Nov. 27, 1923. 1,475,613

J. WICKS

MEASURED SERVICE TELEPHONE SYSTEM

Original Filed Dec. 13, 1919 2 Sheets-Sheet 1

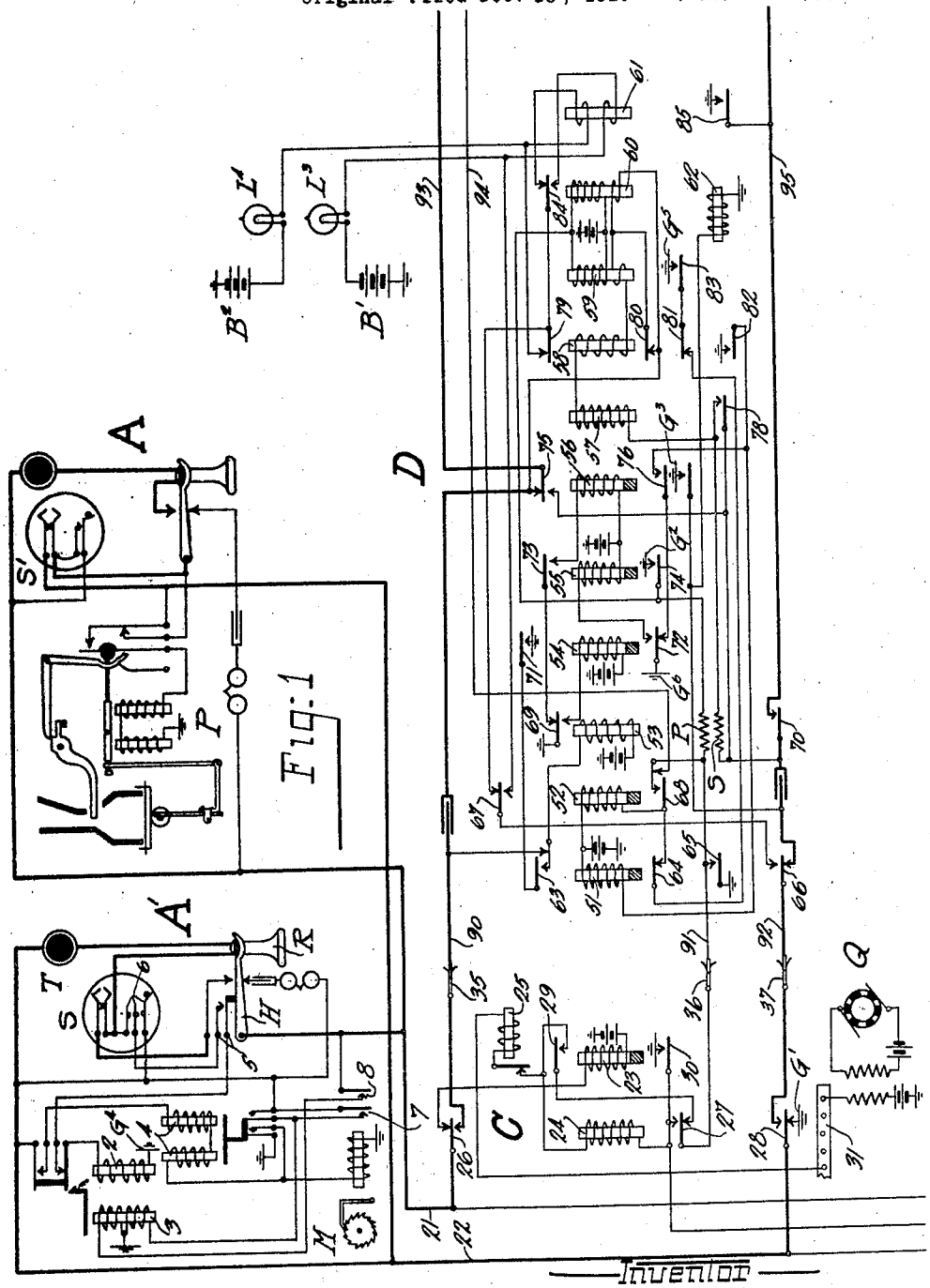

Fig. 1

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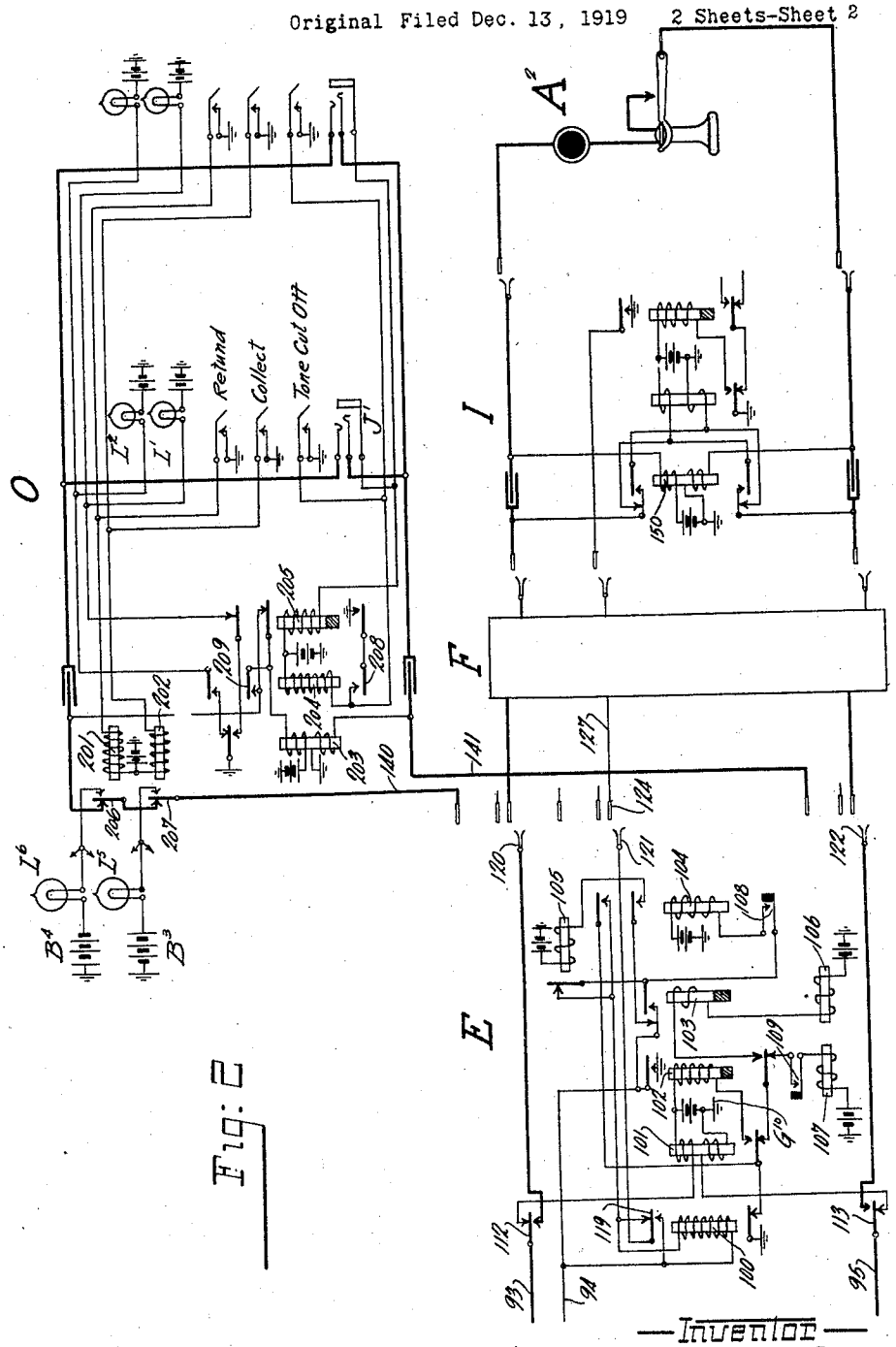

Fig. 2

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Patented Nov. 27, 1923. 1,475,613

UNITED STATES PATENT OFFICE.

JOHN WICKS, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

MEASURED-SERVICE TELEPHONE SYSTEM.

Original application filed December 13, 1919, Serial No. 344,682. Divided and this application filed April 27, 1923. Serial No. 635,060.

To all whom it may concern:

Be it known that I, JOHN WICKS, a citizen of the United States of America, and a resident of Chicago, Cook County, and State of Illinois, have invented certain new and useful Improvements in Measured-Service Telephone Systems, of which the following is a specification.

My invention relates in general to measured service telephone systems but more particularly to methods of providing measured service in automatic telephone systems; and the principal object is the provision, in an automatic system comprising well known types of pay stations and means for controlling the same automatically to collect and refund deposited coins, of means whereby the paystations may be controlled by operators in special cases, as where a subscriber calls a long distance operator and is connected directly with another subscriber in a distant exchange, this type of connection being commonly referred to as a "two number" call.

Referring to the drawings comprising Figs. 1 and 2, the general layout of the system therein disclosed may be described as follows: The two substations A and A′ shown in Fig. 1 are automatic substations which, except for the associated measured service equipment, are of the usual type and are each provided with talking apparatus and an automatic calling device or impulse sender. Substation A is provided, in addition, with a well known type of coin collecting apparatus such as is in wide use by the so called Bell Telephone Company throughout the United States. Substation A′ is provided with a meter for registering calls which is controllable by the same agencies which