

Aug. 10, 1937.

F. J. SCUDDER

2,089,438

TELEPHONE SYSTEM

Filed March 10, 1936

10 Sheets-Sheet 1

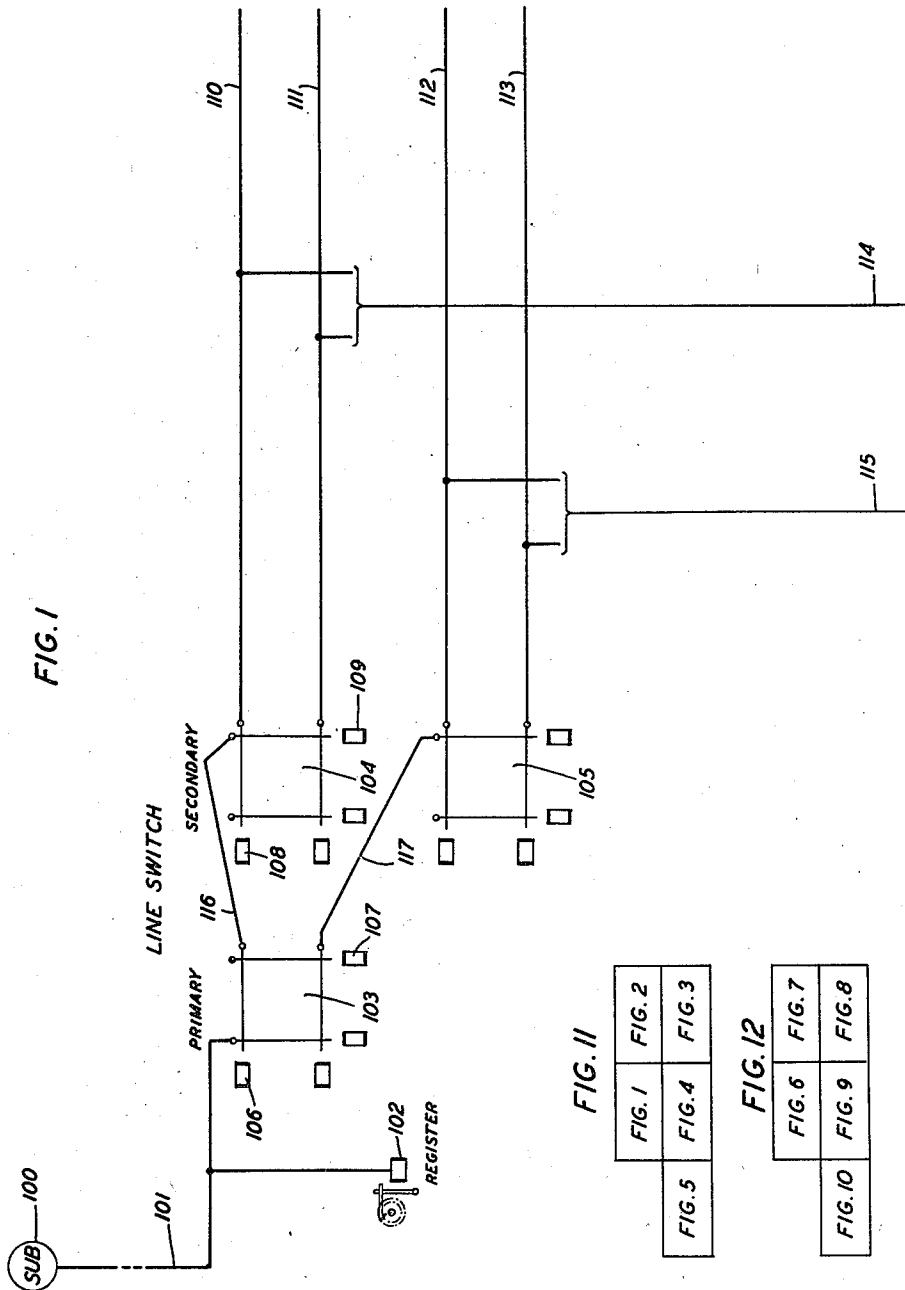


FIG. 11

FIG. 1	FIG. 2
FIG. 4	FIG. 3
FIG. 5	

FIG. 12

FIG. 6	FIG. 7
FIG. 9	FIG. 8
FIG. 10	

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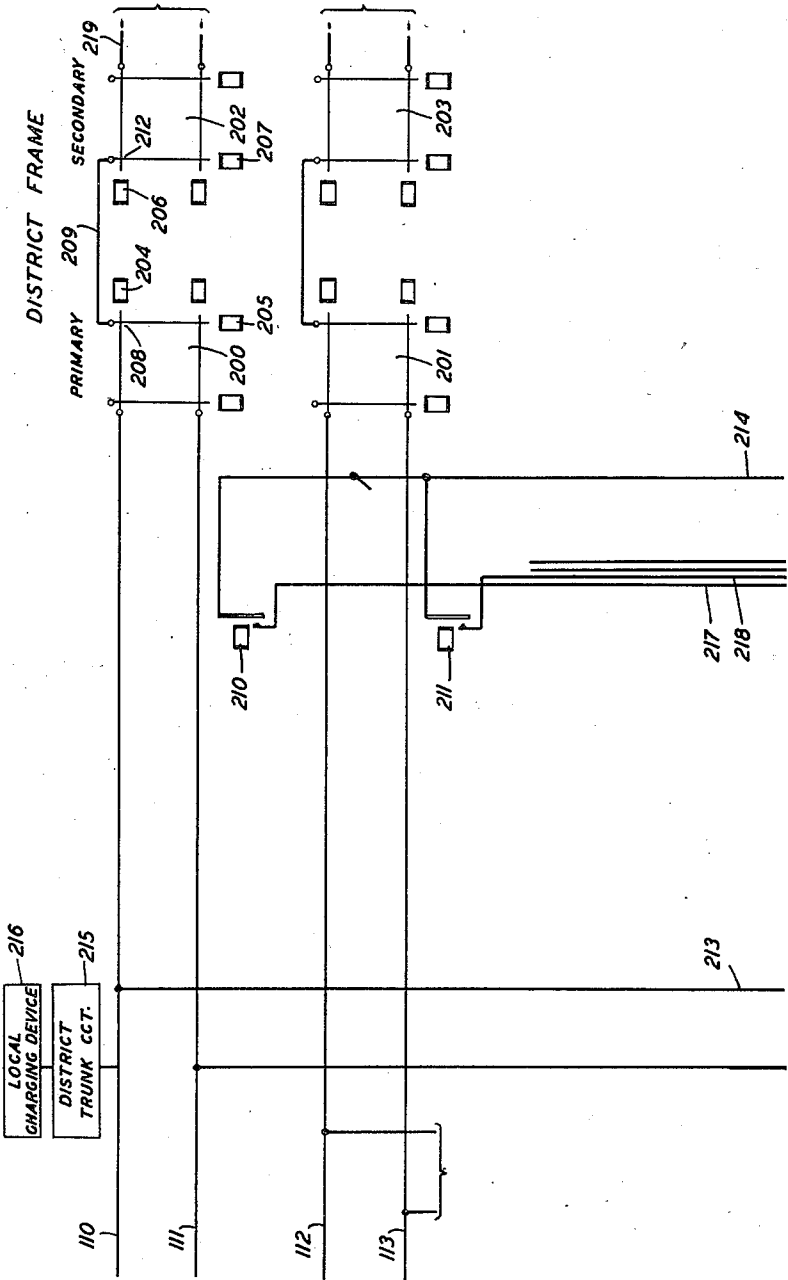
2,089,438

TELEPHONE SYSTEM

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10 Sheets-Sheet 2

FIG. 2



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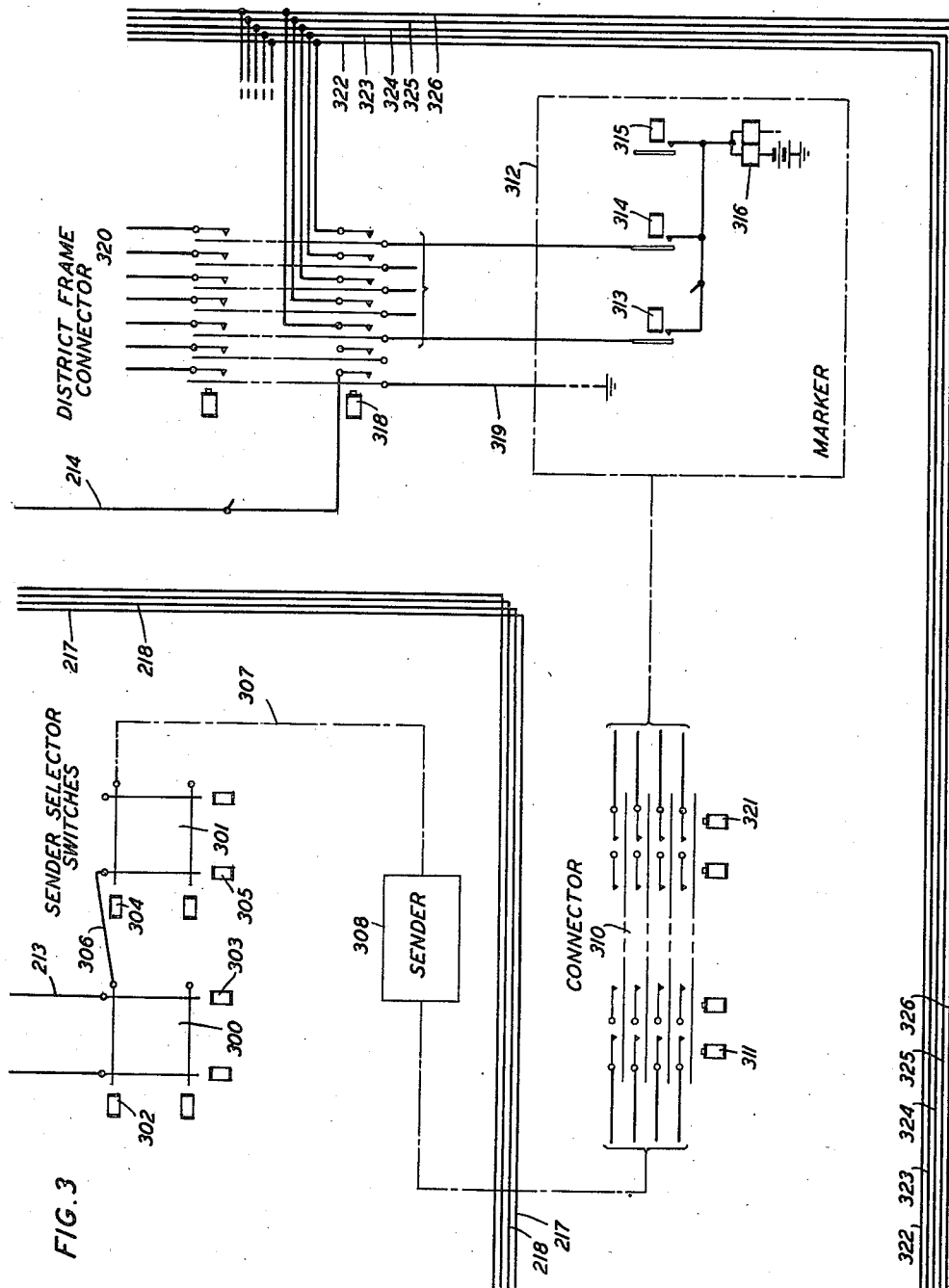
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TELEPHONE SYSTEM

