Nov. 22, 1927.

1,650,410

J. I. BELLAMY

ZONE METERING TELEPHONE SYSTEM

Original Filed Oct. 12, 1921 5 Sheets-Sheet 1

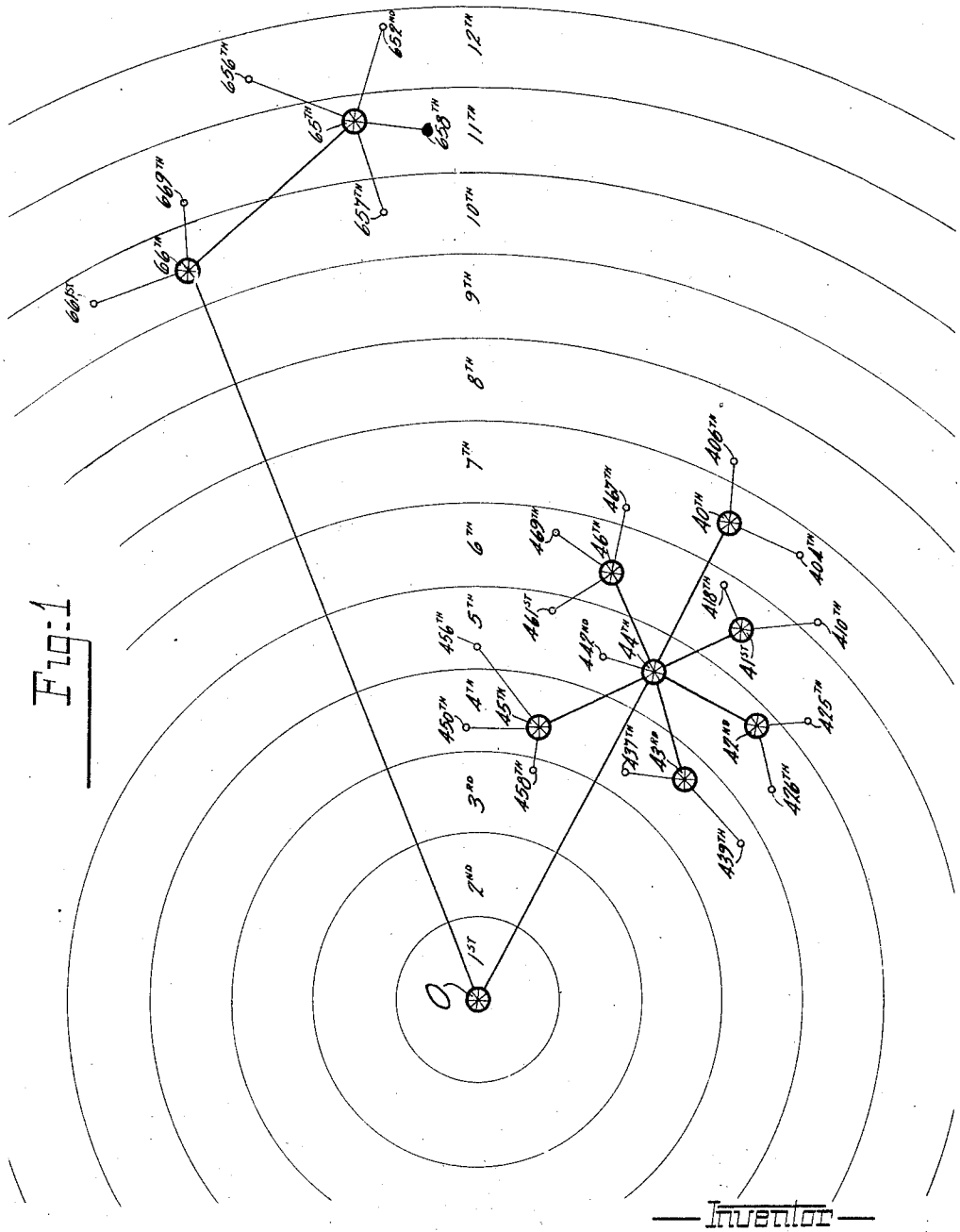

Fig-1

Inventor
John I. Bellamy
Chas. M. Caudy. Atty.

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J. I. BELLAMY

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Original Filed Oct. 12, 1921 5 Sheets-Sheet 2

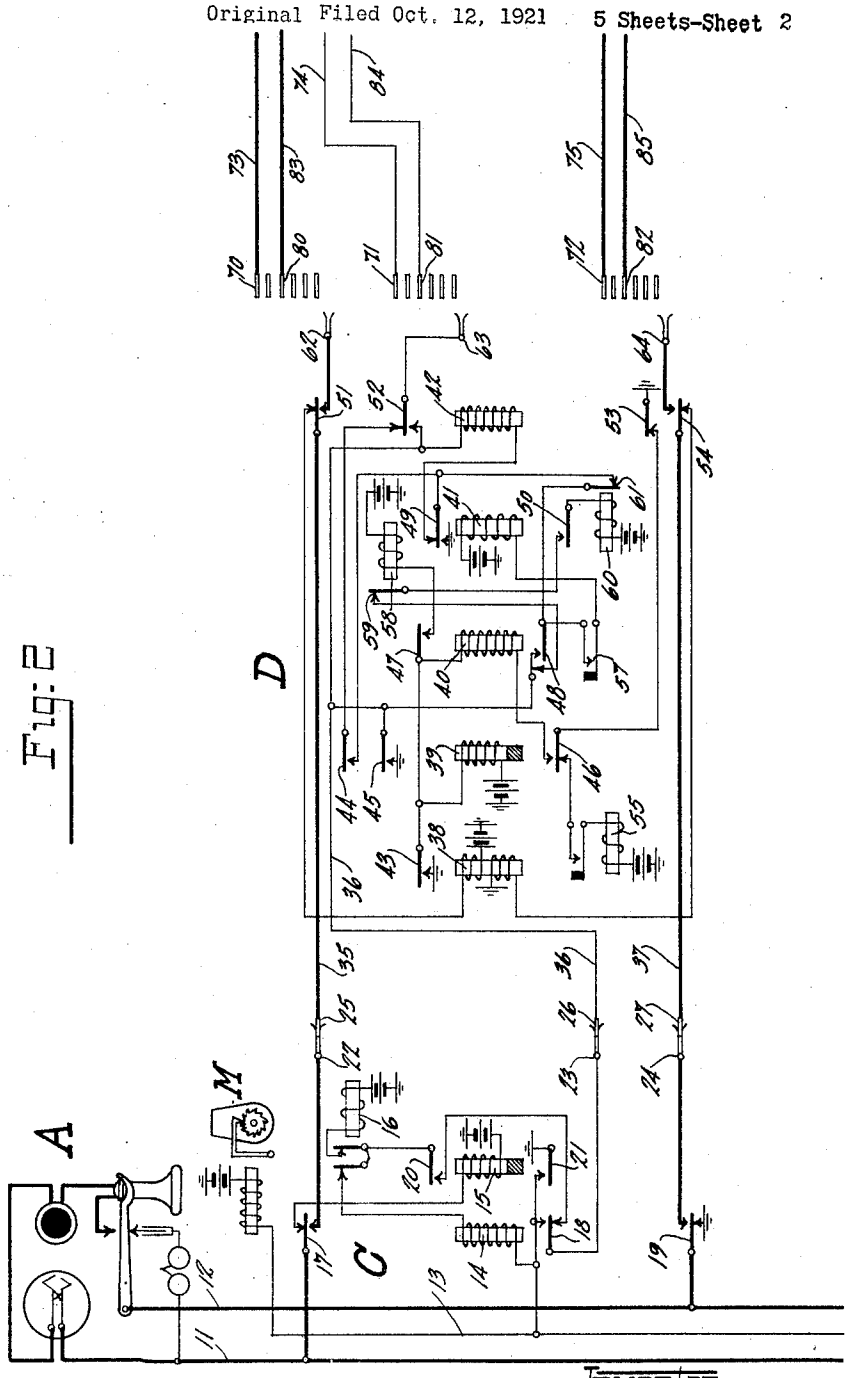

Fig: 2

Inventor
John I. Bellamy
Chas. M. Candy. Atty:

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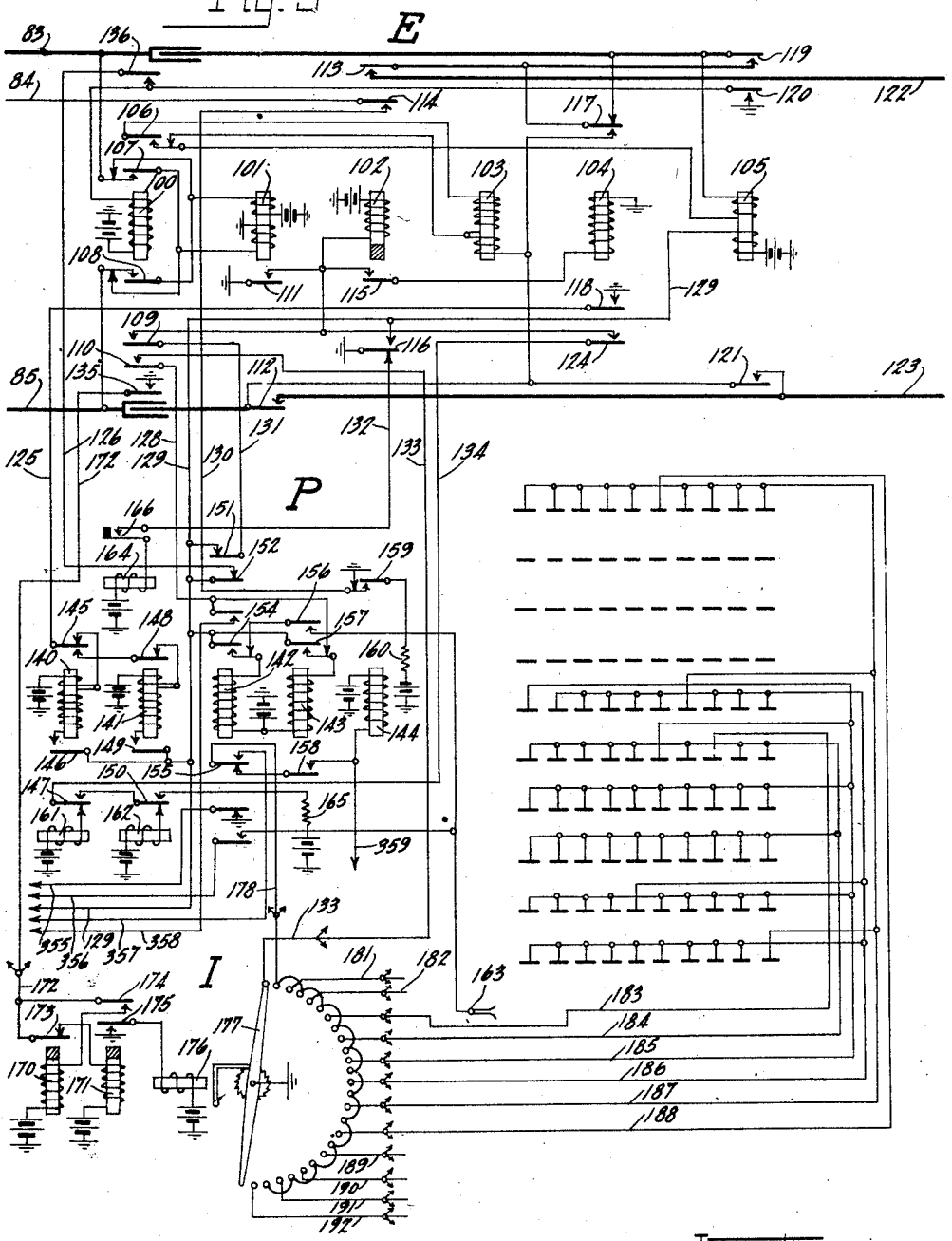
J. I. BELLAMY

ZONE METERING TELEPHONE SYSTEM

Original Filed Oct. 12, 1921 5 Sheets-Sheet 3

Fig: 3



Inventor
John I. Bellamy
Chas. M. Caudy. Atty:

Nov. 22, 1927. 1,650,410

J. I. BELLAMY

ZONE METERING TELEPHONE SYSTEM

Original Filed Oct. 12, 1921 5 Sheets-Sheet 4

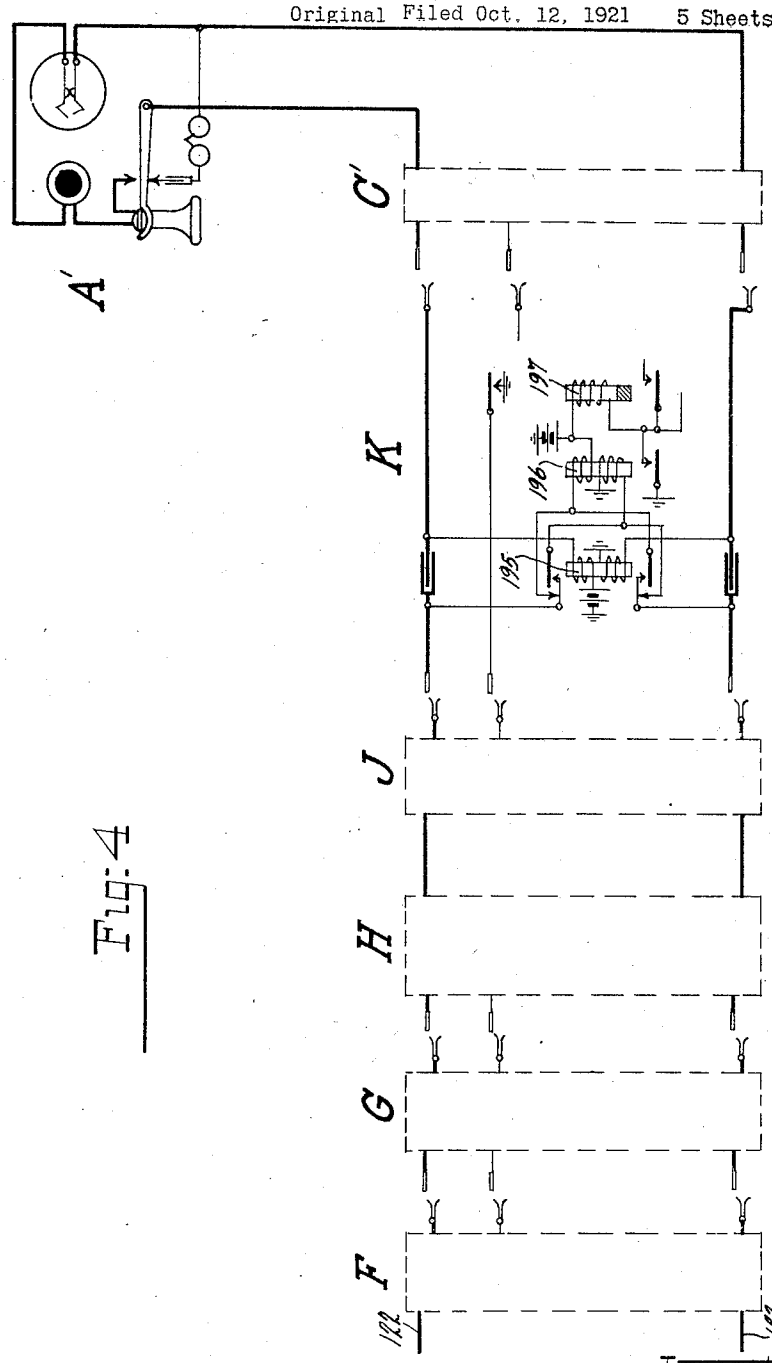


Fig. 4

Inventor
John I. Bellamy
Chas. M. Caudy.
Atty.

Nov. 22, 1927. 1,650,410

J. I. BELLAMY

ZONE METERING TELEPHONE SYSTEM

Original Filed Oct. 12, 1921 5 Sheets-Sheet 5

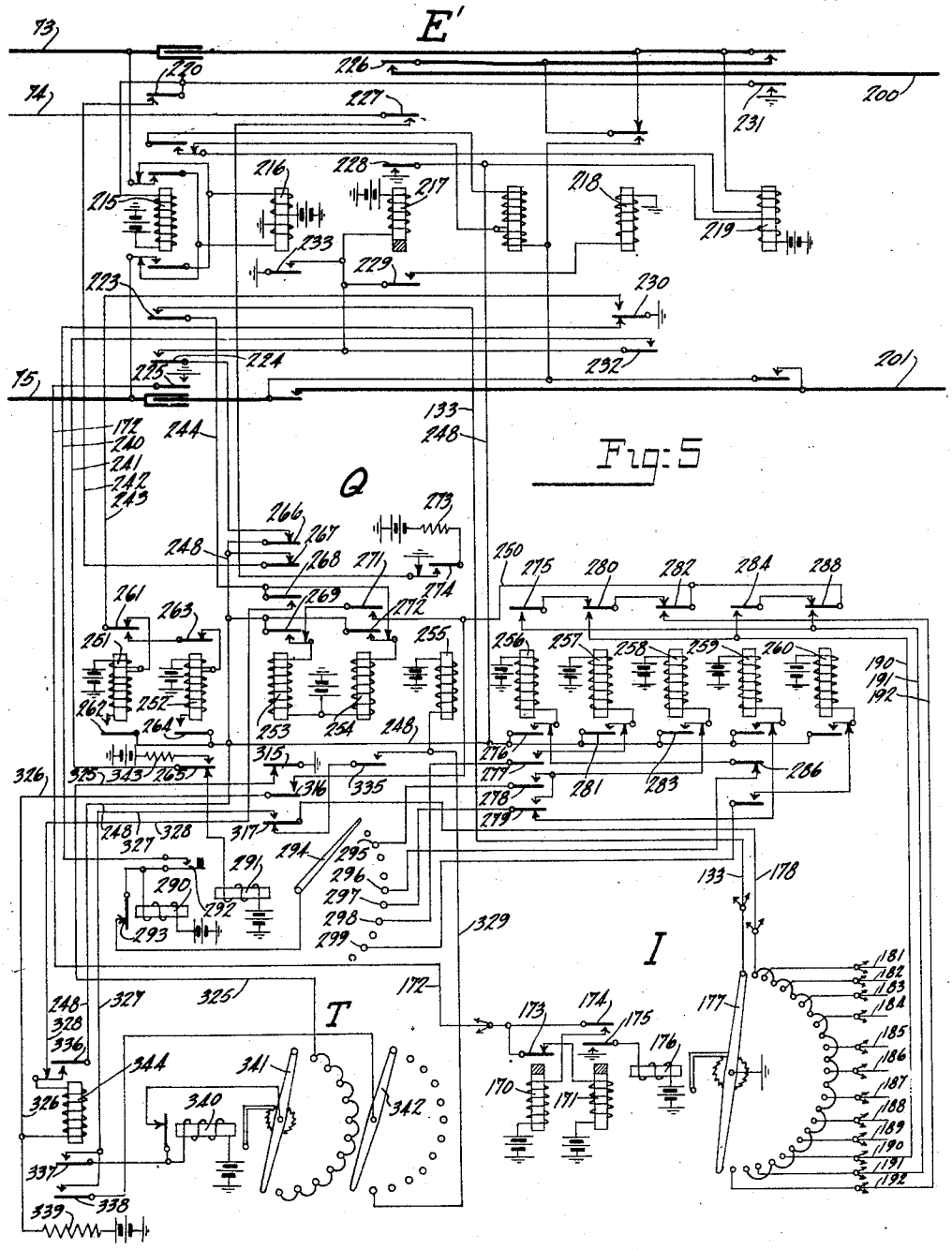


Fig: 5

Inventor
John I. Bellamy
Chas. M. Candy. Atty:

Patented Nov. 22, 1927. 1,650,410

UNITED STATES PATENT OFFICE.