control the coin collecting equipment at substation A. As shown in the drawing, both substations are connected in bridge of line conductors 21 and 22. Of course, each substation may have its own individual line, and it is to be understood that the invention is not primarily a party line system; but inasmuch as the substation equipment is adapted for use on party lines if desired, the two substations have been so shown for convenience.

The line conductors 21 and 22 terminate at the exchange in the individual line switch or trunk selector C, which is of the well known rotary type where the wipers always remain on the contacts last used, and whose function is to extend the line when calling via an idle trunk line to a first selector switch. One of the trunk lines to which the line switch C has access is shown extending to the first selector E, Fig. 2. The relay equipment in Fig. 1, which is indicated by reference character D, is a repeater, there being one such repeater inserted in each first selector trunk.

The first selectors are the first in the series of numerical switches, which may comprise first selectors, second selectors, and connectors, which are used to complete connections between calling and called lines. Reference characters F and I indicate, respectively, a second selector and a connector. Such switches are well understood and on this account it has not been thought necessary to show the complete circuits.

It is customary in automatic exchanges to set aside a certain level of the first selectors for calling the long distance operators, the tenth level being generally reserved for this purpose. Thus the selector E in Fig. 2, has access through its lower levels to groups of trunks extending to second selectors, one of which is the selector F, and has access through its upper or tenth level to a group of trunks extending to the long distance switch-board. One of these latter trunks is shown in the upper half of Fig. 2 as terminating in the manual equipment O which comprises a group of relays and a set of lamps, keys, and a jack multiplied at two operators' positions. Each position is supposed to be equipped with cord circuits (not shown) whereby connections can be made with the long distance lines.