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10 Sheets-Sheet 3



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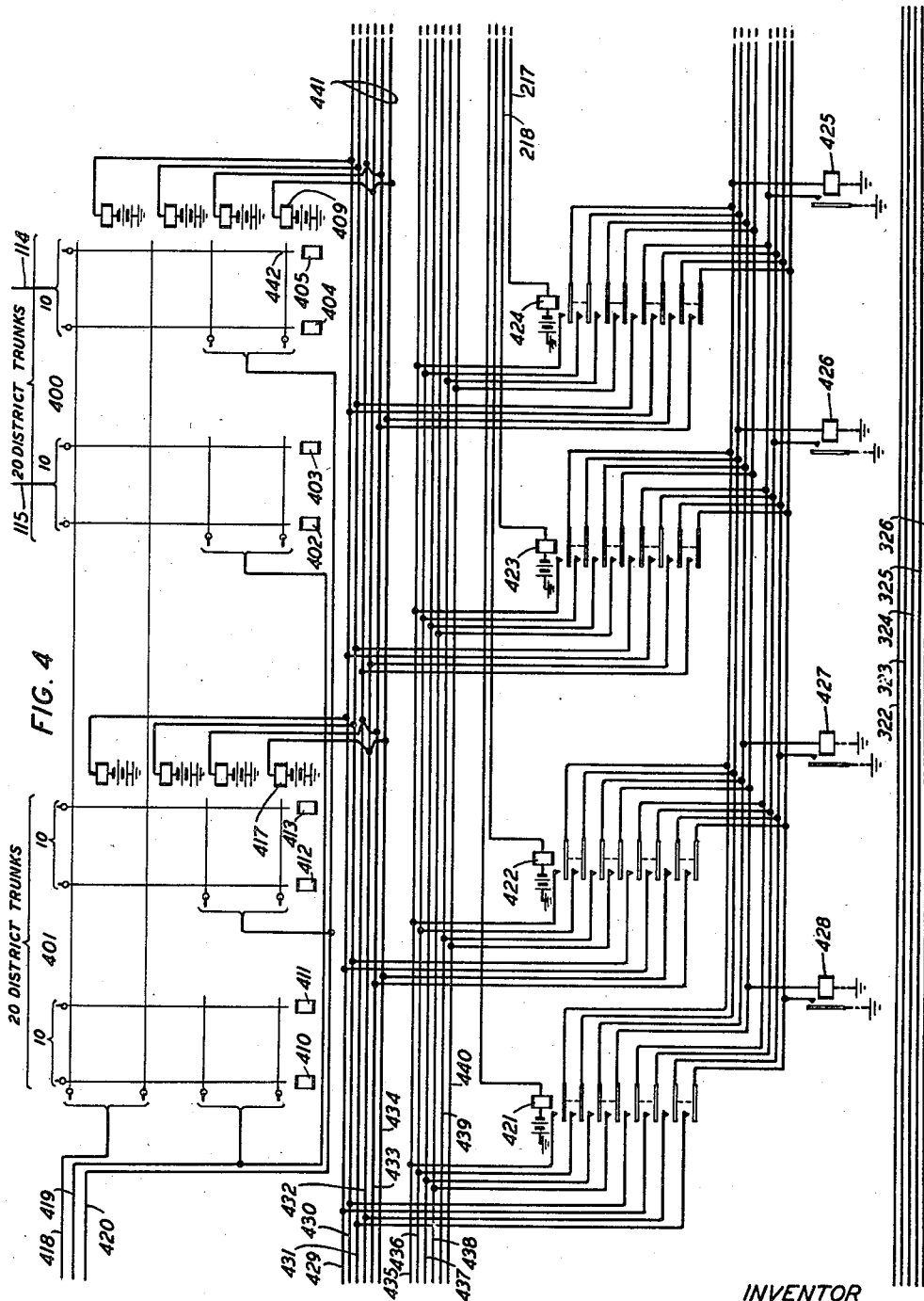
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TELEPHONE SYSTEM

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10 Sheets-Sheet 4



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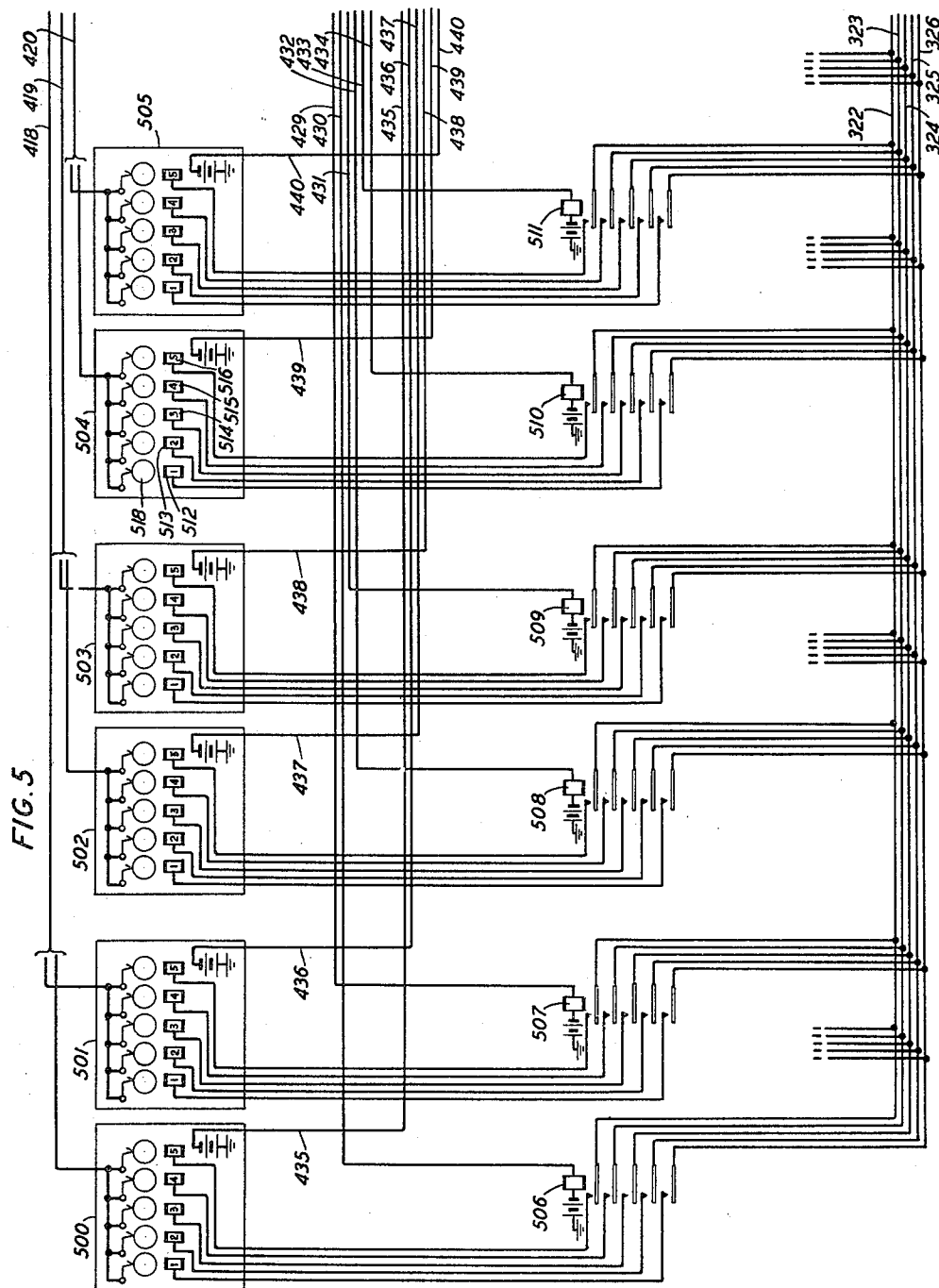
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TELEPHONE SYSTEM

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10 Sheets-Sheet 5



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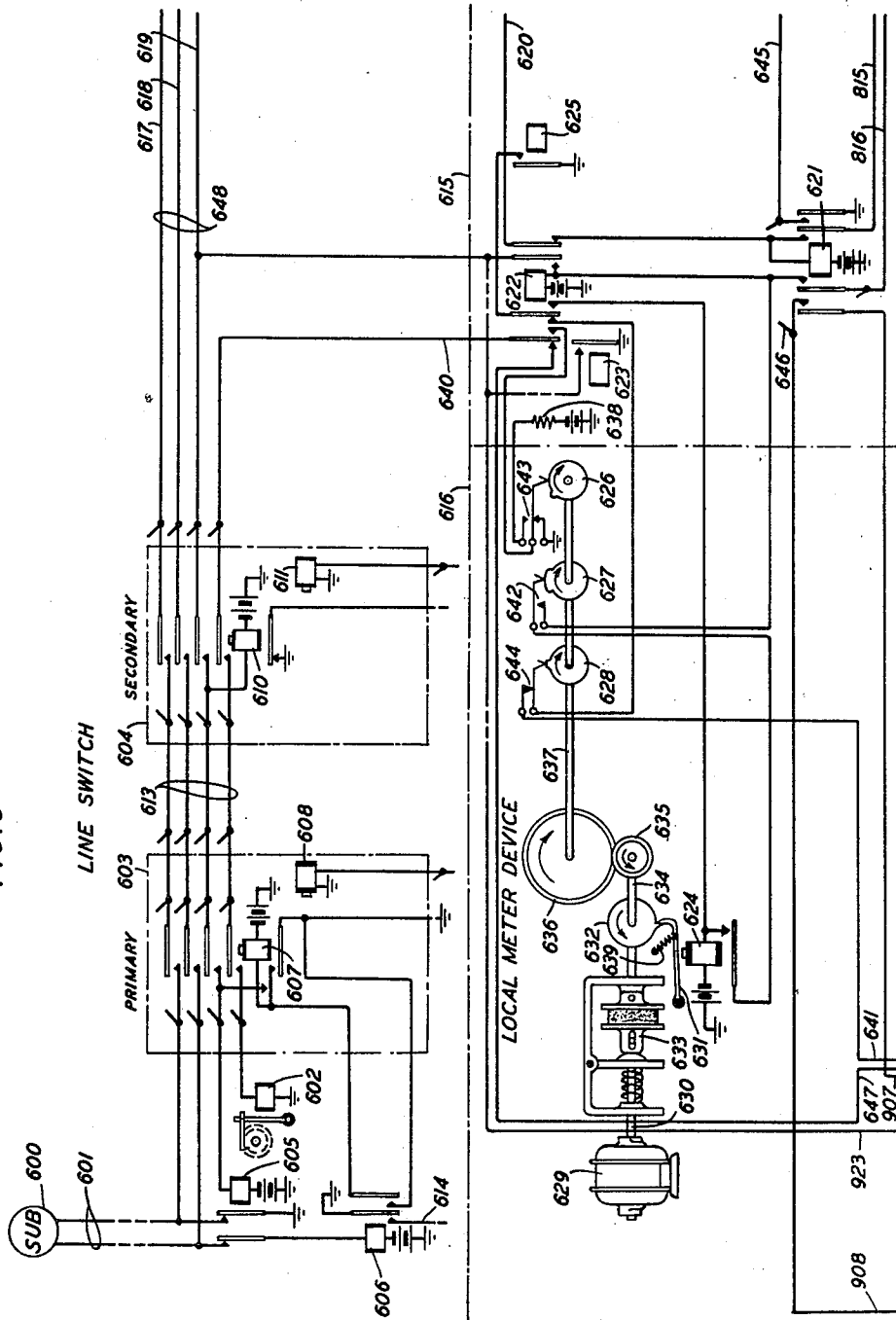
2,089,438

