June 28, 1927. 1,633,678

A. J. RAY

ELAPSED TIME AND ZONE METERING

Filed Jan. 22, 1923 4 Sheets-Sheet 1

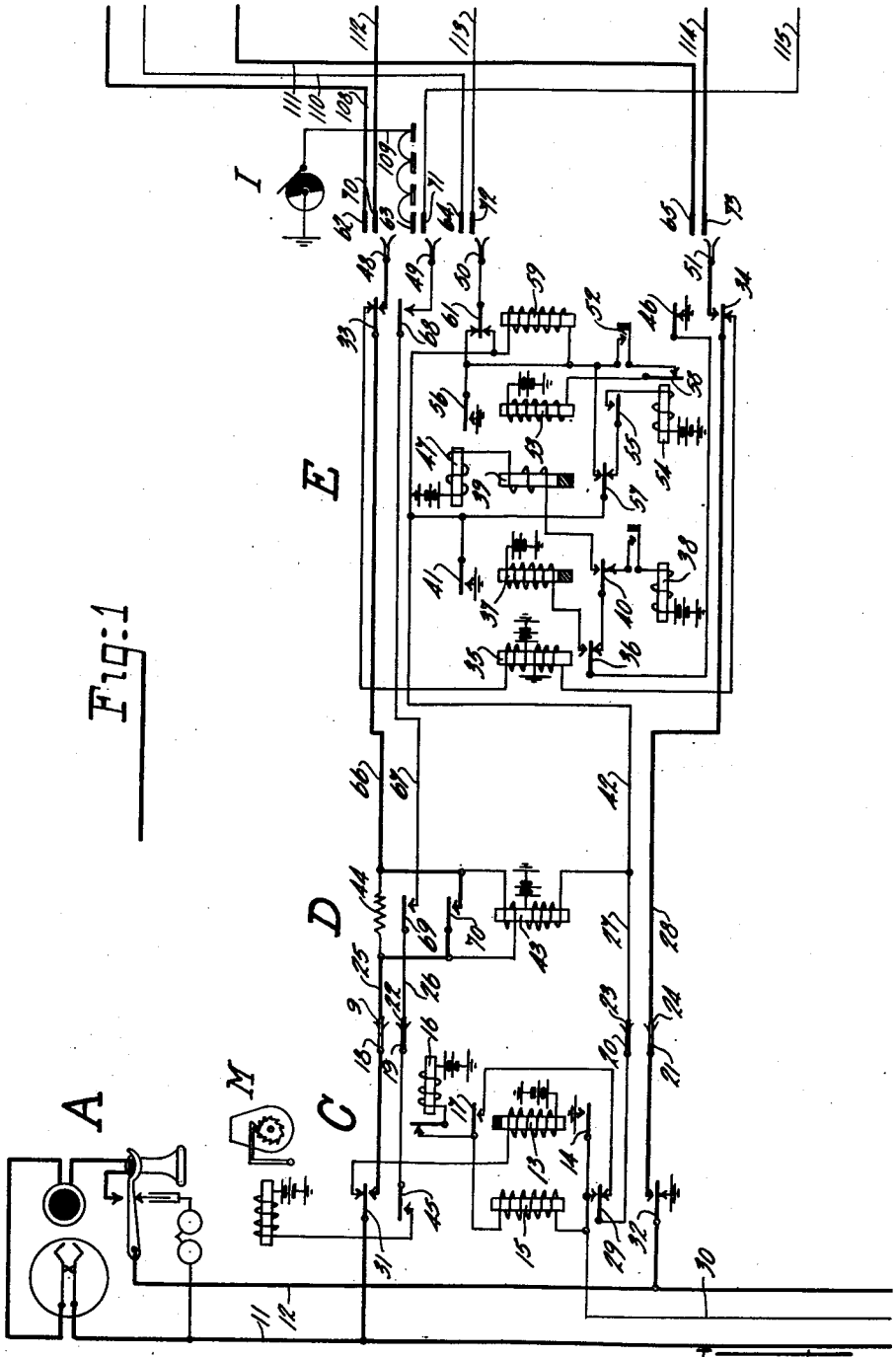


Fig. 1

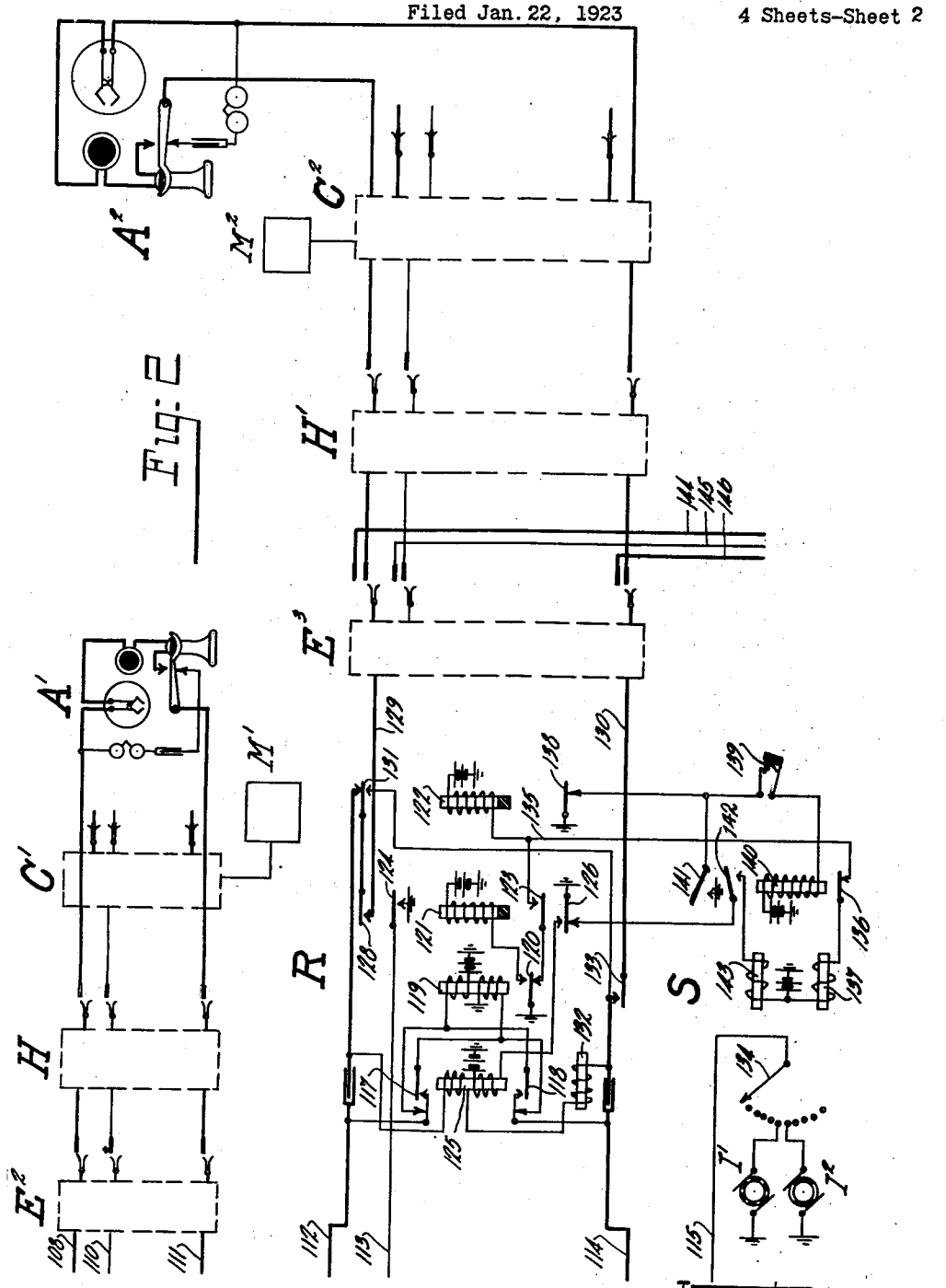
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ELAPSED TIME AND ZONE METERING

