the ratchet wheel to revert to its normal position in proper relation to the operating and escapement mechanism.

In Fig. 8, there is shown diagrammatically a view of the registering mechanism for indicating to the subscriber the amount to be deposited. This comprises a dial 450 upon which is printed various amounts. The indicating mechanism proper consists of a pointer 435 which is controlled by the shaft 416. The shaft 416 by means of the gear wheels 437, 438, and 439 controls the dollars pointer 436. The pointer 436 moves one space for each revolution of the pointer 435. Thus by operating the ratchet wheel 423 the subscriber may be apprised of the amount to deposit in his coin box. It will be noted that the shaft 416, upon advancing one step under influence of the stepping magnet 413, does not cause the indicator pointer 435 to move due to the fact that there is a slot cut in the gear wheel 437. When the shaft 416 advances one step the projection or boss 451 on the shaft falls behind the dog 452 so that when the shaft starts to return to normal the pointer moves back also. When the magnet 419 is operated it will be recalled that it also withdraws the ratchet wheel from the escapement mechanism. This operation also withdraws the boss 451 from position behind the dog 452. When the magnet 419 is deenergized the shaft 416 assumes its normal position in regard to the pointer 435. The above provisions are made so as to compensate for a preliminary step which the ratchet 423 receives as will appear later.

In so far as the measured service features of the present case is concerned it may be considered as an improvement on the system shown in the two prior applications of Wicks Serial Nos. 379,217, and 482,765, filed on May 6, 1920, and July 6, 1921, respectively. In regard to certain features of the toll trunking system, the present system is closely related to the system disclosed in the last mentioned application.

It should be noted that relays which are quick to pull up but slow to release are so indicated on the drawings by showing the copper slug cross hatched, whereas relays which are both slow to pull up and slow to release are so indicated by showing the slug in solid black.

In view of the fact that Strowger switch mechanism is employed, the general character of which is well understood, and also because of the descriptions in the applications above referred to, from which the general purpose of the invention will be easily appreciated, it will be unnecessary to consider in detail the various switches and other parts of the equipment, and the explanation of the operation of the complete system will at once be proceeded with.

In order to describe the operation of the invention it will be assumed that the subscriber at substation A desires to obtain a toll connection, and it will be assumed further that the subscriber has placed the call with the toll recording operator, and that the ticket containing the usual data concerning the desired connection has been forwarded to the toll operator having the cord circuit O, Fig. 1, for completion.

Having extended the connection to the desired distant exchange over one of her toll lines, such for example as the toll line which terminates in the jack J, Fig. 1, and having ordered the proper local line to be connected up in that exchange, the toll operator will next proceed to call the subscriber at substation A by way of the toll service trunking system. Observing that the toll trunk terminating in jack J' is idle, as indicated by the unlighted condition of the lamp L^2, the operator will insert the calling plug P' of the cord circuit O into the jack J', the calling device key K^4 being thrown shortly after. Upon the insertion of the plug P' into the jack J', a circuit is completed for the sleeve relay 50 of the trunk circuit in series with the sleeve relay 14 in the cord circuit O. Relay 50, upon energizing, at its armature 53 closes a circuit for the relay 71. The operation of armature 78 on relay 50 merely opens a point in a certain supervisory controlling circuit as will appear

later. Relay 71, upon operating, at armature 74 establishes a locking circuit for itself, at armature 73 closes a point in the said supervisory controlling circuit, and at armature 75 closes a circuit for the lamp L^2 and its multiples whereby the toll operators are informed that the associated trunk line is now in use. The operation of relay 14 in the cord circuit O is without function for the present. Another result of the insertion of the plug P′ into the jack J′ is that a bridge is closed across trunk conductors 90 and 91 whereby a circuit is completed for the line relay 160 of the toll first selector 1E, Fig. 3, in the main exchange. This circuit may be traced from battery through the upper winding of line relay 160, armature 175 and its back contact, conductor 157, normally closed springs controlled by armature 126, normally closed springs controlled by armature 131, upper left hand winding of the repeating coil, trunk conductor 90, armature 60 and its back contact, ring of jack J′, ring of plug P′, spring 26 on key K^5 and its resting contact, springs 27 of key K^4, through the winding of polarized relay 15, springs 28 on key K^4, resting contact and spring 25 of key K^5, tip of plug P′, tip of jack J′, back contact and armature 63, trunk conductor 91, lower left hand winding of the repeating coil of the repeater R, to ground by way of normally closed springs controlled by armature 133. The line relay 160 of the toll first selector 1E, Fig. 3, is energized over this circuit and, upon operating, completes the circuit of the slow acting relay 161. The latter relay, upon energizing, prepares the impulsing circuit of the first selector 1E in the usual manner. When the calling device key K^4 in the cord circuit O, Fig. 1, is operated, the impulse springs of the calling device S are substituted for the winding of the polarized relay 15 in the cord circuit.

The toll operator will now operate her calling device S in accordance with the telephone number of the subscriber at substation A. When the calling device dial is operated in accordance with the first digit of the desired number, a series of interruptions is produced in the circuit of the line relay 160 of the first selector 1E. The line relay 160 deenergizes a plurality of times in response to these interruptions, each time extending an impulse of current to the vertical magnet 182 in series with the slow acting relay 163. Magnet 182 operates to raise the switch shaft carrying the switch wipers 187—190, inclusive, step by step until the said wipers are brought opposite the level of bank contacts corresponding to the number of interruptions in the digit dialled. The slow acting relay 163 is energized in series with the vertical magnet, maintains its armature attracted throughout the vertical movement of the switch and, upon the first vertical movement of the switch shaft, when the off normal springs are shifted, completes a circuit for the stepping relay 165 at its armature 174. Upon energizing, relay 165, at armature 179, establishes a locking circuit for itself, and at armature 178 prepares a circuit for the rotary magnet 181. Another result of the shifting of the off normal springs is that ground is placed upon the conductor 156 which extends by way of the resistance 147 through a winding of the polarized relay 105. The polarized relay 105 is not operated over this circuit for the reason that its polarizing winding is of high resistance and few turns, and does not generate sufficient flux to cause the armatures to be attracted. Shortly after the termination of the vertical movement of the switch, the slow acting relay 163 deenergizes to complete the circuit of the rotary magnet 181. Magnet 181 operates to rotate the switch shaft thereby bringing the switch wipers into engagement with the first set of bank contacts on the selected level. Assuming that the trunk line associated with this set of bank contacts is busy, there will be a ground potential upon the test contact engaged by the test wiper 189, and the stepping relay 165 will be again energized. Upon operating, relay 165 establishes a locking circuit for itself at armature 179, and at armature 178 closes the circuit of the rotary magnet 181. The rotary magnet 181 rotates the switch shaft bringing the wipers into engagement with the next set of bank contacts on the level selected and, at its armature 177 opens the circuit of the stepping relay 165, which deenergizes, opening the circuit of the rotary magnet, which deenergizes also. The stepping operation of the first selector 1E continues under control of the stepping relay 165 and the rotary magnet 181 until the switch wipers are brought into engagement with a set of bank contacts associated with an idle trunk line, which, we will assume, are the bank contacts 191–194, inclusive. In this case there will be no ground potential upon the test contact 193 engaged by test wiper 189 and no circuit will be completed for the stepping relay 165. The rotary operation of this switch now ceases and the switching relay 162 which has been short circuited during the preceding operation of the selector 1E is energized in series with the stepping relay 165. Relay 162, upon operating, at armature 172 places ground upon the test contact 193 in order to busy the seized trunk line, at armature 171 closes a point in a ringing control circuit, which will be described, at armature 173 opens a point in the circuit of the vertical magnet 182 and at armatures 170 and 180 extends the connection to the second selector 2E.