In accordance with the best practice long distance connections to relatively near points where direct toll lines are available are established directly by the operator who receives the call, and the calling subscriber does not have to hang up his receiver and wait to be called back. These are the so called "two number" calls so denominated because on the single ticket, which is made out by the operator at the originating end, the only data customarily noted down is the number of the calling subscriber and the

number of the called subscriber. In the case of flat rate subscribers the tickets may be collected monthly, but in the case of measured service subscribers the charges must be assessed or collected at once, and the recording operators therefore must be provided with means whereby they can control the subscribers' meters or coin collecting apparatus. My invention provides such means, the operation of which will now be described.

Before proceeding with the explanation, reference is made to the following patents, which indicate the state of the art, and which are relied on to supplement the disclosure in the drawings:

U. S. patent to Keith, No. 1,279,352.

U. S. patent to Forsberg, No. 1,043,219.

U. S. patent to Lamb, No. 1,193,160.

U. S. patent to Keith, Erickson and Erickson, No. 815,321.

U. S. patent to Keith, Erickson and Erickson, No. 815,176.

U. S. patent to Powell, No. 1,308,553.

In order to explain the control of the meter at substation A′ by the repeater D the operation of the circuits in the establishment of a local connection will first be explained. For this purpose it will be assumed that the subscriber at substation A′ desires to obtain connection with the subscriber at substation A^2. When the receiver is removed at substation A′ a circuit is completed for the line relay 23 of the line switch C as follows: ground at G^1, resting contact of armature 28 and the said armature, line conductor 22, transmitter T, receiver R, impulse springs of calling device S, to make contact of the switch hook H and the said switch hook, line conductor 21, armature 26 and its resting contact, and the winding of the line relay 23 to battery. The line relay is energized over the above circuit and upon attracting its armature 30 completes a circuit which extends through the windings of the switching relay 24 and the stepping magnet 25 in series to battery at the tone busbar 31. At the same time relay 23 connects the test wiper 36 to the above circuit at a point midway between the switching relay and the stepping magnet. The operation now depends upon whether the trunk line with which the wipers of line switch C are associated is or is not busy. If the trunk line is busy the test contact with which the test wiper 36 is in engagement will be grounded and as a result the switching relay 24 will be short-circuited and the stepping magnet 25, being supplied with direct ground, will operate as a buzzer to advance the switch wipers step-by-step in search of an idle trunk line. However, we may assume that when the call was initiated the wipers of the line switch C were standing as shown in the drawing, in connection with the trunk line extending to the first selector E, and we may assume furthermore that this trunk line was idle. Under these circumstances when the receiver is removed the energization of the line relay 23 is followed immediately by the energization of the switching relay 24, which is of sufficiently high resistance to prevent the energization of the stepping magnet; and as a result of its energization the switching relay disconnects the line conductors 21 and 22 from the windings of the line relay and from ground, respectively, and extends them by way of armatures 26 and 28 and their working contacts, wipers 35 and 37, trunk conductors 90 and 92, and upper and lower armature contacts controlled by the relay 51 of the repeater D to the windings of the relay 53 and the impedance coil 62, respectively.

Following the extension of the line as above described by the operation of the line switch C, the line relay 53 of the repeater D is energized over the line circuit and at its armature 69 completes a circuit for the slow acting relay 54. Upon attracting its armature 72, relay 54 completes a circuit for the slow acting relay 55, which upon energizing completes a holding circuit for the switching relay 24 of line switch C as follows: ground at G^2, working contact of armature 74 and the said armature, winding p of the induction coil, conductor 91, test wiper 36, armature 27 and its working contact, winding of the switching relay 24, and the winding of the stepping magnet 25 to battery.

It is understood that the above holding circuit is established before the slow acting line relay 23 has had time to deenergize. The operation of armature 74 of relay 55 also closes a circuit for the polarizing windings of the electro-polarized relays 59 and 60; but the polarizing windings are of high resistance and few turns, and the said relays therefore are not operated at this time.

When the line relay 53 of the repeater was energized it closed at its armature 70 a circuit for the line relay 101 of the first selector E which may be traced as follows: ground at G^{10}, lower winding of the line relay 101, resting contact of armature 113 and the said armature, trunk conductor 95, working contact of armature 70 and the said armature, windings of the induction coil, winding of relay 57, winding of relay 58, lower winding of relay 59, armature 80 and its resting contact, resting contact of armature 75 and the said armature, trunk conductor 93, armature 112 and its resting contact, and the upper winding of line relay 101 to battery. Upon energizing, the line relay completes a circuit for the slow acting release relay 102 in the usual manner, which upon energizing in turn, connects ground to the release trunk conductor

94, at its upper armature, and at its lower armature prepares a circuit for the vertical magnet 106.