TELEPHONE SYSTEM

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10 Sheets-Sheet 6

FIG. 6



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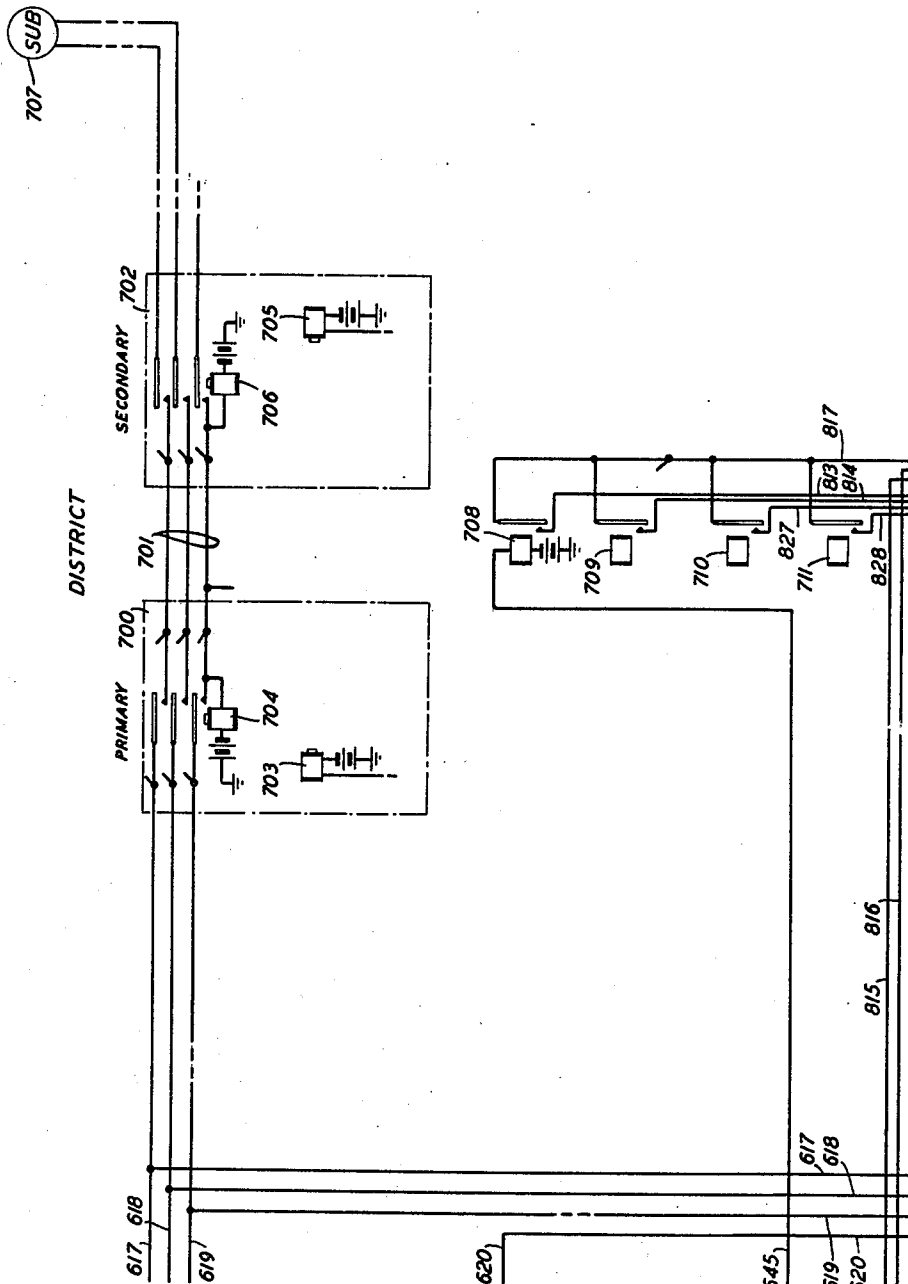
2,089,438

TELEPHONE SYSTEM

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10 Sheets-Sheet 7

FIG. 7



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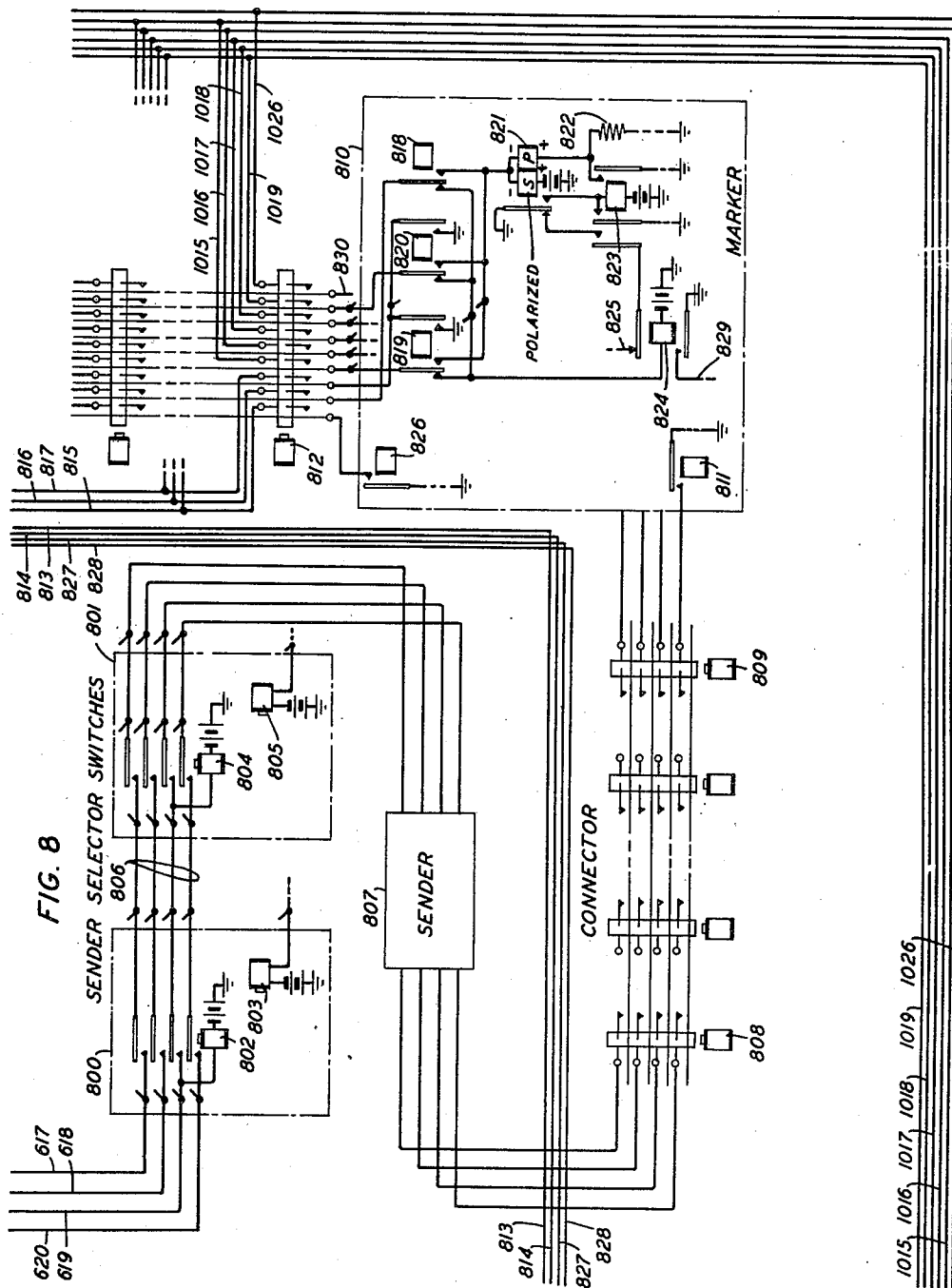
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TELEPHONE SYSTEM

Filed March 10, 1936

10 Sheets-Sheet 8



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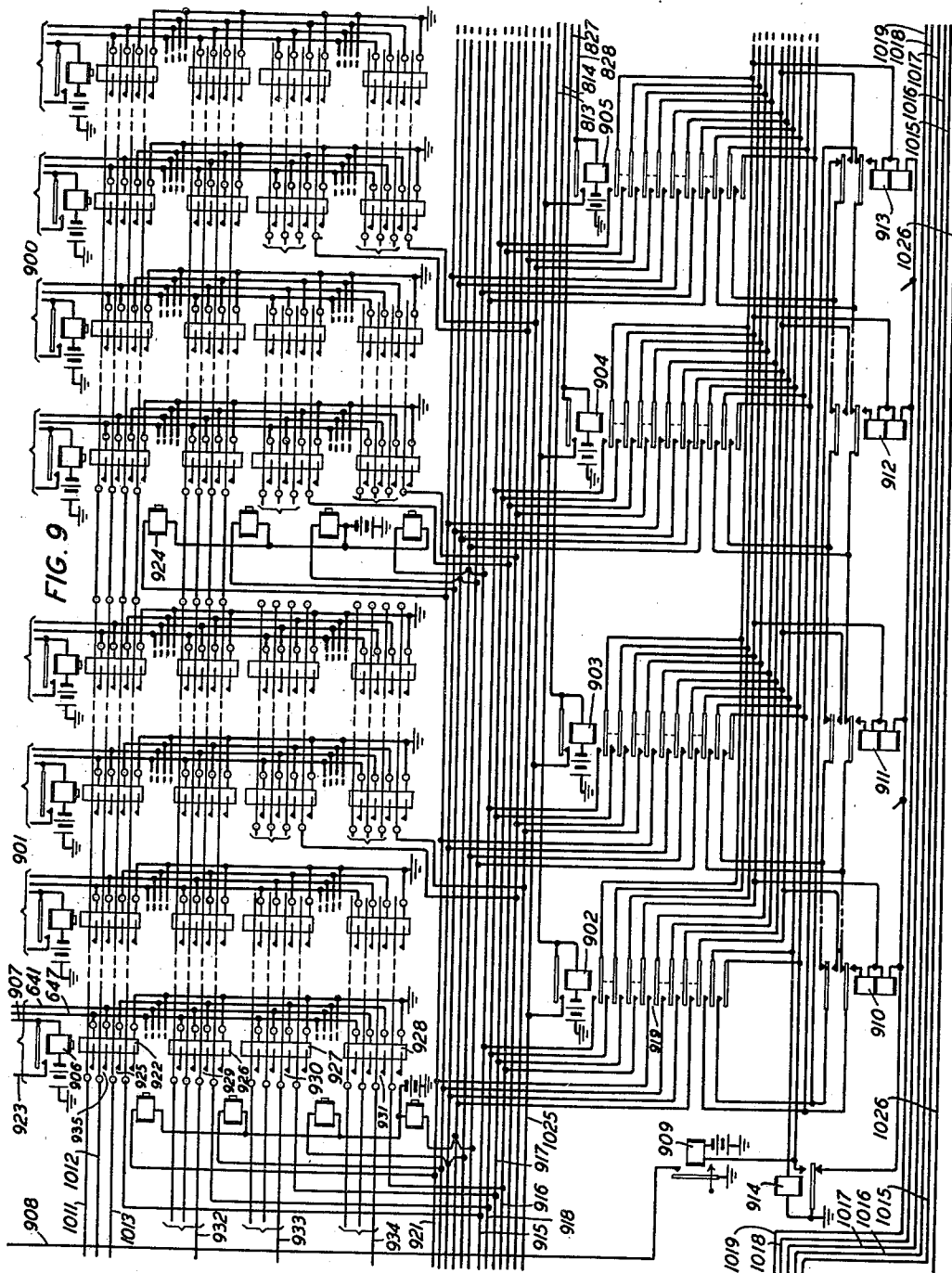
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TELEPHONE SYSTEM