The line relay 195 of the second selector 2E is immediately energized over a circuit extending from battery, through the upper winding of relay 195, by way of back contact and armature 219, bank contact 191, wiper 187, armature 170 and its front contact, front contact and armature 166, conductor 154, armature 144 and its back contact, armature 135 and its back contact, armature 140 and its back contact, normally closed springs controlled by armature 115, upper right hand winding of the repeating coil of the repeater R, armature 129 and its back contact, through the lower winding of the electro-polarized relay 105, lower right hand winding of the repeating coil, back contact and armature 117, back contact and armature 143, back contact and armature 139, back contact and armature 146, over conductor 159, front contact and armature 180, wiper 190, bank contact 194, armature 228 and its back contact, through the lower winding of the relay 195 of the second selector 2E to ground. Relay 195 is immediately energized over this circuit and, upon operating, closes the circuit of the slow acting relay 196. The latter relay energizes to prepare the circuits of the selector 2E for operation, and also places ground upon the release trunk conductor 229. It will be noted that the release trunk conductor 229 has ground placed upon it by the slow acting release relay 161 in the first selector 1E. It will also be noted that the switching relay 162 of the selector 1E, upon energizing, did not open the circuit of the line relay 160, and therefore this relay remains under the control of the impulse springs of the calling device S, it being remembered that the previously traced circuit of the line relay 195 includes the impulsing contact 166 on the line relay 160 of the selector 1E.

It will now be apparent how the second selector 2E is controlled. When the toll operator operates her calling device in accordance with the next digit of the desired number, a series of interruptions is produced in the circuit of the line relay 160 of the selector repeater 1E and, by the deenergizations of this relay, this impulse series is repeated to the line relay 195 of the second selector 2E. The line relay 195 of the second selector operates to control the vertical magnet of this switch in stepping the switch shaft carrying the wipers to the proper level of bank contacts whereupon the trunk hunting operation of the selector ensues and continues until the switch wipers are brought into engagement with a bank contact set associated with an idle trunk line. It will be assumed that the trunk line terminating in bank contacts 201–204, inclusive, is the first one found to be idle. Now, when the switch wipers 197–200, inclusive, are brought into engagement with this set of bank contacts, the switching relay 215 which has hitherto been short circuited will be energized to disconnect the line relay 195 and to extend the connection by way of wipers 197 and 200, bank contacts 201 and 204, trunk conductors 205 and 208, by way of normally closed springs controlled by armatures 329 and 334, armatures 324 and 328, to the upper and lower windings of relay 301 of the toll rotary connector H, Fig. 4.

The relay 301 immediately energizes upon the extension of the connection as described, and operates, at its armature 322 to open a point in the circuit of relay 302, and at armature 321 closes the circuit of the slow acting relay 300. Upon energizing, relay 300 opens the circuit of the release magnet at armature 317, prepares the circuit of the connector H at the front contact of this armature, and at armature 316 completes a circuit for the upper winding of relay 304. The latter relay, upon operating, at armature 336 establishes a locking circuit for itself which may be traced from ground at the transmission repeater R by way of armature 115 and its back contact, ringing control conductor 155, front contact and armature 171, wiper 188, bank contact 192, armature 217 and its front contact, wiper 198, bank contact 202, conductor 206, front contact and armature 336, and through the winding of relay 304 to battery. Another result of the energization of the relay 304 is that the ringing circuit, which would normally be operative immediately upon the connector H connecting with the called line, is opened, and by means of the previously traced locking circuit, is placed under the control of the toll operator.

The toll operator may now operate her calling device in accordance with the next digit in the desired number. This operation produces a series of interruptions in the circuit of the line relay 160 of the selector 1E and by the successive energizations of this relay these impulses are repeated to the line relay 301 of the connector H. Relay 301, on deenergizing in response to these interruptions, sends a plurality of impulses to the vertical magnet 311. The circuit over which the first of these impulses is sent may be traced from ground by way of back contact and armature 327, armature 321 and its back contact, armature 317 and its front contact, off normal springs 318 and 320, through the winding of the vertical magnet 311, and through the winding of the slow acting relay 306 to battery. Upon the first vertical step of the switch shaft, the off normal springs are shifted and the remaining impulses to the magnet are transmitted over a circuit which is similar to the one above traced except that it includes the off normal springs 318 and 319 and armature 341 on

the slow acting relay 306, which is now energized. The vertical magnet 311 operates to raise the switch shaft carrying the switch wipers 360–363, inclusive, step by step until these wipers are brought opposite the level of bank contacts corresponding to the number of interruptions in the digit dialled. The slow acting relay 306 is energized in series with the vertical magnet and, as indicated before, operates to maintain the vertical magnet circuit closed throughout the upward movement of the switch shaft. Shortly after the termination of the vertical movement, the slow acting relay 306 deenergizes to prepare the circuit of the rotary magnet 310.

When the toll operator operates her calling device in accordance with the next and final digit of the desired number, the interruptions produced by the calling device are repeated by way of the springs of the line relay 160 of the toll first selector 1E to the line relay 301 of the connector H. By the deenergization of the latter relay, the rotary magnet 310 is actuated over the following circuit: ground by way of back contact and armature 327, armature 321 and its back contact, armature 317 and its front contact, off normal springs 318 and 319, armature 341 and its back contact, back contact and armature 345, through the winding of slow acting low resistance relay 308, armature 332 and its back contact, and through the winding of the rotary magnet 310 to battery. Magnet 310 operates to rotate the switch wipers 360–363, inclusive, step by step until they are placed into engagement with the bank contact set associated with the line of the substation A, which, we will assume, are the bank contacts 390–393, inclusive. The slow acting relay 308 is energized in series with the rotary magnet, at its armature 349 connects the test wiper 362 to the winding of the test relay 307, at armature 348 opens a point in the automatic rotary circuit which will be described, and at armature 350 short circuits the contact springs comprising armature 345 and its back contact on the test relay 307 so as to prevent the rotary magnet circuit being prematurely opened when the switch wipers are rotated over bank contact sets associated with busy lines.