Filed Jan. 22, 1923 4 Sheets-Sheet 2



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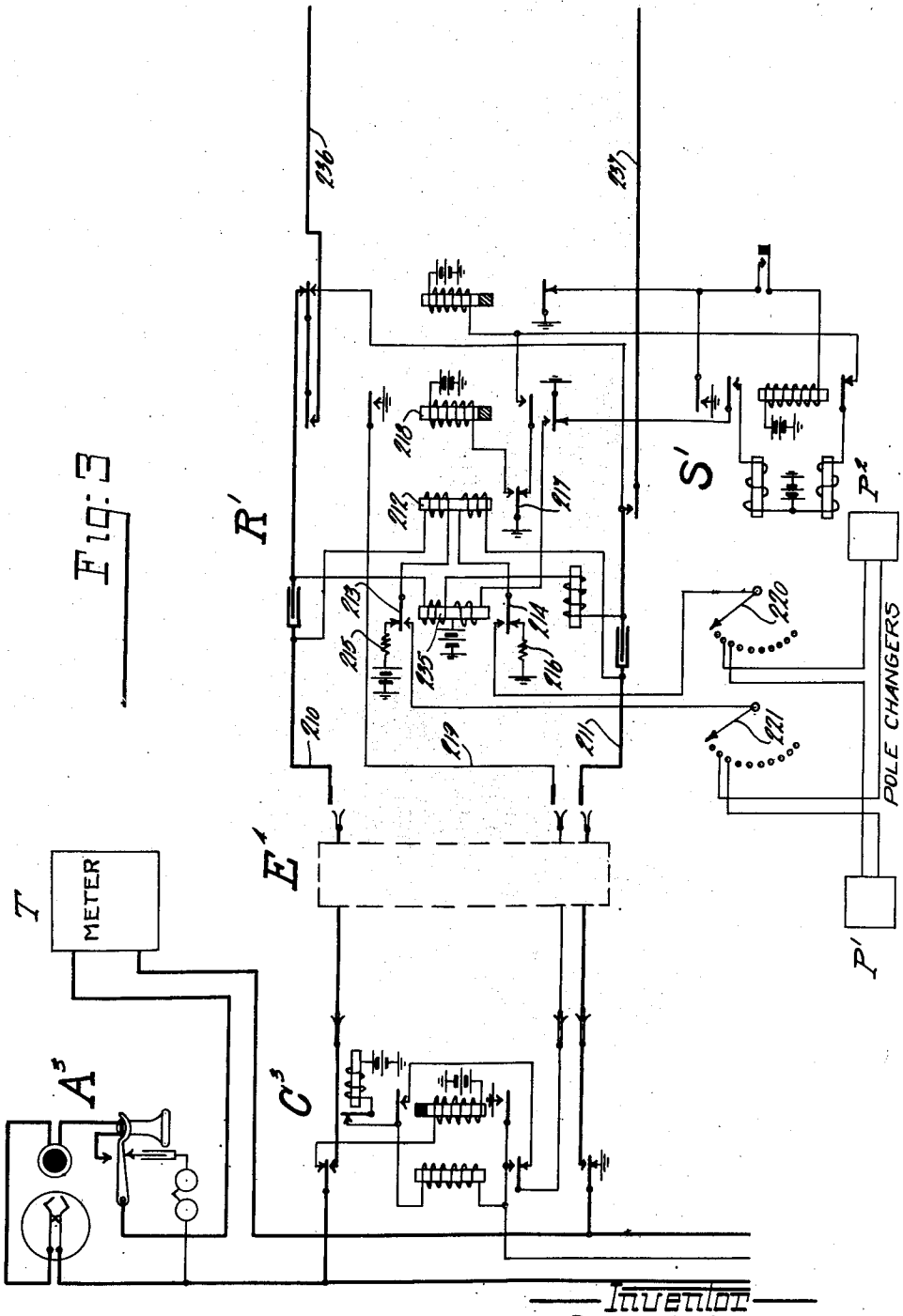
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ELAPSED TIME AND ZONE METERING