JOHN I. BELLAMY, OF BROOKFIELD, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

ZONE METERING TELEPHONE SYSTEM.

Application filed October 12, 1921, Serial No. 507,182. Renewed April 11, 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 whereby a calling subscriber may be charged for a completed call according to the actual location of the office or exchange in which the called line terminates, the charge being independent of the number of inter exchange trunk lines engaged in serial relation and independent of the route by which the called subscriber is reached.

Another object is the provision of improved circuit arrangements whereby an added charge is made in accordance with the length of the conversation and in accordance with the initial charge.

Another object is to accomplish the purposes above set forth by means of apparatus and circuit arrangements which are located wholly in the office in which the call originates.

Other objects have to do with the refinement of the various circuits peculiar to a system of this sort so as to make them more efficient and practical.

These objects, together with others which will not specifically be pointed out now, will be more fully pointed out hereinafter, reference being had to the accompanying drawings comprising Figs. 1–5, inclusive, which show by means of the usual circuit diagrams sufficient of the apparatus employed in a system embodying the principles of the invention to enable the same to be understood.

In the drawings, Fig. 1 is a layout showing two paths leading out from an office on the left hand side of the sheet together with the various other offices which may be reached by way of these two paths.

Figs. 2, 3, and 4 when placed in order with the corresponding lines in alignment represent sufficient of the apparatus used in the trunking layout shown in Fig. 1, to enable the same to be understood.

Fig. 5, when placed on the right of Fig. 2, represents certain apparatus engaged in the connection when a different path from the originating exchange is taken.

Referring now particularly to Fig. 1, the trunking system, a part of which is shown therein, is assumed to have an ultimate capacity of 1,000,000 lines and may be used in a territory containing a large city and its suburbs, or possibly several large adjoining cities. The entire area is assumed to be divided into ten districts and when the system has reached its ultimate capacity there will be ten main offices of 10,000 lines in each district. The offices in the fourth and sixth districts only are indicated, the office indicated by the reference character 0 being assumed to be in one of the other districts which is on the opposite side of the net work from the sixth district. If we assume that a call originates in the office 0 and is intended for some subscriber in the fourth district, the calling of the first digit 4 will cause a district selector in the originating office to raise its wipers to the desired level and pick out a trunk line leading to an office selector in the 44th office, which office is the switching center for the fourth district. If we assume that the second digit dialled is 5, then the office selector to which the connection has been extended raises its wipers to the fifth level and selects an idle trunk line leading to the 45th office. The third digit dialled determines to which thousands group of lines in the 45th office the call is going. If the third digit is 6, 8, or 0 the call goes out to one of the three suboffices which are associated with the 45th office. These suboffices, as well as the suboffices associated with the various other main offices of the system and which are denoted by the small circles, are assumed to have a capacity of 1,000 lines each. After having selected the proper thousands group by dialing the first three digits in the desired number the calling subscriber dials the fourth digit to pick out a particular hundreds group and the fifth and sixth digits to pick out a particular line which terminates in that hundreds group.

If a call originates in the office 0 that is intended for some subscriber whose line terminates in an office in the sixth district, the calling of the first digit causes a district selector in the originating office to raise its wipers to the sixth level and select a trunk line leading to an office selector in the 66th office, which office is the switching center for the sixth district. The calling of the remaining digits causes the switches to extend

the connection to the desired office and finally to the desired line, in the usual manner, the trunking arrangement in the sixth district being similar to the trunking arrangement in the fourth district.

It will be noted that there are a great many more offices in the fourth district than there are in the sixth. This is due to the fact that the fourth district is more nearly in the heart of the city while the sixth district provides telephone service for a section which is as yet more or less thinly populated.

Referring now to Figs. 2, 3, 4, and 5, the automatic switches shown in Figs. 2, 3, and 5 are assumed to be located in the office 0, Fig. 1; the automatic switches F, G, and H shown in Fig. 4 are assumed to be located in the 44th office, Fig. 1; and the remaining switches shown in Fig. 4 are assumed to be located in the 442nd suboffice, Fig. 1.

The automatic substations A, Fig. 2, and A′ Fig. 4, are ordinary automatic substations having the usual talking, signaling, and impulse sending instrumentalities.

The line switch C, Fig. 2, is mechanically of the well known rotary type in which the wipers have no normal position and move in a forward direction only. The line switch C′, Fig. 4, which is denoted by a dotted rectangle is assumed to be identical with the line switch C.

The selector D, Fig. 2, is mechanically of the well known vertical and rotary type and accordingly has its bank contacts arranged in horizontal rows or levels. The circuits of this switch are shown complete and will be explained fully hereinafter. The selector switches denoted by the dotted rectangles F, G, and J, Fig. 4, are each assumed to be identical with the selector D, Fig. 2.

The automatic repeater E, Fig. 3, is fundamentally an ordinary repeater of a type which is in common use, having various circuits added, however, for a purpose that will appear more fully hereinafter. This repeater is used principally to avoid the necessity of having three conductors in the associated trunk line which extends to the next office. The repeater E′, Fig. 5, has fundamentally the same circuits as the repeater E, Fig. 3. The repeater denoted by the dotted rectangle H, is similar to the repeater E, having the various contacts and conductors omitted that are not essential in that case.

The automatic switch indicated by the reference character P, Fig. 3, carries a single wiper 163, but is otherwise mechanically the same as the selector D, Fig. 2. The circuits of this switch, however, are such that it is directively controlled in both its vertical and rotary movements. The circuits of this switch are shown complete and will be described fully hereinafter.

The common impulsing switch I, Figs. 3 and 5, is mechanically similar to a well known rotary line switch in that its wiper has no normal position but moves in a forward direction only. The switch T, which is individual to the switch Q, is mechanically similar to the switch I.

The switch Q, Fig. 5, has one wiper 294 which may be advanced into engagement with any one of the ten contacts shown but does not have any secondary movement. The wiper is shown in normal position.

The system having been described 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. 2, desires to obtain connection with the subscriber at substation A′, Fig. 4, whose line is assumed to terminate in the 442nd office which is a suboffice associated with the 44th office, Fig. 1.

When the receiver is removed at the calling substation, a circuit is closed over the line conductors 11 and 12 for the line relay, 15 of the line switch C. Line relay 15, upon energizing, closes at armature 21 a circuit for switching relay 14 and stepping magnet 16 in series, and at armature 20 connects the test wiper 23 to a point in the circuit between the switching relay 14 and the stepping magnet 16. From this point the operation depends upon whether the trunk line upon which the wipers of the line switch are standing is busy or idle. If it is busy there is a ground potential on test contact 26, switching relay 14 is short circuited, and the stepping magnet 16 which interrupts its own circuit is operated in the manner of a buzzer to advance the switch wipers step by step in search of an idle trunk line. In the present case, however, we shall assume that the trunk line upon which the wipers of the line switch are standing is idle. That being the case, switching relay 14 is not short circuited and stepping magnet 16 is not energized on account of the high resistance of switching relay 14. Switching relay 14, however, is energized and at armature 18 disconnects the test wiper 23 from the point between its own winding and that of stepping magnet 16 and connects it to the grounded private normal conductor 13. As a further result of the energization of switching relay 14, it disconnects the line conductors 11 and 12 from the winding of line relay 15 and ground, respectively, and extends them by way of armatures 17 and 19 and their working contacts, wipers 22 and 24, bank contacts 25 and 27, trunk conductors 35 and 37, and armatures 51 and 54 and their resting contacts to the upper and lower windings of the double wound line relay 38 of the district selector D. Line relay 38 now energizes over the calling subscriber's loop and at its armature 43 closes a circuit for the slow acting release relay 39. Release relay 39, upon energizing, connects up test wiper 63 at armature 44;

opens a point in the circuit of release magnet 55 and prepares a circuit for relay 40 at armature 46; and at armature 45 places ground on release trunk conductor 36, thereby establishing a holding circuit for the line switch C. By means of this ground potential on test contact 26 and its multiples in the banks of the other line switches which have access to the selector D, the seized trunk line is maintained busy in the usual manner. A branch of this holding circuit extends by way of private normal conductor 13 to multiple test contacts in the banks of the connector switches having access to the calling line, thereby guarding it against intrusion in the usual manner.

The meter M which is connected from battery to the private normal conductor 13 is not operated at this time owing to its marginal adjustment. This meter is designed to be operated by so-called booster battery impulses as will be explained more fully hereinafter.

The calling subscriber now operates his calling device in accordance with the first digit 4 of the desired number, thereby producing four interruptions in the circuit of line relay 38 of the district selector D. As soon as line relay 38 deenergizes in response to the first of these interruptions, relay 40, which heretofore has been short circuited, energizes in series with the release relay 39. Upon energizing, relay 40 connects vertical magnet 58 in multiple with release relay 39 at armature 47. Vertical magnet 58, however, is not energized at this time on account of the high resistance of relay 40. As a further result of the energization of relay 40 it opens a point in the circuit of rotary magnet 60 and prepares a circuit for stepping relay 41 at armture 48. When line relay 38 energizes following the first interruption, it closes a direct circuit for slow acting release relay 39 and vertical magnet 58 in multiple, at the sime time short circuiting relay 40. Relay 40, being short circuited, is slow to deenergize and consequently is maintained energized throughout the series of interruptions. Vertical magnet 58, upon energizing, raises the wipers 62–64, inclusive, opposite the first level of bank contacts, whereupon the off normal springs 57 close thus completing the circuit of stepping relay 41. Stepping relay 41, upon energizing, closes a point in the circuit of rotary magnet 60 at armature 50 and at armature 49 closes a locking circuit for itself independent of relay 40. When line relay 38 deenergizes in response to the second interruption produced in its circuit, vertical magnet 58 denergizes on account of the high resistance of relay 40 and is energized again when line relay 38 energizes. By the subsequent operation of vertical magnet 58, the shaft and wipers of the selector D are raised step by step until the latter stand opposite the desired level of bank contacts which in this case is the fourth, or the level in which the trunk line comprising conductors 83–85, inclusive, terminates. After line relay 38 has come to rest in an energized condition at the end of the series of interruptions, relay 40, being short circuited, finally deenergizes; opens the circuit of vertical magnet 58 at armature 47; and at the normally closed contacts controlled by armature 48 opens the initial circuit of the stepping relay 41 and closes a point in the circuit of rotary magnet 60. Just as the armature of vertical magnet 58 comes to rest, the contacts 59 are closed, thereby completing the circuit of rotary magnet 60. It may be explained at this point that the circuit of the rotary magnet is held open by the contacts 59 controlled by the armature of the vertical magnet so as to allow the switch shaft to become settled before the rotary magnet energizes. Rotary magnet 60, upon energizing, advances the wipers 62–64, inclusive, into engagement with the first set of contacts in the level opposite which they are raised and at its interrupter contacts 61 opens the circuit of stepping relay 41. Stepping relay 41, upon deenergizing, opens another point in its circuit and prepares a circuit for switching relay 42 at armature 49 and at armature 50 opens the circuit of rotary magnet 60. Rotary magnet 60, upon deenergizing, closes its interrupter contacts 61 again.