Assuming that the desired line is idle at the present time, there will be no ground potential present upon the test contact 392 and no circuit will be completed for the test relay 307. Then, following the deenergization of the slow acting relay 308, a circuit may be traced extending from ground by way of front contact and armature 315, back contact and armature 343, through the lower winding of the switching relay 303, back contact and armature 349, test wiper 362, test contact 392, private normal conductor 395, through the winding of the switching relay 400 of the line switch C, and thence through the winding of the rotary magnet 402 to battery. The switching relays 303 and 400 are energized over this circuit. However, due to a mechanical locking device controlled by the armature of the line relay 401, which is now normal, the switching relay 400 only partially attracts its armatures enough to disconnect the line of the substation A from its normal battery and ground connections in the line switch C. Relay 303, upon energizing, at armature 331 establishes a locking circuit for itself, at armature 332 opens the circuit of the rotary magnet 310, at armature 333 prepares a circuit for relay 302, and at armatures 329 and 334 reverses the connections of the windings of the line relay 301 with regard to the trunk conductors 205 and 208 whereby the current flow over these conductors is reversed. This current reversal brings about the energization of the electro-polarized relay 105 in the transmission repeater R. Upon operating, relay 105 establishes a locking circuit for itself at armature 130 by short circuiting the resistance 147, at armatures 129 and 132 disconnects its own lower winding from the trunk conductors 154 and 159 and connects the windings of the battery feed relay 104 thereto, at armature 131 places the alternating current relay 106 in bridge of the incoming trunk conductors 90 and 91. The operation of armature 131 also connects the high resistance 40,000 ohm relay 102 from the conductor 90 to ground. In addition, the operation of armatures 131 and 133 connects the line relay 160 of the selector 1E to the conductors 90 and 91 of the incoming trunk line in such a manner that the current flow over these conductors is reversed. Assuming that the operator has restored the calling device key K^4 to normal, as ordinarily will be the case, the polarized relay 15 in the operator's cord circuit will be operated whereby a circuit is completed for the supervisory lamp L′. By the operation of this signal the operator is notified that the connection has been completed.

Returning now to the operation of the electro-polarized relay 105 in the repeater R, another result of its energization is that the circuit of the line relay 301 of the connector H is opened at armature 129 and at the front contact of this armature and the front contact of armature 132 the battery field relay 104 is connected to the conductors 154 and 159 in order to supply talking battery to the called subscriber's telephone when an answer is obtained. It will be seen that ground through the upper winding of relay 104 stands against ground through the lower winding of the relay 301 of the connector H and that battery through the lower winding of relay 104 stands against the

battery through the upper winding of the line relay 301; hence relay 301 will deenergize. The line relay 301, upon deenergizing, at armature 321 opens the circuit of the slow acting relay 300, at the back contact of this armature closes a point in the circuit of the release magnet and at armature 322 closes a circuit for the relay 302. The latter relay, upon operating, at armature 327 opens a point in the circuit of the release magnet, and at armatures 324 and 328 disconnects the windings of line relay 301 from the trunk conductors 205 and 208 thereby providing a direct metallic circuit from the repeating coil in the transmission repeater R to the called line, at armature 326 opens the original energizing circuit of ring cut off relay 304, and at armature 325 opens a point in the circuit of the test relay 307.

The next operation is to ring the subscriber at substation A. For this purpose the toll operator momentarily operates her ringing key K^5 thereby projecting ringing current from the generator Gen.′ out on the trunk line comprising conductors 90 and 91 which operates the alternating relay 106 in the repeater R over a circuit extending from the free pole of the generator Gen.′ by way of resting contact of spring 30 of key K^7 and the said spring, resting contact of spring 31 of key K^6 and the said spring, working contact of spring 26 of key K^5 and the said spring, ring of plug P′, ring of jack J′, back contact and armature 60, trunk conductor 90, upper left hand winding of the repeating coil, springs 149, through the winding of the alternating relay 106, condenser 148, lower left hand winding of the repeating coil, trunk conductor 91, armature 63 and its back contact, tip of jack J′, tip of plug P′, spring 25 of key K^5 and its working contact to ground. A second path over which this ringing current flows extends through the winding of the high resistance relay 102 to ground by way of armature 125 and its back contact, and a third path extends by way of armatures 131 and 136, through the resistance 150, back contact and armature 123, conductor 158, and through the lower winding of relay 160 of the first selector 1E to ground. The relay 102 is of very high resistance and will not be operated by this ringing current. The alternating current flowing through the lower winding of the line relay 160 of the first selector E has no effect on it as a circuit for its upper winding is completed from ground at the working contact of spring 25 of key K^5 in the cord circuit O. The alternating current relay 106 is operated over the previously traced ringing circuit and, upon attracting its armature 134, completes the circuit of the relay 100. Relay 100, upon energizing, removes ground from the ringing control conductor 155 at armature 115. This operation opens the locking circuit of the ring cut off relay 304 in the connector H. The operation of armatures 116 and 117 on the relay 100 is without function in the present instance. The relay 304, upon deenergizing, completes the ringing circuit of the called subscriber. The subscriber at substation A will now be intermittently signalled until he responds. When the receiver is removed at the called substation the ring cut off relay 304 is energized over the called subscriber's line loop and, upon operating, reestablishes its former locking circuit to ground on the ringing control conductor 155 at armature 336, the operator having restored her ringing key by this time to permit the deenergization of the relay 100. Relay 304 also opens at armatures 335 and 338 the ringing circuit of the called substation and at the front contacts of these armatures finally completes the talking connection. Talking battery is now supplied to the transmitter at substation A from the windings of the battery feed relay 104 in the transmission repeater R. This circuit will not be traced in detail but it will be observed that the lower conductor 208 extends uninterruptedly back through the connector H, selectors 2E and 1E, to the lower right hand winding of the repeating coil in the transmission repeater from whence it extends through the lower winding of the battery feed relay 104 to battery, while the upper conductor 205 and extends back through the connector H, selectors 2E and 1E, through the upper right hand winding of the repeating coil from which point it may be traced through the said winding and through the upper winding of the battery feed relay 104 to ground. The relay 104 is energized by the current flow over the called line loop and, upon attracting its armature 128, closes a circuit for the slow acting relay 103, and at armature 127 prepares a certain signalling circuit which will be described subsequently. Relay 103, upon operating, places an additional ground upon the ringing control conductor 155. Another result of the energization of relay 103 is that the high resistance relay 102 is placed in bridge of the trunk conductors 90 and 91 at armature 125. This bridge may be traced from trunk conductor 90, upper left hand winding of the repeating coil, front contact and armature 131, through the winding of high resistance relay 102, armature 125 and its front contact, resistance 151, armature 133 and its front contact, lower left hand winding of the repeating coil to trunk conductor 91. A further result of the energization of the relay 103 is that the line relay 160 of the selector 1E is disconnected from the trunk conductors 90 and 91 and a local circuit is completed for it, which extends from ground, through the lower winding of the relay 160, conductor

158, resistance 152, armature 126 and its front contact, conductor 157, back contact and armature 175, and thence through the upper winding of the relay 160 to battery. The relay 103 also at its armature 124 and its front contacts prepares a certain simplex circuit by short circuiting the condensor 153 in the left hand windings of the repeating coil and by connecting the inside terminals of these windings through the resistances 92 and 93, respectively, and through the winding of the relay 109 to ground. However, relay 109 is not energized at this time as the simplex circuit including trunk conductors 90 and 91 in parallel is not yet completed. As the line relay 160 is disconnected from the trunk conductors 90 and 91, no battery will be present thereon and the polarized relay 15 in the operator's cord circuit will deenergize to efface the supervisory lamp L'.

