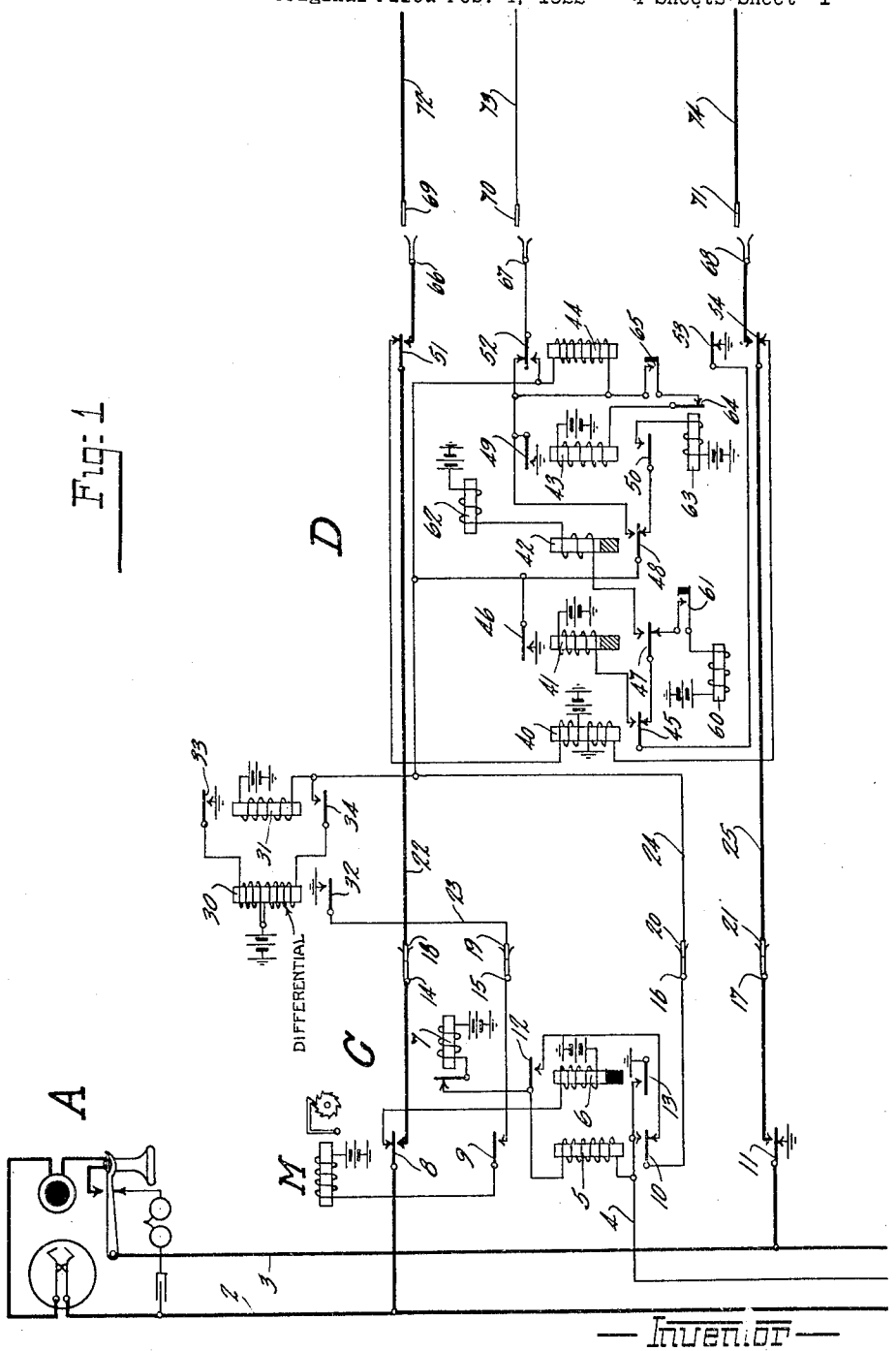
Dec. 20, 1927. 1,653,300

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ZONE METERING TELEPHONE SYSTEM

Original Filed Feb. 4, 1922 4 Sheets-Sheet 1

Fig. 1



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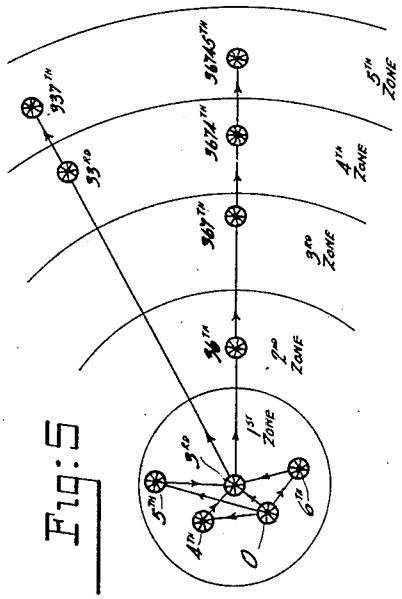