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Fig. 3



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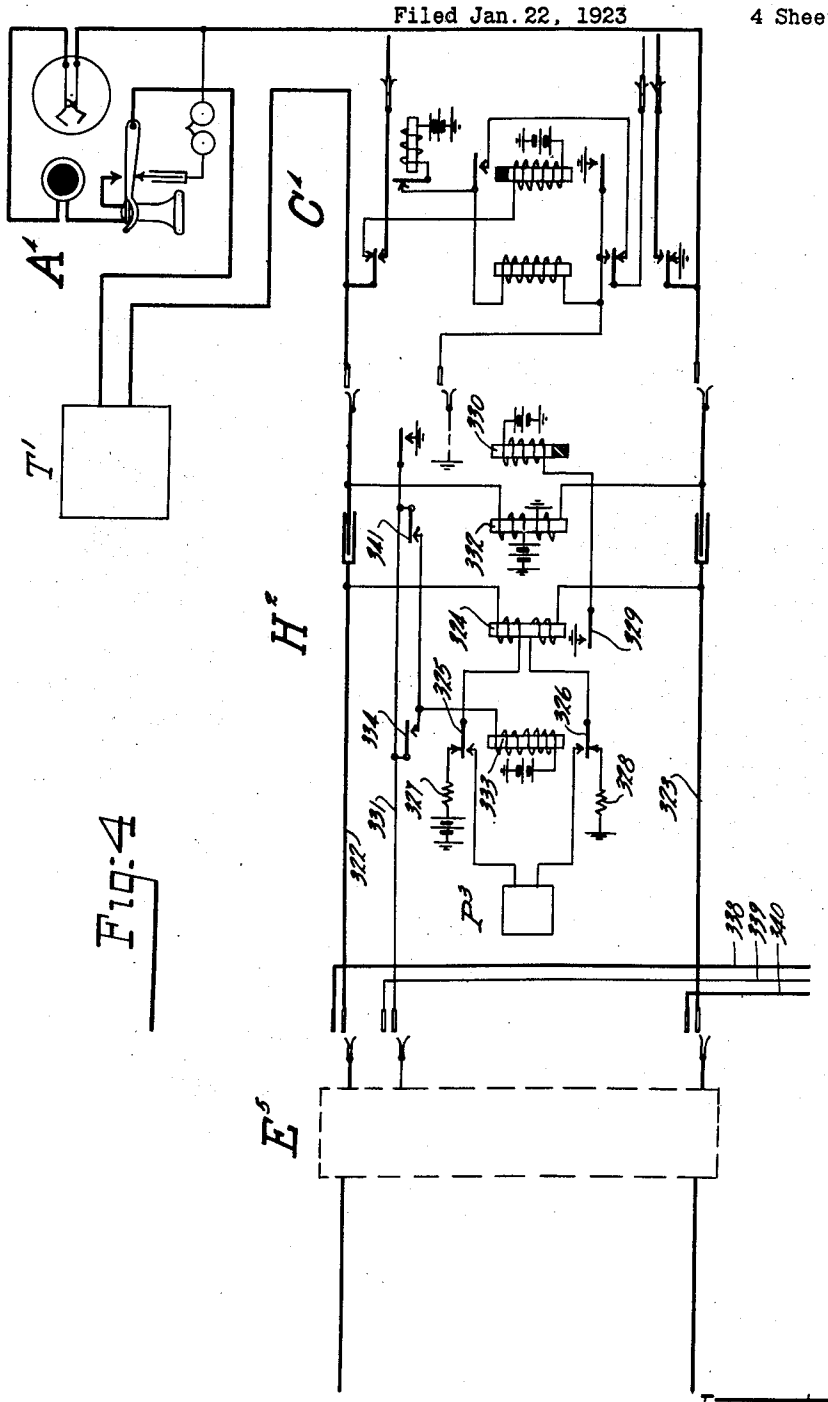


Fig. 4

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UNITED STATES PATENT OFFICE

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ELAPSED TIME AND ZONE METERING.

Application filed January 22, 1923. Serial No. 614,093.

The present invention relates to elapsed time and zone metering in general, but is concerned more particularly with elapsed time and 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 assessed at intervals during the conversation.

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 to 4, 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, Figs. 1 and 2, when placed in order with corresponding lines in alignment, represent the apparatus used to illustrate the invention in connection with meters located at the central office.

Figs. 3 and 4, when placed in order with corresponding lines in alignment, represent the apparatus used to illustrate the invention in connection with meters located at the substations.

Referring to Figs. 1 and 2, the automatic substations A, A′ and A^2 are ordinary automatic substations having the usual talking, signalling, and impulse sending instrumentalities.

The line switch C, Fig. 1, is mechanically of the well-known rotary type in which the wipers have no normal position and move in a forward direction only. Means are provided whereby the meter M may be associated with the metering conductor of a selected trunk. The line switches C′ and C^2, Fig. 2, which are denoted by dotted rectangles, are assumed to be identical with the line switch C.

The meter M, Fig. 1, may be considered as representing any of the well-known devices whereby the closure of a circuit through a magnet results in the operation of a recording means. The meters M′ and M^2, Fig. 2, which are denoted by dotted rectangles, are assumed to be identical with the meter M.

The trunk relay D, Fig. 1, comprises an electropolarized relay, one winding of which is in series with the negative side of the trunk. A reversal of the polarity of the trunk conductors will result in the energization of this relay, which, when once energized, will remain in an operated position by virtue of the second winding, even though the first winding becomes deenergized. The operation of this relay serves to extend a conductor from the meter of the calling subscriber to the meter conductor of the associated first selector.

The selector E, Fig. 1, is mechanically of the well-known vertical and rotary type in which the bank contacts are arranged in horizontal rows or levels. Means are provided whereby the metering conductor may be extended to a metering wiper, the said wiper being indicated by reference character 49 shown at the right of Fig. 1, which also shows the first four contacts in the second level of the bank to which this wiper has access. Certain levels in the banks of the selector E are associated with trunks leading to local second selectors, such as the selector E^2, Fig. 2. On all such levels the ten bank contacts seizable by wiper 49 are multiplied together and connected to an interrupter, such as is indicated by reference character I. As will be more fully explained hereinafter, the interrupter I may serve to energize the meter M at predetermined intervals throughout the period of conversation. Certain levels in the banks of the selector E are associated with trunks leading to repeaters, such as the repeater R, Fig. 2. On all such levels the bank contacts seizable by wiper 49 are connected to the associated repeater in the same manner as are the corresponding contacts seizable by the other wipers of selector E.