Filed March 10, 1936

10 Sheets-Sheet 9



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TELEPHONE SYSTEM

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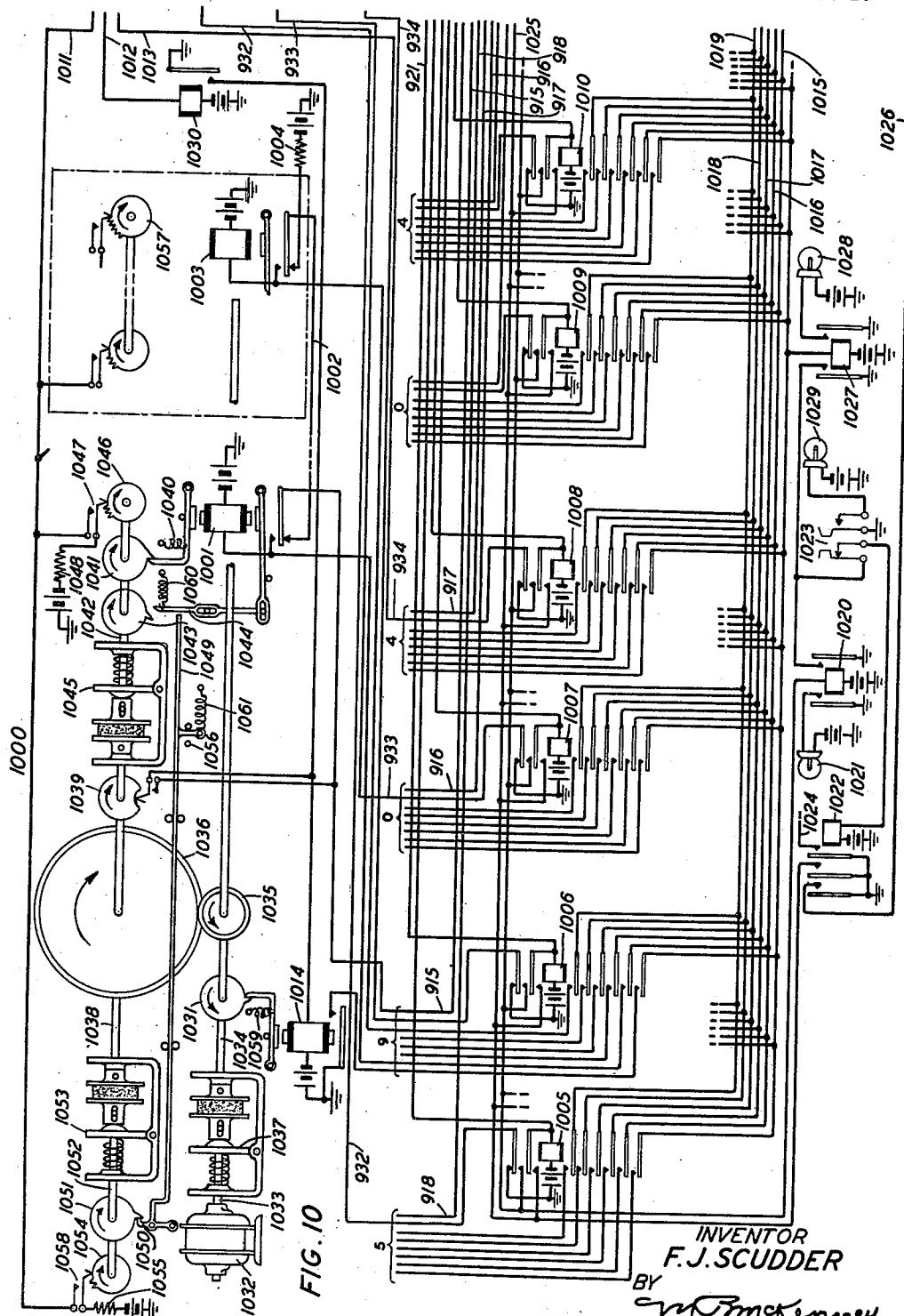


FIG. 10

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UNITED STATES PATENT OFFICE

2,089,438

TELEPHONE SYSTEM

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Application March 10, 1936, Serial No. 68,044

9 Claims. (Cl. 179-7.1)

This invention relates to telephone systems and particularly to those in which message-registers are used for assessing charges for the service rendered.

5 The object of the invention is to simplify and improve the equipment for obtaining and recording information concerning the destination of a call and for utilizing this information to assess charges on the basis of the zone called and also
10 on the basis of the duration of the call.

It has been proposed heretofore to provide a group of trunk circuits with a common message-register operating device which is connected to a calling one of said trunks and receives information as to the called zone to determine the
15 rate of charge of the call. Such a system is shown in the patent to Johnson et al. 1,859,924 of May 24, 1932. In the arrangement of this patent a single message-register control device is provided
20 for a plurality of trunks and is connected periodically to each trunk on which it is necessary to assess a charge. Also the zone information, from which the value of the charge for any particular call is determined, is received by the common register operating device from the trunk
25 circuit to which it has connected, this information having first been set up in the trunk in accordance with the number dialed and recorded in the register-sender. It has also been proposed to employ in systems of the step-by-step
30 type, where central office register-senders are not utilized, a plurality of message-register operating devices in common to a group of conversational trunks. The first idle one of the common operating devices is taken in use when a call
35 appears and is connected to the calling trunk preparatory to receiving the zone information after the designation digits are dialed by the calling subscriber.

40 According to the present invention, improvements are secured over the prior art arrangements by means of a system in which a plurality of zone and time-controlled message-register operating devices are provided in common to a group
45 of conversational trunks, and in which the conversational connections are established under the control of a digit recording mechanism at the central office. Whenever a call is made involving one of said trunks, an idle one of the
50 message-register operating devices is chosen and is connected by means of selective switches to the calling trunk. The idle operating device thus selectively connected to the calling trunk is also connected, independently of the trunk, to the
55 common digit recording mechanism in which the

dialed number has been recorded. In this way the information as to the zone is received by the message-register operating device directly from the digital recording device, and this information need not be established in the trunk circuit.

Another feature is a testing and operating mechanism comprising a series of relays common to all of the meter operating devices and to all of the switches that serve to connect these devices to the trunk circuits, together with
10 means, depending on which trunk is calling, for associating said mechanism with said devices to test them for an idle one, to cause the connection of the chosen idle operating device with the digit recording register which has received
15 the dialed number, and to operate the proper connecting switch to connect said idle device to the calling trunk.

A further feature of the invention is an arrangement by which said register operating devices are divided into a plurality of groups, certain groups serving respectively different groups
20 of trunks and at least one of said groups of devices serving a plurality of said groups of trunks.

These and other features of the invention will be more clearly understood from the following
25 detailed description, which should be taken in conjunction with the accompanying drawings, and also from the appended claims.

Referring to the drawings, Figs. 1 to 5 inclusive, when taken in the order shown in Fig. 11, illustrate schematically the relationship between the various circuit elements involved in the application of the present invention to a telephone system of the cross-bar type and also show, in a
30 general way, the manner in which connections are established between one of a common group of zone and time-controlled message-register operating devices and a conversational trunk over which a call is being made.

Fig. 1 shows a calling subscriber's station and a portion of the primary and secondary line switches and line links over which the calling line is extended to the district trunks and the district frame.

Fig. 2 shows a district trunk circuit and a portion of the district frame primary and secondary switches by means of which the calling line is further extended toward the called station.

Fig. 3 shows a portion of the primary and secondary sender selector switches by means of which connections are established between the calling line and an idle subscriber's register-sender, a decoder marker circuit, a connector circuit for establishing connections between the
55

sender and the decoder marker, and a district frame connector circuit by means of which connections are established between the decoder marker and the district frame.

5 Fig. 4 shows two of the five zone and timing device connecting switches which serve to connect idle zone and timing devices to any of the one hundred district trunks appearing on the district frame with which these five connecting switches are associated. Fig. 4 also shows certain group and test relays associated with the connecting switches.

10 Fig. 5 shows schematically a portion of the zone and timing devices which, by means of the connecting switches shown in Fig. 4, are accessible to the district trunks appearing on the district frame shown in Fig. 2. Fig. 5 also shows certain relays, one for each zone and timing device, which serve to establish control connections between the zone and timing device and the decoder marker, through the district frame connector circuit shown in Fig. 3.

15 Figs. 6 to 10 inclusive, when taken in the order shown in Fig. 12, illustrate the system more in detail.

20 Fig. 6 shows a calling subscriber's station, a portion of a primary and a secondary line switch over which lines are extended to the district frame, certain relays of the district trunk circuit, and the meter operating device, individual to the district trunk, which provides for the operation of the subscriber's message register on local calls.

25 Fig. 7 shows a portion of a primary and a secondary switch of the district frame, certain district frame relays, and a called subscriber's station.

30 Fig. 8 shows portions of a primary and a secondary sender selector switch, a subscriber's register-sender, such portions of a decoder marker circuit as are involved in the control of the zone and timing devices, and portions of a decoder marker connector and a district frame connector circuit.

35 Fig. 9 shows portions of two of the ten zone and timing device connecting switches which serve the one hundred district trunks of a district frame, together with certain associated group and test relays.

40 Fig. 10 shows portions of one zone and timing device, certain relays for associating any one of a plurality of these devices with a decoder marker circuit for control purposes, and also certain checking and alarm equipment associated with the zone and timing devices.

45 Fig. 11 shows the manner in which Figs. 1 to 5 inclusive are arranged.

Fig. 12 shows the manner in which Figs. 6 to 10 inclusive are arranged.

50 Switches 103, 104, 105, 200, 201, 202, 203, 300, 301, 400, 401, 603, 604, 700, 702, 800, 801, 900, and 901 of Figs. 1, 2, 3, 4, 6, 7, 8, and 9 are of the cross-bar type and consist briefly of a plurality of sets of contacts arranged in horizontal and vertical rows or units. Associated with each horizontal row of contact sets is a horizontal operating magnet known as a select magnet, under control of which the said horizontal contact sets are prepared for operation. Associated with each vertical row of contact sets is a vertical magnet known as a hold magnet under control of which any set of contacts in that vertical row, after being prepared by the operation of its respective horizontal select magnet, is operated and held in the operated position until the release of the vertical magnet takes place. For a more detailed ex-

planation of the construction and operation of these cross-bar switches reference may be had to the patent to J. N. Reynolds, No. 2,021,329, granted November 19, 1935.

5 Only such portions of the line switch, district trunk, district frame, sender selector, sender, decoder marker, decoder marker connector and district frame connector circuits are shown as are required for a clear understanding of the invention. For a more detailed explanation and description of the operation of a system of the type to which the present invention is applicable reference may be had to the copending application of W. W. Carpenter, Serial No. 27,305, filed June 19, 1935. 15

Referring to Figs. 1 to 5 inclusive, a general description will now be given to illustrate the application of this invention to a telephone system of the cross-bar type. Line 101 of subscriber's station 100 is shown connected to the left vertical row of contacts of primary line switch 103, the vertical rows of contacts of this primary switch having access, over ten line links such as links 116 and 117, to one of the ten vertical rows of contacts of each of ten secondary line switches. 20 Each of the ten horizontal rows of contacts of each secondary line switch extends to a district trunk circuit and thence to one of ten horizontal rows of contacts of a district frame primary switch. For example, the upper horizontal row of contacts of secondary line switch 104 extends over conductors 110 to district trunk 215 and to the upper horizontal row of contacts of the primary district switch 200. Similarly, the other horizontal rows of contacts of the secondary line switches extend as indicated by conductors, 111, 112 and 113, to other district trunks and other horizontal rows of contacts on primary district switches. 25

Each district trunk circuit also connects to a vertical row of contacts of a primary sender selector switch and also to a vertical row of contacts of a zone and timing device connecting switch. As shown, district trunk 215 connects over conductors 213 to the right vertical contact row of primary sender selector switch 300 and also over conductors 114 to the right vertical contact row of the zone and timing device connecting switch 400. A district frame is provided with ten primary and ten secondary switches interconnected by district links such as link 209, the horizontal contact rows of the secondary switches extending to an office frame (not shown) the switches of which latter frame provide means for further extending the connection to an outgoing trunk or over a local trunk to the called subscriber's line depending upon whether the call is between stations served by the same or by different exchanges. 30

The sender selector circuit is provided with primary switches, such as switch 300, and secondary switches, such as switch 301, interconnected by sender links, in turn extending to subscriber's register-senders, one such connection being shown from the upper horizontal contact row of secondary sender selector switch 301, over conductors 307, to sender 308. A decoder marker connector circuit 310 provides for connecting the sender 308 to a decoder marker connector circuit 312. Each district frame is provided with a district frame connector circuit 320 for establishing connections between any of the one hundred district trunks served by that frame and the particular decoder marker circuit being used in establishing the connection. 35 40 45 50 55 60 65 70 75

In accordance with the present invention each group of district trunks appearing on a district frame is provided with a plurality of zone and time-controlled message register operating devices, such as the devices 500 to 505 inclusive, of Fig. 5, and a common control and connecting circuit such as shown in Fig. 4 for connecting an idle message-register operating device to a calling district trunk circuit, when required, and also for connecting the device to the particular decoder marker serving the call for the transmission of the necessary zone information from the marker to the timing device. The one hundred district trunks appearing on a district frame connect to the vertical rows of contacts of five zone and timing device connecting switches such as switches 400 and 401, each connecting switch being provided with twenty vertical and ten horizontal rows of contacts. As indicated by conductors 114 and 115 the twenty district trunks to which secondary line switches 104 and 105 have access connect to the twenty vertical contact rows of zone and timer connecting switch 400. Similarly, the remaining eighty district trunks located on the same district frame containing district trunk 215 connect to the vertical contact rows of four other connecting switches one of which, switch 401, is shown.