Fig: 5

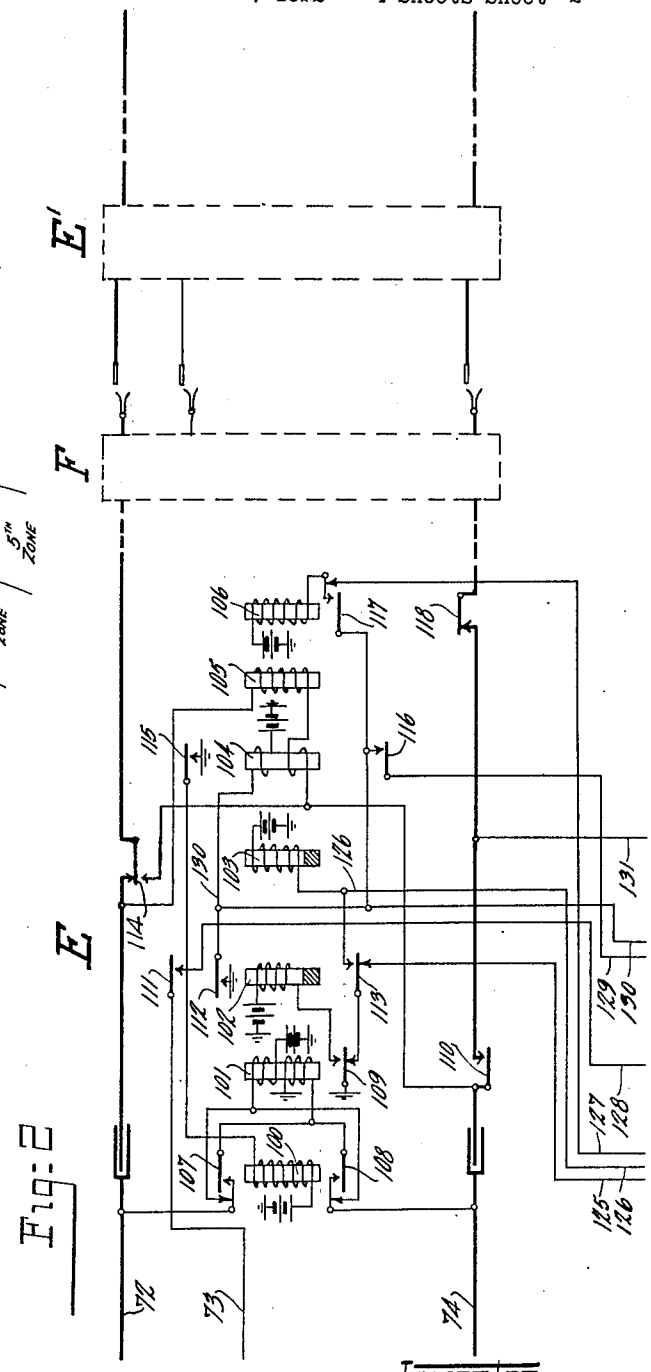


Fig: 2

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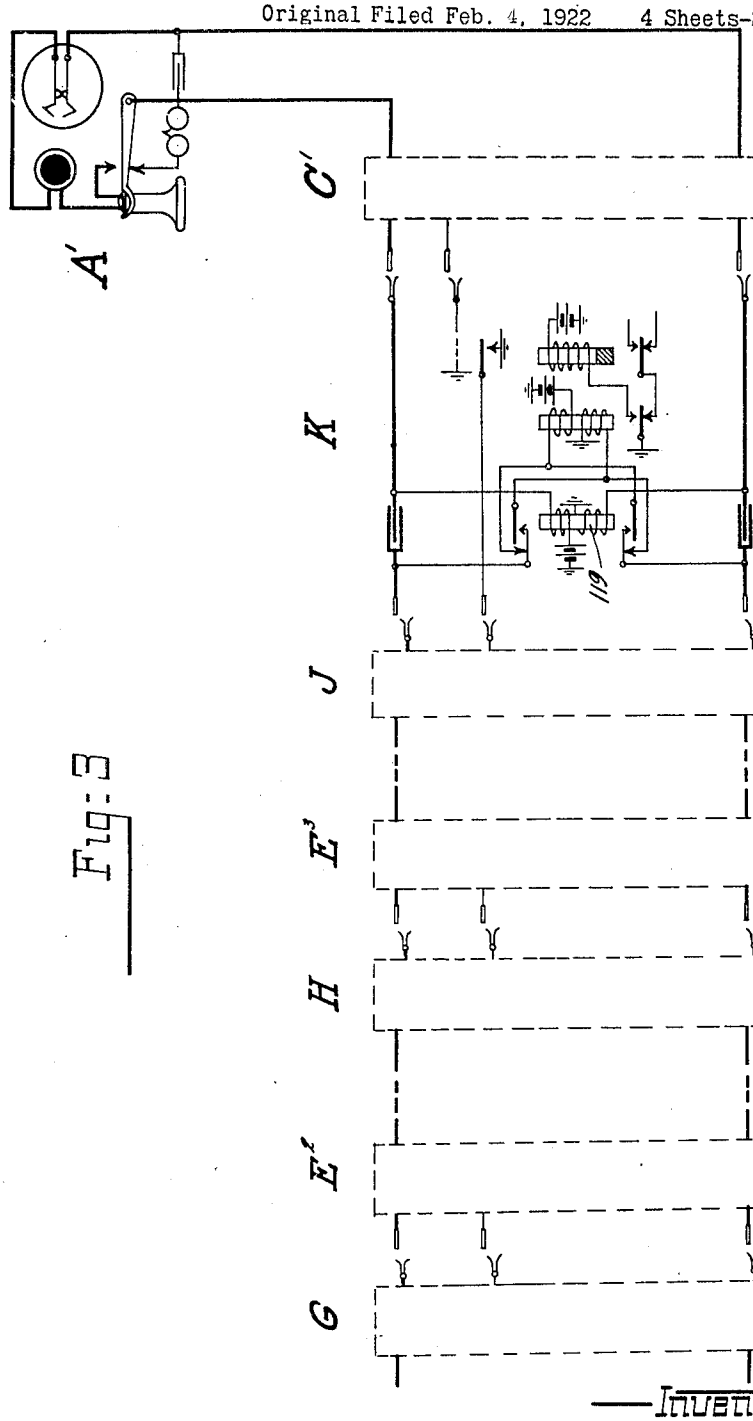


Fig. 3

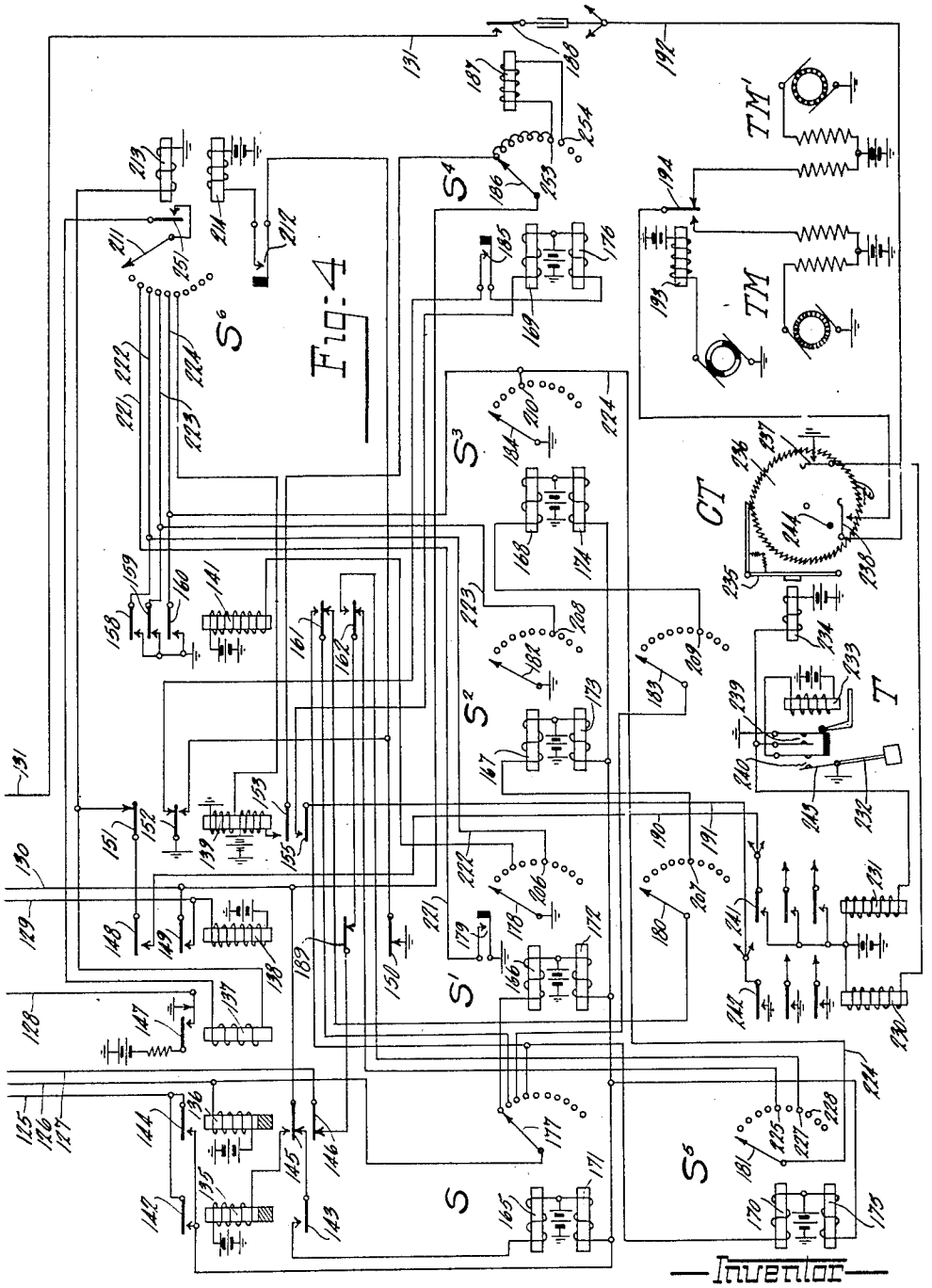
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ZONE METERING TELEPHONE SYSTEM

Original Filed Feb. 4, 1922 4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE.

FRED T. MADSEN, OF FOREST PARK, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

ZONE-METERING TELEPHONE SYSTEM.

Application filed February 4, 1922, Serial No. 534,212. Renewed May 23, 1927.

The present invention relates to zone metering telephone systems in general but is concerned more particularly with zone metering telephone systems in which calls are extended through the medium of automatic switches; and the principal object, briefly stated, is the provision of new and improved circuit arrangements for such a system in which a calling subscriber is charged for a completed call according to the zone in which the exchange of the called subscriber is located, and in which the charge is determined and assessed by means of equipment located in the exchange in which the calling subscriber's line terminates.

Another object is the provision of improved circuit arrangements whereby the initial charge made at the beginning of the conversation is repeated at intervals in case the conversation is longer than a predetermined interval.

Another object of the invention is an improved circuit arrangement whereby the subscriber's meter is operated to register the charge.

Still another object is to prevent a subscriber from calling beyond a predetermined zone.

Other objects have to do with the refinement of the various circuits used so as to make them more efficient and practical.

These objects, together with others which it is not necessary or convenient to point out now, will be pointed out and explained more fully hereinafter, reference being had to the accompanying drawings comprising Figs. 1–4, inclusive, which show by means of the usual circuit diagrams a sufficient amount of the apparatus employed in a system embodying the principles of the invention to enable the same to be understood.

Figs. 1, 2 and 3 of the drawings, when placed in order with the corresponding lines at the ends thereof in alignment represent sufficient apparatus for a complete connection from the calling substation A, Fig. 1, to a called substation A′, Fig. 3.

Fig. 4 should be placed under Fig. 2 with the corresponding lines in alignment. The apparatus shown in this drawing is used to assess the proper charge by operating the subscriber's meter a number of times when the called man answers and a number of times thereafter depending upon the length of the conversation.