The operator will now come in on the line by throwing her listening key K^3 and, after observing that the proper party is at the telephone, will notify him to deposit in the paystation mechanism the amount which will be indicated. The operator will now momentarily operate the key K^9 associated with trunk circuit D. By this operation a circuit is completed for the relay 54. Upon operating, this relay at armature 61 prepares a locking circuit for itself, at armatures 60 and 63 disconnects the trunk conductors 90 and 91 from the ring and tip sides of the jack J', respectively, and at the front contacts of these armatures completes a simplex circuit by connecting the two trunk conductors 90 and 91 together through the springs of the calling device S', and the slow acting low resistance relay 51 to battery. This operation places battery through the relay 51 upon the two trunk conductors 90 and 91 in parallel whereupon a circuit is completed extending over the said trunk conductors, through the left hand windings of the repeating coil in the repeater R by way of armatures 118 and 120, through the resistances 92 and 93, by way of armature 124 and its front contacts, and through the winding of the repeating relay 109 to ground. Relays 51 and 109 in the trunk circuit D and repeater R, respectively, are energized. Upon operating, relay 51, at armature 57 establishes a locking circuit for the relay 54 and at armature 58 places the winding of relay 52 in series with the sleeve relay 50. The latter operation causes the relay 14 in the cord circuit O to deenergize, opening the conductors of the cord circuit at armatures 22 and 21. In the repeater R, the repeating relay 109, upon operating, at armature 145 establishes a circuit for the slow to operate relay 101, at armatures 144 and 146 disconnects the trunk conductors 154 and 159 from the right hand windings of the repeating coil, and connects these conductors through the winding of the low resistance slow releasing relay 108 to the high voltage battery B^2. These operations also close another simplex circuit which may be traced from the ungrounded pole of the high voltage battery B^2, through the winding of relay 108 over the trunk conductors 154 and 159 in parallel, armatures 170 and 180, wipers 187 and 190, bank contacts 191 and 194, armatures 219 and 228, wipers 197 and 200, bank contacts 201 and 204, trunk conductors 205 and 208, armatures 338 and 335, armatures 334 and 329, armatures 328 and 324, wipers 363 and 360, bank contacts 393 and 390, conductors 396 and 394, switchhook springs 500 and calling device springs 501, through the windings of the bell coils, armature 412 and its back contact, resting contact of spring 420 and said spring, and through the winding of stepping magnet 413 to ground. Magnet 413 is energized over this circuit in series with the slow acting relay 108 in the repeater R. The battery B^2 is of high voltage for the reason that the magnet 413 is marginal and is not operated by the ordinary exchange battery voltage so that it will not be operated when the subscriber calls by battery, through the line relays of the automatic switches. Relay 108, upon energizing, at armature 142 opens the circuit of the slow to operate relay 101 before it has had time to operate, and at armature 141 establishes another circuit for the slow acting relay 103. An additional result of the energization of relay 108 is that the talking conductors extending back to the right hand winding of the repeating coil are opened at another point. The disconnecting of trunk conductors 154 and 159 from the right hand windings of the repeating coil causes the battery feed relay 104 to deenergize and open the circuit of the slow acting relay 103. However, the relay 103 does not deenergize at this time as the slow releasing relay 108 energizes immediately after the energization of relay 109.

The operator may now actuate the calling device S' in order to set up the required toll charge. Assuming that the charge is 15 cents, the operator will actuate the dial of the S' by placing her finger in the hole marked 15 and actuating the calling device in the usual manner. By these operations, three interruptions are produced in the circuit of the repeating relay 109 in the transmission repeater R and also in the circuit of the slow acting relay 51 of the trunk circuit D. The slow acting relay 51 maintains its armatures attracted throughout the impulse series. Relay 109 deenergizes three times in response to these interruptions thereby producing three interruptions in the circuit of the stepping magnet 413 in the paystation mechanism at the substation

A. Magnet 413 deenergizes three times to advance the ratchet wheel 423 three more steps. It will be noted that the stepping magnet 413 always takes one additional step to the number of interruptions produced in its circuit for the reason that when its circuit is closed originally, it takes one step. The manner in which this preliminary step is compensated for has already been described. Upon the second step of magnet 413 the cam 421 on the shaft 416 allows the spring 417 to engage its working contact thereby placing the coil 434 in multiple with the stepping magnet 413. This latter operation controls the supervisory circuits in a manner which will become apparent later. As the pointer 435 is attached to the shaft 416 it will be rotated until it stands opposite the 15 cent indication on the dial. By the operation of the pointer 435 the subscriber is informed that it is necessary for him to deposit 15 cents in the paystation. When 5 cents is deposited in the coin chute the lever which would ordinarily be operated by the weight of the coin to actuate a bell in prior systems now operates the spring 440 once. In the same manner if a ten or twenty-five cent piece is deposited the spring 440 would be actuated twice in the first instance or five times in the second case. A Patent No. 1,166,090, issued to Seymour, discloses a method for operating a single pair of springs one or more times, depending on the coin desposited. Another Patent No. 1,137,399, issued to Goodrum, shows an alternative method of accomplishing the same result by causing one or a number of springs common to the same circuit to be operated, depending on the coin desposited. By the operation of the spring 440 the circuit of the magnet 410 is closed momentarily. Magnet 410 operates to open the circuit of the stepping magnet 413 at armature 412 and by the operation of armature 411 releases the ratchet wheel 423 one step. The descent of the coin also actuates the lever 441 whereby the spring 418 is caused to engage its working contact and connect the coin collecting magnet 419 to the line conductors 394 and 396 and to force the spring 420 away from its resting contact thereby disconnecting the stepping magnet 413 from the circuit. The slow acting relay 108 does not deenergize when the stepping magnet 413 is disconnected for the reason that the connection to ground through the resistance coil 434 is still in the circuit. The deposit of 10 cents in the coin chute causes the spring 440 to be actuated twice whereby the escapement magnet 410 is operated twice to release the ratchet wheel 423 two steps. The cam on the shaft 416 now causes the spring 417 to be forced out of engagement with its working contact to disconnect the resistance coil 434 from the previously traced simplex circuit. This operation opens the circuit of the slow acting relay 108 in the toll transmission repeater R. After a short interval relay 108 deenergizes to open the circuit of the slow acting relay 103 at armature 141, and to complete the circuit of the slow to operate relay 101 at armature 142. An additional result of the deenergization of the relay 108 is that at armatures 140 and 143 the talking circuit is prepared. The slow to operate relay 101 energizes over the above circuit and operates to establish a locking circuit for itself at armature 119, and at armatures 118 and 120 opens the previously traced simplex circuit extending back through the relay 51 in the trunk circuit D. Relay 51, upon deenergizing, opens the locking circuit of the relay 54 at armature 57, at armature 56 removes the high resistance relay 49 from bridge of the trunk conductors, and at armature 58 disconnects the relay 52 from in series with the relay 50. Relay 54, upon deenergizing, at armature 62 opens the circuit of the lamp L^3 whereby the operator is informed that the required amount has been deposited in the paystation apparatus at substation A, at armatures 60 and 63 disconnects battery through the winding of relay 51 from the trunk conductors 90 and 91, and at the back contacts of these armatures completes a point in the talking connection. The removal of the relay 52 from in series with the relay 50 causes the relay 14 in the cord circuit O to energize. Upon operating, relay 14 completes the talking circuit by attracting the armatures 22 and 21.

Everything is now in readiness for the conversation to begin, at least so far as the connection to the subscriber at substation A is concerned and ordinarily the operator will have extended the connection to the toll line terminating in the jack J. It will be observed that the connection includes the two trunk conductor line from the toll station to the main exchange, the trunk comprising conductors 90 and 91. It should be noted that the called subscriber at substation A controls the release of the connection while the receiver is removed through the medium of the battery feed relay 104 and slow acting relay 103. The latter controlling the local circuit of the line relay 160 of the first selector 1E. This relay makes it possible for the toll operator to change cord circuits after the called party has answered without releasing the established connection.