The zone and timing devices, such as the devices 500 to 505 inclusive, connect to the horizontal rows of contacts of the connecting switches and may or may not be multiplied throughout the five connecting switches depending upon the zone traffic encountered on a particular group of one hundred district trunks. Where the traffic is such that ten devices are sufficient to provide for timing on the maximum number of simultaneous zone calls anticipated for a group of district trunks, these ten devices are multiplied throughout the horizontal contact rows of the five connecting switches in the manner in which the devices 500 and 501 are shown connected, over conductor 412, to the upper five horizontal rows of contacts of connecting switches 401 and 400. Where the anticipated zone traffic on a group of district trunks is such that more than ten zone and timing devices may be required simultaneously the multiple across the horizontal contact rows of the connecting switches is split to accommodate additional zone and timing devices as shown on the lower portion of switches 400 and 401. As illustrated, the multiple across the lower five horizontal rows of contacts of these switches is split between the tenth and eleventh vertical contact rows and the corresponding lower five left and right rows of contacts of the respective switches are multiplied. With the connecting switch arrangement shown in Fig. 4 therefore, fifteen zone and timing devices are accessible to the district trunks of the district frame with which the five connecting switches represented by switches 400 and 401 are associated. Zone and timing devices 500 and 501, representing one group of five such devices, connect over conductors 412 to the upper five horizontal rows of contacts of switch 401 and are multiplied throughout the entire five connecting switches. Zone and timing devices 502 and 503, representing another group of five such devices, connect over conductors 419 to the lower five horizontal contact rows of each connecting switch, the multiple across these contact rows, however, being split at the mid-point of each switch. Zone and timing devices 504 and 505, representing a third group of five such devices, connect over conductors 420 to

the lower five horizontal contact rows in the left half of each connecting switch.

When the subscriber at station 100 initiates a call the line switch control circuit (not shown) associated with the primary and secondary line switches 103, 104 and 105 functions to select the calling line and thereupon operates select magnet 106 of primary line switch 103. The line switch control circuit also tests the district trunk groups which may be reached over idle line links such as links 116 and 117 to determine which of these groups contain idle district trunk circuits and prefers and selects a particular group of ten district trunks if several groups are available. The sender selector control circuit (not shown) associated with the primary and secondary sender selector switches 300 and 301 thereupon tests the group of district trunks chosen by the line switch control circuit and selects one of these trunks which has an idle path to an available idle subscribers' sender. The proper select and hold magnets of the line and sender selector switches are thereupon operated to extend the calling station line to the chosen district trunk and subscribers' sender circuits.

For the purpose of this description it will be assumed that subscribers' sender 308 and district trunk 215 are selected by the sender selector control circuit which therefore causes the operation of select magnets 100, 302 and 304 and hold magnets 107, 109, 303 and 305 of switches 103, 104, 300 and 301 respectively. Select magnet 106 of primary line switch 103 having been operated by the line switch control circuit, the operation of hold magnet 107 closes the right upper cross-points of switch 103 and extends the calling line 101 to secondary line switch 104 over line link 116. The operation of select magnet 100 and hold magnet 109 of switch 104 causes the right upper cross-points of that switch to close and extend the calling line, over conductors 110, to district trunk circuit 215. Select magnets 302 and 304 and hold magnets 303 and 305 of the primary and secondary sender selector switches 300 and 301 also being operated, the calling line is also extended over conductors 212, the right upper cross-points of switch 300, sender link 306, and the left upper cross-points of switch 301, to the idle subscriber's register-sender 308 which latter circuit returns an audible signal to the calling station as an indication that the dialing of the desired station number may proceed. The sender registers the dialed office designation and simultaneously causes the control circuit (not shown) of the decoder marker connector circuit 310 to function and establish connections, by the operation of relays 311 and 321, to an idle decoder marker circuit 312 after which the sender transmits the wanted office designation to the decoder marker. The sender also transmits the number of the district frame to the decoder marker and this latter circuit, by means of the district frame connector 320, establishes connections between itself and the district trunk being used for the call.

From the wanted office designation received from the sender the decoder marker knows the destination of the call and accordingly controls the charging operations on the basis of this information. If the destination of the call is to another subscriber served by the same exchange or by an exchange within the local area having the same rate of charge, the decoder marker 312 recognizes this call as a local call and operates its local call relay 315. The operation of relay

315 causes the district trunk circuit to prepare for charging the call under control of a local timing device 216 which is individual to the district trunk circuit. The manner in which the decoder marker passes this information to the district trunk as well as the subsequent operation of the district trunk and its associated local timing device in effecting the charging of the local call will be set forth later under the detailed description of the operation.

If the destination of the call is to an exchange outside of the local area the decoder marker 312, knowing this from the office code information transmitted to it from the sender 308, operates one of a plurality of zone relays 313, 314, etc., the particular relay operated depending upon the zone in which the called station is located. It will be assumed that for the particular call under discussion, zone relay 313 is operated. The function of the operated zone relay 313 will be described later. The decoder marker circuit also connects ground to conductor 319, this ground extending over a front contact of the operated district frame connector relay 318 and over conductor 214 to an armature of each of ten district frame relays such as relays 210 and 211, there being ten such relays per district frame, one relay being common to the ten district trunk circuits connected to each of the ten primary district switches. These relays 210 and 211 are operated under control of the district trunk circuits with which they are associated whenever one of the trunks of the group is in use. Since it has been assumed that district trunk 215 of that group of trunks connecting to primary district switch 200 is being used for the connection being described, relay 210 is therefore operated under control of that district trunk circuit. Relay 210, in operating, extends the ground previously traced to its armature, over its front contact and over conductor 217, to battery through the winding of a timing device connecting switch group relay 424, operating that relay. The operation of relay 424 closes the test conductors of the ten timing devices which are accessible to the district trunks connected to the right half of connecting switch 400 to the windings of ten test relays four of which, relays 425 to 428 inclusive, are shown. Since the zone and timing devices 500, 501, 504 and 505 serve the district trunks connected to the right half of connecting switch 400, the operation of relay 424 therefore closes through the respective test conductors 435, 436, 439 and 440 of these devices, over its front contacts, to ground through the windings of test relays 425, 426, 427 and 428 respectively. Associated with each zone and timing device is a cut-through relay, such as relays 506 to 511 inclusive, the function of which is to close through the zone control conductors of the device with which it is associated to the decoder marker circuit. The windings of these cut-through relays extend over conductors 429 to 434 inclusive, to the front contacts of the test relays 425 to 428 inclusive, over front contacts of the connecting switch group relays 421 to 424 inclusive, the particular ten cut-through relays connecting to the front contacts of the ten test relays at any one time depending upon which group relay is operated. For example, with relay 424 operated as set forth above, the windings of the ten cut-through relays represented by relays 506, 507 and 510, 511 are connected to the front contacts of ten test relays represented by relays 425 to 428 inclusive, the cut-through re-

lays 506, 507 and 510, 511 being associated with the zone and timing devices 500, 501 and 504, 505 respectively.

Relay 423 is a group relay similar in function to relay 424 but associated with that group of ten district trunks connected to the left half of connecting switch 400, these district trunks having access, through the left half of the switch, to the ten zone and timing devices represented by devices 500, 501 and 502, 503. The operating circuit for relay 423 extends over conductor 218 to the front contact of district frame relay 211 which is associated with this group of trunks connected to the left half of switch 400. Relays 421 and 422 are group relays associated with connecting switch 401 and the district trunk groups connected thereto, and perform functions similar to those performed by relays 423 and 424 respectively. In those cases (not shown) where a maximum of ten zone and timing devices are provided for a district frame only one group relay is provided for each connecting switch since the same zone and timing devices serve all of the district trunks connected to the connecting switches.

Each zone and timing device, when idle, connects battery to its test conductor as an indication that it is available for use. The six zone and timing devices shown in Fig. 5 are all assumed to be idle as indicated by the battery connected to test conductors 435 to 440 inclusive, by the devices 500 to 505 inclusive, respectively. When group relay 424 operates, as set forth above, all of the test relays 425 to 428 inclusive, therefore operate due to the presence of battery on conductors 435, 436, 439 and 440. In a circuit arrangement later to be disclosed in connection with the detailed description of this invention one of the operated test relays, relay 427 for example, locks in series with an end relay (not shown), this end relay operating and opening the circuits for the other operated test relays all of which release. Cut-through relay 510 now operates in a circuit from battery through its winding, over conductor 434, and over a front contact of relay 424 and the front contact of relay 427 to ground. Select magnets 409 and 417 of connecting switches 400 and 401 respectively, also operate to this same ground supplied over the front contacts of relays 427 and 424. The select magnets of the corresponding contact level of the three other connecting switches (not shown), also operate, the corresponding level select magnets of all five connecting switches being multiplied as indicated by conductors 441.

Each zone and timing device is provided with a plurality of zone clutch magnets such as the magnets 512 to 516 inclusive, of device 504. A zone clutch magnet, when operated, locks electrically in that position and prepares the device for actuating the zone timing cams associated with that particular zone clutch magnet upon the subsequent operation of the master clutch magnet of the device under control of the district trunk circuit, in a manner which will be set forth in detail later. The aforementioned operation of cut-through relay 510 completes the circuits from the windings of the five clutch magnets of device 504, over its front contacts, conductors 322 to 326 inclusive, and over front contacts of the district frame connector relay 318 to front contacts of the five decoder marker zone relays represented by relays 313 and 314. Since it was assumed that zone relay 313 previously operated, a circuit is therefore completed from the winding of zone clutch magnet 512 of device 504 to the winding

the contacts of the decoder marker connector relays 888 and 809. The sender thereupon transmits to the decoder marker such information regarding the destination of the call as this latter circuit requires for performing its functions in the extension of the connection. Information is also passed from the sender to the decoder marker regarding the number of the district frame containing the particular district trunk circuit selected for use on this call, and the decoder marker thereupon establishes connections between itself and that district frame by operating the district frame connector relay 812. From the office code information received from the sender the decoder marker knows whether or not the call is to a station within the local area, and, if it is a local area call, operates its local area relay 818. If the call is not within the local area, the decoder marker operates one of its zone relays 819, 820, the particular zone relay operated depending upon the zone in which the exchange serving the called station is located.