Fig. 5 is a layout showing the arrangement of exchanges and some of the interconnecting trunks. Each of the exchanges is numbered in accordance with the number that must be called by a subscriber, whose line terminates in the exchange O, to reach that exchange. The 3rd exchange, for example, is reached from exchange O by dialling 3, the 33rd, by dialling 3—3, the 36th, by dialling 3—6, the 367th, by dialling 3—6—7, etc. The surrounding territory is laid out in zones determined by the concentric circles drawn around the 3rd exchange which is a switching center for certain calls.

Referring now again to Figs. 1, 2 and 4, the automatic switches shown therein, comprising the line switch C, the selector D, the repeater E, and the metering equipment in Fig. 4, are assumed to be located in the exchange O, Fig. 5; the remaining equipment in Fig. 2 comprising the selector F and the repeater E′, which are denoted by the dotted rectangles bearing those reference characters, is assumed to be located in the third exchange, Fig. 5.

In Fig. 3, the selector G and the repeater E^2 are assumed to be located in the 36th exchange; the selector H and the repeater E^3 in the 367th exchange; and the selector J, connector K, and line switch C′ are assumed to be located in the 3674th exchange.

In connection with Fig. 5, it will be noted that there are other exchanges beyond the 4th zone, but a calling subscriber is not permitted to call beyond the 4th zone, such calls being taken care of by the regular toll system. However, subscribers in the 36th exchange are permitted to call to the next exchange beyond the 3674th and since all calls going from the 36th exchange to the one next in order which is the 367th take the same group of trunks, special means must be provided to prevent a calling subscriber from calling into the 5th zone or even further in case he knows or can find out what number to call in order to reach the desired subscriber. This is prevented by making a discrimination amongst the various digits dialed after the 4th zone is reached, as will appear more fully hereinafter.

The calling substation A, Fig. 1, is an ordinary automatic substation, having the usual talking, signalling, and switch controlling instrumentalities. The substation A′, Fig. 3, is an exact duplicate of the substation A.

The line switch C, Fig. 1, in which the line of substation A terminates, is mechanically of the usual rotary type in which the wipers have no normal position and move in a forward direction only. The relay 6 has a copper collar in order to make it slow acting. This copper collar, however, is placed on the armature end of the relay, rather than on the heel end, in order to make it somewhat slow to pull up, as well as slow to fall back. This difference is indicated in the drawing by showing the copper slug in solid black instead of shaded. The line switch C′, Fig. 3, which is denoted by the dotted rectangle bearing that reference character is assumed to be an exact duplicate of the line switch C.

The selector D, Fig. 1, is an automatic switch of the usual vertical and rotary type in which the bank contacts are arranged in horizontal rows or levels. The circuits of this switch are shown complete and will be explained fully hereinafter. The selectors F, G, H and J, which are denoted by dotted rectangles, Figs. 2 and 3, may be exact duplicates of selector D, Fig. 1, with the exception that, since these latter switches are incoming selectors, the release trunk conductors, such as the release trunk conductor 24 of the selector D, are omitted.

The repeater E, Fig. 2, with the exception of the addition of cut off relay 106, is substantially identical with a great many of the automatic repeaters now in common use. The functions of repeaters are well known and do not need to be dwelt upon at this time. The circuits of this repeater will be explained in the course of the specification. Each of the repeaters E′, E² and E³, which are denoted by dotted rectangles, Figs. 2 and 3, are assumed to be identical with the repeater E.

The metering equipment shown in Fig. 4, with the exception of the common timing devices and tone machine shown in the lower part of the drawings, is individual to the repeater E, and is composed of the group of relays shown, together with a plurality of so called minor switches, comprising switches S–S⁶, inclusive. Each of these switches is of simple construction and carries one or two wipers, depending upon its function, and has movement in one plane only, being operated by a single magnet and restored to normal by a single other magnet. It is with the equipment on this sheet, together with its combination with the remaining part of the equipment, that the invention is chiefly concerned.

The timing device T, shown in the lower part of Fig. 4, is essentially an electromagnetically operated pendulum, being arranged to close an external circuit once during each cycle of two swings. The cumulative time switch CT, associated with the timing device T, is arranged to close its contacts at intervals which are directly proportional to the number of teeth thereon. The operation of these devices will be explained fully hereinafter.

The apparatus, having been described more less in general, will now be described in connection with a detailed description of its operation. For this purpose it will be assumed that the subscriber at substation A, Fig. 1, whose line terminates in the exchange O, Fig. 5, desires to converse with the subscriber at substation A′, Fig. 3, whose line terminates in the 3674th exchange, Fig. 5, and whose number, when called from the exchange O is 3,674,821. When the receiver is removed at substation A, a circuit is closed over line conductors 2 and 3 for line relay 6 of the line switch C. Line relay 6, upon energizing, places ground upon private normal conductor 4 at armature 13, thereby closing a circuit for switching relay 5 and stepping magnet 7 in series, and at armature 12 connects test wiper 16 to the circuit at a point between switching relay 5 and stepping magnet 7. The operation now depends upon whether the trunk, upon which the wipers of the line switch are standing, is busy or idle. If it is idle there is no ground potential upon the test contact thereof and switching relay 5 energizes immediately. On the other hand, if it is busy the test contact thereof is grounded; switching relay 5 is short circuited; and stepping magnet 7 which interrupts its own circuit is operated in the manner of a buzzer to advance the switch wipers 14–17, inclusive, in search of an idle trunk. Assuming that the trunk comprising conductors 22–25, inclusive, is the first one found to be idle, switching relay 5, being no longer short circuited after the wipers 14–17, inclusive, arrive upon bank contacts 18–21, inclusive, energizes in series with stepping magnet 7. Stepping magnet 7, however, does not energize at this time on account of the high resistance of switching relay 5. Switching relay 5, upon energizing, connects the meter M at armature 9, by way of wiper 15, bank contact 19, and trunk conductor 23, to armature 32 of the meter operating relay 30; opens the test circuit and grounds the test wiper, thereby making a seized trunk busy immediately, at armature 10; and at armatures 8 and 11 disconnects the line conductors 2 and 3 from the winding of line relay 6 and from ground, respectively, and extends them by way of the working contacts of these armatures, wipers 14 and 17, bank contacts 18 and 21, conductors 22

and 25, and armatures 51 and 54 to the upper and lower windings of line relay 40 of the selector D. Line relay 40, upon energizing over the calling subscriber's loop, closes a circuit for release relay 41 at its armature 45. Release relay 41, upon energizing, opens a point in the circuit of release magnet 60 and prepares a circuit for vertical magnet 62 at armature 47, and at armature 46 places ground upon release trunk conductor 24, thereby completing the usual holding circuit for switching relay 5 of the line switch C before the slow acting line relay 6 has had time to deenergize.

When ground is placed upon release trunk conductor 24, a circuit is closed for relay 31, and the said relay, upon energizing, closes a circuit for the upper and lower windings of metering relay 30 at armatures 33 and 34. Relay 30, however, being differentially wound, does not energize at this time.

The calling subscriber now operates his calling device in accordance with the first digit 3 in the desired number, thereby producing three interruptions in the circuit of line relay 40 of the selector D. Upon deenergizing, in response to each of these interruptions, line relay 40, closes at armature 45 the following circuit: From ground by way of the resting contact of armature 53 and said armature, armature 45 and its resting contact, armature 47 and its working contact, relay 42, and vertical magnet 62 to battery. By the operation of the vertical magnet, the switch wipers 66–68, inclusive, are raised opposite the third level of bank contacts. Relay 42 is energized in series with vertical magnet 62 and, being slow acting, retains its armature 48 attracted throughout the series of interruptions, and upon the closure of off normal contacts 65, which occurs upon the completion of the first vertical step, completes a circuit for stepping relay 43. Stepping relay 43, upon energizing, closes a locking circuit for itself at armature 49, and at armature 50 prepares a circuit for the rotary magnet 63.

At the end of the vertical movement, slow acting relay 42 deenergizes, thereby completing a circuit for rotary magnet 63 including armatures 46, 48 and 50. Rotary magnet 63, upon energizing, advances the wipers 66–68, inclusive, into engagement with the first set of contacts in the third level, at the same time opening the circuit of stepping relay 43 at interrupter contacts 64. Stepping relay 43, upon deenergizing, opens the circuit of rotary magnet 63 at armature 50. Rotary magnet 63, upon deenergizing, closes its interrupter contacts 64 again. If the trunk terminating in the first set of contacts is idle, switching relay 44 energizes immediately, but if the trunk is busy there is a ground potential on the test contact thereof, switching relay 44 is short circuited, and stepping magnet 43, upon energizing, closes the circuit of rotary magnet 63, whereupon the wipers are advanced into engagement with the second set of contacts. This alternate operation of rotary magnet 63 and stepping relay 43 continues until an idle trunk is reached.