From this point the operation depends upon whether the trunk line terminating in the first set of contacts is busy or idle. If it is busy, stepping relay 41 energizes again over the following circuit: from ground by way of the test contact with which test wiper 63 is in engagement, test wiper 63, armature 52 and its resting contact, armature 44 and its working contact, interrupter contacts 61, off-normal contacts 57, and stepping relay 41 to battery. Stepping relay 41, upon energizing, disconnects switching relay 42 and closes a locking circuit for itself at armature 49 and at armature 50 completes the circuit of rotary magnet 60 again. This alternate operation of the stepping relay and rotary magnet continues as long as test wiper 63 engages grounded contacts. In this case, we shall assume, that the trunk line comprising conductors 83–85, inclusive, is the one first found to be idle. That being the case, when the wipers of the selector D arrive upon the bank contacts 80–82, inclusive, there is no ground potential on test contact 81 and consequently stepping relay 41 does not energize. With this condition existing, switching relay 42 energizes over the following circuit: from ground by way of release trunk conductor 36, switching relay 42, resting contact of armature 49 and said armature, in-

terrupter contacts 61, off normal contacts 57, and stepping relay 41 to battery. Stepping relay 41, however, does not energize over this circuit on account of the relatively high resistance of switching relay 42. Switching relay 42, upon energizing, removes ground from armature 46 of release relay 39 at armature 53; disconnects test wiper 63 from the point between switching relay 42 and stepping relay 41 and connects it to ground by way of release trunk conductor 36 at armature 52, thus making the seized trunk busy immediately; and at armatures 51 and 54 disconnects the line conductors 35 and 37 from the windings of line relay 38 and extends them by way of the working contacts of these armatures, wipers 62 and 64, bank contacts 80 and 82, trunk conductors 83 and 85, and the normally closed contacts controlled by armatures 107 and 108 to the upper and lower windings of line relay 101 of the repeater E. Line relay 101 now energizes over the calling subscriber's loop and at armature 111 closes the circuit of release relay 102. Release relay 102, upon energizing prepares a circuit for relay 104 at armature 115 and places ground on release trunk conductor 84 at armature 114, thereby establishing the usual holding circuit for the switch D and the line switch C before the slow acting release relay 39 of selector D has had time to deenergize.

Returning now to the repeater E, as a still further result of the energization of release relay 102 it places ground on the conductor 129 at armature 116, thereby closing the circuit of the lower or polarizing winding of electro polarized relay 105. This winding alone, however, consisting of few turns of high resistance is not able to effectively energize the relay. As a still further result of the energization of release relay 102, it completes at armature 113 a bridge across the trunk conductors 122 and 123 as follows: from conductor 123 by way of the working contact of armature 112 and said armature, lower winding of impedance 103, normally closed contacts controlled by armature 106, upper winding of electropolarized relay 105, resting contacts of armature 117 and said armature, and armature 113 and its working contact to conductor 122. In response to the closure of this bridge the line and release relays of the office selector F, Fig. 4, energize and prepare the switch for operation in the usual manner. Electropolarized relay 105, however, is not energized at this time owing to the fact that the current flowing in either winding is in a direction opposite to that flowing in the other winding.

The calling subscriber now operates his calling device in accordance with the second digit 4 of the desired number, thereby producing a corresponding number of interruptions in the circuit of line relay 101. Each time line relay 101 deenergizes, it opens the circuit of the line relay of the office selector F at armature 112, and at armature 111 removes the short circuit from around relay 104. Relay 104 energizes immediately in series with release relay 102 and, being short circuited each time line relay 101 energizes, retains its armatures attracted throughout the series of interruptions. At armature 117 relay 104 completes the bridge across trunk conductors 122 and 123 by a more direct path excluding the lower winding of impedance 103 and the upper winding of relay 105. This is the usual expedient made use of in order to obtain first class switch control.

The office selector F, in response to the four interruptions produced in the circuit of its line relay, raises its wipers to the fourth level and rotates them in search of an idle trunk line leading to a thousands selector in the 44th office. In the present case, we shall assume that the trunk line terminating in the thousands selector G is the first one found to be idle and consequently the one selected. That being the case, the line and release relays of the selector G energize and prepare the switch for operation in the usual manner.

The calling subscriber may now operate his calling device in accordance with the third digit 2 of the desired number, whereupon, the selector G is caused to raise its wipers to the second level and rotate them in search of an idle trunk line leading to an idle hundreds selector in the desired thousands group. Assuming that the trunk line leading to the selector J, by way of the repeater H, is the first one found to be idle and consequently the one selected, the line and release relays of the said repeater immediately energize and prepare the switch for operation, at the same time closing a bridge across the conductors of the trunk line leading to the incoming hundreds selector J in the 442nd suboffice, Fig. 1. The line and release relays of the selector J now energize and prepare the switch for operation in the usual manner.

In response to the calling of the fourth digit in the desired number the selector J raises its wipers to the desired level and rotates them in search of an idle trunk line leading to a connector in the desired hundreds group. Assuming that the trunk line extending to the connector K is the first one found to be idle and consequently the one selected, the line and release relays 196 and 197 energize and prepare the switch for operation in the usual manner.

The calling subscriber now manipulates his calling device in accordance with the two remaining digits of the desired number, whereupon the connector K is operated to bring its wipers into engagement with the contacts in which the desired line terminates.

Ringing current is now intermittently sent out in a manner not shown to ring the bridged bell at the called substation A'.

Before going further, the operation of the repeater E together with the operation of its associated equipment will be explained more in detail. It will be remembered that relay 104 is maintained energized throughout each series of interruptions and that it falls back at the end of each series of interruptions. Relay 104, upon energizing, in response to the first digit dialled after the connection is extended to the repeater E which is the second digit of the called number, closes at armature 118 a circuit for the upper winding of the marginally adjusted delay 140 of the switch P. This winding, however, is composed of a small number of turns of high resistance and consequently the relay is energized just enough to bring armature 146 into engagement with its working contact but not enough to operate either armature 145 or armature 147. It will be noted that armature 146 is connected with the grounded conductor 129 and consequently the lower winding of relay 140 is short circuited at this time. As a further result of the energization of relay 104 it closes at armature 124 a point in the circuit of vertical magnet 161 of the switch P. Each time line relay 101 energizes following an interruption produced in its circuit it closes a circuit for vertical magnet 161 as follows: from ground by way of armature 111 and its working contact, working contact of armature 124 and said armature, conductor 134, armature 147 and its resting contact, and vertical magnet 161 to battery. By the operation of the vertical magnet the switch shaft and wiper 163 are raised step by step until the latter stands opposite the fourth level of bank contacts. At the end of the series of interruptions, relay 104 deenergizes; opens the circuit of vertical magnet 161 at armature 124; and at armature 118 opens the initial circuit of the upper winding of relay 140, thereby removing the short circuit from around the lower winding of the said relay 140. Relay 140 now pulls all the way up, the lower winding being composed of a large number of turns having a relatively low resistance. Upon operating fully, relay 140 transfers the impulsing circuit from the vertical to the rotary magnet at armature 147 and at armature 145 transfers the energizing circuit from its own upper winding to the upper winding of relay 141.

When relay 104 energizes in response to the calling of the next digit 2, it prepares a circuit for the rotary magnet 162 at armature 124 and at armature 118 closes the circuit of the upper winding of relay 141, which upper winding is similar to the upper winding of relay 140. Relay 141 is accordingly energized just sufficiently to bring armature 149 into engagement with its working contact but not sufficiently to operate armature 148 or armature 150. By the operation of the rotary magnet 162 which is energized following each interruption in the circuit of line relay 101, the wiper 163 is advanced into engagement with the second bank contact in the fourth level. At the end of the series of interruptions, relay 104 deenergizes and at armature 118 removes the short circuit from around the lower winding of relay 141, whereupon relay 141 completely energizes; opens another point in the initial circuit of its upper winding at armature 148; and at armature 150 disconnects the impulsing conductor 134 from rotary magnet 150 and connects it to resistance 165.

The repeater E functions as hereinbefore described to repeat the impulses to the switches ahead during the calling of the remaining digits in the desired number but does not cause any further movement of the wiper 163 of the switch P.

When the called subscriber responds by removing his receiver, the source of intermittent ringing current is removed from his line and the back bridge relay 195 of the connector K is connected up as shown. Back bridge relay 195, upon energizing, reverses the incoming trunk conductors as regards their connection with the upper and lower winding of line relay 196, thereby causing a reversal in the current flowing in the loop extending back to the repeater H. The repeater H in a well known manner now reverses the direction of the current flowing in the loop extending back to the repeater E.