The apparatus at the central office is now ready for the reception of the plurality of series of impulses which the calling subscriber at substation A′ now proceeds to generate through the medium of the calling device S in order to complete the desired connection. Before considering the operation of the selector in response to the first series of impulses the operation which takes place at the substation A′ will be briefly explained. When the calling device dial is rotated in accordance with the first digit, as soon as it leaves its normal position the shunt springs 6 are closed, with the result that the transmitter T and the receiver R are short-circuited as usual, and with the additional result that a circuit is completed for the relay 2 as follows: ground at G^4, winding of the said relay 2, lower set of contact springs controlled by the said relay, switch hook contact springs 5, middle and upper shunt springs, impulse springs, and make contact of the switch hook H and the said switch hook to the line conductor 21, whence it extends to the exchange and by way of the upper conductor of the line circuit thru the winding of the line relay 53 of the repeater D to battery. Upon energizing, relay 2 locks itself mechanically and breaks its own circuit. By the closure of its upper set of contacts, relay 2 also completes a connection from the line conductor 22 thru the windings of the polarized relay 4 and the operating magnet of the meter M to ground. Thus the meter is put in condition to be operated subsequently to register the call. It should be stated that the circuit thru the polarized relay 4 and the meter magnet is of very high resistance and does not affect the transmission of impulses, or the talking qualities of the circuit.

Returning now to the consideration of the operation of the central office equipment, when the calling device is operated in accordance with the first digit of the number a series of interruptions is produced in the line circuit, thereby producing a series of deenergizations of the line relay 53. At its armature 69 and resting contact thereof the line relay 53 closes a circuit each time it deenergizes for the slow acting relay 56, which relay is energized the first time its circuit is closed and remains energized while relay 53 is operating responsive to the interruptions in the line circuit. In its energized position relay 56 connects ground G^3 to the lower line conductor, thereby short circuiting the impedance coil 62; and also connects the trunk conductors 93 and 95 over a direct path which includes only the armature 75 and its working contact and the armature 70 of the line relay 53 and its working contact. By this means all unnecessary resistance and impedance is removed from the circuits over which impulses are transmitted to operate the selector E, and the other switches to be used in establishing the connection.

Responsive to the interruptions produced in its circuit by the intermittent retractions of armature 70 of the line relay 53, the line relay 101 of the first selector E is intermittently deenergized a plurality of times and at each deenergization sends an impulse thru the vertical magnet 106 to battery. The slow acting relay 103 which is in series with the vertical magnet, is energized by the first impulse and retains its armature attracted while the vertical magnet is being operated. At the first upward movement of the shaft a circuit is completed from the grounded release conductor 94 thru the make contact of relay 103 and thru the now closed off normal contacts 108 to the stepping relay 104, which upon energizing, closes a locking circuit for itself at its upper pair of contacts. At the end of the vertical operation of the switch the slow acting relay 103 is deenergized, thereby closing a circuit for the rotary magnet 105, this circuit being readily traceable by way of the lower set of contacts controlled by the stepping relay 104, which is now energized. Upon energizing, the rotary magnet operates to advance the wipers 120—122, inclusive, into engagement with the first set of bank contacts in the level opposite which they were raised in the vertical movement of the switch, and also breaks the locking circuit of the stepping relay 104. Relay 104 therefore deenergizes and breaks the circuit of the rotary magnet, which accordingly retracts its armature and again closes the interrupter contact controlled thereby. The operation now depends upon whether the test wiper 121 is in engagement with a busy test contact or not. If the test contact with which the wiper 121 has made connection is busy it will be grounded and the stepping relay 104 will again be energized over a circuit including contacts controlled by the switching relay 100, the interrupter contact controlled by the rotary magnet 105, and the off-normal springs 108. The energization of the stepping relay 104 results in another closure of the circuit of the rotary magnet, which advances the wipers into engagement with the next set of bank contacts. This operation by which the stepping relay 104 and the rotary magnet 105 are alternately energized and deenergized takes place very rapidly, and will continue until the test wiper 121 arrives at a non-busy and ungrounded test contact. Assuming that the wipers of the switch were raised opposite to the level in which the

terminals of the trunk line extending to the second selector F are located, and assuming also that this trunk line is the first idle trunk line in the level, then when the test wiper 121 arrives at test contact 124 it will find no ground potential and the stepping relay 104 will not again be energized. Instead, the switching relay 100, which was connected in series with the stepping relay 104 at the first upward movement of the shaft and which until now has remained short-circuited, will energize with the result that the trunk conductors 93 and 95 are disconnected from the windings of the line relay 101 and are extended by way of armatures 112 and 113 and wipers 120 and 122 to the line relay (not shown) of the second selector F. The line and release relays of the second selector are accordingly energized over the line in the usual manner and the latter relay closes the usual holding circuit which extends by way of release trunk conductor 127, test contact 124, test wiper 121, armature 119 and its working contact, winding of the switching relay 100, interrupter contact of the rotary magnet, off normal springs 108, and the winding of stepping relay 104 to battery. The latter relay remains inoperative because of the high resistance of the switching relay. It will be observed that the release trunk conductor 94, which is grounded at the repeater D, also supplies ground to the holding circuit just described. This is of no particular importance in the present case but is essential in case the selector E is used to call the long distance switch board, the trunks to which are not provided with release trunk conductors.