Assuming that the trunk comprising conductors 72–74, inclusive, is the first one found to be idle, switching relay 44, being no longer short circuited when the switch wipers arrive upon the bank contacts 69–71, inclusive, energizes over the following circuit: From ground by way of the working contact of armature 46 and said armature, switching relay 44, off normal contacts 65, interrupter contacts 64, and stepping relay 43 to battery. Stepping relay 43, however, does not energize at this time owing to the high resistance of switching relay 44. Switching relay 44, upon energizing, disconnects ground from armature 45 of line relay 40, at armature 53; opens the test circuit and places ground on test wiper 67, thereby making the seized trunk busy immediately, at armature 52; and at armatures 51 and 54 disconnects trunk conductors 22 and 25 from the windings of line relay 40 and extends them by way of the working contacts of these armatures, wipers 66 and 68, bank contacts 69 and 71, trunk conductors 72 and 74, and the normally closed contacts controlled by armatures 107 and 108 to the upper and lower windings, respectively, of line relay 101 of the repeater E. Line relay 101, upon energizing, closes the circuit of the slow acting release relay 102 at armature 109. Release relay 102, upon energizing, prepares a circuit for slow acting relay 103 at armature 113; places ground on conductor 130 at armature 112; and at armature 111 places ground on release trunk conductor 73 by way of conductor 128, which conductor is grounded by way of the normally closed contacts controlled by armature 147, Fig. 4. The placing of ground upon release trunk conductor 73 closes the usual holding circuit for switching relay 44 of the selector D and switching relay 5 of the line switch C before the slow acting relay 41 of the selector D has had time to deenergize.

In the repeater E, as a further result of the energization of line relay 101, it places a bridge across the conductors of the trunk extending to the selector F, at armature 110, as follows: From the lower conductor of the said trunk, by way of armature 118 and its resting contact, working contact of armature 110 and said armature, lower winding of electropolarized relay 104, impedance 105, and armature 114 and its resting contact, to the upper conductor of the said trunk. In response to the closure of this bridge, the line and release relays (not shown) of the selector F energize, thereby preparing the

switch for operation in the usual manner. It will be noted that current is now flowing through both the upper and lower windings of electropolarized relay 104. The said relay is not energized at this time, however, owing to the fact that the current flowing in either winding is in a direction opposite to that flowing in the other winding. Neither will the relay energize if one winding is opened because neither winding alone is able to energize the relay.

The calling subscriber, having called the first digit 3 by which means he extended a connection to the selector F, Fig. 2, which is located in the third exchange, Fig. 5, now operates his calling device in accordance with the second digit 6 in the desired number, thereby producing six interruptions in the circuit of line relay 101 in the repeater E. Each time line relay 101 deenergizes in response to one of these interruptions, it opens the bridge across the trunk line leading to the selector F at armature 110, thereby producing six interruptions in the circuit of the line relay of the selector F. Slow acting relay 103, the circuit of which is closed at armature 109 upon each deenergization of line relay 101, is maintained energized throughout the series of interruptions and at armature 114 shifts the bridge across the conductors of the trunk leading to the selector F so that it includes a more direct path which is exclusive of the impedance 105 and the lower winding of electropolarized relay 104. This is the usual expedient made use of in order to obtain first class switch control.

In response to the six interruptions produced in the circuit of its line relay, the selector F in the 3rd exchange raises its shaft and wipers until the latter stand opposite the 6th level of bank contacts and, upon the termination of the series of interruptions, rotates its wipers and picks out an idle trunk leading to the 36th exchange, Fig. 5, which trunk we shall assume is the one controlled by the repeater E′. That being the case, the repeater E′, upon being seized, prepares itself for operation in the usual manner and at the same time closes a bridge across the conductors leading to the selector G in the 36th exchange, whereupon the said selector prepares itself for operation in the usual manner.

The calling subscriber now operates his calling device in accordance with the third digit 7 in the desired number, whereupon the seven interruptions produced are repeated from the repeater E to the repeater E′ and thence to the selector G in the 36th exchange, and as a result the selector G raises its wipers to the seventh level and picks out an idle trunk, which trunk we shall assume is the one extending to the 367th exchange, Fig. 5, and controlled by the repeater E^2. That being the case, the repeater E^2 and also the selector H, in the 367th exchange, with which the repeater E^2 is directly associated, are prepared for operation in the usual manner.

In response to the calling of the next digit 4, the four interruptions produced by the calling subscriber's calling device are repeated from the repeater E to the repeater E′ and from thence to the repeater E^2 which repeats them to the incoming selector H in the 367th exchange. As a result, the selector H raises its shaft and wipers to the 4th level and rotates them to pick out an idle trunk leading to the 3674th exchange, Fig. 5, which trunk we shall assume is the one controlled by the repeater E^3. That being the case, the repeater E^3 and also the selector J, which is located in the 3674th exchange, are prepared for operation in the usual manner.

In response to the calling of the next digit 8 in the desired number, the eight interruptions produced are repeated from the repeater E to the repeater E′ and thence to the repeater E^2 and from thence to the repeater E^3, which repeats them to the incoming selector J, which raises its wipers to the eighth level and rotates them to pick out an idle connector. Assuming that the connector K is the one selected, the line and release relays thereof pull up, thereby preparing the switch for operation in the usual manner.

In response to the calling of the remaining two digits 21 in the desired number, the connector K operates first to raise its wipers to the second level and then to bring them into engagement with the first set of contacts in that level, which set is the one in which the desired line terminates. The connector K (by means of a ringing circuit which is not shown) now projects ringing current out over the called line, intermittently, thereby ringing the bridged bell at the called sub-station.

Returning now to the repeater E, Fig. 2, and the associated apparatus in Fig. 4, the operation of the metering equipment will now be explained. When relay 101 of the repeater E operates in response to the calling of the second digit 6, each time it deenergizes it transmits an impulse of current to slow acting relay 103 by way of armature 109 and its resting contact and armature 113 and its working contact, as explained hereinbefore. A branch of this circuit extends by way of conductor 126 to relay 136, Fig. 4, and another branch extends still further by way of wiper 177 of the switch S to rotary magnet 166 of the switch S′. Accordingly when the second digit 6 is dialled rotary magnet 166 of the switch S′ is operated six times, thereby bringing the wipers 178 and 180 into engagement with the 6th set of contacts, which set comprises contacts 206 and 207. Wiper 180, upon com-

ing into engagement with bank contact 207, prepares a circuit for rotary magnet 167 of the switch S^2. Wiper 178, upon coming into engagement with bank contact 206, places ground upon the second zone metering conductor 222, which conductor extends to and terminates in the bank of the metering switch S^6, the first zone metering conductor 221 having been grounded at off normal contacts 179 as soon as the switch was moved from its normal position, in response to the first impulse of current sent to the magnet 166.

Slow relay 136 energizes when the first ground impulse is sent over impulse conductor 126 and, being slow acting, retains its armatures attracted throughout the series of impulses. Upon energizing, relay 136 closes a circuit for slow acting relay 135 at armature 145. Slow acting relay 135, upon energizing, prepares a circuit for stepping magnet 165 of the switch S at armature 143. When relay 136 deenergizes, at the end of the series of impulses, it opens the circuit of slow acting relay 135 at armature 145, at the same time closing a circuit for stepping magnet 165 by way of armature 143 and its working contact. Stepping magnet 165, upon energizing, advances the wiper 177 into engagement with the second bank contact. A moment later, slow acting relay 135 deenergizes and opens the circuit of stepping magnet 165 at armature 143.

In response to the calling of the next digit 7 which is the third digit in the desired number, line relay 101 of the repeater E transmits seven impulses to impulse conductor 126. In addition to maintaining slow acting relay 135 energized, each of these seven impulses is transmitted by way of wiper 177, the second associated bank contact, armature 161 and its resting contact, wiper 180 of the switch S', bank contact 207, and rotary magnet 167 of the switch S^2. In response to these impulses, stepping magnet 167 is operated seven times, thereby advancing the wipers 182 and 183 into engagement with the seventh set of bank contacts, which set comprises bank contacts 208 and 209. Wiper 183, upon coming into engagement with bank contact 209, prepares a circuit for rotary magnet 168 of the switch S^3. Wiper 182, upon coming into engagement with bank contact 208, places a ground potential upon the third zone metering conductor 223. At the end of this series of impulses slow acting relays 136 and 135 fall back one after the other in the order named, thereby closing a circuit for stepping magnet 165 of the switch S momentarily, whereupon the wiper 177 is advanced into engagement with the third bank contact, thereby preparing a circuit for stepping magnet 168 of the switch S^3.