The selector switches denoted by the dotted

rectangles E^2 and E^3, Fig. 2, are each assumed to be similar to selector E, except in that they are not provided with a metering wiper and the associated bank.

The automatic repeater R, Fig. 2, is an ordinary repeater of the type commonly in use, and has associated with it the switch S, which may be considered as a simple ten-point step-by-step switch. The switch S is provided with an operating magnet and a release magnet, it also being provided with a set of off-normal springs which are operated when the switch wipers are advanced out of their normal position. The association between the repeater R and the switch S is such that the first digit dialled through the repeater will cause the switch S to advance its wiper a corresponding number of steps. A further operation of the repeater will not affect the switch S. The metering conductor from the bank of selector E terminates in the wiper of switch S. Certain contacts in the bank to which this wiper has access are connected to interrupters of varying frequency, such as the interrupters I′ and I^2. As will be more fully explained hereinafter, the interrupter I′ or I^2 may serve to energize the meter M at predetermined intervals throughout the period of conversation.

The interrupters I, I′, and I^2 may be considered as any continuously driven cam arrangement adapted to supply grounded impulses at the desired frequency.

The connector switches denoted by the dotted rectangles H and H′, Fig. 2, are each assumed to be a connector of the well-known vertical and rotary type having its bank contacts arranged in horizontal rows or levels.

From the foregoing, it will be seen that provision has been made whereby a meter associated with the calling line at the central station will be operated at predetermined intervals during the time of conversation, the frequency of operation being determined by the actual location of the office or exchange in which the called line terminates.

Referring to Figs. 3 and 4, the automatic substations A^3 and A^4 are ordinary automatic substations having the usual talking, signalling, and impulses sending instrumentalities. Associated with each substation, and adjacent thereto, is a meter denoted by the rectangles T and T′, which may be considered as a device whereby the reversal of the polarity of the line conductors results in the operation of a recording means. A device of this kind is illustrated in United States Letters Patent No. 912,268, issued to Charles M. Beattie, under date of February 9, 1909.

The line switches C^3 and C^4 are similar to line switch C, Fig. 1, with the exception that no metering conductor is provided.

The selectors E^4 and E^5 may be assumed to be identical with selector E^2, Fig. 2.

The repeater R′ and the switch S′ are mechanically the same as repeater R and the switch S, Fig. 2, the circuits having been modified, however, in order that a meter at the substation may be operated thereby.

The connector H^2 is a vertical and rotary switch of the Strowger type, and is similar to connectors H and H′, except that the battery feed connections for the calling line are modified in order to provide for operating a meter at the substation.

The apparatus represented by the rectangles P′, P^2, and P^3 may be considered as a continuously operating device by means of which the polarity of the two associated conductors is reversed at predetermined intervals. As will be more fully explained hereinafter, the said conductors, under certain conditions, serve as a source of battery feed for the calling line and, in order that there may be no interruption of the undulatory voice currents which may be traversing said line, the apparatus is arranged to gradually decrease the potential and subsequently increase it gradually to the maximum voltage. A device of this kind is shown in United States Letters Patent No. 912,268, issued to Charles M. Beattie under date of February 9, 1909.

From the foregoing, it will be seen that provision has been made whereby a meter at the calling substation will be operated at predetermined intervals during the conversation, the frequency of operation being determined by the actual location of the office or exchange in which the called line terminates.

The system having been described in general, a detailed description will now be given of its operation. The operation of a central office meter, as the result of the establishment of a local connection, will now be explained, and for this purpose it will be assumed that the subscriber at substation A, Fig. 1, desires to call the subscriber at substation A′, Fig. 2, whose number is assumed to be 2536.

When the receiver is removed at the calling substation, a circuit is closed over the line conductors 11 and 12 for the line relay 13 of the line switch C. Line relay 13, upon energizing, closes at armature 14 a circuit for switching relay 15 and stepping magnet 16 in series, and at armature 17 connects the test wiper 20 to a point in the circuit between the switching relay 15 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 23, switching relay 15 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 15 is not short-circuited and stepping magnet 16 is not energized on account of the high resistance of switching relay 15. Switching relay 15, however, is energized and at armature 29 disconnects the test wiper 20 from the point between its own winding and that of stepping magnet 16 and connects it to the grounded private normal conductor 30. As a further result of the energization of switching relay 15, it disconnects the line conductors 11 and 12 from the winding of line relay 13 and ground, respectively, and extends them by way of armatures 31 and 32 and their working contacts, wipers 18 and 21, bank contacts 9 and 24, trunk conductors 25 and 28, the upper winding of relay 43 in parallel with the noninductive resistance 44, armatures 33 and 34 and their resting contacts to the upper and lower windings of the line relay 35 of the selector E. Line relay 35 now energizes over the calling subscriber's loop and at its armature 36 closes a circuit for the slow-acting release relay 37. Release relay 37, upon energizing, opens a point in the circuit of release magnet 38, prepares a circuit for relay 39 at armature 40, and at armature 41 places ground upon release trunk conductor 42, thereby establishing a holding circuit for the line switch C. By means of this ground potential on test contact 23 and its multiples in the banks of the other line switches which have access to the selector E, the seized trunk line is maintained busy in the usual manner. A branch of this holding circuit extends by way of private normal conductor 30 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 lower winding of trunk relay 43 is connected from battery to the grounded release trunk conductor 42, the said relay does not operate at this time, however, because the polarity of the trunk conductors 66 and 28 is such that the two windings oppose each other. It may be mentioned that a further result of the energization of the switching relay 15 was the extension of the metering conductor by way of armature 45, wiper 19, bank contact 22 to conductor 26.