It will first be assumed that the call under discussion is between exchanges within the local area; the decoder marker therefore operates the local area relay 818. The decoder marker, at the time of its connection with the district trunk over the sender selector switches, also operated its relay 811 thereby operating relay 621 of the district trunk in a circuit traceable from battery through the winding of relay 621, over the right back contact of relay 622, conductor 623, lowest contacts of the sender selector primary and secondary switch cross-points 890 and 891, through the sender 807 and the lowest contacts of decoder marker connector relays 888 and 809, to ground over the front contact of relay 811. With relay 621 operated a circuit is completed from battery through the winding of relay 622 of the district trunk circuit, over the left inner front contact of relay 621, conductor 816, a front contact of district frame connector relay 812, and over the front contact of relay 818 to the windings of a polarized trouble detecting relay 821. The two windings of relay 821 are so connected that they oppose each other electrically and these windings are normally energized in a circuit from battery through the windings in series to ground through resistance 822. The left winding of relay 821 is provided with a greater number of turns than the right winding and is so connected that the greater force which it exerts upon the relay armature over that exerted by the right winding tends to hold the relay in the unoperated position before the circuit to the junction of its windings is closed by the operation of relay 818. When relay 818 operates, as set forth above, the left winding of relay 821 is shunted by the battery supplied through the winding of relay 622, provided that the circuit extending from the winding of relay 622 to the armature of relay 818 is complete and is not falsely grounded, thereby allowing relay 821 to operate under control of the force exerted by its right winding. The operation of relay 821 operates relay 823 in a local circuit. Relay 823, in operating, locks over its left inner front contact under control of another decoder marker relay (not shown) and connects ground directly to the right winding of relay 821 thereby short-circuiting resistance 822. Relay 622 of the district trunk, which did not receive sufficient current to operate in series with the right winding of relay 821 and resistance 822, now operates and locks over its right inner front contact to an off-normal ground supplied

over the front contact of a previously operated district trunk relay 623. Relay 621 remains locked upon the operation of relay 622, in a circuit over its right inner front contact, conductor 815, a front contact of connector relay 812, to ground over the front contact of decoder marker relay 826, which previously operated. The closure of the locking circuit for relay 622 short-circuits the right winding of relay 821 of the decoder marker and this latter relay thereupon releases due to the force exerted by its left winding. The release of relay 821 completes a circuit from ground over its back contact, over the left outer front contact of relay 823, over the back contact of relay 824, and over conductor 825 to a relay (not shown) of the decoder marker which records the fact that the local area call charging information has been passed to the district trunk by the operation of relay 622 of that trunk. The decoder marker circuit thereupon proceeds with its functions in extending the connection. Select magnets 703 and 705 and hold magnets 704 and 706 of the primary and secondary district frame switches are operated under control of the decoder marker thereby causing the closure of cross-points 700 and 702 and extending the connection over district link 701 to the office frame switches (not shown). The connection to the called station 707 is completed over the office, incoming and final switch circuits (not shown) under control of the decoder marker and the sender in the manner described in the aforementioned copending application of W. W. Carpenter, Serial No. 27,305.

Upon the aforementioned operation of relay 622 a circuit is closed from battery through the winding of clutch magnet 624 of the local timing device 616, over the left inner front contact of relay 622, to the front contact of the called station supervisory relay 625 of the district trunk circuit. A circuit is also completed from ground through the winding of the message register 602 which is associated with the calling station line 601, over the lowest contacts of the primary and secondary line switch cross-point 603 and 604, conductor 640, left outer front contact of relay 622, and over the normally closed contacts associated with the charging cam 626 to ground thereby short-circuiting the message register 602 to prevent any possibility of its false operation prior to the charging of the call.

When the called subscriber answers, supervisory relay 625 operates and completes the operating circuit from clutch magnet 624 to the ground over its front contact and armature. The operation of magnet 624 disengages the armature 631 from the clutch cam 632 and permits clutch 633 to function and engage driving shafts 630 and 634. Shaft 630 is rotated continuously by a synchronous motor 629 and this motion is transmitted, upon the engaging of shaft 634 with shaft 630, over the reduction gears 635 and 636 to shaft 637 and its associated interrupter cams 626, 627 and 628. As soon as shaft 637 starts to rotate, the off-normal cam 628 causes its associated contacts 644 to open thereby opening the circuit between the left inner back contact of relay 622 and conductor 641, this conductor being the zone and timing device start conductor extending to a set of cross-point contacts on one of the zone and timing device connecting switches. This aforementioned circuit is opened to prevent the starting of a zone and timing device in connection with a zone call if the local timing device associated with the district trunk circuit over

of a check relay 316 of the decoder marker. The decoder marker at this time makes certain check tests which will be described later and thereupon causes zone clutch magnet 512 to operate and lock, thereby preparing device 504 for subsequently transmitting charging pulses in accordance with the zone information recorded in the decoder marker.

As previously stated, each of the one hundred district trunks of a district frame connects to one vertical row of contacts of one of the five connecting switches, such as switches 400 and 401. A hold magnet such as magnets 402 to 405 inclusive, of switch 400 and magnets 410 and 413 inclusive, of switch 401 is associated with each vertical row of contacts of each switch, there being twenty such hold magnets per switch. Following the aforementioned operation of the end relay (not shown) which operates in series with test relay 427, a circuit is completed for operating hold magnet 405 of switch 400, it being assumed that magnet 405 is associated with that vertical row of contacts in the right half of switch 400 to which district trunk 215 is connected. The operating circuit for magnet 405 will subsequently be described under the detailed operation of the invention. Select magnet 409 having previously operated together with the corresponding select magnets of the four other connecting switches, the operation of hold magnet 405 causes cross-point contacts 442 of switch 400 to close and thereby establish connection between the selected zone and timing device 504 and the district trunk circuit 215.

After operating the zone clutch magnet 512 of device 504 and checking that this magnet has properly locked, the decoder marker proceeds to extend the connection. Select magnet 204 of the primary district switch 200 is operated under control of district trunk 215. Hold magnet 235 of switch 230 as well as select magnet 206 and hold magnet 207 of the secondary district switch are operated by the decoder marker thereby causing the closure of cross-points 208 of switch 200 and cross-points 212 of switch 202. The connection is thus extended from district trunk 215, over district link 209, and over conductor 219 to an office frame (not shown). The connection is further extended over the office frame switches and an outgoing trunk (not shown) under control of the decoder marker. The connection to the called subscriber's station is completed by the various circuits (not shown) at the distant exchange under control of the subscriber's register-sender 308. For a description of these circuits which have not been shown, as well as the manner of their operation in completing the connection, reference may be had to the aforementioned copending application of Carpenter, Serial No. 27,305, filed June 19, 1935.

When the called subscriber answers the call, the district trunk circuit 215 functions in a manner which will subsequently be described and energizes the master clutch (not shown) of the device 504. The device 504 thereupon functions and transmits the proper charge pulses, under control of cam 518 which is associated with the operated zone clutch magnet 512, over the district trunk circuit, and back to the message register 102 of the calling station line 101.

The decoder marker circuit, after it has transmitted the necessary zone information to the zone and timing device 504, removes the ground from the armature of relay 210 of the district frame, thereby releasing relay 424. The release

of relay 424 releases relay 510 and the select magnets 409, 417 etc., of the five connecting switches. Hold magnet 405 remains locked under control of the district trunk circuit until the termination of the connection between the subscribers after which the district trunk releases the hold magnet, thereby restoring the connecting switch cross-points 442 to normal.

Referring now to Figs. 6 to 10 inclusive, a detailed description of the operation of this system will be given. Assuming that the subscriber at dial station 600 initiates a call, the closure of the loop of line 601 due to the removal of the receiver from the switchhook at station 600 causes line relay 606 to operate in a circuit extending over the back contacts of cut-off relay 605. The operation of relay 606 closes in part the operating circuit for hold magnet 607, this magnet being associated with that vertical row of primary line switch contacts to which the calling line 601 is connected, and also grounds conductor 614 which extends to the associated line switch control circuit (not shown). The line switch control circuit and the sender selector control circuit (not shown) now function and extend the calling line to an idle district trunk circuit and to an idle subscribers' register-sender. For a detailed description of the circuits involved in the establishment of these connections between the calling line and the district trunk and subscribers' sender, reference may be had to the copending application of W. W. Carpenter, Serial No. 27,305, filed June 19, 1935.

For the purposes of this description it will be assumed that the district trunk 648 and the indicated subscribers' register-sender 807 are selected for use on the call under discussion by the aforementioned operations of the line switch and sender selector control circuits, these control circuits thereupon completing operating circuits for select magnet 608 and hold magnet 607 of the primary line switch, select magnet 611 and hold magnet 610 of the secondary line switch, select magnet 803 and hold magnet 802 of the primary sender selector switch, and select magnet 805 and hold magnet 804 of the secondary sender selector switch. The operation of select magnet 608 and hold magnet 607 causes cross-points 603 of the primary line switch to operate, while the operation of select magnet 611 and hold magnet 610 operates the secondary line switch cross-points 604. The calling line 601 is thereby extended, over cross-points 603, line link 613, and cross-points 604, to district trunk 615 and also over conductors 617, 618 and 619, to the primary district frame switch upon which cross-points 700 appear. The operation of select magnet 803 and hold magnet 802 of the primary sender selector switch closes cross-points 800 of that switch, while the operation of select magnet 805 and hold magnet 804 closes cross-points 801 of the secondary sender selector switch. The calling line 601 and the district trunk circuit 648 are therefore also extended, over primary sender selector switch cross-points 800, sender link 806, and over the secondary sender selector switch cross-points 801 to the subscribers' register-sender 807, this sender thereupon returning an audible indication to the calling station that dialing may proceed.

The designation of the wanted station, as dialed by the calling subscriber, is recorded on the register mechanism of the sender 807 which, after it has recorded a portion of the number, associates itself with an idle decoder marker 810 over

which the zone call is being extended is not in its normal position, thus eliminating the possibility of a double charge in the event that the local timing device of the district trunk is functioning, due to a trouble condition, at the time that the district trunk is being used for a zone call.

Holding cam 627 functions shortly after shaft 637 starts rotating and closes its associated contacts 642 thereby locking the clutch magnet 624 for the duration of the timing interval regardless of any momentary releases of supervisory relay 625 due to switch-hook flashing at the called station. This locking circuit for magnet 624 is traceable from battery through the magnet and over its front contact, over contacts 642 of hold cam 627, over the right inner front relay 622, to an off-normal ground supplied over the front contact of relay 623. As shaft 637 continues to rotate, the charging cam 626 actuates its associated contacts 643 for a brief interval and then restores these contacts to their normal position. During this charging interval the opening of the lower contact of springs 643 removes the ground from conductor 640 while the closure of the upper contact of these springs connects battery through resistance 638 to conductor 640 and over a previously traced circuit to the winding of message register 602 thereby causing the register to operate and record one local call. Upon the restoring of springs 643 ground is once more connected to conductor 640 thus again placing a short circuit around the winding of message register 602. Shaft 637 and its attached cams 626, 627 and 628 make one complete revolution for each time charge interval and continue to rotate as long as the subscribers remain in communication. Although hold cam 627 causes its associated contacts 642 to open the locking circuit for clutch magnet 624 at the completion of each revolution of shaft 637, the clutch magnet remains energized during the open interval of contacts 642, over its original operating circuit to the ground over the front contact of the calling supervisory relay 625 as long as the subscribers remain in communication. The functioning of charging cam 626 and its associated contacts 643 cause one pulse of battery to be connected over conductor 640 to the message register 602 for each overtime charge interval thereby causing that register to record the additional charge.

Whenever the calling subscriber places his receiver back on the switch-hook, relay 623 of the district trunk circuit releases, in turn releasing relay 622 which opens the operating and locking circuits for clutch magnet 624. The timing device 616 is so constructed that the release of magnet 624 causes the shafts 634 and 637 and their attached cams to immediately restore to normal regardless of the position of these shafts and cams at the time that magnet 624 is de-energized. This immediate restoring is accomplished mechanically by means of a spring (not shown) which winds up during the initial revolution of shaft 634. The purpose of restoring the timing device to normal at once is to enable the district trunk circuit with which the device is associated to be immediately available for use in connection with another call. When clutch magnet 624 deenergizes, armature 631 is restored to its original position by spring 639 and engages the clutch cam 632 thereby preventing any further motion of shafts 634 and 637 and thus restoring the timing device 616 to normal.

In the event that the calling subscriber remains connected to the district trunk circuit after the

called subscriber has replaced his receiver, clutch magnet 624 remains energized over its locking circuit until cam 627 opens contacts 642 at the completion of the particular timing interval being measured. Upon the opening of contacts 642 clutch magnet 624 deenergizes, since its original energizing circuit is open due to the previous release of the called station supervisory relay 625, and the timing device thereupon restores to normal mechanically as set forth above. Should the called subscriber again remove his receiver from the switch-hook at this time the subsequent operation of relay 625 closes the energizing circuit for clutch magnet 624 and the charging and timing for the next interval will immediately begin.