In response to the calling of the next digit 4 in the desired number, line relay 101 of the repeater E transmits four impulses to impulse conductor 126. These impulses extend by way of wiper 177 of switch S, the third associated bank contact, wiper 183 of the switch S^2, and bank contact 209 to stepping magnet 168 of the switch S^3. In response to these four impulses, stepping magnet 168 advances the wiper 184 into engagement with the fourth bank contact 210, thereby placing ground upon the fourth zone metering conductor 224. The combined operation of relays 136 and 135 delivers another impulse of current to stepping magnet 165, upon the termination of this series of impulses, whereupon the wiper 177 is advanced into engagement with the fourth bank contact which extends to the rotary magnet 170 of the switch S^5.

In response to the calling of the next digit 8 in the desired number, line relay 101 of the repeater E transmits eight impulses of current to impulse conductor 126. These impulses extend by way of wiper 177, the fourth associated bank contact, and stepping magnet 170 of the cut off switch S^5 to battery. In response to these eight impulses, stepping magnet 170 advances wiper 181 into engagement with the eighth bank contact 228. This, however, does not produce any result at this time owing to the fact that bank contact 228 is not connected up. The function of the switch S^5, it may be said, is to prevent a subscriber from calling into an exchange in the fifth zone. In order to explain this, it will be assumed for the time being that the last digit called was 5, instead of 8, in which case wiper 181 would have been stopped on the fifth bank contact 225. That being the case, slow acting relay 136, upon falling back, completes at armature 146 the following circuit: From ground by way of the fourth zone metering conductor 224, wiper 181 of the cut off switch S^5, bank contact 225, resting contact of armature 162 and said armature, resting contact of armature 189 and said armature, resting contact of armature 146 and said armature, conductor 127, normally closed contacts controlled by armature 117, and cut off relay 106 to battery. Cut off relay 106, upon energizing, opens its initial circuit and closes a locking circuit for itself at armature 117, and at armature 118, opens the lower conductor of the trunk extending to the selector F, whereupon the connection ahead releases in the usual manner. However, since the digit called was not 5, cut off relay 106 does not energize and the connection is not released.

To continue with the operation, it may be

said that upon the termination of the calling of the digit 8, which caused the operation of the switch S^5, as explained above, the combined operation of relays 136 and 135 sends an impulse of current to stepping magnet 165, whereupon the wiper 177 is advanced into engagement with the fifth bank contact, which contact is left dead. The calling of the remaining two digits, 2 and 1, in the desired number, which are the two digits that cause the operation of the connector K, Fig. 3, does not produce any result in the metering equipment shown in Fig. 4, with the exception of the incidental operation of the switch S which advances the wiper 177 two more steps.

It will be noted that the four metering conductors 221–224, inclusive, are grounded so as to cause the calling subscriber to be assessed four charges, in accordance with the call, which is extended into the fourth zone, upon the response of the called person.

When the called subscriber responds to the ringing of his bell by removing his receiver, the connector K disconnects the source of ringing current from his line and connects the latter to the windings of back bridge relay 119. Back bridge relay 119, upon energizing over the called line, reverses the incoming trunk conductors as regards their connection with the associated line relay, thereby causing a reversal in the direction of current flow in said trunk conductors. When this occurs, the repeaters E^3, E^2 and E′ reverse their respective incoming trunk conductors also. When this occurs, electropolarized relay 104 of the repeater E energizes, on account of the upper winding assisting the lower winding after the reversal takes place, and closes a circuit for reversing relay 100 at armature 115. Reversing relay 100, upon energizing, reverses the trunk conductors 72 and 74 as regards their connection with the windings of line relay 101. The consequent reversal of current flow in conductors 72 and 74 does not perform any useful function in this case, but may be used, when an operator is extending a connection, to give answering supervision. As a further result of the energization of electropolarized relay 104, it places ground, from the grounded conductor 130, upon conductor 129 at armature 116, thereby closing a circuit for relay 138, Fig. 4. Relay 138, upon energizing, closes a locking circuit for itself at armature 149; opens the lead 127 extending to cut off relay 106 in the repeater E at armature 189; opens a point in the circuit of release magnet 214 of metering switch S^6 at armature 150; and at armature 148 connects the common impulse conductor 190 with stepping magnet 213 of the metering switch S^6 by way of armature 151.

Before going further, the operation of the timing device T, may be explained. The pendulum 232 is constantly swinging to and fro and each time it swings to the left, contacts 240 are closed, whereupon magnet 233 energizes, thereby bending the spring 243, so as to push the pendulum back, and operating relay 231 by closing the contacts 239. Contacts 239 remain closed until the pendulum 232 has swung to the left far enough to open the contacts 240. When this occurs, relay 233 deenergizes and opens contacts 239. This pendulum, it may be said, is of such a length that it swings to the right and to the left twice per second. Of course any other speed may be used, but this speed has been arbitrarily chosen for the device in the present showing. It may be pointed out that each time relay 231 energizes, in response to the closure of contacts 239, battery is placed upon common conductor 190 at armature 241.

The operation will now be proceeded with. The next time that battery is placed upon conductor 190, at armature 241 of relay 231, after conductor 190 is connected up, at armature 148 of relay 138, the following circuit is closed for stepping magnet 213 of the switch S^6: From ground by way of stepping magnet 213, resting contact of armature 151 and said armature, armature 148 and its working contact, and common conductor 190 to battery. Stepping magnet 213, upon energizing, advances the wiper 211 into engagement with the first associated bank contact. This first step, however, serves merely as a pick up or synchronizing step which is taken to insure that the following step will begin just as battery is placed upon common conductor 190. When battery is removed from common conductor 190, upon the subsequent deenergization of relay 231, rotary magnet 213 deenergizes, and when battery is placed upon conductor 190 again, rotary magnet 213 energizes, thereby advancing wiper 211 into engagement with the second associated contact, which is the contact in which the first zone metering conductor 221 terminates. When this occurs, the following circuit is closed: From ground by way of off normal contacts 179 of the switch S′, the first zone metering conductor 221, wiper 211, working contact of armature 251 of stepping magnet 213 and said armature, metering relay 137, and thence to battery by way of common conductor 190. Metering relay 137, upon energizing, disconnects ground from conductor 128 and connects so called booster battery thereto at armature 147. It will be noted that this so called booster battery is opposite in polarity to the regular exchange battery and, accordingly, the current flow through any relays which are connected from the exchange battery to release trunk conductor 73 is increased. It will be understood, however, that the increase in current flow through relay 44 of the selector D is not

sufficient to bring about the operation of stepping relay 43, nor is the increase in current flow through relay 5 of the line switch C sufficient to bring about the operation of the stepping magnet 7. This increase of current flow unbalances the differentially wound relay 30, Fig. 1, and the said relay, upon energizing, places ground upon metering conductor 23 at armature 32, thereby closing a circuit for the magnet of the meter M. The magnet of the meter M, upon energizing, advances the meter number wheels, thereby registering one charge against the calling subscriber.

When battery is again removed from conductor 190, Fig. 4, rotary magnet 213 of the switch S^6 and metering relay 137 deenergize. Metering relay 137, upon deenergizing, places ground upon conductor 128 and consequently upon release trunk conductor 73 of the repeater E and removes booster battery therefrom, thereby restoring the balance to the two windings of relay 30, Fig. 1. Relay 30 now deenergizes, thereby opening the circuit of the magnet of the meter M, whereupon the said magnet deenergizes, allowing its armature to engage another notch on the associated ratchet wheel. When battery is again placed upon common conductor 190, Fig. 4, rotary magnet 213, upon energizing, advances wiper 211 into engagement with the bank contact in which the second zone metering conductor 222 terminates, thereby closing the following circuit for metering relay 137: From ground by way of wiper 178 of the switch S', bank contact 206, second zone metering conductor 222, wiper 211, and thence to battery, by way of metering relay 137 and common conductor 190. Metering relay 137, upon energizing, causes the meter M to be operated a second time in the previously described manner. When battery is again removed from common conductor 190, metering relay 137 and stepping magnet 213 deenergize.

By identical operation stepping magnet 213 of the switch S^6 and metering relay 137 energize when the next impulse of battery is placed on conductor 190 and deenergize again when it is removed therefrom. At this time wiper 211, of course, is brought into engagement with the bank contact in which the third zone metering conductor 223 is terminated.