The subscriber at substation A′ will now operate his calling device in accordance with the remaining digits in the called number. Responsive to interruptions produced in the line circuit, and repeated by the repeater D, the sceond selector F and the connector I are successively operated and the connection is thereby completed to the called substation A^2. The operation of these switches is well known and has been described in the publications previously referred to and hence will not now be explained in detail. Upon the completion of the connection suitable ringing apparatus is automatically operated to signal the subscriber at substation A^2. When the receiver is removed from the hook a circuit is completed for the back bridge relay 150 of the connector I and this relay upon energizing reverses the direction of current flow in the incoming trunk line in the usual and well known manner. The effect of this reversal of current at the repeater D will now be considered. It has been previously explained that the bridge across the trunk conductors 93 and 95 includes the relays 57, 58, and the lower winding of electro-polarized relay 59. The usual flow of current thru the bridge from the line relay of the switch ahead is sufficient to energize relay 57 but not relay 58, which latter relay is of low resistance and is also marginally adjusted. Also, until the current is reversed in the trunk line by the response of the called subscriber, the windings of the electro-polarized relay 59 are in opposition and this relay remains inoperative. When the current is reversed however the two windings assist each other and relay 59 is operated to close a circuit for the slow acting relay 52 as follows: ground at G^5, working contact of armature 83 and the said armature, armature 81 and its resting contact, armature 64 and its resting contact, and the winding of relay 52 to battery. Upon energizing, relay 52 establishes a locking circuit for itself at its armature 68, and at its armature 67 prepares a circuit over which the high voltage battery B′ may be connected to the trunk conductor 92.

When the conversation is finished both subscribers will replace their receivers. When the receiver is hung up at substation A′ the energizing circuit of the line relay 53 of the repeater D is permanently opened and the said line relay is deenergized to open the circuit of the slow acting relay 54 and also the bridge across the trunk conductors 93 and 95. As a result of the latter operation the selector and connector switches used in the establishment of the connection are released in the usual and well understood manner. The breaking of the circuit of the slow acting relay 54 is followed by the deenergization of this relay which thereupon breaks the circuit of the slow acting relay 55 at its armature 72, and at the resting contact of the same armature closes a circuit for the relay 51 as follows: ground at G^6, armature 72 and its resting contact, armature 76 and its working contact (relay 56 was energized by the retraction of armature 69 of the line relay), and the winding of the slow acting relay 51 to battery.

The above described circuit is closed only for a short interval, for the circuit of relay 55 has already been broken and when this relay deenergizes it breaks the circuit of relay 56 which in turn will deenergize to break the circuit of the slow acting relay 51. While it is energized relay 51 connects ground to conductor 91 by means of its armature 65 thereby preventing the line switch C from releasing; and at its armature 66 connects the lower trunk conductor 92 by way of the working contact of the said armature, armature 67 and its working contact, and the lamp L^3 to the positive pole of the high voltage battery B^1. Current from battery B^1 will now flow for a brief interval over the trunk conductor 92, line conductor 22, thru the contact springs controlled by

relay 2 at the substation A′, thru the winding of the polarized relay 4, and thru the winding of the meter magnet to ground. The direction of the current flow as above described is such that the polarized relay 4 is not operated, but the meter magnet is energized and attracts its armature to register a call. At the same time the meter magnet also closes its contact springs 7, whereby the line conductor 22 is connected over another path by way of the lower winding of relay 3 to ground. Relay 3 is accordingly energized in parallel with the meter magnet and upon attracting its armature releases or unlocks the armature of relay 2, with the result that the circuit thru the polarized relay 4 and the meter magnet is broken. The substation A′ is now in its original condition as it was before the call was initiated, except that the meter M has been operated to register the call. At the repeater D all relays have been deenergized except relays 51 and 52, the latter relay being locked to the grounded conductor 91 which is maintained grounded at armature 65 of relay 51. When relay 51 deenergizes, therefore, following the breaking of its circuit by the deenergization of relay 56, relay 52 will be deenergized also and the repeater will be in its normal condition.

Having described the operation in the case where the called man answers his telephone, I will now describe how the meter is prevented from registering and at the same time is disconnected from the line when the receiver is replaced at substation A′ after an unsuccessful connection. It will be assumed that the connection has been extended as before thru the medium the repeater D, first selector E, second selector F, and the connector I to the line of substation A^2, and it will be assumed further that no response was secured and that finally the receiver was replaced at substation A′. In this case, since the called subscriber did not answer, the electro-polarized relay 59 and the slow acting relay 52 will not be energized, and when the slow acting relay 51 is operated following the replacement of the receiver, the high voltage battery B^2 instead of battery B^1 will be connected to the trunk conductor 92 as follows: Battery B^2, lamp L^4, resting contact of armature 79 and the said armature, resting contact of armature 67 and the said armature, and the working contact of armature 66 and the said armature to conductor 92. Current from battery B^2 will now flow over the line conductor 22 and thru the polarized relay 4 and the magnet of meter M to ground as before, except that now the flow of current is in the opposite direction and the polarized relay 4 will be operated. It is well known that a polarized relay is extremely sensitive and will operate faster than a magnet having a heavy armature such as the magnet of the meter M. The polarized relay 4 therefore operates slightly before the meter magnet and at its left hand pair of contacts short-circuits the latter to prevent its energization, while at its right hand pair of contacts the line conductor 22 is connected thru the lower winding of relay 3 to ground. Relay 3 is therefore operated as before to open the circuit thru the polarized relay 4 and the meter magnet, whereupon the substation will have been restored to normal condition. The meter M has not been operated in this case to register a call, and should not have been, for the connection was unsuccessful.