When the district trunk circuit relay 623 releases upon the replacing of the calling subscriber's receiver on the switch-hook, ground is removed from the holding conductor 619 thereby releasing the operated hold magnets 607, 610, 704 and 706 of the line and district frame switches thus causing cross-point contacts 603, 604, 700 and 701 of these switches to restore to normal. The select magnets associated with the horizontal rows of contacts containing these cross-points, as well as the sender selector switch select magnets 803 and 805 and hold magnets 802 and 804, previously released at the time that the line switch and sender selector control circuits restored to normal.

The charging and timing operations involved in recording a local area call on the calling subscriber's message register having been described, it will now be assumed that the call initiated by the calling station 600 is to a station served by an exchange located outside of the local call area. The connections between the calling subscriber's line 601, district trunk 648, sender 807 and decoder marker 810, as well as the connections between decoder marker 810 and the district trunk and district frame over the district frame connector relay 812, are established in the manner identical with that hereinbefore described in connection with the local area call. The decoder marker 810, knowing from the office code information transmitted to it by the sender that this is a zone call, operates one of its zone relays, such as relays 819 and 820, the particular zone relay operating being dependent upon the zone in which the called station exchange is located. It will be assumed for the call being described that decoder marker zone relay 819 operates.

Following the establishment of connections between the district trunk and the decoder marker, district trunk relay 621 operates in a previously traced circuit extending over the sender selector switches and the sender to a ground over the front contact of the operated decoder marker relay 811. Relay 621, in operating, closes in part the operating circuit for hold magnet 906 of the zone and timing device connecting switch 901, this hold magnet 906 being associated with that vertical row of contacts of switch 901 to which district trunk 648 connects. This operating circuit is traceable from battery through the winding of magnet 906, over conductor 907, left outer front contact of relay 621, conductor 908, to the front contact of relay 909 which is unoperated at this time. Relay 621 also closes a circuit from ground over its right outer front contact and over conductor 645 to battery through the winding of district frame relay 708 which is common to that group of ten district trunk circuits,

including trunk 648, which extend to the same primary district frame switch and which also connects to the ten vertical rows of contacts in the left half of zone and timing device connecting switch 901 of Fig. 9. Relay 708 operates and completes the operating circuit for group relay 902 of the timer connecting switch. This operating circuit is traceable from ground over the right front contact of the operated zone relay 819, a front contact of connector relay 812, conductor 817, front contact of relay 708, conductor 813, to battery through the winding of relay 902. Relays 709, 710 and 711 are other district frame relays, similar to relay 708, associated with other groups of ten district trunks. The front contacts of relays 709, 710 and 711 extend over conductors 814, 827 and 828 to the windings of zone and timing device connecting switch group relays 903, 904 and 905 respectively. Group relays 903, 904 and 905 perform functions, in connection with the district trunk groups with which they are associated, identical with those performed by relay 902 as herein-after described.

The operation of relay 902 closes circuits from the test conductors of the ten zone and timing devices accessible to the ten district trunks connected to the left half of connecting switch 901 to the windings of ten test relays of which four, relays 910 to 913 inclusive, are shown. As hereinbefore stated in the general description, an idle zone and timing device has battery connected to its test conductor and therefore operates its associated test relay. Assuming that the zone and timing device 1000, partly shown in the upper portion of Fig. 10, is idle at this time, test relay 913 operates in a circuit traceable from ground over the back contact of relay 914, lower winding of relay 913, lower inner front contact of group relay 902, conductor 915, over the back contact of zone clutch magnet 1001, conductor 1002, over the back contacts of three other zone clutch magnets (not shown), and over the back contact of zone clutch magnet 1003, to battery through resistance 1004. The ground over the back contact of relay 914 also extends through the lower windings of the other test relays, such as relays 910, 911 and 912, over other lower front contacts of relay 902, to test conductors 916, 917 and 918 respectively, which extend to other zone and timing devices (not shown). Any test relay having an idle timing device connected to its winding will therefore operate. For the purpose of this description it will be assumed that only the device 1000 is idle. Upon the operation of group relay 902 therefore, test relay 913 alone operates. Relay 913, in operating, locks in a circuit from the battery previously traced to conductor 915, through its upper winding and over its inner front contact, inner back contacts of the unoperated test relays 912, 911 and 910, in that order, and over the lower next-to-outer contact of relay 902 to ground through the winding of end relay 914. Relay 914 operates in series with the upper winding of relay 913 and removes ground from the lower windings of all of the test relays thereby causing the release of all operated test relays, with the exception of the test relay which is locked in series with end relay 914, in those cases where more than one test relay operates.

It will be noted that the locking circuit for each test relay extends over its inner front contact to the winding of end relay 914 either directly over a front contact of the group relay

shown directly above that test relay or over a chain circuit extending over the inner back contacts of the other test relays and the front contact of whichever group relay is operated. This arrangement provides a preference in the selection of a zone and timing device if more than one device is idle, a particular group relay always preferring a particular timing device, if available. Each group relay connects the inner armature of a different test relay directly to the winding of end relay 914 thereby providing a direct locking circuit for that test relay in the event that it operates due to its associated device being idle. In this manner each group prefers the zone and timing devices in a different order thereby distributing the use of these devices evenly.

When end relay 914 operates in series with test relay 913 as hereinbefore described, it energizes slow-to-operate relay 909 and also closes a circuit from ground over its front contact, lower outer front contact of relay 902, outer back contacts of relays 910, 911 and 912, outer front contact of relay 913, front contact 919 of relay 902, to battery through the winding of select magnet 920 of connecting switch 901. This same ground also extends over conductor 921 to battery through the winding of cut-through relay 1006 which is associated with the zone and timing device 1000. Relays 1005 and 1007 to 1010 inclusive represent cut-through relays associated with other zone and timing devices (not shown). Select magnet 920 of switch 901 operates and prepares the upper row of cross-point contacts of that switch for operation. Slow-to-operate relay 909 now operates and closes a circuit from ground over its front contact, over conductor 908, left outer front contact of district trunk relay 621, conductor 907, to battery through the winding of hold magnet 906 of switch 901. Magnet 906 operates and, since select magnet 920 is already operated, closes cross-point contacts 922 of switch 901 thereby connecting district trunk 615 to zone and timing device 1000 over conductors 641 and 647 and 1011 and 1012 respectively.

At the time that select magnet 920 of switch 901 operates, the select magnets of the corresponding levels of the other connecting switches, such as magnet 924 of switch 900, also operate, the windings of these magnets being multiplied together. Since only hold magnet 906 of switch 901 operates at this time, the cross-point contacts of the other connecting switches do not operate. Relay 909 is made slow-to-operate to provide sufficient time for the connecting switch select magnets, such as magnets 920 and 924, to operate before the hold magnet circuit is closed thereby insuring the proper operation of the connecting switch cross-points. As indicated by multiple strap 946 at the left outer front contact of district trunk relay 621, conductor 908 from the front contact of relay 909 connects to the left outer front contact of each of the one hundred district trunk relays identical to relay 621. Only one zone and timing device connecting switch hold magnet operates at a time however since only one relay, such as relay 621, of the one hundred district trunks of a district frame is operated at any particular time.

Upon the operation of cross-points 922 ground is connected, over the lowest contact set of those cross-points, to conductor 915 thereby short-circuiting test relay 913 and end relay 914 both of which release. The release of relay 914 re-

leases relay 909 which in turn opens the previously traced operating circuit for hold magnet 906. Magnet 906 remains locked in a circuit from battery through its winding and over its front contact, conductor 923, to ground over the front contact of the operated relay 623 of the district trunk circuit. The release of relay 914 opens the original operating circuit for cut-through relay 1006 and select magnet 920, this relay and select magnet now remaining locked over the upper inner front contact of relay 1006, conductor 1025, upper front contact of the operated group relay 902, to the previously traced operating ground for relay 902 over conductor 813.

Each zone and timing device, such as the device 1000 of Fig. 10, is provided with a plurality of zone clutch magnets and one master clutch magnet. It is assumed that device 1000 is arranged to transmit five different sets of zone charge pulses and the device is therefore provided with five zone clutch magnets two of which, magnets 1001 and 1003, are shown. Magnet 1014 is the master clutch magnet for the device 1000. The aforementioned operation of cut-through relay 1006 closes circuits from each of the five zone clutch magnet windings to the left armatures of the decoder marker zone relays 819, 820. The circuit for zone clutch magnet 1001 may be traced from battery through the winding of that magnet, over the lower next-to-outer front contact of relay 1006, conductor 1015, a front contact of connector relay 812, and over the left front contact of the operated zone relay 819 to the windings of polarized relay 821. As hereinbefore described in connection with the charging of a local area call, relay 821 is normally energized in a circuit from battery through its windings in series to ground through resistance 822, the left winding of the relay exerting a greater force than the right winding and thereby holding the relay in its unoperated position. If the circuit extending from the winding of zone clutch magnet 1001 to the windings of relay 821 is complete and not falsely grounded, the battery through that magnet shunts the left winding of relay 821 and that relay thereupon operates under control of the force exerted by its right winding. Zone clutch magnet 1001 does not operate at this time due to the current limiting effect of resistance 822 which is in series with the right winding of relay 821 and the clutch magnet. The operation of relay 821 operates relay 823 locally. Relay 823 locks under control of another decoder marker relay (not shown) and connects direct ground to the right winding of relay 821 thereby short-circuiting resistance 822 and allowing zone clutch magnet 1001 to receive sufficient current to operate.

In operating, zone clutch magnet 1001 locks over its front contact and over conductor 915 to ground over the lowest contact of the operated cross-point 922 of switch 901. The closure of this locking circuit connects direct ground to conductor 1015 thereby short-circuiting the right winding of relay 821 which thereupon releases due to the force exerted by its left winding. Relay 821, in releasing, closes a circuit from ground over its back contact, over the left outer front contact of relay 823, back contact of relay 824 and over conductor 825 to a relay (not shown) of the decoder marker which operates and records the fact that the zone clutch magnet of the timing device has properly locked. Conductors 1016 to 1019 inclusive, which extend from the windings of the four other zone clutch mag-

nets of device 1000 over front contacts of relay 1006 to the left armatures of the unoperated decoder marker zone relays such as relay 820, connect over the left back contacts of these zone relays to battery through the winding of a trouble detecting relay 824. Should a false ground be present on any of the unused zone clutch magnet conductors the trouble detecting relay 824 will operate. If operating, relay 824 opens the circuit over conductor 825 thereby preventing the decoder marker from proceeding any further in the extension of the connection. The operation of relay 824 also connects ground to conductor 829 which causes the decoder marker to function and record a trouble condition.

At the time that cut-through relay 1006 operates and establishes connections between the zone and timing device 1000 and the decoder marker 812 it also completes a testing circuit for checking that the district trunk circuit 615 is connected through to but one zone and timing device, i. e., the device 1000. This testing circuit extends from battery through the winding of relay 1020, over the upper outer front contact of relay 1006, conductor 1013, to the armature of contact set 925 of cross-points 922. Since cross-points 922 are operated this battery through the winding of relay 1020 is further extended to the front contacts of contact sets 929, 930 and 931 of cross-points 926, 927, and 928, respectively. The armatures of contact sets 929, 930, and 931 extend, over conductors 932, 933, and 934, to the upper outer armatures of cut-through relays 1005, 1007, and 1008, respectively, and, since these relays are unoperated at this time, ground over their back contacts is connected to the armatures of cross-point contact sets 929, 930, and 931. In the event that a second set of cross-points in the same vertical row with cross-points 922 is falsely operated at this time, relay 1020 operates over conductor 1013, cross-point 925, the cross-point 929, 930, or 931 of the falsely operated set, to ground over conductor 932, 933, or 934 as the case may be. The operation of relay 1020 lights an associated lamp 1021 as an indication of the double-connection encountered and also operates alarm relay 1022 in a circuit from battery through the winding of that relay, back contact of key 1023, to ground over its right front contact. The operation of relay 1022 grounds conductor 1024 which causes an audible alarm (not shown) to sound; connects a ground over its middle front contact, over conductor 1025, to the upper front contact of group relay 902 to lock that relay; and completes a circuit from ground over its outer front contact, conductor 1026, a front contact of relay 812, to conductor 830 of the decoder marker 810 for the purpose of informing the decoder marker that a trouble condition has been encountered during the selection of a zone and timing device.