When the next impulse of battery is placed upon common conductor 190, stepping magnet 213 energizes, thereby advancing wiper 211 into engagement with the bank contact in which the fourth zone metering conductor 224 is terminated, whereupon metering relay 137 energizes again, and when battery is removed from conductor 190, metering relay 137 and stepping magnet 213 deenergize. When the following impulse of battery is placed upon common conductor 190, rotary magnet 213 advances wiper 211 into engagement with the bank contact which is connected with the upper winding of relay 139 and, upon completing its stroke, connects up wiper 211, thereby closing the following circuit for relay 139: From the upper winding of relay 139 by way of the bank contact with which it is connected; wiper 211, working contact of armature 251 and said armature, metering relay 137, and thence by way of the previously traced circuit to battery. Relay 139 energizes over this circuit, but relay 137 does not energize owing to the high resistance of the upper winding of relay 139. Relay 139, upon energizing, completes a locking circuit for its lower winding at armature 153 as follows: From ground by way of the grounded locking conductor 130, wiper 186 of the switch S^4, the first associated bank contact, armature 153 and its working contact, and the lower winding of relay 139, to battery. As a further result of the energization of relay 139, it disconnects common conductor 190 from stepping magnet 213 and metering relay 137, at armature 151; connects common conductor 191 with stepping magnet 169 of the switch S^4 at armature 155; and at armature 152 opens a point in the circuit of release magnet 176 of the switch S^4 and closes a circuit for release magnet 214 of the switch S^6 by way of off normal contacts 212 of the switch S^6. Release magnet 214 of the switch S^6, upon energizing, restores the wiper 211 to normal, whereupon off normal contacts 212 separate, thereby opening the circuit of release magnet 214.

It will be remembered that common conductor 191 was connected with stepping magnet 169 of the switch S^4 at armature 155, upon the energization of relay 139. The effect produced by this will now be explained. It will be noted that upon each closure of contacts 239 of the time device T, a circuit is closed for stepping magnet 234 of the cumulative time device CT in multiple with relay 231. Each time stepping magnet 234 energizes, the associated armature 235 causes the notched member 236 to revolve one step. Since there are sixty teeth on the member 236, and since the contacts 239 are closed twice per second, the member 236 makes a complete revolution in half a minute. That being the case, the projection 244 one the member 236 operates springs 238 and 237 once during each half minute. Each time spring 237 is operated, it places ground upon the associated conductor, thereby closing a circuit for relay 230. Relay 230, upon energizing, places ground upon common conductor 191 at armature 242. This, of course, occurs momentarily once during each half minute. As soon as

ground is placed upon conductor 191, after armature 155 of relay 139 has been operated, a circuit is closed for stepping magnet 169 of the switch S^4. Stepping magnet 169, upon energizing, advances wiper 186 into engagement with the second bank contact. When this occurs, off normal contacts 185 close, thereby preparing a circuit for release magnet 176. The switch S^4 continues to advance one step during each half minute until the wiper 186 passes off the last connected contact at which time the metering process, previously explained, will be repeated if the calling subscriber has not hung up.

Before repeating the metering operation it is desirable to give the calling subscriber a momentary warning so that, if desired, he may terminate his conversation before he is assessed another charge. The manner in which this is done will now be explained. At the end of the sixth time interval of one-half minute, the stepping magnet 169 will have been operated six times and the wiper 186 will have been advanced into engagement with bank contact 253. When the next momentary ground impulse is placed upon common conductor 191, stepping magnet 169 advances wiper 186 into engagement with bank contact 254, whereupon relay 187 energizes in series with the lower winding of relay 139 and, at armature 188, connects the common tone lead 192 with conductor 131 through a condenser as shown. Conductor 131, it will be noted, is connected to the lower talking conductor of the repeater E. This operation, it will be understood, occurs as the projection 244 on the member 246 of the device CT operates spring 237. When the projection 244 is rotated about three-fourths of the way around to spring 237, it again operates spring 238, thereby connecting the common tone lead 192 with armature 194 of the interrupter relay 193. Relay 193 is being alternately energized and deenergized and, accordingly, during the time that spring 238 is operated, the calling subscriber will hear the tones produced by the tone machine TM and the tone machine TM′ alternately. This will indicate to him that he must quickly terminate his conversation and release the connection or he will be assessed another charge.

As the member 236 rotates further, spring 238 again moves out of engagement with its working contact, thereby disconnecting common conductor 192 and removing the distinctive tone combination from the line.

When another ground impulse is placed upon common conductor 191, a few seconds later in response to spring 237 being operated, assuming that the calling subscriber is not through conversing and that he holds the connection, stepping magnet 169 of the switch S^4 advances the wiper 186 into engagement with the next contact, thereby opening the circuit of relays 187 and 139, whereupon they both deenergize. Relay 139, upon deenergizing, connects up common conductor 190 with rotary magnet 213 of the switch S^6 and with metering relay 137, at armature 151, whereupon the previously described metering operations take place again with the result that the calling subscriber's meter is operated four times more. As a further result of the deenergization of relay 139, it closes, at armature 152 and its resting contact, a circuit for release magnet 176 of the switch S^4, whereupon the wiper 186 is restored to normal, the circuit of release magnet 176 being opened at off normal contacts 185 when wiper 186 reaches normal position.

After the termination of the second series of meter operations, relay 139 is again energized; the stepping magnet 169 of the switch S^4 is connected with common conductor 191; and the switch S^6 is released in the previously described manner; and if the calling subscriber continues to hold the line the metering operations will be repeated about every four minutes until he hangs up.

When the conversation is terminated, the calling and called subscribers replace their receivers. When the receiver is replaced at the called substation, the circuit of back bridge relay 119 of the connector K is opened, and the said relay, upon deenergizing, reverses the incoming trunk conductors back to normal, which reversal is relayed back over the established connection from repeater to repeater until it reaches the repeater E. When the current flow in the lower winding of electropolarized relay 104 of the repeater E is reversed to normal by the repeater E′, the said relay 104 deenergizes, thereby opening the circuit of reversing relay 100, whereupon the current flow in the conductors 72 and 74 is reversed back to normal. As a further result of the deenergization of relay 104, the initial circuit of relay 138, Fig. 4, is opened at armature 116. Relay 138, however, remains energized over its previously described locking circuit which includes armature 149 and the grounded conductor 130.

When the receiver is replaced at the calling substation A, Fig. 1, the circuit of line relay 101 of the repeater E is opened. Line relay 101, upon deenergizing, opens the bridge across the trunk extending to selector F at armature 110, whereupon the connection ahead is released in the well known manner. As a further result of the deenergization of line relay 101, it opens the circuit of release relay 102 and places ground upon conductor 126 at armature 109. This causes relay 103 to energize, but this does not produce any useful function at this

time. As a further result of the ground potential being placed upon conductor 126, relay 136, Fig. 4, energizes; prepares a circuit for release magnets 171–175, inclusive, at armature 144; and at armature 145 closes a circuit for relay 135. Relay 135, upon energizing, closes a shunt around armature 144 and its working contact at armature 142. When release relay 102 deenergizes, it removes ground from conductor 130 at armature 112, and at armature 113 removes ground from conductor 126 and places it upon conductor 125, thereby completing the following circuit for release magnets 171–175, inclusive: From ground by way of armature 109 and its resting contact, armature 113 and its resting contact, conductor 125, armatures 144 and 142 and their working contacts in multiple, and thence to battery by way of release magnets 171–175, inclusive, thereby restoring the associated wipers of the switches S–S^3, inclusive, and S^5 to normal. A short time later relays 135 and 136 deenergize, thereby opening the circuits of the mentioned release magnets. Relay 103 of the repeater E also deenergizes in response to the removal of ground potential from conductor 126.

In response to the removal of ground potential from locking conductor 130 by release relay 102 of the repeater E, at armature 112, relays 138 and 139, Fig. 4, deenergize. Relay 138, upon deenergizing, closes a circuit for release magnet 214 of the switch S^6 by way of off normal contacts 212, at armature 150, in case the switch S^6 is off normal. In this case, release magnet 214, upon energizing, restores wiper 211 to normal, its circuit being opened at off normal contacts 212 when wiper 211 reaches normal position. Relay 139, upon deenergizing, closes a circuit for release magnet 176 of the switch S^4, at armature 152, by way of off normal contacts 185, in case the switch is off normal. In this case the wiper 186 is restored to normal by the operation of release magnet 176, the circuit of release magnet 176 being opened at off normal contacts 185 when wiper 186 reaches normal position. The entire metering apparatus shown in Fig. 4 is now in normal position.