The calling subscriber now operates his calling device in accordance with the first digit 2 of the desired number, thereby producing two interruptions in the circuit of the line relay 35 of the first selector E. As soon as line relay 35 deenergizes in response to the first of these interruptions, a circuit is closed which is traceable from ground at armature 46, armature 36 and its resting contact, armature 40 and its working contact, winding of the series relay 39, winding of the vertical magnet 47 to battery. Vertical magnet 47, upon energizing, raises the wipers 48 to 51, inclusive, opposite the first level of bank contacts, whereupon the off normal springs 52 close and complete a circuit traceable from the grounded release trunk conductor 42 by way of armature 57 and its working contact, off normal springs 52, armature 58 and its resting contact, winding of relay 53 to battery. Stepping relay 53, upon energizing, closes a point in the circuit of rotary magnet 54 at armature 55, and at armature 56 closes a locking circuit for itself independent of relay 39. When line relay 35 deenergizes in response to the second interruption produced in its circuit, the vertical magnet is again operated to raise the wipers one step, bringing them opposite the desired level of bank contacts. The relay 39, being slow-acting, will remain energized while impulses are passing through it to the vertical magnet. Shortly after the last vertical impulse, relay 39 will deenergize and close a circuit through the rotary magnet 54 at armature 57. Rotary magnet 54, upon energizing, advances the wipers 48 to 51, inclusive, into engagement with the first set of contacts in the second level, and at armature 58 opens the circuit of stepping relay 53. Stepping relay 53, upon deenergizing, opens another point in its circuit, and at armature 55 opens the circuit of rotary magnet 54. Rotary magnet 54, upon deenergizing, again closes the contact at armature 58.

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, the stepping relay 53 energizes again over the following circuit: from ground by way of the test contact with which test wiper 50 is in engagement, test wiper 50, armature 61 and its resting contact, off normal springs 52, armature 58 and its resting contact, winding of relay 53 to battery. Stepping relay 53, upon energizing, closes a locking circuit for itself at armature 56 and at armature 55 again completes the circuit of rotary magnet 54. This alternate operation of the stepping relay and rotary magnet continues so long as test wiper 50 engages grounded contacts. In this case we will assume that the trunk line comprising conductors 108 to 111, inclusive, is the one first found to be idle. That being the case, when the wipers of the selector E arrive upon the bank contacts 62 to 65, inclusive, there is no ground potential on test contact 64 and, consequently, stepping relay 53 does not energize. With this condition existing, switching relay 59 energizes over the following circuit: from ground by way of release trunk conductor 42, switching re-

lay 59, off normal springs 52, armature 58 and its resting contact, winding of relay 53 to battery. Stepping relay 53, however, does not energize over this circuit on account of the relatively high resistance of switching relay 59. Switching relay 59, upon energizing, removes ground from armature 40 of release relay 37 at armature 46; disconnects test wiper 50 from the point between switching relay 59 and stepping magnet 53 and connects it to ground by way of release trunk conductor 42 at armature 61, thus making the seized trunk busy immediately; and at armatures 33 and 34 disconnects the line conductors 66 and 28 from the windings of line relay 35 and extends them by way of the working contacts of these armatures, wipers 48 and 51, bank contacts 62 and 65, trunk conductors 108 and 111 to the line relay of the incoming second selector E^2, Fig. 2. Selector E^2 thereupon places ground upon the release trunk conductor 110, thereby establishing the usual holding circuit for the selector E and the line switch C before the slow-acting release relay 37 of selector E has had time to deenergize. A further result of the energization of relay 59 is the extension of metering conductor 67 by way of armature 68, wiper 49, bank contact 63, and conductor 109 to interrupter I.

Assuming now that the calling subscriber dials the second figure 5 of the called number, as a result of which the selector E^2 raises its wipers to the fifth level and selects an idle trunk line extending to a connector switch, which we will assume to be the connector H. When the calling subscriber dials the third figure 3 of the called number, the connector H will raise its wipers to the third level of bank contacts. The calling subscriber now dials the final figure 6 of the called number, as a result of which the connector rotates its wipers six steps into connection with the line extending to the station A'. Upon the completion of the connection to the called line, a signalling circuit is established in the connector in the usual manner, and the bell at the called station is operated to notify the subscriber that he is wanted.

When the called party answers, the connector will cause a reversal of the polarity of the trunk conductors in the usual well-known manner. Returning to a consideration of trunk relay 43, Fig. 1, it may be said that this relay will now operate, as the polarity of the trunk conductors is such that the current in its two windings assist each other. When once energized, the lower winding of relay 43 will hold said relay in an operated position irrespective of the deenergization of its upper winding. Relay 43, upon energizing, connects metering conductor 26 with metering conductor 67 by way of armature 69, at the same time short-circuiting its upper winding, and the non-inductive resistance 44, at armature 70. The meter M will now be operated at predetermined intervals by the interrupter I until such time as the connection is released. The circuit over which the meter is operated is traceable from ground at the interrupter I, by way of bank contact 63, metering wiper 49, armature 68, conductor 67, armature 69, conductor 26, bank contact 22, metering wiper 19, armature 45, winding of meter M to battery. The release of the connection is controlled by the calling subscriber, who, when the conversation is completed, will replace his receiver; as a result of which the line and release relays of the connector H will deenergize and remove ground from the release trunk conductor. It follows that all of the automatic switches involved in the connection are restored to normal according to well-known practice.

The operation of a central office meter as the result of the establishment of an interoffice connection will now be explained. For this purpose it will be assumed that the subscriber at substation A, Fig. 1, desires to call the subscriber at substation A^2, Fig. 2, whose number is assumed to be 1536. When the calling subscriber removes his receiver, his line is extended to a first selector as previously explained, it being assumed that selector E is the one taken for use. The selector E now responds to the dialling of the first figure 1 of the called number, and operates to raise its wipers to the first level and selects an idle trunk line extending to a repeater, which we will assume to be the repeater R, Fig. 2. Switching relay 59 of the selector E, upon operating, disconnects the line conductors 66 and 28 from the windings of line relay 35, and extends them by way of the working contacts of armatures 33 and 34, wipers 48 and 51, bank contacts 70 and 73, trunk conductors 112 and 114, and the normally closed contacts controlled by armatures 117 and 118 to the upper and lower windings of the line relay 119 of the repeater R. Line relay 119 now energizes over the calling subscriber's loop and at armature 120 closes the circuit of release relay 121. Release relay 121, upon energizing, prepares a circuit for relay 122 at armature 123 and places ground on release trunk conductor 113 at armature 124, thereby establishing the usual holding circuit for the selector E and the line switch C before the slow-acting release relay 39 of selector E has had time to deenergize. A further result of the energization of relay 59 is the extension of metering conductor 67 by way of armature 68, wiper 49, bank contact 71, conductor 115 to wiper 134 of switch S.