In the repeater E the two windings of electro-polarized relay 105 which heretofore have opposed each other now assist each other in energizing the said relay 105. Upon energizing, relay 105 places a shunt around armature 117 and its resting contact at armature 119, places a shunt around armature 112 and its working contact at armature 121, and at armature 120 closes the circuit of reversing relay 100. Reversing relay 100, upon energizing, reverses the conductors 83 and 85 as regards their connection with the upper and lower windings of relay 101 at armatures 107 and 108. This reversal of current flow in these conductors may be used in certain cases to operate supervisory signals and the like.

The calling and called subscribers may now converse with each other as desired, the talking circuits being outlined by the heavy conductors.

As a further result of the energization of reversing relay 100, it places a ground potential on starting conductor 172 at armature 135. As soon as ground is placed upon starting conductor 172, relay 171 energizes and closes the circuit of relay 170 at armature 174. Relay 170, upon energizing, opens

the circuit of relay 171 at armature 173. Relay 171, being slow acting retains its armatures attracted for an interval. Upon deenergizing, relay 171 opens the circuit of relay 170 at armature 174. Relay 170, being slow acting also, retains its armature attracted for an interval. When relay 170 falls back it closes the circuit of relay 171 at armature 173 whereupon relay 171 energizes and closes the circuit of relay 170 at armature 174. This cycle of operation is repeated over and over as long as there is a ground potential on conductor 172. It will be noted that each time relay 171 energizes it closes a circiut for stepping magnet 176 at armature 175. Stepping magnet 176, upon energizing, causes the pawl of its armature to engage another notch on the drive wheel of the wiper 177. When magnet 176 deenergizes the wiper 177 is rotated in a clockwise direction and comes to rest in engagement with the next contact.

Wiper 177 continues to advance step by step without producing any particular effect until it comes into engagement with the contact in which the common pick up conductor 133 terminates, whereupon pick up relay 143 of the switch P is energized over the following circuit: from ground by way of wiper 177, pick up conductor 133, working contact of armature 110 and said armature, normally closed contacts controlled by armature 157, and relay 143 to battery. Pick up relay 143, upon energizing, closes a locking circuit for itself and opens its initial energizing circuit at armature 157; connects up the wiper 163 at armature 156; and at armature 158 connects the common impulse conductor 178 with relay 144 through the resting contact of armature 155 and said armature. As soon as wiper 177 is stepped into engagement with the next contact, ground is placed upon the common impulsing conductor 178, thereby closing a circuit for relay 144. Relay 144, upon energizing, disconnects release trunk conductor 84 from ground and connects it to so called booster battery through resistance 160, at armature 159. The various holding relays which are connected from release trunk conductor 84 to battery obviously do not deenergize at this time but are held even more firmly than before and the magnet of the marginally adjusted meter M associated with private normal conductor 13, Fig. 2, energizes at this time on account of the increased flow of current caused by the so called booster battery being connected in series with the regular exchange battery as described. The magnet of meter M, upon energizing, advances the number wheels to register the impulse.

Returning now to the impulse switch I, when wiper 177 is advanced into engagement with the next contact the circuit of relay 144 is opened, whereupon the said relay 144 deenergizes and replaces ground upon release trunk conductor 84. The magnet of the meter M now retracts its armature. As a further result of wiper 177 being advanced into engagement with the next contact, ground is placed upon the common stop conductor 181. Since this conductor is not connected in any way with the wiper 163 this does not produce any effect at this time. When wiper 177 is advanced into engagement with the next contact ground is again placed upon the common impulse lead 178 whereupon relay 144 is energized again; so called booster battery is again placed upon release trunk conductor 84; and the meter M is operated again. The next step of wiper 177 brings it into engagement with the contact associated with the common stop conductor 182 and the succeeding step brings it into engagement with a contact into which conductor 178 is multipled. This alternate operation of placing ground first upon the common impulse conductor 178 and then upon a stop conductor continues until ground has been placed upon impulse conductor 178 five times and consequently until the meter M has been operated a like number of times. When wiper 177 is advanced into engagement with the contact associated with the fifth stop conductor 185, stop relay 142 of the switch P is energized over the following circuit: from ground by way of wiper 177, stop conductor 185, the second bank contact in the fourth level with which wiper 163 is now in engagement, wiper 163, working contact of armature 156 and said armature, normally closed contacts controlled by armature 154, and relay 142 to battery. Relay 142, upon energizing, disconnects the common impulse conductor 178 from relay 144 and connects it to conductor 357 at armature 155, and locks itself to conductor 129 and disconnects test wiper 163 at armature 154.

It will be convenient to explain at this time the function of a special circuit arrangement that is used in both the line switch C and the selector D. It frequently occurs that while booster battery is connected to a particular release trunk conductor so as to operate a subscriber's meter, a switch such as the selector D rotates over a set of contacts in which that release trunk conductor is multipled. The result is that some current flows through the switching relay of the hunting switch. The current is limited, however, by the resistance coil which is between the release trunk conductor and booster battery, and the stiffly adjusted switching relay does not have time to energize before it is completely short circuited by the pulling up of the stepping relay after which the wipers are stepped onto the next set of bank contacts and the short circuit is removed from around the switching relay. If the re-

lease trunk conductor connected with this set of contacts also is connected to booster battery the switching relay which, due to the sluggish effect of placing a short circuit around it, has not lost all the magnetism obtained from the kick it received on the previous set of contacts, is likely to energize fully at this time with the result that the rotary movement is stopped and the connection is extended to a busy trunk. In case the energization of the switching relay does not occur on this trunk it is likely to occur on one of the following trunks if the release trunk conductors thereof happen to be connected to booster battery. This difficulty is obviated in the present invention by arranging the circuit so that the switching relay 42 is not short circuited by the stepping relay 41 when it energizes but is disconnected at armature 49, thereby allowing the built up lines of force in the switching relay to collapse between the testing of one contact and the testing of the other. It will be noted also that the circuit of switching relay 14 of the line switch C is opened each time stepping magnet 16 energizes. This is done for the same reason.

After the conversation is finished the two subscribers replace their receivers upon the switch hooks. When the receiver is replaced at the substation A', the current flow in the entire connection is reversed back to normal and relays 100 and 105 of the repeater E are deenergized. When the receiver is replaced at the substation A, the circuit of line relay 101 is opened. Line relay 101, upon deenergizing, opens the bridge across trunk conductors 122 and 123 at armature 112 whereupon the connection extending forward is released in the usual manner. As a further result of the deenergization of relay 101 it opens the circuit of release relay 102 at armature 111. Relay 104 now energizes in series with release relay 102 and at armature 124 places the relatively low resistance 165 in multiple with the said release relay 102 so as to shunt the latter and allow it to deenergize. Release relay 102, upon deenergizing, opens the circuit of relay 104 at armature 115 and at armature 116 removes ground from locking conductor 129, whereupon all the locked up relays in the switch P deenergize. As a further result of the deenergization of relay 102, it closes the circuit of release magnet 164 at armature 116. By the operation of release magnet 164 the shaft and wiper of the switch P are restored to normal position in the usual manner, the circuit of release magnet 164 being opened at off normal contacts 166 by the switch shaft when it reaches normal position. The entire connection is now released and the switches engaged therein are ready for another call.

It sometimes happens that a subscriber makes a call but holds the connection a very short time and consequently may often replace his receiver before the metering operations have been finished, or even started perhaps, and unless special provision were made he would be charged either insufficiently for the call or not at all. The manner in which this is taken care of will now be explained. Referring now again to the repeater E Fig. 2, reversing relay 100, upon energizing, in addition to closing the circuits pointed to hereinbefore, closes a locking circuit for itself at armature 136 in series with the resting contact of armature 152 and said armature of stop relay 142; and at armature 109 closes a circuit for release relay 102 independent of line relay 101 and in series with armature 151 of stop relay 142 and its resting contact. It is seen now that as soon as reversing relay 100 energizes in response to the answering of the called subscriber a locking circuit for the release relay and a locking circuit for itself are closed and remain closed until stop relay 142 is energized which does not happen until the metering operations are completed.

Referring now particularly to Fig. 3, it will be pointed out that the stop conductors 183–188, inclusive, are connected up in the bank of the switch P in accordance with the zones in which the exchanges corresponding to these bank contacts are located, reference being had to Fig. 1. For example, if the first digit called is 4 and the second digit is one, the forty first exchange is selected and the called subscriber's line terminates in the sixth zone, and as may be seen in Fig. 1, unless the third digit called is 0, in which case the called subscriber's line terminates in the 410th exchange which is located in the seventh zone. This is taken care of in the switch P by multipling the sixth stop conductor 186 to each contact in the first level of the switch P except the tenth which is associated with seventh stop conductor 187.

It may be pointed out also that when the first digit called is four and the second digit is two, the called subscriber's line terminates at the forty second exchange, located in the fifth zone, as may be seen in Fig. 1 unless the third digit called is five in which case it terminates at the 425th exchange, located in the sixth zone. This case is taken care of in the switch P by multipling the fifth stop conductor 185 with all the contacts in the second level of the switch P except the fifth contact which is associated with the sixth stop conductor 186. A further examination of the drawings will show that this same scheme has been carried out as regards each office and suboffice that may be reached when the first digit called is four. It is seen also that the charge which is to be assessed the calling subscriber is entirely independent of the route taken or the number called, being

dependent merely upon the zone in which the called subscriber's line terminates.

We shall assume now that the subscriber at substation A desires to call a subscriber whose line terminates in the 657th suboffice, Fig. 1. The 657th suboffice, it will be noted is a satellite of the fifth main office in the sixth district and is located in the tenth zone from the originating office 0.

When the receiver is removed at substation A, the line switch C operates in a manner hereinbefore described to pick out a trunk line leading to an idle district selector. Assuming that the trunk line extending to the district selector D is the first one found to be idle and consequently the one selected, the line and release relays 38 and 39 energize in the usual manner and perform the usual functions.