I will now describe briefly the process of obtaining a so called "two number" connection in order to explain how the meter at substation A′ is controlled by an operator. It will be assumed that the subscriber at substation A′ desires to obtain connection with a subscriber at some distant point, connections to which are obtainable only with the assistance of a recording toll operator. It will be necessary then for the calling subscriber to first establish connection with the operator by calling the digit 0 on his dial, after which the operator will extend the connection to the desired line in any suitable manner. Assuming that the receiver has been removed at substation A′ and that the connection has been extended to the first selector E, when the calling device is operated in accordance with the digit 0 the selector switch is operated in the usual manner to raise its shaft step by step until the wipers 120—122, inclusive, stand opposite the tenth level of bank contacts. Thereafter the trunk selecting movement is initiated automatically as previously described and the wipers are rotated in search of an idle trunk line. Assuming that the trunk line shown in the drawing is the first trunk line found to be idle the wipers will be stepped in connection therewith, the private contacts of the O level being multipled with all corresponding O level trunks and of course are not grounded unless other selectors are occupying them, and the moment that an idle or ungrounded contact is reached the shunt circuit around relay 100 is removed, and the switching relay 100 will energize to extend the trunk conductors 93 and 95 by way of wipers 120 and 122 and conductors 140 and 141 to the upper and lower windings of the double wound line relay 203, respectively. There being no release trunk conductor extending back from the operator's position, the switching relay 100 is maintained energized by the grounded conductor 94 coming from the repeater D. Upon the extension of the line to relay 203 the said relay is energized and completes a circuit thru the lamp L^1 which is lighted to notify the operator that a call has been received. When the operator notices the signal she will insert the

answering plug of one of the cord circuits with which she is provided in the jack J^1, at the same time throwing her listening key. Operator's cord circuits and associated equipment are well known in the art and hence have not been shown, as any suitable type of such equipment may be used. When the plug is inserted in the jack, relay 205 is energized by ground over the sleeve of the cord circuit to open the circuit of the lamp L^1, and also to break the circuit thru the upper winding of the line relay 203. The result of this operation is to give the operator a distinctive audible signal indicating that the calling line is a measured service line, which is produced in the following manner. Reverting to the repeater D it will be recollected that the bridge across the trunk conductors 93 and 95 includes the secondary windings of the induction coil (unless short circuited by relay 57), and the windings of relays 57, 58, and 59 in series. Under normal conditions current flow thru the bridge is such that only relay 57 is energized, this relay having the function of short circuiting the secondary windings of the induction coil. Now when the circuit of the line relay 203 at the operator's position is broken current flow in the bridge will be interrupted entirely and relay 57 will be deenergized, thereby including the secondary windings in the circuit. It will be observed that a circuit normally exists throughout the duration of the connection which extends from ground G^2 thru the primary winding P of the induction coil and by way of trunk conductor 91, wiper 36, winding of switching relay 24, winding of stepping magnet 25, bus-bar 31, and the low resistance secondary winding of the signaling machine Q to battery. It follows that a high frequency tone is induced in the secondary windings which gives the operator an audible signal. This indicates to her that the calling line is a measured service line, and it may be stated that all such lines have their stepping magnets, such as magnet 25, of their associated line switches connected to battery at the tone bus-bar 31 instead of direct. It is necessary for the operator to know when a measured service line is calling in order that she may operate the substation meter, or collect deposited coins in the case of a pay station, at the proper time.

Having perceived the audible signal, the operator will depress the tone cut-off key momentarily thereby closing a circuit for the relay 204. Upon energizing, relay 204 locks itself at its armature 208, and at its armature 209 reestablishes the circuit extending from the line conductor 140 thru the upper winding of relay 203 to battery. As a result relay 203 and the relay 57 at the repeater D are again energized, the latter relay short circuiting the secondary windings to cut the tone off the line. The operator will now obtain the desired number from the calling subscriber and will proceed to complete the connection. Before permitting the subscribers to talk, however, the meter at substation A' must be actuated the proper number of times to pay for the call and the operator will therefore actuate the key marked "Collect" accordingly. Each time the key is actuated a circuit is closed for the relay 202, which upon energizing substitutes the lamp L^5 and high voltage battery B^3 for the upper winding of the line relay 203 and the regular exchange battery. Although direction of current flow is not changed by the above operation, it is greatly increased due to the high voltage of battery B^3, with the result that the marginal relay 58 at the repeater D is energized. The operation of relay 58 results in the removal of the short circuit from the lower winding of electro-polarized relay 60 and in the closure of the circuit of the slow acting relay 51. The lower winding of the electro-polarized relay 60 is now included in the bridge across the trunk conductors 93 and 95 and the direction of current flow is such that this relay is operated. Upon the operation of relay 51 a circuit is completed which extends from ground by way of the working contact of armature 71 and the said armature, armature 63 and its working contact and the winding of the line relay 53 to battery. The line relay 53 is thus maintained energized locally after it is disconnected from the trunk conductor 90 to prevent the release of the connection. Relay 51 also connects the battery B^1 to the line conductor 92 as follows: battery B^1, lamp L^3, lower winding of relay 61, working contact of armature 84 and the said armature, resting contact of armature 67 and the said armature, and the working contact of armature 66 and the said armature to conductor 92. Current from battery B^1 now flows over the line conductor 22 to substation A' and operates the meter M as before to register a call. The meter is not disconnected from the line, however, due to a circuit which is completed to the upper winding of the relay 3 as follows: line conductor 22, transmitter T, receiver R, impulse springs of the calling device S, make contact of the switch hook H and the said switch hook, contact springs 8, and the upper winding of relay 3 to ground. The above circuit is closed at the same time that the circuit is closed thru the lower winding of relay 3 and since this relay is differentially wound it is not energized and the armature of relay 2 is not unlocked. It follows that the meter and polarized relay 4 remain connected to the line and the meter will be actuated as many times as the operator actuates her collect key. It will be noticed

that the circuit over which the meter is operated includes the lower winding of relay 61 and in case the circuit is complete at the substation the relay 61 will energize each time that the battery B^1 is connected to the line at the repeater. As a result the conductor 95 is grounded, thereby short circuiting the lower winding of the line relay 203 at the operator's position. The line relay is accordingly deenergized and closes a circuit for the lamp L^2, the illumination of which indicates to the operator that the meter at the calling substation is being operated, because if for any reason the meter has not been connected to the line the circuit to ground at the substation would be open, relay 61 would not energize. the line relay 203 would not fall back, and the lamp would not be lighted. Although as stated this lamp indicates to the operator that the meter is being operated correctly, or rather is properly connected to the line for operation, its chief use is to indicate to the operator, when the calling line is a pay station line, that the calling subscriber has deposited a coin. Further mention of this will be made hereinafter.