Referring to the repeater R, as a further result of the energization of release relay

121, a circuit is closed through the lower winding of the electro-polarized relay 125 at armature 126. This winding alone, however, consisting of a few turns of high resistance is not able to effectively operate the relay. As a still further result of the energization of release relay 121, it completes at armature 128 a bridge across the trunk conductors 129 and 130 as follows: from conductor 129 by way of armature 128 and its working contact, armature 131 and its resting contact, upper winding of electro-polarized relay 125, impedance 132, working contact and armature 133 to conductor 130. In response to the closure of this bridge, the line and release relays of the second selector E^3 in the distant office energize and prepare the switch for operation in the usual manner. Electro-polarized relay 125, 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 figure 5 of the desired number, thereby producing a corresponding number of interruptions in the circuit of line relay 119. Each time line relay 119 deenergizes, it opens the circuit of the line relay of the incoming second selector E^3 at armature 133, and at armature 120 closes a circuit traceable from ground at armature 120 and its resting contact, armature 123 and its working contact, conductor 135, winding of relay 122 to battery. A branch of the above traced circuit may be traced from grounded conductor 135, armature 136 and its resting contact, winding of the stepping magnet 137 of the switch S to battery. At armature 131 relay 122 completes the bridge across trunk conductors 129 and 130 by a more direct path excluding the upper winding of relay 125 and the impedance 132. This is the usual expedient made use of to obtain improved switch control.

The stepping magnet 137 of the switch S, in response to the five impulses of current sent through it by the line relay 119, operates to advance the wiper 134 into engagement with the fifth contact in the associated bank, the interrupter I′ is now connected to the metering conductor 67, Fig. 1. The relay 122, being slow-acting, will maintain its armature in an operated position so long as impulses are passing through it. Shortly after the completion of the first series of impulses, the relay 122 will deenergize and close a circuit traceable from ground at armature 138, by way of off normal springs 139, which become operated at the first step of the magnet 137, winding of cut-off relay 140 to battery. The cut-off relay, upon energizing, opens the circuit of the stepping magnet 137 at armature 136, in order that further operation of the line relay 119 may have no effect upon the stepping magnet 137. Furthermore, relay 140, upon energizing, closes a locking circuit for itself at armature 141, thus rendering it independent of the further operation of relay 122.

The incoming second selector E^3, in response to the five interruptions produced in the circuit of its line relay, raises its wipers to the fifth level of bank contacts and selects an idle trunk line leading to a connector, which we will assume to be the connector H′. When the calling subscriber dials the third figure 3 of the called number, a series of three impulses are produced which are repeated by the repeater R to the connector H′, which raises its wipers to the fifth level of bank contacts. When the calling subscriber dials the final figure 6 of the called number, a series of six impulses are produced which are repeated by the repeater R to the connector H′, which is operated in the usual manner to rotate its wipers into connection with the line extending to the substation A^2. Upon the completion of the connection to the called line, a signalling circuit is established in the connector in the usual manner and the bell at the called station is operated to notify the subscriber that he is wanted.

When the called party answers, the connector will cause a reversal of the polarity of the trunk conductors 129 and 130 in the usual well-known manner. Returning to a consideration of the repeater R, it may be said that the polarized relay 125 will now operate, as the polarity of the trunk conductors is such that the current in its two windings assist each other. When once energized, the lower winding of relay 125 will hold said relay in an operated position irrespective of the direction of the current flow in its upper winding. Relay 125, upon energizing, causes a reversal of the polarity of the trunk conductors 112 and 114, and as a result, the electro-polarized relay 43 of the trunk equipment D, Fig. 1, will now operate, as the polarity of the trunk conductors is such that the current in its two windings assist each other. When once energized, the lower winding of relay 43 will hold said relay in an operated position irrespective of the deenergization of its upper winding. Relay 43, upon energizing, connects metering conductor 26 with metering conductor 67 by way of armature 69, at the same time short-circuiting its upper winding, and the non-inductive resistance 44, at armature 70. The meter M will now be operated at predetermined intervals by the interrupter I′ until such time as the connection is released. The circuit over which the meter is operated is traceable

from ground at interrupter I', wiper 134 in fifth position, conductor 115, bank contact 71, wiper 49, armature 68, conductor 67, armature 69, bank contact 22, wiper 19, armature 45, winding of meter M to battery. The release of the connection is controlled by the calling subscriber, who, when the conversation is completed, will replace his receiver, thereby causing the deenergization of the line and release relays 119 and 121 of the repeater R. As a result of the foregoing, the holding circuit for the automatic switches in the originating exchange is broken, and with the further result that the control circuit extending over the trunk conductors 129 and 130 is broken also. It follows that all of the automatic switches involved in the connection are restored to normal according to well-known practice. The release of the switch S is brought about by the deenergization of release relay 121 of the repeater R, a circuit being closed from ground at armature 126 and its resting contact, by way of armature 142 and its working contact, winding of release magnet 143 to battery. Release magnet 143, upon energizing, causes the release of switch S, the wiper 134 restoring to its normal position. The restoration of wiper 134 to its normal position causes the off normal spring 139 to be opened, and as a result, relay 140 will deenergize and open the circuit of the release magnet 143 at armature 142, thus completing the releasing operation.