The calling subscriber now operates his calling device in accordance with the first digit 6 of the desired number, whereupon the selector D raises its wipers 62–64, inclusive, opposite the sixth level of bank contacts and rotates them in search of an idle trunk line. Assuming that the trunk line terminating in bank contacts 70–72, inclusive, is the first one found to be idle and consequently the one selected, the connection is extended through by way of the trunk line comprising conductors 73, 74, and 75 to the repeater E′, Fig. 5, whereupon line and release relays 216 and 217 of the repeater E′ energize and the latter places ground upon release trunk conductor 74 at armature 227, thereby establishing the usual holding circuit. As a further result of the energization of release relay 217 it completes a bridge across the trunk conductors 200 and 201 at armature 226, whereupon an office selector in the sixty sixth office, Fig. 1, to which this trunk line extends prepares itself for operation in the usual manner. As a still further result of the energization of release relay 217, ground is placed upon conductor 248 at armature 228, thereby closing a circuit for the lower or polarizing winding of the electropolarized relay 219. Electropolarized relay 219, however, being similar to electropolarized relay 105 of the repeater E, Fig. 3, does not energize at this time for the reasons previously given for electropolarized relay 105.

The calling subscriber now manipulates his calling device in accordance with the next digit 5 in the desired number whereupon the line relay 216 opens the bridge across conductors 200 and 201 five times momentarily. Relay 218, being similar to relay 104 of the repeater E, is maintained energized throughout the series of interruptions and serves to complete the bridge across conductors 200 and 201 by a more direct path so as to improve the impulsing circuit.

In response to the impulses repeated to it, the office selector in the sixty sixth office raises its wipers to the fifth level and selects an idle trunk leading to a thousands selector in the sixty fifth office.

In response to the calling of the third digit 7 in the desired number, the thousands selector in the sixty fifth office to which the connection has been extended raises its wipers to the seventh level and rotates them in search of an idle hundreds selector in the 657th suboffice. In response to the calling of the next digit, the hundreds selector to which the connection has been extended raises its wipers to the desired level and selects an idle conductor in the desired hundreds group, and in response to the calling of the remaining two digits the connector to which the connection has been extended brings its wipers into engagement with the contacts in which the desired line terminates and begins to send out ringing current intermittently to ring the bridged bell at the called substation.

Returning now to the repeater E′, Fig. 5, its operation in connection with its associated equipment will be explained a little more in detail. Relay 218, upon energizing, in response to the first digit called after the connection is extended to the repeater E′, or the second digit in the desired number, places ground upon the conductor 243 at armature 230, thereby closing a circuit for the upper winding of the marginally adjusted relay 251 of the switch Q. Relay 251, energizes at this time just sufficiently to bring armature 262 into engagement with its working contact but not sufficiently to operate armature 261. As a further result of the energization of relay 218 it prepares a circuit for the operating magnet 291 of the switch Q at armature 232. Each time line relay 216 energizes following an interruption produced in its circuit it closes the following circuit: from ground by way of armature 233 and its working contact, armature 232 and its working contact, conductor 241, armature 265 and its resting contact, and operating magnet 291 to battery. By the operation of magnet 291 which receives five impulses at this time the wiper 294 is brought into engagement with the fifth bank contact 296. At the end of the series of impulses, relay 218 deenergizes; opens the circuit of operating magnet 291 at armature 232; and opens at armature 230 the initial energizing circuit for the upper winding of relay 251, thereby removing the short circuit from around the lower winding, whereupon the said relay 151 energizes fully and transfers conductor 243 from its own upper winding to the upper winding of relay 263. As a further result of the deenergization of relay 218, it completes at armature 230 the following circuit: from ground by way of armature 230 and its resting contact,

conductor 240, off-normal contacts 292, and release magnet 290 to battery. A branch of this circuit extends by way of armature 293 of release magnet 290 and its resting contact, wiper 294, bank contact 296, resting contact of armature 286 and said armature, normally closed contacts controlled by armature 276, and relay 256 to battery. Upon energizing, relay 256 closes a locking circuit for itself and disconnects itself from bank contact 296 at armature 276; connects up the seventh bank contact 298 to relay 257 at armature 277; connects up the the second bank contact 295 with relay 258 at armature 278; disconnects the sixth bank contact 297 from relay 259 and connects it to relay 258 at armature 279; and at armature 275 connects the individual stop conductor 250 to common stop conductor 191 which is the stop conductor associated with the eleventh zone in which the 65th main office is located. Release magnet 290, upon energizing, disconnects wiper 294 at armature 293 and by means of a mechanical arrangement (not shown) releases the wiper 294 allowing it to return to normal position, the circuit of release magnet 290 being opened at off-normal contacts 292 as soon as the wiper 294 reaches normal position.

When relay 218 energizes in response to the calling of the next digit 7 of the desired number, it prepares a circuit for operating magnet 291 of the switch Q at armature 232 and at armature 230 closes a circuit for the upper winding of the marginally adjusted relay 252. Relay 252 energizes at this time just sufficiently to bring armature 264 into engagement with its working contact but not sufficiently to operate either armature 263 or armature 265. By the operation of the operating magnet 291 which is energized each time line relay 216 energizes, wiper 294 is brought into engagement with the seventh bank contact 298 which at this time is connected with relay 257. Relay 218, upon deenergizing, at the end of the series of interruptions opens the circuit of the operating manget 291 at armature 232 and at armature 230 opens the initial energizing circuit of relay 252 whereupon the said relay energizes fully; opening its own circuit at armature 263 and transferring the operating circuit from magnet 291 to resistance 343 at armature 265. As a further result of the deenergization of relay 218 it closes at armature 230 and its resting contact the previously traced circuit for release magnet 290, a branch of which circuit extends by way of wiper 294, bank contact 298, armature 277 and its working contact, normally closed contacts controlled by armature 281, and relay 257 to battery. Relay 257, upon energizing, locks itself to conductor 248 and disconnects itself from bank contact 298 at armature 281, and at armature 280 disconnects the individual stop conductor 250 from the common stop conductor 191 and connects it with the common stop conductor 190 which is the stop conductor associated with the tenth zone in which the 657th suboffice is located. Release magnet 290, upon energizing, disconnects wiper 294 at armature 293 and restores the said wiper to normal position, the circuit of the release magnet being opened at off-normal contacts 292. Since the operating magnet 291 is now disconnected from the operating conductor 241, the calling of the remaining digits in the desired number does not cause any further movement of the wiper 294.

When the called subscriber responds to the ringing of his bell by removing his receiver, the current flow is reversed in the conductors 200 and 201 of the trunk line associated with the repeater E′, whereupon the electropolarized relay 219 energizes and closes a circuit for reversing relay 215 at armature 231. Reversing relay 215, upon energizing, reverses the current flow in the trunk conductors 73 and 75 in the usual manner and closes a locking circuit for itself at armature 220 in series with armature 267 and its resting contact; closes a multiple circuit for release relay 217 at armature 224 in series with the resting contact of armature 266 and the said armature; places ground upon conductor 172 at armature 225 thereby closing a starting circuit for the impulsing machine I; and at armature 223 connects up the common pick up conductor 133 with pick up relay 254 of the switch Q. The wiper 177 of the common impulsing machine I is now advanced step by step in a manner described hereinbefore. As soon as wiper 177 arrives upon the bank contact in which conductor 133 terminates the following circuit is closed: from ground by way of wiper 177, conductor 133, working contact of armature 223 and said armature, normally closed contacts controlled by armature 272, and relay 254 to battery. Relay 254, upon energizing, locks itself to conductor 248 and disconnects itself from pick up conductor 133 at armature 272, connects up the individual stop conductor 250 with stop relay 253 at armature 271; and at armature 335 connects relay 255 with the common impulse conductor 178 by way of the resting contact of armature 317 and said armature. As soon as wiper 177 comes into engagement with the next contact, ground is placed upon the common impulse conductor 178 thereby closing a circuit for relay 255. Relay 255, upon energizing, disconnects release trunk conductor 74 from ground and connects it to so called booster battery through resistance 273 at armature 274, thereby operating the magnet of the meter M in a manner hereinbefore described. Upon the next step of the wiper 177, ground is removed from conductor 178

and placed upon the first stop conductor 181, whereupon relay 255 deenergizes and replaces ground upon conductor 74 and disconnects booster battery therefrom. The magnet of the meter M now deenergizes. The wiper 177 continues to advance and the meter M continues to be operated upon each alternate step thereof until the said wiper has come into engagement with the tenth stop conductor 190 and the said meter M has been operated ten times. When wiper 177 arrives upon the contact in which conductor 190 terminates, the following circuit is closed: from ground by way of wiper 177, conductor 190, working contact of armature 280 and said armature, resting contact of armature 282 and said armature, conductor 250, working contact of armature 271 and said armature, normally closed contacts controlled by armature 269, and stop relay 253 to battery. Relay 253, upon energizing, locks itself to conductor 248 and disconnects itself from stop conductor 250 at armature 269; extends the common pick up conductor 133 to the individual pick up conductor 328 at armature 268; opens the locking circuit of reversing relay 215 at armature 267; removes release relay 217 from under control of reversing relay 215 at armature 266; removes ground from conductor 325 at armature 315; connects stop conductor 326 with stop conductor 250 at armature 316; and at armature 317 disconnects the common impulse conductor 178 from relay 255 and connects it to the individual impulse conductor 327. With stop relay 253 energized the further movement of the wiper 177 does not cause any further operation of the meter M for the time being, the initial charge for the call having already been made.