When the conversation is terminated both subscribers will replace their receivers. Upon the replacement of the receiver at the substation A the battery feed relay 104 in the transmission repeater is deenergized to open the circuit of the slow acting relay 103. The latter relay deenergizes to again

connect the line relay 160 of the first selector 1E to the trunk conductors 90 and 91. As a result the polarized relay 15 in the operator's cord circuit operates to attract its armature to close the circuit of the supervisory lamp L′ thereby giving the operator a disconnect signal. Before releasing the connection the operator will have to collect whatever coins were deposited and this operation will now be explained.

In order to collect the deposited coins the operator will throw the collect master key K^6 and operate the ringing key K^5 in the cord circuit O. The keys K^6 and K^7 are common to all the cord circuits at the operator's position and, when thrown, serve to connect leads from either of the high voltage batteries, B or B′, to the generator leads extending to the various ringing keys in the cord circuits. By the operation of the ringing key K^5 the lead from the high voltage battery B is connected to the trunk conductor 90 from whence it flows through the upper left hand winding of the repeating coil in the transmission repeater, front contact and armature 131, through the winding of the high resistance relay 102 to ground by way of armature 125 and its back contact. The relay 102 is operated by the high voltage current from the battery B and, upon energizing, closes the circuit of the slow acting relay 107 at armature 121 and at armature 114 opens the locking circuit of relay 101. The purpose of the latter operation will be described hereinafter. Relay 107, upon energizing, completes a circuit for the upper winding of the line relay 160 of the first selector 1E in order to maintain this switch, the selector 2E and the connector H in their operated positions, connects the trunk conductor 90 direct to the trunk conductors 154 and 159 by way of armatures 135, 136, and 139, and at the same time connects the conductors 154 and 159 to ground by way of the resistance 95 and the condenser at armature 137. Current now flows from the battery B through the low resistance relay 40, working contact of spring 31 and the said spring, working contact and spring 26 and the said spring, ring of the plug P′, ring of jack J′, back contact and armature 60, conductor 90, front contact and armature 136 where the circuit divides, one branch extending by way of the front contact and armature 139, back contact and armature 146, conductor 159, front contact and armature 180, wiper 190, bank contact 194, armature 228 and its front contact, wiper 200, bank contact 204, trunk conductor 208, front contact and armature 335, armature 329 and its front contact, armature 324 and its front contact, wiper 360, bank contact 390, line conductor 394, and conductor 505, working contact and spring 418 and the said spring, and through the winding of the polarized magnet 419 to ground, and the other branch extending by way of front contact and armature 135, back contact and armature 144, conductor 154, armature 166 and its front contact, front contact and armature 170, wiper 187, bank contact 191, armature 119 and its front contact, wiper 197, bank contact 201, conductor 205, front contact and armature 338, armature 334 and its front contact, armature 328 and its front contact, wiper 163, bank contact 393, conductor 396, impulse springs 501, through the ringer magnets, and through the switchhook contacts 500 where it also connects with conductor 394, conductor 505, spring 418 and its working contact to windings of the polarized magnet 419 and ground. The current from the battery B flows in the circuit of the polarized magnet in the proper direction to actuate it to collect the deposited coins, the paystation mechanism being re-set at the same time. The armature 433 on the polarized magnet is immediately operated and serves to withdraw the ratchet wheel 423 by means of the shaft 416 from engagement with the escapement 411 and from the path of the actuating pawl 414. As the ratchet wheel 423 is one step away from normal, it releases to normal position.

When the circuit through the polarized magnet 419 is established the resulting current flow is sufficient to operate the low resistance relay 40 in series with the battery lead from the battery B, and this relay, upon operating, closes the circuit of the supervisory lamp L^7 thereby advising the operator that the collect circuits are operating and that the coins are being collected. The supervisory lamp L^7 is common to all the cord circuits of the position, and notifies the operator of the successful operation of the collecting or refunding circuits.

While it is true that the alternating current relay 106 of the transmission repeater R will be momentarily energized due to the charging of the condenser 148, the momentary operation of the armature 134 will have no effect as the relay 107 operates at once and ground is removed from the front contact of armature 134.

Having been informed by the operation of the lamp L^7 that the coin collecting apparatus at the subscriber's paystation is functioning properly, the operator will restore the ringing key K^5 to normal after an interval in order to give the apparatus time to function properly and also the master collect control key K^6.

If the toll operator desires to refund the deposited coins rather than collect them she may do so by operating the master refund key K^7 and then the ringing key K^5. Assuming that the same conditions exist as in the previous case where the operator col-

lected the coin, when the master refunding key K^6 and the ringing key K^5 is operated the battery lead from the battery B′ is connected to the trunk conductor 90. This high voltage battery is similar to the battery B but it supplies current of the opposite polarity and it follows therefore that the polarized magnet at the substation A will be operated in the opposite direction to refund the deposited coins rather than collect them. Except as pointed out, the refunding operation is the same as the collecting operation and the operator is given supervision by means of the lamp L^7 in the same manner as was hereinbefore described.

Under certain operations the toll operator may find it desirable to collect or refund the coins deposited before she completes the connection. She may desire to refund the coins and re-set the paystation mechanism in case there is a dispute between herself and the subscriber as to the amount deposited. This operation will now be briefly described. If the subscriber does not deposit the required amount in the paystation mechanism, the escapement magnet 410 will not operate to completely restore the ratchet wheel 423 to allow the coil 434 to be disconnected from the simplex circuit. Consequently, the relay 108 in the transmission repeater R will remain energized and the lamp L^3 in the trunk circuit D will remain lighted. The operator, noticing the signal burning an undue length of time, will come in on the line by operating her listening key K^3. By this operation, in addition to connecting head set to the trunk comprising conductors 90 and 91, battery through the resistance 45 is connected by way of working contact of spring 46 and the said spring to the sleeve of the plug P′ whereby the marginal relay 52 in the trunk circuit D is energized. Upon operating, relay 52 at its armature 59 opens the locking circuit of the relay 54. Relay 54 deenergizes to open the simplex circuit extending to the repeating relay 109 in the transmission repeater R and reestablish certain points in the talking connection. Relay 109 in the repeater R deenergizes to open the simplex circuit extending to the paystation mechanism and completes the talking connection. The operator may now converse with the subscriber at substation A. If the subscriber maintains that he has deposited the proper amount in the coin box, the operator will operate the master refund key K^7 and then the ringing key K^5. As the receiver is off the switchhook at substation A the battery feed relay 104 in the transmission repeater R will be energized and the high resistance relay 102 will be placed in bridge of the trunk conductors 90 and 91. Now, when the keys K^7 and K^5 are operated, the refunding operation takes place in the same manner as has been before described. The operation of the polarized magnet 419 at the substation A also re-sets the ratchet wheel 423. The operator will now again set up on the toll assessing device the amount by operating the key K^9 and then the calling device S′ to assess the required amount of toll in a manner similar to that already described.

Should the operator have found upon coming in on the line that the subscriber at substation A had merely delayed depositing the proper amount, she may restore the circuits in the same condition as before restoring her listening key K^3 and by momentarily operating the key K^9 whereby the simplex circuits extending to the substation A are reestablished.