If the repeater R is used only in extending calls to a single distant office, it follows that the first figure dialed on the repeater will always be the same. Under the condition stated above, it would not be advisable to combine a switch, such as the switch S, with the repeater; for the same metering could be obtained by connecting the interrupter I' to the bank contacts, seizable by the wiper 49 of selector E, in the level associated with the group of repeaters of which repeater R forms a part. It is advisable to use the switch S in connection with a repeater, such as the repeater R, only when the repeater may be used to extend a connection to two or more distant offices. In further explanation, we may assume that the contacts in the sixth level of the incoming second selector E^3, Fig. 2, are associated with trunk lines leading by way of repeaters to incoming third selectors in a distant office. The first two digits in the call number of a telephone located in the last mentioned office are necessarily 16. When calling a number located therein, the dialling of the second digit 6 may be assumed as operating the line relay 119 of the repeater R six times, which results in the advancement of the wiper 134 into engagement with the sixth contact in its bank and at the same time causes the incoming second selector E^3 to raise its wipers opposite the sixth level of bank contacts; following which it selects an idle trunk line extending to a repeater, which trunk line may be assumed to be represented by the conductors 144, 145, and 146. The advancement of the wiper 134 has resulted in the connection of the interrupter I^2 to the metering conductor 67, Fig. 1, and, when the connection is completed and the called party has answered, the polarized relay 43, Fig. 1, will operate in the usual manner to connect the interrupter I^2 with the meter M. The meter M will now be operated at predetermined intervals by the interrupter I^2 until such time as the connection is released; the release of the connection being controlled by the calling subscriber in the usual manner.

The operation of a substation meter, as the result of the establishment of an interoffice connection, will now be explained. For this purpose it will be assumed that the subscriber at substation A^3, Fig. 3, desires to call the subscriber at substation A^4, Fig. 4, whose number is assumed to be 3236. When the calling subscriber removes his receiver, there is no operation of the meter T, as the normal line polarity is such that the meter is inoperative at this time; the line, however, will be extended to a first selector in the usual manner, it being assumed that the selector E^4 is the one taken for use. The selector E^4 now responds to the dialling of the first figure 3 of the called number, and operates to raise its wipers to the third level and selects an idle trunk line extending to a repeater, which we will assume to be the repeater R'. The extension may be traced from trunk conductors 210 and 211, the upper and lower windings of line relay 212, armatures 213 and 214 and their resting contacts, resistances 215 and 216, to battery and ground, respectively. The line relay 212 now energizes over the calling subscriber's loop and at armature 217 closes the circuit of release relay 218, which relay, upon energizing, places ground upon release trunk conductor 219, thereby establishing the usual holding circuit for the selector E^4 and the line switch C^3.

The calling subscriber now operates his calling device in accordance with the second digit 2 of the called number, as a result of which the repeater R' operates in a manner similar to that previously described in connection with repeater R, Fig. 2, to advance the wipers 220 and 221 of the switch S' into engagement with the second contact in their respective banks; at the same time causing the incoming second selector E^5 to raise its wipers opposite the second level of bank contacts. The selector E^5 thereupon selects an idle trunk line extending to a connector, which we will assume to be the connector H^2. The extension may be traced from

trunk conductors 322 and 323, the upper and lower windings of line relay 324, armatures 325 and 326 and their resting contacts, resistances 327 and 328, to battery and ground, respectively. The line relay 324 now energizes over the trunk loop from repeater R' and at armature 329 closes the circuit of release relay 330, which relay, upon energizing, places ground upon the release trunk conductor 331, thereby establishing the usual holding circuit for the selector E^5.

The calling subscriber now operates his calling device in accordance with the third figure 3 of the called number, and a series of three impulses are produced which are repeated by the repeater R' to the connector H^2, which raises its wipers to the third level of bank contacts. When the calling subscribed dials the final figure 6 of the called number, a series of six impulses are produced which are repeated by a repeater R' to the connector H^2, which is operated in the usual manner to rotate its wipers into connection with the line extending to the substation A^4. Upon the completion of the connection to the called line, a signalling circuit is established in the connector in the usual manner, and the bell at the called substation is operated to notify the subscriber that he is wanted.

When the called party answers, he will draw talking battery through the back bridge relay 332, which, upon energizing, closes a circuit for relay 333 at armature 341. Relay 333, upon energizing, forms a locking circuit for itself from the grounded release trunk conductor 331 by way of armature 334. A further result of the operation of relay 333 is the substitution at armatures 325 and 326 of the pole changer P^3 for the normal battery feed represented by the resistances 327 and 328. The pole changer P^3 now feeds current to the trunk conductors 322 and 323 by way of armatures 325 and 326 and the upper and lower windings of line relay 324, the polarity changing at predetermined intervals dependent upon the structure of the pole changer.

Sometime subsequent to the operation of relay 333, the polarity of the trunk conductors will be such that the polarized relay 235 of the repeater R', Fig. 2, will become operated; and, it is to be remembered, when this winding is once operated, the lower winding is effective to hold the said relay in an operated position irrespective of the direction of the current flow in its upper winding. Relay 235, upon operating, substitutes the pole changer P^2 for the resistances 215 and 216, at armatures 213 and 214. The pole changer P^2 now feeds current to the calling line by way of wipers 220 and 221, armatures 213 and 214, upper and lower winding of line relay 212 and trunk conductors 210 and 211, the polarity changing at predetermined intervals dependent upon the structure of the pole changer. The meter T at the substation A^3 will now operate in response to the changes of polarity until such time as the connection is released. The release of the connection is controlled by the calling subscriber, who, when the conversation is completed, will replace his receiver, thereby causing the deenergization of the line and release relays 212 and 218 of the repeater R'. As a result of the foregoing, the holding circuit for the automatic switches in the originating exchange is broken, and with the further result that the control circuit extending over the trunk conductors 236 and 237 is broken also. It follows that all of the automatic switches involved in the connection are restored to normal according to well-known practice. The release of the switch S' is brought about in a manner similar to that previously explained in connection with switch S, Fig. 2.

If the called station is located in the same office as the calling station, the connection will be built up without the use of a repeater, the final connection being made by a connector switch similar to connector H^2; in this case the meter at the calling station will be operated directly by the pole changer associated with the said connector.