In repeater E, as a further result of the deenergization of release relay 102, the ground potential is removed from release trunk conductor 73 at armature 111. When this occurs, switching relays 5 and 44, of the line switch C and selector D, respectively, and relay 31 deenergize. The deenergization of switching relay 5 restores conditions in the line switch C to normal. Switching relay 44 of the selector D, upon deenergizing, closes a circuit for release magnet 60 by way of armatures 45 and 47 and off normal contacts 61. Release magnet 60, upon energizing, allows the wipers of the selector D to be restored to normal position, whereupon the circuit of release magnet 60 is opened at off normal contacts 61.

In regard to relays 30 and 31, it may be said that, even though the removal of the ground potential from release trunk conductor 24 unbalances relay 30, leaving the circuit through the upper winding intact for an interval, owing to the stiff adjustment of this relay, it does not have time to energize before its circuit is opened at armature 33 of relay 31, which relay is designed and adjusted so as to deenergize very quickly after its circuit is opened. The entire connection is now released and the apparatus used therein is restored to normal.

In order to explain how the metering is affected when the 33rd exchange is called, it may be said that, the dialling of the second digit 3 causes the selector F, Fig. 2, assuming the first digit dialled to be 3 and the repeater E to be seized, to raise its wipers to the 3rd level and select an idle trunk leading to the 33rd exchange, Fig. 5, which exchange is located in the 4th zone. In the metering equipment, Fig. 4, the dialling of the second digit 3 causes the wiper 178 of the switch S′ to be operated in the previously described manner, by stepping magnet 166, with the result that the said wiper 178 is stepped into engagement with the third bank contact. When this occurs, a circuit is closed for relay 141 and the said relay, upon energizing, places ground upon the second, third, and fourth zone metering conductors at armatures 158–160, inclusive, the first zone metering conductor 221 having been grounded at off normal contacts 179. As a further result of the energization of relay 141, it disconnects the second bank contact associated with wiper 177 of the switch S from wiper 180 of the switch S′ at armature 161, and connects it to stepping magnet 170 of the switch S^5; disconnects the cut off lead 127 from bank contact 225 of the switch S^5, at armature 162, and connects it to the seventh bank contact 227.

Upon the calling of the next digit of the desired number, an incoming selector in the 33rd exchange, Fig. 5, is caused to raise its wipers and select an idle trunk in the desired level, and at the same time wiper 181 of the switch S^5, Fig. 4, is stepped around to the corresponding contact. Assuming that the number called is a number local to the 33rd exchange, or in other words, some number other than 7, the operation of the switch S^5 does not produce any result, and the dialling of the remaining digits in the desired number results in the connection being extended to the desired line. On the other hand, if we assume that the digit called is 7, the previously mentioned selector in the 33rd exchange, Fig. 5, raises its wipers to the 7th level and picks out a trunk to the 337th ex-

change, which exchange is located in the 5th zone. In this case the wiper 181 of the switch S^5, Fig. 4, is brought into engagement with the 7th contact 227, thereby closing the following circuit for cut off relay 106 of the repeater E: From ground by way of the 4th zone metering conductor 224, wiper 181 of the switch S^5, bank contact 227, working contact of armature 162 and said armature, and thence by way of a previously traced circuit to battery through the cut off relay 106 of the repeater E. Cut off relay 106, upon energizing, opens its initial circuit and closes a locking circuit for itself at armature 117, and at armature 118 opens the bridge across the conductors of the associated trunk, whereupon the connection extending ahead is released in the usual manner.

Assuming now that the number called was some number other than 7, the calling of the remaining digits of the desired number, in addition to extending the connection to the called line, causes an incidental operation of the switch S, Fig. 4, but this does not perform any useful function.

When the called subscriber answers, the operation of electropolarized relay 104 of the repeater E starts the metering apparatus into action and since the metering conductors 221–224, inclusive, are grounded, the initial charge is four operations of the meter M, Fig. 1, as described hereinbefore, and the subsequent operation depends upon the length of the conversation.

It will be understood, of course, that if the first digit of the number called is 3, and the second digit is some digit other than 3 or 6, the connection will be extended to some subscriber in the 3rd exchange, Fig. 5, which exchange is in the first zone, and in this case only the first zone metering conductor 221 will be grounded at off normal contacts 179 of the switch S′, Fig. 4. It will be understood also that if a call is extended to the 36th exchange and if the next digit called is any other than 7, only the first and second metering conductors 221 and 222 are grounded and, of course, only two initial charges are made when the called man answers. Similarly if the call is extended to the exchange 367 in the 3rd zone, and if the next digit called is not 4, only the first three metering conductors 221–223, inclusive, will be grounded and an initial charge of three registrations of the meter will be made. Obviously, in any case, as long as the line is held, the initial charge will be repeated every four minutes. It will be understood also that this time interval is shown merely as an example and that any time interval other than four minutes may be chosen. For example, the speed of the cumulative time device CT, Fig. 4, may be varied or the number of active contacts in the bank of the switch S^4 may be varied, thereby, in either case, varying the time interval accordingly.

It will be understood also that each of the repeaters E′, E^2 and E^3 are equipped with similar metering arrangements which are effective only when a subscriber local to the exchange in which they are located is calling. Of course, the wiring of the bank contacts of the number registering switches associated with these repeaters is changed according to the location of each repeater. It will be understood also that, while the subscribers in the first zone are not permitted to call subscribers in the fifth zone, a subscriber of the 36th exchange, Fig. 5, in the second zone is permitted to call a subscriber in the fifth zone, which becomes the fourth zone automatically from the viewpoint of a subscriber of the 36th exchange. Similarly any subscriber in the entire system is permitted to call any other subscriber in the system whose line terminates in an exchange which is located within the fourth zone counting from the calling exchange, and the cut off relays of the various repeaters, such as the cut off relay 106 of the repeater E, are connected up so as to operate only when a subscriber attempts to call into the fifth zone or beyond.

The various features of the invention having been described and ascertained fully in the foregoing will now be pointed out in the appended claims.

What is claimed is:

1. In an automatic telephone system, a plurality of exchanges, means whereby a calling subscriber in one of said exchanges can extend a connection to a second exchange, means operated when the digit is called which routes the call to said second exchange for predetermining a certain charge to be assessed against the calling subscriber, automatic switching mechanism in said second exchange responsive to the next digit in the called number for extending the connection on toward a called subscriber in the same exchange or to a third exchange, an automatic switch in the calling exchange operated responsive to the impulses of the last named digit, another automatic switch, and means controlled by said switch for making a suitable increase in the predetermined charge and for connecting up said other automatic switch in case the call is extended to said third exchange.

2. In an automatic telephone system, a plurality of exchanges, means whereby a calling subscriber in one of said exchanges can extend a connection to a second exchange, means operated when the digit is called which routes the call to the second named exchange for predetermining a certain charge to be assessed against the calling subscriber, automatic switching mechanism

in said second named exchange responsive to the next digit in the called number for extending the connection on toward a called subscriber in the same exchange or to a third exchange, an automatic switch in the calling exchange operated responsive to the impulses of the last named digit, means controlled by said switch for making a suitable increase in the predetermined charge, a second automatic switch, said first automatic switch connecting up said second automatic switch in case the call is extended to said third exchange, and means for operating the last named switch upon the calling of the next digit to cause it to perform the same functions as the first named switch.

3. In an automatic telephone system laid out in zones, means whereby a calling subscriber can extend a connection to a called subscriber in any one of a plurality of zones, means operated in response to the answering of the called subscriber for assessing the calling subscriber an initial charge predetermined for that zone, a common timing mechanism, a step by step automatic switch separate from said assessing means and individual to the connection operated at intervals by said common timing device after the call is answered, and means controlled by said switch for repeating the initial charge at regular predetermined intervals during the conversation.

4. In an automatic telephone system, a calling line, an automatic switching mechanism, means controlled by a subscriber on said line for extending a connection from said line to another line by way of said mechanism, a holding conductor, means for connecting said conductor to one pole of a source of current to retain said mechanism in operated position, charge assessing means comprising a differentially wound magnet, means for connecting one winding of said magnet with said holding conductor and the other winding with said pole of said source of current, and means for varying the potential on said holding conductor so as to assess a charge against the calling subscriber by energizing said differentially wound magnet while retaining said mechanism in operated position.

5. In an automatic telephone system, a calling line, an automatic switching mechanism, a meter individual to said line, means controlled by a subscriber on said line for extending a connection from said line to another line by way of said mechanism, a holding conductor, means for connecting said conductor to one pole of a source of current whereby said mechanism is held in operated position, a differentially wound relay, means for connecting one winding of said relay with said holding conductor and the other winding with said pole of said source of current, means for varying the potential on said holding conductor so as to operate said differentially wound relay while retaining said mechanism in operated position, and means controlled by said relay for operating said meter.