In setting up the charge at the substation A, the operator may make a mistake in operating the calling device S′ and desire to release the mechanism. In order to do this, she will operate the master refund key K^7 and then the ringing key K^5. These operations bring about the energization of the high resistance relay 49 in bridge of the trunk conductors 90 and 91 in the trunk circuit D. Upon operating, relay 49 opens the simplex circuit extending to the transmission repeater R. Relay 109 therein deenergizes to open the simplex circuits extending to the substation A. The relay 54 in the trunk circuit D deenergizes and allows high voltage current to flow over the trunk conductors 90 and 91. The high resistance relay 102 in the transmission repeater now operates to project high voltage refunding current out to the substation A whereby the polarized magnet 419 is operated to release the toll assessing mechanism in a manner already described. To against set the toll assessing device the operator momentarily operates the key K^9 and proceeds in the same manner as before.

Attention is directed to the fact that each time a coin is deposited the escapement magnet 410 at substation A is operated to allow the ratchet wheel 423 to release one step. The pointer 435 is attached to the ratchet wheel and consequently at all times is opposite the amount the subscriber has yet to deposit before he is able to obtain the desired connection. This of course tends to lessen the number of disputes that might otherwise arise.

The release of the main connection over the toll service trunk is brought about by the removal of the plug P′ from the jack J′. At least this is true if the called subscriber has replaced his receiver. In order to explain this operation more fully it will be assumed that the plug P′ is removed from the jack J′ before the subscriber at substation A has hung up. By removal of the plug P′ from the jack J′ the circuit of the sleeve relay 50 is opened and this relay deenergizes to

connect the high resistance relay 70 in bridge of the conductors 90 and 91. The relay 71 does not denergize at this time as its locking circuit remains intact. The busy lamp L^2 is thus maintained lighted to indicate that the associated trunk line is busy. Now, when the called subscriber replaces his receiver the relay 104 in the repeater R is deenergized and the line relay 160 of the toll first selector 1E is again connected to the trunk conductors 90 and 91, as was explained hereinbefore in connection with the control of the supervision. The effect of this is to energize the relay 70 in the trunk circuit D. Relay 70, upon energizing, at its armature 72 opens the locking circuit of the relay 71. Upon retracting its armatures, the latter relay opens the circuit of the busy lamp L^2 and at its armature 73 removes the relay 70 from in bridge of the trunk conductors 90 and 91. The line relay 160 of the selector 1E now deenergizes to open the circuit of the associated slow acting relay 161 at armature 167, and at armature 166 opens the operating circuit extending to the connector H. The slow acting relay 161, upon energizing, completes the circuit of the release magnet 183 in multiple with the relay 164 at armature 169, and at armature 168 removes ground from the release trunk conductor 207 thereby allowing relay 303 in the connector H to deenergize and also the switching relay 215 of the second selector 2E. Relay 164 in the selector 1E is energized in multiple with the release magnet 183 and operates to open a point in the circuit of the upper winding of the line relay 160 at armature 175, and at armature 176 to open a point in the locking circuit of the relay 165 so as to prevent relay 165 from energizing in case the switch wipers during the release should encounter any bank contact sets associated with busy trunk lines. At the connector H, the relay 303, upon deenergizing, opens the circuit of the relay 302. The latter relay, upon retracting its armature 327, closes the circuit of the release magnet 309. In this manner, the connector H is restored to normal. As mentioned before, the retraction of armature 168 on the slow acting relay 161 in the toll first selector 1E also opens the holding circuit of the switching relay 215 of the second selector 2E. The latter relay deenergizes to restore this selector to normal by closing the circuit of the usual release magnet. Upon the selector 1E restoring to normal, the electro-polarized relay 105 in the transmission repeater R which has been maintained energized by ground through off normal spring 186 and its working contact, deenergizes to restore certain circuits in the transmission repeater R. In this manner all the apparatus used in the connection is restored to its normal position.

Returning now to the operation of the connector H when engagement is made with the bank contacts 390–393, inclusive, associated with the line of the substation A, it will be assumed that this line is busy. Under these conditions, there will be a ground potential present upon the test contact engaged by the test wiper 362 and a circuit will be completed for the test relay 307. Relay 307, upon energizing, prepares a locking circuit for itself at armature 344 to ground on the said test contact, this locking circuit being effective immediately following the deenergization of the slow acting relay 308, and at armature 347 connects a lead from the busy signalling machine to the lower heavy talking conductor.

Having called the digits corresponding to the called subscriber's number, the toll operator will restore her calling device key K^4 to its normal position. As the supervisory lamp L′ is not lighted at this time, the toll operator will come in on the line by actuating the listening key K^3 in order to ascertain whether or not the desired line is busy. The busy tone which was placed on the heavy talking conductor is now audible to the toll operator, and she will restore her listening key to normal and busy herself with other connections while waiting for the desired line to become idle. When the line of the substation A becomes idle, ground will be removed from the test contact 375 and the test relay 307 will be deenergized to remove the tone from the upper heavy talking conductor, and at the same time complete the circuit of the relay 303. This relay will operate to reverse the battery flow over the incoming trunk line. By the latter operation, the electro-polarized relay 105 in the repeater R is energized and operates in the usual manner to establish a locking circuit for itself and to prepare a circuit for the battery feed relay 104. Another result of the energization of the relay 105 is that battery is reversed over conductors 90 and 91 in the usual manner and the polarized relay 15 in the cord circuit O is operated to light the supervisory lamp L′. The lighting of the supervisory lamp notifies the operator that the desired line has become idle. In the connector H the relay 303 is energized and a metallic circuit projects back to the repeating coil in the transmission repeater R. The operator at the toll board noticing the operations of the lamp L′ will now operate her ringing key and the signalling current will be projected out on the called line as before described. When the called party responds, the battery feed relay 104 will be energized over the called line loop and will operate to disconnect the line relay 160 from the trunk conductors 90 and 91. The latter operation causes the polarized relay 15 in

the operator's cord circuit to deenergize to extinguish the supervisory lamp L' and notify the operator that the connection is completed. The subsequent operations in which the connection is finally completed, the coins collected or refunded, as the case may be, and the connection finally released, will take place in the same manner as was hereinbefore described.