Having made the proper charge for the call as above described, the operator will permit the conversation to proceed. When the subscribers have finished they will replace their receivers and a suitable means of supervision in the operator's cord is controlled in the proper manner to give the operator a disconnect signal and she will therefore pull down the connection. When the receiver is replaced at substation A' the line relay 53 of the repeater D is deenergized and as a result the selector E is restored to normal and relays 54 and 55 of the repeater are deenergized. As before explained the deenergization of these two relays brings about a temporary energization of the relay 51 of the repeater which operates to connect the battery B^2 to the conductor 92 for a brief interval, thereby bringing about the disconnection of the polarized relay 4 and the meter from the line as before explained.

In view of the foregoing explanation of the manner in which the meter at substation A' is controlled under different circumstances it is believed that it will be unnecessary to enter into a detail description of the operation of the pay station equipment at substation A. The substation A comprises an ordinary automatic telephone and a pay station of well known type which is described in the U. S. patent to Forsberg, No. 1,043,219, previously mentioned. The only change is in the circuit of the contact springs, which are so connected that the impulse springs of the calling device S' are normally short circuited, from which it will appear that it will be necessary for the subscriber to deposit a coin before he can make a call. When calls are extended to local subscribers the collection and refunding of the deposited coins is controlled automatically by the repeater D which applies either positive or negative high potential to the line to actuate the polarized magnet at the pay station to either collect or refund the coin, depending on whether the call has been answered or not. The operation is identical so far as the exchange apparatus is concerned as it is in the case where the substation A' is concerned, and in view of the fact that the operation at a pay station of this type when coins are being collected or refunded is well understood, it is believed that further description of the operation on automatic connections will be unnecessary.

When long distance connections are established with the aid of the operator, deposited coins are of course collected responsive to the actuation of the collect key by the operator which results also in the application of high voltage current of suitable polarity to the line. In case it is desired to refund deposited coins it is not necessary for the operator to take any action in order to accomplish this under ordinary circumstances because when the calling subscriber hangs up his receiver any coins which remain uncollected will be automatically refunded by the operation of the repeater D during the release of the connection. However, it may happen that the subscriber by mistake has deposited the wrong coins. In this case it will be desirable to refund the coin without requiring the subscriber to hang up his receiver, with a view to his depositing the correct coin immediately thereafter. To accomplish this the operator will actuate her key marked "Refund," thereby energizing her relay 201. As a result, the high voltage battery B^4 and the lamp L^6 are substituted for the upper winding of relay 203 and the exchange battery. This operation is similar to the operation before described whereby battery B^3 was inserted in the circuit and is followed by similar results at the repeater D, except that now, since the current flow thru the bridged relays at the repeater is in the reverse direction, the electro-polarized relay 60 will not be energized. It follows therefore that upon the energization of relay 51 battery B^2 will be connected to conductor 92 as follows: battery B^2, lamp L^4, upper winding of relay 61, resting contact of armature 84 and the said armature, resting contact of armature 67 and the said armature, and the working contact of armature 66 and the said armature to conductor 92. The current flow over line conductor 22 is now in the proper direction to operate the polarized magnet at the pay station so as to refund the coin or coins. Whether coins are being collected or refunded relay 61 is operated each time, pro-

vided of course that a coin has actually been deposited and the polarized magnet has been connected to the line, and the operator is thereby informed that collection or refunding is actually taking place, and the possibility of her being imposed upon by a subscriber who might attempt to obtain a connection without depositing a coin is prevented.

Having described my invention what I consider to be new and desire to have protected by Letters Patent will be pointed out in the appended claims.

What I claim as my invention is:

1. In a telephone system, a calling station and a line therefor extending to a central exchange, paystation equipment at said station including a polarized relay adapted to be connected to the line for controlling the collection and refunding of deposited coins, automatic switches at the exchange controllable from said station for extending a connection to an operator's position, means whereby the operator may complete the connection to a called station, current sources of opposite polarity, and means whereby the operator while maintaining the connection can connect either of said sources to the calling line to control said relay as desired.

2. In a telephone system, a calling station and a line therefor extending to a central exchange, paystation equipment at said station including a polarized magnet adapted to be connected to the line for controlling the collection and refunding of deposited coins, automatic switches at the exchange controllable from said station for extending a connection to a called station or to an operator's position at the option of the calling subscriber, current sources of opposite polarity, means operated automatically in case the connection has been extended to a called station to thereafter connect the proper one of said sources to the calling line to either collect or refund a deposited coin depending on whether the called subscriber has answered or not, manual equipment whereby a connection extended from said calling line to the operator's position may be completed to a second called line, and means whereby the operator can control the connection of said current sources to the calling line to collect or refund as desired, while maintaining the connection.