It is in most instances desirable to charge a calling subscriber, not only in accordance with the distance over which the call is extended but also, in accordance with the time which the conversation consumes. It will now be shown how the calling subscriber is assessed an additional charge at regularly occurring intervals until the conversation is completed. The wiper 177, which continues to advance, upon arriving the next time upon the contact in which the pick up conductor 133 terminates, closes the following circuit: from ground by way of wiper 177, conductor 133, working contact of armature 223 and said armature, armature 268 and its working contact, normally closed contacts controlled by armature 336, relay 344, and resistance 339 to battery. Relay 344, upon energizing, locks itself to conductor 248 and disconnects itself from conductor 328 at armature 336; prepares a circuit for the operating magnet 340 of the switch T at armature 337; and at armature 338 connects up wiper 342. As soon as wiper 177 arrives upon the next contact it places ground upon the common impulse conductor 178, thereby closing the following circuit: from ground by way of wiper 177, impulse conductor 178, armature 317 and its working contact, conductor 327, working contact of armature 337 and said armature, and stepping magnet 340 to battery. Stepping magnet 340, upon energizing, causes the pawl of its associated armature to engage another notch on the ratchet wheel which drives the wipers 341 and 342. As soon as the wiper 177 takes another step, ground is disconnected from conductor 178 and connected to conductor 181 instead, whereupon stepping magnet 340 deenergizes and advances the wipers 341 and 342 into engagement with the next set of contacts. As wiper 177 continues to advance, stepping magnet 340 is operated upon each alternate step of the said wiper 177 until wiper 177 arrives upon the bank contact in which the stop conductor 190 terminates, at which time stepping magnet 340 will have been operated ten times. When wiper 177 arrives upon the bank contact in which conductor 190 terminates, the following circuit is closed: from ground by way of a circuit previously traced to the individual stop conductor 250 and thence by way of the working contact of armature 316 and the said armature, conductor 326, and resistance 339 to battery. The closure of this circuit results in the short circuiting of relay 344 which deenergizes. Relay 344, upon deenergizing, disconnects wiper 342 at armature 338; opens a point in the circuit of stepping magnet 340 at armature 337; and at armature 336 disconnects locking conductor 248 and connects up pick up conductor 328 again. The further movement of wiper 177 does not cause the wipers 341 and 342 of the switch T to be advanced until the said wiper 177 has completed this half revolution and has started upon the next half at which time ground will again be placed upon conductor 133 with the result that relay 344 energizes and connects up stepping magnet 340 again. The same cycle of operation is repeated over and over as long as the conversation continues, the wipers 341 and 342 taking ten steps for each half revolution of the wiper 177 of the switch I.

The operation of stepping magnet 340 continues as described and the wipers 341 and 342 continue to advance without producing any result until the wiper 342 arrives upon the bank contact in which conductor 329 terminates. It will be remembered that the wipers 341 and 342 are advanced not when the stepping magnet 340 energizes but upon the deenergization thereof and consequently when the said wiper 342 arrives upon the bank contact in which conductor 329 terminates stepping magnet 340 is not energized and there is no ground potential upon conductor 327. When the

ground potential is again placed upon conductor 327 to energize stepping magnet 340 for the next step, the said magnet attracts its armature in the usual manner. A branch of the circuit for energizing magnet 340 extends by way of the working contact of armature 338 and said armature, wiper 342, conductor 329, and relay 255 to battery. Relay 255, upon energizing, disconnects ground from release trunk conductor 74 and connects booster battery thereto, whereupon the magnet of the meter M is operated again. When the ground potential is removed from conductor 327 relay 255 deenergizes and magnet 340 advances the wipers 341 and 342 into engagement with the next set of contacts. Relay 255, upon deenergizing, connects ground to release trunk conductor 74 again and disconnects booster battery therefrom, whereupon the magnet of the meter M deenergizes. As long as the conversation continues, the wipers of the switch T continue to advance step by step and the meter M is operated in the manner described once during every half revolution of the said wipers.

From the above it will be seen that, since the calling subscriber's meter is operated once during each half revolution of the wipers of the time switch T, and since the rate at which the wipers of the time switch T are advanced (or, in other words, the number of steps taken by the said wipers for each cycle of operation of the impulse machine I) is proportionate to the zone in which the called subscriber's line is located, the intervals between successive additional charges are inversely proportionate to the zone in which the called line is located.

In order to insure that the meter of the calling subscriber is operated at the correct intervals, the impulsing relays associated with the impulse machine I are so adjusted that the wiper 177 advances at a definite unchanging speed. This speed should be low enough to allow time for the satisfactory operation of the subscriber's meters such as the meter M, and should be high enough to complete the initial charge for a call quickly so as not to tie up the trunk lines and the calling subscriber's telephone for an undue length of time in case the conversation is very short. At any rate, after the speed of the wiper 177 has been fixed the number of contacts in the bank of the time switch T may be so regulated that the initial charge, whatever it may be, will be fully repeated in any desired length of time.

When the conversation terminates the calling and called subscribers replace their receivers. When the receiver is replaced at the called substation the current flow in the trunk line comprising conductors 200 and 201 is reversed back to normal whereupon electropolarized relay 219 and reversing relay 215 deenergize. Reversing relay 215, upon deenergizing, reverses the current flow in the conductors 73 and 75 back to normal. This, however, does not have any particular function at this time.

When the receiver is replaced at the calling substation, the circuit of line relay 216 is opened and the said relay, upon deenergizing, opens the bridge across the conductors 200 and 201 at its lower pair of contacts, whereupon the connection extending to the distant exchange is released in the usual manner. As a further result of the deenergization of line relay 216 it opens the circuit of release relay 217 at armature 233 whereupon relay 218 energizes in series with release relay 217 and at armature 232 places the relatively low resistance 343 in multiple with the latter relay 217. Release relay 217 now deenergizes on account of being shunted by resistance 343 and at armature 229 opens the circuit of relay 218, whereupon that relay also deenergizes. As a further result of the deenergization of release relay 217, ground is removed from release trunk conductor 74 at armature 227 whereupon the line switch C and the selector D are restored to normal. As a still further result of the deenergization of relay 217 it removes ground from the locking conductor 248 at armature 228, whereupon relays 251, 252, 253, 254, 257, and 258 immediately deenergize. Relay 344 of the switch T deenergizes also in case that relay is locked up at this time. In case the wipers of the switch T are not at the normal position shown in the drawings, which they most likely will not be, relay 253, upon deenergizing, completes at armature 315 the following circuit: from ground by way of armature 315 and its resting contact, conductor 325, wiper 341, interrupter contacts of stepping magnet 340, and said stepping magnet 340 to battery. The wipers 341 and 342 are now advanced step by step by stepping magnet 340, which interrupts its own circuit at this time, until they come into the position shown in the drawing, at which time the wiper 341 breaks the circuit by passing off the last contact in which conductor 325 is multipled. The entire connection is now released and the apparatus shown is ready for another call.

Referring now again to Fig. 3, it will be noted that the switch P is provided with conductors 355, 356, 129, 357, 358, and 359. These conductors, it may be said, correspond to the conductors 325, 326, 248, 327, 328, and 329, respectively, of the switch Q, Fig. 5, and are assumed to extend to a time switch identical with the time switch T associated with the switch Q, the time switch being eliminated in this instance so as not to encumber the drawings unnecessarily. It is obvious that in case it is so desired the time switches such as the time switch T may be eliminated

in which case the initial charge is the only one made for a call.

Referring now particularly to Figs. 1 and 5, it will be pointed out just how the equipment shown in Fig. 5 operates to assess an equitable charge each time it is used in extending a connection from the originating exchange 0, Fig. 1, to some exchange located in the sixth district.

The calling of the first digit 6 as before pointed out, causes a district selector to pick out an idle trunk line leading to the 66th main office, which trunk line has a repeater associated with it such as the repeater E′, Fig. 5. Since there are only two main offices in the sixth district, the fifth and the sixth, the second digit called in this case will be either a five or a six. Assuming that the repeater E′ is the one through which the connection is extended, the calling of the second digit five causes the relay 256 of the switch Q to energize in a manner hereinbefore pointed out with the result that the individual stop conductor 250 is connected with the common stop conductor 191 which is the stop conductor associated with the 11th zone which is the zone in which the sixty fifth main office is located. It has before been pointed out that if the third digit called is seven the wiper 294 of the switch Q will land upon the seventh contact 298 with the result that relay 257 energizes and shifts the individual stop conductor 250 from the stop conductor 191 associated with the 11th zone to the stop conductor 190 associated with the 10th zone which is the zone in which the 657th suboffice is located. If the third digit instead of being seven had been two or six the wiper 294 would have come into engagement with the second bank contact 295 or the sixth bank contact 297 and in either case relay 258 would have energized and shifted the individual stop conductor 250 to the stop conductor 192 associated with the 12th zone which is the zone in which the 652nd and 656th suboffices are located. It will become apparent also from an examination of the drawings that if the third digit called in this case is any other than 2, 6, or 7 the wiper 294 comes into engagement with a bank contact with which no relay is connected and consequently the individual stop conductor 250 remains in connection with the stop conductor 191 associated with the 11th zone which, as before stated, is the zone in which the 65th main office is located.

If we assume now that the second digit instead of being 5, is 6 the connection is extended not to a thousands selector in the 65th main office but to a thousands selector in the 66th main office and at the same time the wiper 294 is brought into engagement with the sixth bank contact 297 with the result that relay 259 energizes; connects the individual stop conductor 250 with the common stop conductor 190 associated with the 10th zone which is the zone in which the 66th main office is located; and prepares a circuit for relay 260 which is associated with the 9th bank contact 299. If the third digit called is nine relay 260 energizes and shifts the individual stop conductor 250 into engagement with the common stop conductor 191 which is associated with the 11th zone which is the zone in which the 669th suboffice is located. If the third digit called is any digit other than nine the wiper 294 is brought into engagement with a bank contact with which no relay is associated at this time and consequently the individual stop conductor 250 remains connected with the stop conductor 190 associated with the 10th zone which, as before stated, is the zone in which the 66th main office and the 661st suboffice are located.

It is to be understood that in case other main and suboffices are added in this district other groups of relays may be added to the switch Q and that they may be wired in substantially the same manner as those shown, so as to assess the calling subscriber an equitable charge. The relay equipment Q, however, is best adapted for use with such trunk lines as extend to districts having only a few offices, as the 6th district, and the trunk lines which extend to the heavily populated districts are preferably equipped as shown in Fig. 3.