If, at the time that cut-through relay 1006 operates, the master clutch magnet 1014 of device 1000 is prematurely operated due to a trouble condition, trouble detecting relay 1027 operates in a circuit from battery through its winding, over the lower outer front contact of relay 1006, to ground over the front contact of magnet 1014. The operation of relay 1027 lights an associated alarm lamp 1028 and also operates alarm relay 1022 over the back contact of key 1023. Alarm relay 1022 functions as previously set forth, causing an audible alarm (not shown) to sound, locking group relay 902 operated, and grounding conductor 830 of the decoder marker to inform that

circuit of the trouble encountered. While a trouble condition is being cleared the locking type key 1023 may be operated to release the alarm relay and thereby silence the audible alarm. An associated lamp 1029 lights whenever key 1023 is in the operated position.

After the decoder marker 810 has recorded the fact that the zone clutch magnet 1001 has properly operated and locked, as indicated by the release of its relay 821, and, assuming that none of the other trouble conditions set forth above have been encountered, the decoder marker releases its operated zone relay 819 and proceeds with its functions. The connection to the called station 707 is established in the same manner as previously described in connection with the local area call. The release of relay 819 removes the ground from conductor 816, the armature of relay 708, and conductor 813, thereby releasing group relay 902, cut-through relay 1006 and select magnet 920. The release of relay 1006 opens the circuits from the windings of the zone clutch magnets of device 1000 to the decoder marker 810 and also opens the circuit to the winding of trouble detecting relay 1027 thereby restoring the control and testing equipment associated with the zone and timing devices and with the connecting switches to normal.

At the time that zone clutch magnet 1001 operates and locks as hereinbefore set forth, it disengages its upper armature from the initial charge clutch release cam 1041 and also, due to the movement of its lower inner armature, causes latch 1044 to move upward into a position such that this latch will engage the tooth of cam 1043 after this latter cam has completed one revolution. By these aforementioned operations those portions of the zone and timing device 1000 which are associated with the zone clutch magnet 1001 are prepared for functioning upon the subsequent operation of the master clutch magnet 1014.

When the call is answered by the subscriber at station 707, the called party supervisory relay 625 of the district trunk circuit operates and completes a circuit from ground over its front contact, over the left inner front contact of relay 622, contacts 644 of the local timing device 616 providing that this local timing device is normal, over conductor 641, contacts 935 of the operated connecting switch cross-points 922, conductor 1012, to battery through the winding of start relay 1030. Relay 1030 operates and closes an obvious circuit for energizing the master clutch magnet 1014 which disengages its upper armature from the master clutch release cam 1031. Synchronous motor 1032 and its attached shaft 1033 are running continuously and, upon the release of cam 1031 by the operation of magnet 1014, the motion of shaft 1033 is imparted to shaft 1034 through the action of the master clutch 1037. This motion is further imparted through the reduction gears 1035 and 1036 to shaft 1038. The motion of shaft 1038 is imparted to shaft 1042 through the action of clutch 1045, shaft 1042 being free to move since the operation of zone clutch magnet 1001 caused the freeing of release cam 1041 as previously stated.

As soon as shaft 1038 starts to rotate, holding cam 1039 functions and closes its associated contacts thereby completing a locking circuit for the master clutch magnet 1014. This locking circuit is traceable from battery through the winding of magnet 1014, over the contacts associated with cam 1039, conductor 915, to ground

over the lowest set of contacts of the operated cross-points 922 of switch 901. Immediately after shaft 1042 starts to rotate, the teeth of cam 1046 actuate the initial charge contacts 1047 which connect pulses of battery, supplied through resistance 1048, to conductor 1011. These battery pulses extend over the upper set of contacts of cross-points 922, conductor 647, left outer back contact of relay 622, to conductor 640, which extends over a previously traced circuit to the winding of the subscriber's message register 602. Since cam 1046 is provided with four teeth, register 602 therefore operates four times and thereby records the initial charge for the zone call being made. Cam 1057, which is associated with the zone clutch magnet 1003, represents the initial charge cam for some other zone and is provided with five teeth, as shown.

As shaft 1042 completes its revolution at the end of the initial conversation period, the tooth of cam 1043 engages the latch 1044 and forces that latch and the associated rod 1049 to the left until the motion of rod 1049 is stopped by the pin 1056. Since latch 1044 cannot move any further to the left it stops the motion of cam 1043 and also of shaft 1042 and cams 1041 and 1046. The movement of rod 1049 to the left causes latch 1050 to disengage from the tooth of the overtime charge release cam 1051. Shaft 1052 now rotates in unison with shaft 1038, the coupling between these shafts being supplied by clutch 1053. Immediately after shaft 1052 starts rotating the overtime charge cam 1054 actuates the overtime charge contacts 1058, the two teeth of cam 1054 causing two pulses of battery, supplied through resistance 1055, to be transmitted to the winding of the subscriber's message register 602 over a previously traced circuit. Register 602 operates twice and thereby records the charge for the first overtime period. Shaft 1052 and its attached cams 1051 and 1054 make one complete revolution for each overtime conversation period and continue to rotate as long as the subscribers remain in communication with each other. Immediately after the start of each additional overtime period cam 1054 and springs 1058 function and transmit charging pulses for that overtime period in the same manner as has already been described for the initial overtime period. Although hold cam 1039 causes its associated contacts to open the locking circuit for the master clutch magnet 1014 at the completion of each revolution of shaft 1038, the master clutch magnet remains energized during the open interval of the hold cam contacts over its original operating circuit as long as the called subscriber remains connected and relays 625 and 1030 remain operated.

When the calling subscriber replaces his receiver on the switch-hook, relay 623 of the district trunk circuit releases and removes the ground from conductors 619 and 923. The removal of ground from conductor 619 releases hold magnets 607, 610, 704 and 706 of the line and district frame switches thereby restoring cross-points 603, 604, 700 and 701 of these switches to normal. The removal of ground from conductor 923 opens the locking circuit for hold magnet 906 of switch 901. Hold magnet 906 releases and restores cross-points 922 to normal. The restoring of cross-points 922 opens the operating circuit for relay 1030 which now releases if it has not already done so due to the called subscriber disconnecting before the calling subscriber. The release of relay 1030 opens the orig-

inal operating circuit for the master clutch magnet 1014. The restoring of cross-points 922 also removes ground from conductor 915 thereby opening the locking circuits for master clutch magnet 1014 and zone clutch magnet 1001 both of which release. The zone and timing device 1000 is so constructed that the release of magnets 1001 and 1014 causes shafts 1034, 1038, 1042 and 1052 and the cams attached to these shafts to restore to their normal positions immediately regardless of the positions of these shafts at the time that the magnets release. This immediate restoring is accomplished mechanically by means of springs (not shown) which wind up during the revolution of the shafts. By restoring the device immediately it is at once made available for use on another connection.

When master clutch magnet 1014 deenergizes, its upper armature is restored to its original position by spring 1059 and engages cam 1031 thereby preventing any further motion of shaft 1034. When zone clutch magnet 1001 deenergizes, spring 1040 causes the upper armature of the magnet to assume its original position and engage cam 1041 thereby locking shaft 1042. Spring 1060 causes latch 1044 to restore to its original position while spring 1061 allows the rod 1049 to move to its original position and again cause latch 1050 to engage cam 1051 thereby locking shaft 1052 and thus restoring zone and timing device 1000 to normal. The release of zone clutch magnet 1001 again closes, over its back contact, the chain circuit extending from battery through resistance 1004, over the back contacts of all of the zone clutch magnets of device 1000, to test conductor 915 thereby again indicating that this device is idle and may be selected for use in connection with another zone call.

For a detailed description of the structure of a zone and time charging mechanism of a type suitable in general for use in the present system, reference is made to the application of E. D. Mead, Serial No. 68,073, filed March 10, 1936.

What is claimed is:

1. In combination, a plurality of conversational circuits, means for extending calls over said circuits to different destinations, variably-operable message registers for registering the charges for said calls, a digit-recording mechanism for recording the designation of the call, a plurality of control devices common to said conversational circuits, means for connecting one of said devices to the particular one of said circuits over which a call is being extended, means controlled by said digit-recording mechanism for setting up in the connected device information as to the destination of the call, and means in the connected device for operating one of said registers in accordance with the destination of the call.

2. In combination, a plurality of trunks to which calls are extended, selective switches for extending said calls to different zones, variably-operable message registers for registering the charges for said calls, digit-recording mechanism for controlling said switches, a plurality of operating devices for variably operating said message registers, means for connecting one of said message register operating devices to the particular one of said trunk circuits over which a call is being extended, means to connect said message register operating device to said digit-recording mechanism, and means controlled by said recording mechanism to establish in said message register operating device a record of the zone to which the call is being extended.

3. In a telephone system, a trunk circuit, means for extending a call to said trunk circuit, a message register for registering the charge for said call, automatic switches for extending the call, a digit-recording mechanism for controlling the selective operation of said switches, a number of message register operating devices, means for associating any idle one of said devices with said trunk circuit for the purpose of variably operating said message register in accordance with the destination of the call, means for connecting the associated operating device to said digit-recording mechanism independently of said trunk circuit, and means for transferring from the digit-recording mechanism to the connected operating device a record of the destination of the call.

4. In a telephone system, a group of trunks, means for extending a call to any particular one of said trunks, a message register for assessing the charges for said call, selective switches for further extending the call, a plurality of markers, means for connecting the calling trunk to an idle one of said markers, means for establishing in said marker the wanted designation, means for associating the marker with the switches serving to extend the calling trunk, a number of message register operating devices common to said trunks, means to connect an idle one of said devices to the calling trunk, means to connect such idle device to the selected marker, means under the control of the marker for establishing in the connected register operating device a record of the destination of the call, and means in said device for periodically operating said message register in accordance with the destination of the call.

5. In combination, a plurality of trunks, means for extending calls over said trunks to different destinations, message registers for charging for said calls, a plurality of control devices common to said trunks, a plurality of switches for selectively connecting said devices to calling trunks, a digit-recording mechanism for recording the designation of a call, means for operating one of said switches to connect a selected one of said devices to a calling trunk, means for connecting the selected device to said digit-recording mechanism, and means in the connected device for operating one of said message registers in accordance with the destination of the call.

6. In combination, a plurality of trunks, means for extending calls over said trunks to different destinations, variably-operable message registers for registering the charges for said calls, a plurality of control devices common to said trunks, mechanism common to said control devices for testing and selecting an idle one for use, and means for connecting a selected idle control device to a calling trunk for the purpose of operating one of said message registers in accordance with the destination of the call.

7. In a telephone system, a plurality of trunks, means to extend calls over said trunks to different zones, message registers for charging for said calls, a plurality of control devices common to said trunks, a plurality of switches for selectively connecting said devices to calling trunks, a digit-recording mechanism for recording the designation of a call, a testing mechanism common to said control devices for selecting an idle one for use, means controlled by said testing mechanism for operating one of said switches to connect the selected idle device to a calling trunk, means controlled by said common testing

mechanism for connecting the selected idle device to said digit-recording mechanism, and means in the selected idle device for operating one of said message registers in accordance with
5 the destination of the call.

8. In combination, a plurality of trunks arranged in groups, means for extending calls over said trunks, message registers for registering the charges for said calls, a plurality of register-
10 operating devices for operating said message registers, said devices being arranged in groups, and means for connecting said groups of devices respectively to the trunks of different groups of trunks.

9. In combination, a plurality of trunks arranged in groups, means for extending calls over said trunks, message registers for registering the charges for said calls, a number of groups of register-operating devices, certain of said groups
5 of devices serving respectively different groups of trunks, one of said groups of devices serving all groups of trunks, switches for connecting said devices to calling trunks, and means in said
10 devices for variably operating said message registers.

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