6. In a telephone system laid out in zones, means whereby a calling subscriber in one exchange can extend a connection to a second exchange located in a distant zone and thence by way of a particular trunk to a called subscriber in a third exchange located in a more distant zone, means whereby a calling subscriber in said second exchange can extend a connection over said trunk to said third exchange and thence to a called subscriber in a fourth exchange located in a still more distant zone, and means for preventing a calling subscriber in the first named exchange from calling a subscriber in said fourth exchange, by releasing the connection extended from said first exchange.

7. In a telephone system laid out in zones, means whereby a calling subscriber can extend a connection to a called subscriber in any one of a plurality of zones, a busy tone generator, means for applying this tone to the calling line if the called line is busy, means operated in response to the answering of the called subscriber for assessing the calling subscriber an initial charge predetermined for that zone, means for assessing additional charges at intervals during the conversation, a second tone generator, and means for placing said second tone on the line prior to the assessing of each additional charge.

8. In a telephone system, automatic switches for connecting a calling and a called line, a conductor connecting two of said switches, means for impressing a potential on said conductor at the second switch to maintain a flow of current thereover, a differential meter control relay associated with the first switch and having one winding energized over said conductor and the other winding energized in a local circuit, and means for increasing said potential to operate said relay.

9. In a telephone system, automatic switches for connecting a calling and a called line, a release trunk conductor for holding one of said switches in operated position, a differential meter control relay having one winding energized over said conductor and the other winding energized in a local circuit, and means for changing the potential on said conductor to operate said relay.

10. In a telephone system, a plurality of serially related exchanges connected by trunk lines, automatic trunking and local switches, in said exchanges controllable by a calling subscriber in the first of said exchanges to connect with called subscribers in any of the other exchanges, a plurality of register switches one for each of said other

exchanges, means for operating each exchange register at the same time that the trunking switch in such exchange is operated during the setting up of a call, means for preventing the operation of further register switches when a call reaches the local switches in any exchange, and measured service equipment for the calling subscriber controlled by said register switches.

11. In a telephone system, a plurality of serially related exchanges interconnected by trunk lines, subscribers' lines terminating in said exchanges, message registers associated with said lines, automatic switches in said exchanges, certain of said switches being operable by a calling one of said subscribers to extend a connection in the direction of a distant exchange, a repeater included in said connection, said repeater being repeatedly operated in the establishment of said connection, zone metering equipment associated with said repeater, said equipment including a sequence switch and a plurality of register switches, circuit means for operating the first of said registers simultaneously with said repeater to register the digit called, means operable at the end of that digit for operating said sequence switch to prepare circuits for operating a second of said registers, means for operating said second registers simultaneously with said repeater as the connection is extended to the exchange containing the desired called line, means for extending the connection to the called line without operating additional registers, means operable upon response of the called party for operating said called line message register to assess a charge, the amount of which is determined by the setting of said operated register switches.

12. In an automatic telephone system, a plurality of exchanges, a plurality of charge assessing switches in each exchange, means whereby a calling subscriber in one of said exchanges can extend a connection to a second exchange, means operable when the digit is called which routes the call to said second exchange for operating one of said switches for predetermining a certain charge to be assessed against the calling line, automatic switching mechanism in said second exchange responsive to the next digit in the called number for extending the connection on toward a called subscriber in the same exchange or to a third exchange, a second of said automatic switches in the calling exchange operated responsive to the impulses of the last said digit, and means controlled by the switch for making a suitable increase in the predetermined charge and for connecting up another of said automatic switches in case the call is extended to a third exchange.

13. In a telephone system having a plurality of zones, a first and a second exchange located in a certain zone, calling subscribers at said exchanges, a trunk line accessible to said subscribers, a plurality of exchanges located in different zones accessible to said trunk line, and means associated with said trunk line for restricting the subscribers of said first exchange to calls within certain zones by releasing connections extended beyond said zones, while permitting the subscribers of said second exchange to call beyond said zones.

14. In a telephone system having a plurality of zones, an exchange located in a certain zone, lines at said exchange, a trunk line accessible to said lines, a plurality of exchanges located in different zones accessible to said trunk line, and means associated with said trunk line for preventing a calling one of said lines from extending a call beyond a certain zone, by releasing the extended connection.

15. In a telephone system having a plurality of zones, an exchange located in a certain zone, lines at said exchange, a trunk line accessible to said lines, a plurality of exchanges located in different zones accessible to said trunk line, and means associated with said trunk line for preventing a calling one of said lines from extending a call beyond a certain zone, by releasing the connection extended beyond said trunk line.

16. In an automatic telephone system having a plurality of zones, an exchange located in a certain zone, lines at said exchange, a trunk line accessible to said lines, a plurality of exchanges located in different zones accessible to said trunk line, a repeater associated with said trunk line, a relay in said repeater, and switching means associated with said repeater for operating said relay to release the extended connection if a calling one of said lines attempts to call beyond a certain zone.

17. In an automatic telephone system having a plurality of zones, an exchange located in a certain zone, lines at said exchange, a trunk line accessible to said lines, a plurality of exchanges located in different zones accessible to said trunk line, switches, a repeater associated with said trunk line for repeating trains of impulses generated at a calling one of said lines to said switches to extend a call, and means associated with said repeater and responsive to a train of impulses designating a certain zone for releasing the extended connection if said calling line attempts to extend a call to said zone.

18. In an automatic telephone system having a plurality of zones, an exchange located in a certain zone, lines at said exchange provided with message registers, a first trunk line accessible to said lines and leading directly to a first exchange in a second zone, a second trunk line accessible to said lines

and leading to a second exchange in said second zone by way of a plurality of intermediate exchanges each located in a different zone, a charge assessing device associated with said trunk lines for actuating the message register of a calling line in accordance with the called zone and with the duration of a call, means in said device responsive to a single train of impulses generated at a calling station and designating said first exchange in said second zone accessible directly over said first trunk line for predetermining the charge to be assessed, and means in said device responsive to a plurality of successive trains of impulses designating successive intermediate exchanges interconnecting said second trunk line with said second exchange in said second zone for predetermining the assessment of a charge identical with said first charge.

19. In a measured service automatic telephone system having a plurality of zones, a first exchange, in a first zone, subscribers' stations thereat, message registers therefor, trunk lines accessible to said stations, a second exchange in a second zone directly accessible to one of said trunk lines, a third exchange in said second zone accessible over another trunk line by way of a plurality of intermediate exchanges, charge assessing means associated with said trunk lines, and means in said charge assessing means for predetermining an identical charge to be assessed against a calling station of said first exchange extending a call to either one of said exchanges in said second zone.

20. In a measured service automatic telephone system having a plurality of zones, a first exchange in a first zone, subscribers' lines thereat provided with means for automatically extending connections, message registers for said lines, trunk lines accessible to said lines, a second exchange in a second zone directly connected with said first exchange over one of said trunk lines, a third exchange in said second zone accessible to said first exchange over another trunk line by way of a plurality of intermediate exchanges located in different zones, a charge assessing device adapted to be used with either of said trunk lines, and means in said device directively controlled by a calling line in said first exchange for predetermining an identical charge to be assessed against said line regardless whether the call is extended to said second or to said third exchange.

21. In a measured service automatic telephone system having a plurality of zones, a first exchange in a first zone, subscribers' lines thereat provided with impulse transmitting devices, message registers for said lines, trunk lines and automatic switches accessible to said lines for extending calls, a plurality of exchanges located in a second zone, each of said exchanges accessible to said lines over a different number of trunk lines and switches, and charge assessing means responsive to trains of impulses generated at a calling line for predetermining an identical charge to be assessed against said line regardless of the number of trunks and switches employed in the extension of a call from said first zone to exchanges in said second zone.

22. In a measured service automatic telephone system having a plurality of zones, a first exchange in a first zone, subscribers' lines thereat provided with impulse transmitting devices, message registers for said lines, trunk lines and automatic switches accessible to said lines for extending calls, a plurality of exchanges located in a second zone, each of said exchanges accessible to said lines over a different number of trunk lines and switches, and charge assessing means responsive to trains of impulses generated at a calling line for operating switches to extend a call for predetermining an identical charge to be assessed against said calling line regardless of the number of trunks and switches employed in an extension from said first zone to exchanges in said second zone.

In witness whereof, I hereunto subscribe my name this 16th day of January, A. D., 1922.

FRED T. MADSEN.