The above is the normal operation of the connector H when engagement is made with the bank contact set associated with a busy line if this line is a private line. However, should the line of the substation A be one of the group of lines, the test contacts 391 and 392 thereof will be connected in a manner shown in Fig. 6. Fig. 6 represents a level of bank contacts in which are terminated private lines and group lines, the lines of the group being the fourth, fifth, sixth, and seventh bank contacts. These lines are all listed under one number in the directory and when connection is desired with one of these lines the wipers of the connector H will be rotated into engagement with the set of bank contacts associated with the first set of bank contacts. If this line is busy and if there is an idle line in the group, the connector H will operate to automatically select and connect with it. However, if all the lines in the group are busy, the connector will remain with its wipers in engagement with the fourth set of bank contacts, transmitting a busy signal to the calling toll operator until one of the lines in the group becomes idle. Upon this latter event, the connector will operate as previously mentioned. This operation of the connector H will now be described a little more fully. For this purpose it will be assumed that the line of the substation A is the first one of a group of lines and is busy when the connector wipers are rotated into engagement with the bank contact set comprising contacts 390–393, inclusive. As there is a ground potential present upon the test contact 392 the test relay 307 will be energized in the usual manner. As the test contacts 302 and 391 are connected together there will also be a ground potential upon the test contact 391. Following the deenergization of the slow acting relay 308, a circuit may be traced extending from grounded test contact 391, wiper 361, armature 348 and its back contact, back contact and armature 337, armature 346 and its front contact, through the winding of the stepping relay 305, and through the winding of the slow acting relay 306 to battery. Relays 305 and 306 are energized over the above circuit. Relay 305, upon operating, at armature 339 establishes a locking circuit for itself, and at armature 340 completes the circuit of the rotary magnet 310. Magnet 310 operates to advance the wipers of the switch one step into engagement with the next set of bank contacts, and at armature 337 opens the circuit of the stepping relay 305, which deenergizes opening the circuit of the rotary magnet, which deenergizes also. The energization of the slow acting relay 306 serves merely to maintain the lead from the busy signalling machine disconnected from the upper heavy talking conductor during the automatic rotary movement of the connector. If the next line of the group is busy the test relay 307 will be maintained energized and the stepping relay 305 will again operate to close the circuit of the rotary magnet 310. Magnet 310 will operate to open the locking circuit of the stepping relay and to again advance the wipers. The stepping relay 305 is deenergized to open the circuit of the rotary magnet, which deenergizes. The alternate operation of the stepping relay 305 and the rotary magnet 310 continues until the switch wipers are rotated into engagement with a set of bank contacts associated with an idle line. When the switch wipers 360–363, inclusive, are brought into engagement with a set of bank contacts associated with an idle trunk line, there will be no circuit for the test relay 307, and this relay will deenergize and a circuit is thereby completed for the switching relay 303. The subsequent operations take place in a manner similar to that already described.

The relays 370 and 373, inclusive, are associated with the test contacts of the various lines of the group and are connected in multiple with the private normal conductors extending from each test contact of the group. Therefore, as each line becomes busy the associated relays will be energized and when all the lines of the group are busy the connection between the test contacts associated with the first line of the group will be opened and should the switch wipers of the connector such as H be rotated into engagement with the first set of bank contacts, under these conditions, the connector would operate in the same manner as if engagement were made with the contact set associated with a busy private line. As soon as one of the lines in the group becomes idle the associated relay, such as the relay 373, will be deenergized and complete the connection between the test contacts 374 and 375 whereby the automatic rotary movement of the connector is initiated. The connector will then operate to select the idle line in the usual manner.

It is the usual practice in automatic telephone systems, to take the trunk lines which extend to private branch exchange from bank contacts accessible to rotary connector switches. The toll connector H is also a sotary connector and has access to certain of these trunk lines, and should the toll operator desire to connect with a subscriber in a branch exchange, she will operate her calling

device in accordance with the directory number of the private branch exchange in the usual manner. In response to the operations of the calling device, connection will set up in the same manner as was described hereinbefore, and it will be assumed that the switches 1E, 2E and H are the ones used in extending the connection to the private branch exchange trunk line. When the wipers of the connector H are brought into engagement with the bank contacts associated with the first trunk line extending to the private branch exchange, if this trunk line is busy, the connector will operate to automatically select an idle trunk line in the group. When such selection takes place, the switching relay 303 is energized and operates to reverse the battery flow over the trunk line comprising conductors 205 and 208 whereby the current flow through the electro polarized relay 105 in the repeater R is reversed. Upon energizing, relay 105 reverses the connections of line relay 160 of the first selector 1E with regard to the trunk conductors 90 and 91. This operation brings about the lighting of the supervisory lamp L′ in the operator's cord circuit, thereby notifying the operator that the desired connection is completed. The foregoing operations take place in a manner similar to that before described. However, the trunk lines extending to the branch exchange are usually provided with a signal across the trunk. This being the case, the battery feed relay 104 in the repeater R will be immediately energized over the connected trunk line and, upon operating, will close the circuit of the slow acting relay 103. The operation of the latter relay places an additional ground upon the ringing control conductor 155 and completes a local circuit for the line relay 160 of the first selector 1E. In addition the operation of the relay 103 serves to disconnect battery from the trunk conductors 90 and 91 and the bridged polarized relay 15 in the operator's cord circuit is deenergized to extinguish the supervisory lamp L′. Ordinarily the effacement of this signal serves to inform the operator that the called subscriber has answered. However, the operator will remember that she has called a private branch exchange and she will operate the ringing key K^5 in her cord circuit in the same manner as if she were signalling a local party. The alternating current relay 106 in the repeater R operates as before to complete a circuit for relay 100. Relay 100, upon operating, at armature 115 removes one ground connection from the ringing control conductor 155, but this operation is ineffective to open the circuit of the ring cut off relay 104 in the connector H, as the ringing control conductor has been grounded by the operation of the relay 103. A further result of the energization of relay 100 is that the right hand winding of the repeating coil is disconnected from the trunk conductors extending to the connector H at armature 115 and 117, and the battery feed relay 104 would be deenergized were it not for the fact that there is a local circuit completed for it which extends from ground by way of front contact and armature 122, resistance 99, armature 116 and its front contact, lower right-hand winding of the repeating coil, front contact and armature 132 and through the lower winding of relay 104 to battery. As the relays 100 and 104 are now both operated, ringing current from the generator Gen. is connected to the trunk line extending to the private branch exchange in order to operate the bridged ring down signal thereat. The subsequent operation wherein the connection is completed to the desired called subscriber in the private branch exchange, the conversation completed, the coins collected or refunded, and the connection finally released, will take place in the usual manner which need not be described.

It is sometimes necessary for the toll operator, after the connection is completed, to make an additional charge, as the called automatic subscriber may have conversed for a period of time longer than he has originally paid for. In order to describe the operation of this condition, it will be assumed that the subscriber at substation A is required to pay an additional amount for his connection. When the conversation is terminated, the operator receives the usual disconnect signal by the lighting of the supervisory lamp L′ as a result of the called subscriber replacing his receiver. The operator will collect the coins already deposited at the substation A. To do this she will operate the master collect key K^6 and then the ringing key K^5. This operation brings about the operation of the high resistance relay 102 in the repeater R whereby the coin collecting magnet 419 operates to collect the coins deposited and also re-sets the toll assessing mechanism including the ratchet wheel 423 and the pointers 435 and 436. The energization of the high resistance relay 102 in the repeater R also opens the locking circuit of the slow to operate relay 101. Relay 101, upon deenergizing, closes certain points in the previously traced simplex circuit at armatures 118 and 120. As it is necessary for the subscriber at substation A to deposit more money in the coin box, the operator will signal him by operating the ringing key K^5. This operation brings about the operation of the alternating relay 106 in the transmission repeater R. Upon operating, relay 106 closes the circuit of the relay 100. Relay 100 operates to remove ground from the ringing control conductor 155 at armature 115. These operations bring about the deenergization of the ring

cut off relay 304 in the connector H and the signalling device at substation A is automatically operated in the usual manner. When the subscriber responds by removing his receiver, the ring cut off relay is energized to disconnect the signalling circuit and the battery feed 104 in the system R again energizes. By the effacement of the supervisory lamp L' in the cord circuit O the operator is given supervision. The toll operator will now request the subscriber to deposit the additional amount which will be indicated on the toll assessing dial at the substation. In order to assess this charge the operator will momentarily operate the key K^9 as before. This operation brings about the energization of relay 54 which operates to establish the usual simplex circuits for controlling the stepping magnet 413 in the toll assessing mechanism at the paystation apparatus of the substation A. The subsequent operations wherein the coins are refunded or collected, and the connection finally released, take place in the usual manner.