It will be noted that the armatures of the line relays throughout the drawings do not have the usual resting contacts through which the change over relay or both the change over relay and the operating magnets have been controlled formerly and that not only the release relay but also the operating magnets and the change over relay as well are controlled by a simple pair of contacts on the line relay. This makes unnecessary the former practice of dividing the impulsing cycle between the resting and working contacts and consequently allows the switch to be adjusted to operate under more severe line conditions.

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

What is claimed is:

1. In a telephone system, a plurality of exchanges, means for connecting a calling subscriber in one exchange with called subscribers in the other exchanges, toll assessing machanism in the first exchange operative to predetermine a particular charge as soon as a calling subscriber calls a digit which routes the call to a particular one of the other exchanges, and means for decreasing the predetermined charge in case a subsequent digit routes the call to a different exchange.

2. In a telephone system, a plurality of exchanges, means for connecting a calling sub-

scriber in one exchange with called subscribers in the other exchanges, toll assessing mechanism in the first exchange operative to predetermine a particular charge as soon as a calling subscriber calls a digit which routes the call to a particular one of the other exchanges, and means for either decreasing or increasing the predetermined charge in case a subsequent digit routes the call to another exchange which is a lesser or greater distance from the originating exchange than the first exchange through which the call was routed.

3. In an automatic telephone system divided into a plurality of zones by imaginary circles concentric with a central exchange, a switching point located in a distant zone, means whereby a calling subscriber in the central exchange can extend a connection by way of said switching point to called subscribers in the zone in which the switching point is located and also to called subscribers in closer and more distant zones, and mechanism responsive to the impulses constituting a plurality of digits in any particular called number for assessing a charge against the calling subscriber which is proportionate to the zone in which the called subscriber is located.

4. In an automatic telephone system divided into a plurality of zones by imaginary circles concentric with a central exchange, a switching point located in a distant zone, means whereby a calling subscriber in the central exchange can extend a connection by way of said switching point to called subscribers in the zone in which the switching point is located and also to called subscribers in closer and more distant zones, means operated when the digit of a called number is called which routes the call to said switching point for predetermining a certain charge to be assessed against the calling subscriber, and means responsive to a subsequent digit for either decreasing or increasing such charge depending on whether the called subscriber is located in a closer or a more distant zone.

5. In an automatic telephone system comprising a plurality of exchanges, means for setting up a connection between lines in different exchanges, an automatic switch in the exchange in which the calling line terminates having a primary and secondary movement, means for operating said switch in its primary movement in response to the calling of one digit in the called number, and for operating the said switch in its secondary movement in response to the calling of the following digit, and means controlled by the setting of the said switch for determining the charge to be assessed for the call.

6. In an automatic telephone system comprising a plurality of exchanges, means for setting up connections between lines terminating in said exchanges, a device located in the exchange in which the calling line terminates for assessing an initial charge at the beginning of conversation varying in accordance with the distance between the exchange in which the calling line terminates and the exchange in which the called line terminates, and means for assessing additional charges for each connection at intervals which are inversely proportionate to the initial charges.

7. In an automatic telephone system divided into a plurality of zones by imaginary circles concentric with a central exchange, a switching point located in a distant zone, means whereby a calling subscriber in the central exchange can extend a connection by way of said switching point to called subscribers in the zone in which the switching point is located and also to called subscribers in closer and more distant zones, mechanism responsive to the impulses constituting a plurality of digits in any particular called number for assessing a charge against the calling subscriber which is proportionate to the zone in which the called subscriber is located and mechanism operative after the connection is established for assessing an elapsed time charge against the calling subscriber at intervals which are inversely proportionate to the zone in which the called subscriber is located.

8. In a measured service telephone system, means for setting up connections of different values, a charge assessing control device, means for advancing said device during the time a connection is established and at different rates for each connection, the rate being substantially proportionate to the value of the connection, and means including said device for assessing the calling subscriber a fixed charge each time said device moves a definite pre-determined amount.

9. In a measured service telephone system, means for setting up connections of different values, a step by step charge assessing control device, means for advancing said device at rates that are substantially proportionate to the values of the different connections, and means including said device for assessing the calling subscriber a fixed charge each time said device takes a pre-determined number of steps.

10. In a measured service telephone system, a trunk line over which calls of different values may be made, a charge assessing control device individual thereto, means for advancing said device at rates that are substantially proportionate to the value of the connections set up, and means including said device for assessing the calling subscriber a fixed charge each time said device moves a definite pre-determined amount.

11. In a measured service telephone system, a trunk line over which calls of differ-

ent values may be made, a step by step charge assessing control device individual thereto, means for advancing said device at rates that are substantially proportionate to the value of the calls, and means including said device for assessing the calling subscriber a fixed charge each time said device takes a pre-determined number of steps.

12. In a meter control apparatus, a meter control conductor, an automatic switch for intermittently grounding said conductor, "pick up" and "stop" relays for closing and opening said conductor, respectively, a pick up wire connected between said pick up relay and a contact in the bank of said switch, a plurality of stop conductors, and a second automatic switch for connecting the stop relay with any one of said stop conductors.

13. In a meter control apparatus, a control conductor, an automatic step by step switch for delivering impulses to said conductor, a plurality of stop wires successively grounded in the travel of said switch by a wiper thereof, a stop relay for opening said conductor, and a second automatic switch for connecting said stop relay with any one of said stop conductors.

14. In a meter control apparatus, two automatic step by step switches, banks for said switches permanently wired together, means for setting the first switch under subscriber control, means for automatically stepping the second switch, a meter control circuit excluding the first switch and controlled by the second switch, a relay for determining the duration of the control of said circuit exercised by the second switch, and a circuit for said relay including one of the permanent connections between said banks.

15. In a meter control apparatus, two automatic step by step switches, banks for said switches permanently wired together, means for setting the first switch under subscriber control, means for automatically stepping the second switch, a meter control circuit controlled by the second switch independent of the first, and means for determining the duration of the control controlled jointly by said switches over one of said permanent bank connections.

16. In a meter control apparatus, two automatic step by step switches, banks for said switches permanently wired together, means for setting the first switch under subscriber control, means for automatically stepping the second switch, a meter control circuit, a relay for intermittently closing said circuit, an impulse wire leading to said relay from said second switch, a pick up relay controlled by said second switch for closing said impulse wire, a stop relay for opening said impulse wire, and a circuit for said stop relay including one of said permanent bank connections.

17. In a meter control apparatus, two automatic step by step switches, banks for said switches permanently wired together, means for setting the first switch under subscriber control, means for automatically stepping the second switch, a meter control circuit, a relay for closing said circuit, a conductor over which the second switch transmits impulses to said relay, pick up and stop relays for determining the number of impulses transmitted, a circuit for one of said last mentioned relays controlled by the second switch independent of the first, and a circuit for the other relay controlled by said switches jointly over said permanent bank connections.

18. In a measured service telephone system, an impulse conductor, a contact making device, a plurality of impulse governing conductors connected up successively by said device, an impulsing circuit, means controlled by one of said impulse governing conductors for connecting said impulse conductor with said impulsing circuit, means controlled by another of said impulse governing conductors for subsequently disconnecting said impulse conductor from said impulsing circuit, and selecting means for choosing one of the two conductors last mentioned, the other being a fixed pre-determined one.

19. In a telephone system divided into zones from the standpoint of a particular exchange, a group of terminals, one for each exchange, means located in each exchange responding to a plurality of digits in a called number for selecting the terminal corresponding to the called exchange, and means controlled through the selected terminal for assessing varying charges according to the zone in which the called exchange is located.

20. In a telephone system, a plurality of exchanges, an automatic switch in each exchange having a group of terminals, one for each exchange, other automatic switches, the said first switch responding to a plurality of digits of a called number for selecting a terminal corresponding to the called exchange, means controlled through the selected terminal for assessing a charge according to the zone in which the called exchange is located, and the other switches also responding to the same respective digits to extend the connection.

21. In a zone metering telephone system, a plurality of exchanges, a selecting device in each exchange having a plurality of contacts, one for each of the other exchanges, said switch responsive to impulse series transmitted to switches used in trunking calls to select the particular contact corre-

sponding to the called exchange, and circuit arrangements and apparatus by means of which each selecting device controls the assessing of initial and time lapse charges depending upon the exchanges between which the calls are extended.

22. In a zone metering telephone system, a plurality of exchanges, a selecting device in each exchange having a plurality of contacts, one for each of the other exchanges, means in each respective exchange operable when calls are set up to select the particular contact corresponding to the called exchange, and circuit arrangements and apparatus by means of which each selecting device controls the assessing of initial and time lapse charges in accordance with the exchanges between which the calls are extended.

23. In a measured service telephone system, a calling line having a meter, a trunk line for extending calls from said calling line to called lines located in different zones, a charge assessing control device individual to said trunk line, a relay in said device for controlling the operation of said meter, a first automatic switch for variably operating said relay in accordance with the called zone for assessing an initial charge, a second automatic switch for operating said relay in accordance with the duration of a call for assessing a time charge, means for transferring the control of said relay from said first switch to said second switch, and automatic switching means directively controlled during the setting up of a call, for determining the operation of said transferring means.

24. In a measured service telephone system, a calling line having a meter, a trunk line for extending calls from said calling line to called lines located in different zones, a charge assessing control device individual to said trunk line, a first means in said device for operating said meter a plurality of times in accordance with the called zone for assessing an initial charge, a second means for operating said meter in accordance with the duration of a call for assessing a time charge, means for transferring the control of said meter from said first means to said second means, and means directively controlled during the setting up of a call, for determining the operation of said transferring means.

25. In a measured service telephone system, a calling line provided with a meter, a trunk line for extending calls from said calling line to called lines located in different zones, a charge assessing control device individual to said trunk line, impulsing means in said device for transmitting operating impulses to said meter, and means directively controlled from the calling line during the setting up of a call for controlling said impulsing means to first transmit impulses to said meter in accordance with the zone for assessing an initial charge, and to then transmit impulses to said meter in accordance with the duration of the call for assessing a time charge.

In witness whereof, I hereunto subscribe my name this 4th day of October, A. D. 1921.

JOHN I. BELLAMY.