3. In a telephone system, a calling station and a line therefore extending to a central exchange, a paystation equipment at said station comprising a polarized relay connected to the line for controlling the collection or refunding of deposited coins, current sources of opposite polarity at the exchange, automatic switches and manual equipment at the exchange, a called station to which connection can be extended under the sole control of the subscriber on the calling line, a second called station to which a connection can only be extended under the joint control of said calling subscriber and the operator, means whereby after a connection has been extended to said first called line, one or the other of said sources is necessarily connected automatically to the calling line to properly operate said relay, and means whereby when a connection has been extended to the said second called line the operator is enabled to connect either one of said sources to the calling line for the same purpose while maintaining the connection.

4. In a telephone system, a substation and a line therefor extending to a central exchange, paystation mechanism including a polarized relay connected to the line when calling, sources of current of opposite polarity at the exchange for controlling the operation of said mechanism, automatic switches controlled by the subscriber at said station, an operator's equipment cooperating therewith to extend a connection to a called line, and means whereby the operator can connect either of said sources to the calling line to control said paystation mechanism as desired.

5. In a telephone system, a substation and a line therefor extending to a central exchange, paystation mechanism including a polarized relay connected to the line when calling, sources of current of opposite polarity at the exchange for controlling the operation of said mechanism, non-numeral and numeral automatic switches controlled by the subscriber at said station, an operator's equipment cooperating therewith to extend a connection to a called line, and means whereby the operator can connect either of said sources to the calling line to control said paystation mechanism as desired.

6. In a telephone system, a subscriber's line, paystation mechanism associated therewith and connected to the line when calling, sources of current of opposite polarity at the exchange, means including an automatic switch directively controlled at said station for extending a connection to an operator's position, means whereby the operator may complete the connection to a called station, means whereby the operator can connect either of said sources to the calling line to control said paystation mechanism as desired, and a signal at the operator's position actuated each time said paystation device is operated.

7. In a telephone system, a substation and a line therefor extending to a central exchange, coin collecting and refunding mechanism including a polarized relay connected to the line when calling, sources of current of opposite polarity at the exchange for controlling the operation and disconnection of said mechanism, automatic

switches controlled by the subscriber at said station, operator's equipment cooperating therewith to extend a connection to a called line, and means whereby the operator can connect either of said sources to the calling line to control said coin collecting and refunding mechanism as desired, the connection of either source being effective to disconnect said mechanism from the line, the connection of a particular one of said sources being effective to collect a coin before the mechanism is disconnected, and the connection of the other source being effective to refund the coin before the mechanism is disconnected.

8. In a telephone system, a calling station and a line therefor extending to a central exchange, paystation equipment at said station including a polarized relay adapted to be connected to the line for controlling the collection and refunding of deposited coins, automatic switches at the exchange controllable from said station for extending a connection to an operator's position, means whereby the operator may complete the connection to a called station, current sources of opposite polarity, means whereby the operator can connect either of said sources to the calling line to control said relay as desired, and a signal at the operator's position actuated during the control of said relay when a coin is being collected or refunded to notify the operator that the coin has been deposited.

9. In a telephone system, a substation and a line therefor extending to a central exchange, paystation mechanism including a polarized relay connected to the line when calling, sources of current of opposite polarity at the exchange for controlling the operation of said mechanism, automatic switches controlled by the subscriber at said station, an operator's equipment cooperating therewith to extend a connection to a called line, a repeater connected in series between two of said switches, relay means in said repeater for connecting one or the other of said sources to the calling line to collect or refund a deposited coin and circuits over which the operator can control said relay means as desired.

10. In a telephone system, a substation and a line therefor extending to a central exchange, paystation mechanism including a polarized relay connected to the line when calling, sources of current of opposite polarity at the exchange for controlling the operation of said mechanism, automatic switches controlled by the subscriber at said station, an operator's equipment cooperating therewith to extend a connection to a called line, a repeater connected in series between two of said switches, relay means in said repeater for connecting one or the other of said sources to the calling line to collect or refund a deposited coin, said relay means including two polar relays, and means including two other sources of current of opposite polarity whereby the operator can control said relay means as desired.

11. In a telephone system, a substation and a line therefor extending to a central exchange, paystation mechanism including a polarized relay connected to the line when calling, sources of current of opposite polarity at the exchange for controlling the operation of said mechanism, automatic switches controlled by the subscriber at said station to complete a connection to a called subscriber's line, an operator's equipment cooperating with certain of said switches to extend a connection to another called subscriber's line after the first connection is released, and means whereby the operator can connect either of said sources to the calling line to control said paystation mechanism as desired.

12. In a telephone system, a substation and a line therefor extending to a central exchange, paystation mechanism including a polarized relay connected to the line when calling, sources of current of opposite polarity at the exchange for controlling the operation of said mechanism, a manual switchboard, means including an automatic switch directively controlled by the subscriber at said station in accordance with a particular digit for trunking the calling line to said switchboard, operator controlled means for completing the connection to a called line, and means whereby the operator can connect either of said sources to the calling line to control said paystation mechanism as desired.

13. In a telephone system, a substation and a line therefor extending to a central exchange, a manual switchboard, means including an automatic switch directively controlled by the subscriber on said line in accordance with a particular digit to trunk said line to said board, operator controlled means for completing the connection to a called line, a paystation mechanism at the calling station, said mechanism including a polarized relay connected to the line when calling but unresponsive to the battery used for operating said switches, and means whereby the operator can transmit a high voltage positive or negative current impulse over the calling line to collect or refund a deposited coin.

In witness whereof, I hereunto subscribe my name this 23d day of April, A. D., 1923.

JOHN WICKS.