The features of the invention having been described and ascertained what is considered to be new and desired to have protected by Letters Patent will be pointed out in the appended claims.

What I claim is:

1. In a telephone system, telephone lines, means for establishing a connection between said lines, paystation mechanism on one line, and mechanism at the station of said line operative after the connection is completed to visually indicate to the subscriber thereat of the charge to be placed in said paystation mechanism to pay for the connection.

2. In a telephone system, a toll board, a telephone line, automatic switches controlled from the toll board to establish a connection with said line, paystation mechanism at the station on said line, and means controlled from the toll board to operate said mechanism to notify the subscriber the amount of charge for an established toll connection.

3. In a telephone system, a local exchange equipped with a toll board, a distant exchange, trunk lines extending from said distant exchange terminating in said toll board, means including cord circuits at the toll board and automatic switches at the local exchange whereby toll lines and subscribers' lines may be connected over said trunk lines, paystation equipment at the stations on the subscribers' lines, and means whereby the toll operator may visually indicate to the subscriber on the called line the amount to be deposited in said paystation equipment to pay for established toll connections.

4. In a telephone system, a toll board, a telephone line, automatic switches controlled from the toll board to establish a connection with said line, paystation mechanism at the station on said line, means controlled from the toll board to operate said mechanism to notify the subscriber the amount of charge for an established toll connection, and means operative when various amounts are deposited in the paystation mechanism for subtracting the amount deposited from the amount set up.

5. In a telephone system, a toll board, a telephone line, automatic switches controlled from the toll board to establish a connection with said line, paystation mechanism at the station on said line, means controlled from the toll board to operate said mechanism to notify the subscriber the amount of charge for an established toll connection, means operative when a certain amount is deposited in the paystation mechanism for subtracting that amount from the amount set up, and means operative when another coin is deposited for subtracting its amount from the amount indicated so that at all times the amount set up is indicative of the amount still necessary to deposit to pay for the established connection.

6. In a telephone system, a toll board, a telephone line, automatic switches controlled from the toll board to establish a connection with said line, paystation mechanism at the station on said line, means controlled from the toll board to operate said mechanism to notify the subscriber the amount of charge for an established toll connection, and means operative as coins are deposited in the paystation mechanism for indicating to the subscriber the amount still to be deposited.

7. In a telephone system, two telephone lines, an operator's position, means controlled from said position for connecting said two lines, paystation mechanism at the station on one of said lines, means for notifying the subscriber at said station of the amount necessary to deposit in said mechanism to pay for the connection, a visual signal at said position, and means for operating said signal when the correct amount is deposited in said paystation mechanism.

8. In a telephone system, two telephone lines, an operator's position, means controlled from said position for connecting said two lines, paystation mechanism at the station on one of said lines, operator controlled electro mechanical means for notifying the subscriber at said station of the amount necessary to deposit in said mechanism to pay for the connection, and means for preventing the complete establishment of the connection until said amount is deposited.

9. In a telephone system, two telephone lines, an operator's position, means controlled from said position for connecting said two lines, paystation mechanism at the station on one of said lines, means for visually notifying the subscriber at said station of

the amount necessary to deposit in said mechanism to pay for the connection, means for preventing the complete establishment of the connection until said amount is deposited, and means for establishing the connection when said amount is deposited.

10. In a telephone system, two telephone lines, an operator's position, means controlled from said position for connecting said lines, paystation mechanism at the station on one of said lines, means controlled from said position for operating said mechanism to indicate to the subscriber thereat the amount necessary to deposit to pay for the connection, a signal at said position, and means for operating said signal when the correct amount is deposited.

11. In a telephone system, two telephone lines, an operator's position, means controlled from said position for extending a connection to each of said lines, operator controlled pay station mechanism for notifying one of the subscribers of the amount to be deposited to pay for the connection, and automatic means operative when said amount is deposited in said mechanism for connecting said two lines.

12. In a telephone system, a toll board, a telephone line, automatic switches controlled from the toll board to establish a connection with said line, paystation mechanism at the station on said line, and means including a simplex circuit connecting said mechanism with the toll board for permitting the operator to operate said mechanism to indicate to the subscriber the amount of charge for the connection.

13. In a telephone system, a toll board, a telephone line, automatic switches controlled from the toll board to establish a connection with said line, paystation mechanism at the station on said line including a device for visually indicating to the subscriber the amount which must be deposited before the connection can be completed, and operator controlled means for setting said indicating mechanism.

14. In a telephone system, a toll board, a telephone line, automatic switches controlled from the toll board to establish a connection with said line, paystation mechanism at the station on said line including a device for visually indicating to the subscriber the amount which must be deposited before the connection can be completed, operator controlled means for setting said indicating mechanism, and operator controlled means for restoring said device in case it has been improperly set.

15. In a telephone system, telephone lines, paystation equipment on each line, an operator's position, means controlled by the operator for establishing connections requiring different charges and for setting the paystation mechanism on one of the lines connected together to require the subscriber on that line to deposit a certain plurality of coins to pay the charge for the connection.

16. In a telephone system, a line, means for establishing a connection therefrom, paystation mechanism on said line, means controlled over the established connection for setting the paystation to require the deposit of a certain amount therein to pay the charge for the connection, said mechanism controlled by the deposit of only the required amount to complete the connection.

17. In a telephone system, telephone lines, paystation equipment on each line, an operator's position, means controlled by the operator for establishing connections requiring different charges and for setting the paystation mechanism on one of the lines connected together, to require the subscriber on that line to deposit a certain plurality of coins to pay the charge for the connection.

18. In a telephone system, a line, means for establishing a connection therefrom, paystation mechanism on said line, means controlled over a circuit superimposed on the established connection for setting the paystation to require the deposit of a certain amount therein to pay the charge for the connection, said mechanism controlled by the deposit of only the required amount to complete the connection.

19. In a telephone system, a line, paystation mechanism on the line, means for establishing connections of different value from the line, means in the mechanism operated a varying number of times over the established connection depending on the value of the connection, said last means restored by the deposit of coins of the proper amount or value to complete the established connection.

20. In a telephone system, a line, paystation mechanism on the line, means for establishing a connection from said line, means controlled over said established connection for setting said paystation to require the deposit of a certain amount to pay for the established connection, means at the paystation for indicating the amount required, and means for restoring the indicator and completing the established connection when the required amount has been deposited.

21. In a telephone system, a line, means for establishing a connection from said line, paystation mechanism on said line, means controlled over said established connection for setting said paystation mechanism to visually indicate the amount required for the connection, and means for establishing a talking connection when the required amount has been deposited.

22. In a telephone system, a line, means for establishing a connection from said line, paystation mechanism on said line, means

controlled over a circuit superimposed on said established connection for setting the paystation mechanism to indicate the amount of the charge for the connection, means for preventing the establishment of a talking connection until the full amount of the charge is deposited, and means for automatically completing a talking connection when the exact amount of the charge has been deposited.

In witness whereof, I hereunto subscribe my name this 20th day of June, A. D., 1922.

JOHN E. GARDNER.