As previously explained in connection with repeater R, Fig. 2, it is advisable to associate a switch S' with the repeater R' only when the repeater may be used to extend a connection to two or more distant offices. In further explanation, we may assume that the contacts in the third level of the incoming second selector E^5, Fig. 4, are associated with trunk lines leading by way of repeaters to incoming third selectors in a distant office. When calling a number located therein, the dialling of the second digit 3 may be assumed as operating the line relay 212 of the repeater R' three times, which results in the advancement of the wipers 220 and 221 into engagement with the third contacts in their respective banks, and at the same time causes the incoming second selector E^5 to raise its wipers opposite the third level of bank contacts; following which it selects an idle trunk line extending to a repeater, which trunk line may be assumed to be represented by the conductors 338, 339, and 340. The advancement of the wipers 220 and 221 has prepared the circuit of pole changer P', and, when the connection is completed and the called party has answered, the polarized relay 235 will operate in the usual manner to connect pole changer P' to the calling line. The meter T will now be operated at predetermined intervals by the pole changer P' until such time as the connection is released; the release of the connection being controlled by the calling subscriber in the usual manner.

The object and scope of the invention having been described, what is considered to be new and what it is desired to have protected by Letters Patent will be pointed out more specifically in the appended claims.

What I claim is:

1. In a multi-office telephone system, automatic switches including a selector for setting up local connections in each exchange, a repeater for cooperating with said selector to establish inter-exchange connections, elapsed time meters for the calling subscribers, a constantly operating meter mechanism connected to certain bank contacts of the selector and directly effective, when such selector is used to set up a local connection to operate the meter of the calling party periodically for the duration of a call, an auxiliary switch associated with said repeater having a wiper connected to other bank contacts of said selector, other meter operating mechanisms accessible to said wiper, and circuit arrangements such that when an inter-exchange connection is established said auxiliary switch wiper is positioned to cause the calling party's meter to be directly operated by a particular one of said last mechanisms instead of by the first.

2. In a multi-office telephone system, a first exchange and a plurality of other exchanges, automatic switches in said first exchange including selectors for setting up local connections, repeaters cooperating with selectors of a certain class to extend connections to the other exchanges, elapsed time meters for the subscribers in said first exchange, meter operating mechanism and directly effective to operate the meter of the calling party when a local connection is established, a plurality of meter operating mechanisms associated with each of said repeaters, each mechanism corresponding to a different exchange, and each mechanism operating at a different rate from the others, any one of said last mentioned mechanisms being effective to directly operate the calling party's meter when an inter-exchange connection is established, and switching means for each repeater operated after the repeater is seized to establish a connection to select the particular mechanism which corresponds to the exchange to which the connection is extended.

3. In a measured service telephone system, a calling line equipped with an elapsed time meter, means for setting up local and inter-office connections, said means including an automatic switch used in connections of either class and including a repeater used in inter-office connections only, meter operating means associated with said common automatic switch, meter operating mechanisms associated with said repeater, an auxiliary switch equipped with a wiper connected to bank contacts of said first switch and having access to said last meter operating mechanisms, means in said repeater operative responsive to a particular group of impulses transmitted to further extend the connection to connect a particular one of said last meter operating mechanisms to the calling line when the connection is established.

4. In a measured service telephone system, automatic switches including a selector for setting up local and inter-exchange connections, an elapsed time meter mechanism terminating in the various bank levels of said selector switch, other elapsed time meter operating mechanisms, auxiliary switches each having access to a different group of said last mechanisms, said selector definitely connecting with the first one of said meter operating mechanisms when operated to extend a local connection and to select one of a particular group of said auxiliary switches when operated to extend an inter-exchange connection.

5. In a measured service telephone system, automatic switches including selectors for setting up local and inter-exchange connections, an elapsed time meter operating mechanism terminating in the various bank levels of said selector switches, other elapsed time meter operating mechanisms, a plurality of trunks terminating in repeaters, said selectors definitely connecting with the first one of said meter operating mechanisms when operated to extend local connections and to select one of a particular group of said repeaters when operated to extend an inter-exchange connection, and means subsequently responsive, as the extension of an inter-exchange connection progresses, to complete the selection of one of the meter operating mechanisms.

6. In a measured service telephone system, a calling line equipped with a meter, means including a selector switch for establishing local and inter-exchange connections between said line and called lines, meter operating mechanisms, a definite one of said mechanisms being selected by said selector when used to establish a local connection, and a group of said mechanisms being selected by said selector when operated to extend an inter-exchange connection and an auxiliary switch for selecting any one of the selected groups of mechanisms during the further progress of the call.

7. In a measured telephone system, a calling line equipped with a meter, a selector accessible to the calling line and having access to calling lines of the same or other exchanges, a constantly operating meter operating device connected to bank contacts of the selector which are seized only when local connections are being set up, repeaters connected to other bank contacts of said selector seizable by the selector only when inter-

exchange calls are being set up, auxiliary switches, there being one individual to each of said repeaters, a plurality of constantly operating meter operating devices terminating in the bank contacts of said auxiliary switches, and a wiper for each of said switches connected to bank contacts of said selector seized only when inter-exchange connections are being established and means in said repeater for causing said auxiliary switch to operate to select a particular one of said devices depending on the destination of the call.

8. In a measured service telephone system, a calling line equipped with a meter, means including a selector switch for use in extending local and inter-exchange connections and also including a repeater for use in completing inter-exchange connections only, a bank of contacts for said selector switch in which terminate both local and inter-office branches, two groups of elapsed time meter operating mechanisms, mechanisms of one group being accessible to said selector direct through contacts available to the said selector only when a local connection is being set up, and any one of the mechanisms of the other group being accessible to said selector only via contacts thereof selectable at the same time an inter-exchange connection is being set up.

9. In a measured service telephone system, a calling line equipped with a meter, means including a selector switch for use in extending local and inter-exchange connections and also including a repeater for use in completing inter-exchange connections only, a bank of contacts for said selector switch in which terminate both local and inter-office branches, a constantly operating interrupter connected to contacts selected when a local connection is set up, a plurality of interrupters associated with said repeater and a wiper for selecting any one of them connected to contacts selected when an inter-exchange connection is set up.

In witness whereof, I hereunto subscribe my name this 18th day of January, A. D., 1923.

ARTHUR J. RAY.